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BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PROGRAM QUARTERLY
MONITORING REPORT JULY 1997 EVENT NAS FORT WORTH TX
1/1/1998
HYDROGEOLOGIC



**NAVAL AIR STATION
FORT WORTH JRB
CARSWELL FIELD
TEXAS**

**ADMINISTRATIVE RECORD
COVER SHEET**

AR File Number 407



HQ Air Force Center for Environmental Excellence

Final
Basewide Groundwater Sampling and Analysis Program
Quarterly Monitoring Report
July 1997 Event

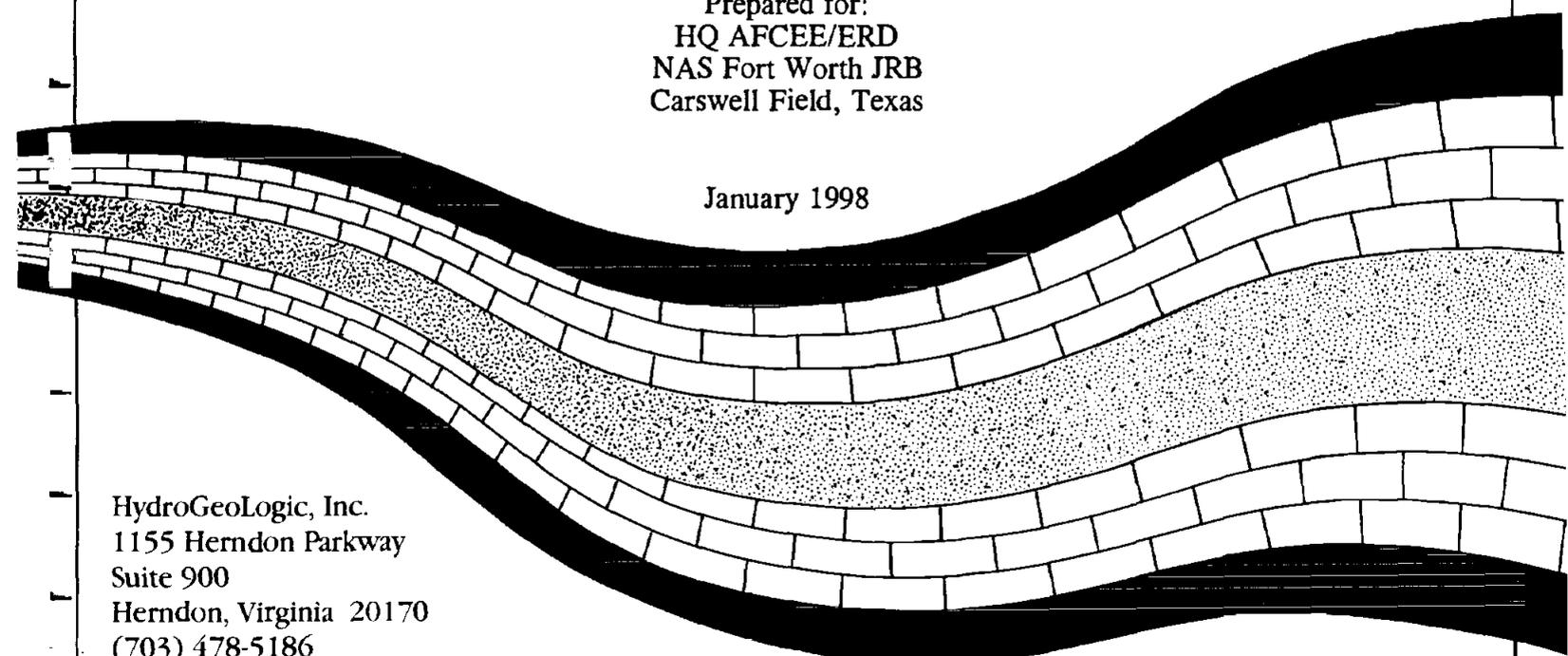
Contract No.: F41624-95-D-8005-0007



Prepared for:
HQ AFCEE/ERD
NAS Fort Worth JRB
Carswell Field, Texas

January 1998

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HQ Air Force Center for Environmental Excellence

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Basewide Groundwater Sampling and Analysis Program
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REPORT DOCUMENTATION PAGE

Form Approved
QMB No. 0704-0188

Public reporting for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1024, Arlington, VA 22202-1302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY <i>(Leave blank)</i>		2. REPORT DATE January 1998	3. REPORT TYPE AND DATES COVERED Final Basewide Groundwater Sampling Report - July 1997	
4. TITLE AND SUBTITLE Final Basewide Groundwater Sampling and Analysis Program Quarterly Monitoring Report - July 1997 Event NAS Fort Worth, Carswell Field, Texas			4. FUNDING NUMBERS C-F41624-95-D-8005-0007	
6. AUTHOR(S) HydroGeoLogic, Inc				
7. PERFORMANCE ORGANIZATION NAME(S) AND ADDRESS(S) HydroGeoLogic, Inc. 1155 Herndon Parkway, Suite 900 Herndon, VA 20170			8. PERFORMANCE ORGANIZATION REPORT NUMBER N/A	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(S) AFCEE/ERD 3207 North Road Brooks AFB, TX 78235-5328			10. SPONSORING/MONITORING AGENCY REPORT NUMBER CDRL No.: A003A A004A Project 72435	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for Public Release Distribution is Unlimited			12b. DISTRIBUTION CODE	
13. ABSTRACT <small>(Maximum 200 words)</small> This document presents the Final Basewide Groundwater Sampling and Analysis Program Quarterly Monitoring Report for the July 1997 quarterly monitoring event conducted at Naval Air Station Fort Worth JRB (NAS Fort Worth JRB), Carswell Field, Texas. The objectives of the basewide quarterly monitoring program are to 1) identify potential impacts to off-site receptors through perimeter monitoring, 2) delineate the contaminant source and the dissolved and non-aqueous phase plumes, and 3) establish a process for collecting data to support closure of solid waste management units (SWMUs) and areas of concern (AOCs) at the base. This report summarizes the results of field screening and analytical results of samples collected during the third quarter 1997 event and provides recommendations for the adjustments to the basewide program.				
14. SUBJECT TERMS			15. NUMBER OF PAGES	
17. SECURITY CLASSIFICATION OF REPORT			16. PRICE CODE	
18. SECURITY CLASSIFICATION OF THIS PAGE.	19. SECURITY CLASSIFICATION OF ABSTRACT.	20. LIMITATION OF ABSTRACT		

PREFACE

This Groundwater Sampling and Analysis Program Third Quarterly Groundwater Monitoring Report was prepared for the Air Force Center for Environmental Excellence (AFCEE) to describe the basewide quarterly groundwater monitoring event conducted at Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), Carswell Field, Texas during July 1997. The work has been conducted under Contract Number F41624-95-D-8005-0007, Delivery Order 07, issued to HydroGeoLogic, Inc., as described by the Statement of Work dated April 12, 1996. The AFCEE Contracting Officer's Representative (COR) is Joseph Dunkle. HydroGeoLogic's Program Manager is James Costello.

Activities described by the Quarterly Groundwater Monitoring Report were performed in accordance with CH2M HILL's draft Groundwater Sampling & Analysis Plan (CH2M HILL, 1996a), the draft Basewide Quality Assurance Project Plan (CH2M HILL 1996c), and AFCEE-approved modifications.

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LIST OF ACRONYMS AND ABBREVIATIONS

1,2-DCE	1,2-Dichloroethene
1,1,1-TCA	1,1,1-Trichloroethane
ACL	alternative concentration limits
AFB	Air Force Base
AFCEE	U.S. Air Force Center for Environmental Excellence
AFP-4	Air Force Plant 4
AOC	Area of Concern
ARARs	Applicable or Relevant and Appropriate Requirements
ASCII	American Standard Code for Information Interchange
B	data qualifier indicating analyte was detected in field or method blanks above PQL
BOD	biological oxygen demand
BTEX	benzene, toluene, ethylbenzene, and xylenes
CaCO ₃	total alkalinity
CAFB	Carswell Air Force Base
CCB	continuing calibration blank
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CH ₄	methane
cis-1,2,-DCE	cis-1,2,-Dichloroethene
CFR	Code of Federal Regulation
CLP	Contract Laboratory Program
cm/sec	centimeters per second
CoC	chain of custody
COC	contaminants of concern
COPC	chemical of potential concern
DCB	Dichlorobenzene
DCE	Dichloroethene
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DERA	Defense Environmental Restoration Account
DERP	Defense Environmental Restoration Program
DNAPL	dense non-aqueous phase liquids
DO	dissolved oxygen
DoD	Department of Defense
DPDO	Defense Property Disposal Office
DQE	data quality evaluation
DQO	data quality objectives
EC	electrical conductance
EDMS	Environmental Data Management System

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

Eh	oxidation-reduction potential
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ERD	Environmental Restoration Division
F	data qualifier indicating analyte was detected at concentration less than PQL but greater than MDL. Value may not be accurate or precise (estimated)
FAR	Federal Acquisition Regulation
°F	degrees Fahrenheit
FD	data qualifier indicating field duplicate RPD criteria was exceeded
Fe ²⁺	ferrous iron
FHS	fuel hydrant system
FSP	Field Sampling Plan
ft/d	feet per day
GC/MS	Gas Chromatograph / Mass Spectrometry
GFAA	graphite furnace atomic absorption
gpd/ft	gallons per day per foot
gpd/ft ²	gallons per day per square foot
GSAP	Groundwater Sampling and Analysis Plan
Handbook	IRPIMS Data Loading Handbook
HNO ₃	nitric acid
H ₂ SO ₄	sulfuric acid
HSP	Health and Safety Plan
ICB	initial calibration blank
ICP	inductively coupled plasma
IDW	investigative-derived waste
ILS	Instrument Landing System
Inc.	Incorporated
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
IS	Internal Standard
IT	International Technology Corporation
ITS	ITS Environmental, Inc.
J	Data qualifier indicating analyte is present but the reported value may not be accurate or precise (estimated)
JP-4	jet propulsion fuel (grade 4)
JRB	Joint Reserve Base
L	liter
LAN	Local area network

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

LAW	Law Engineering and Environmental Services, Incorporated
LCL	lower control unit
LCS	laboratory control sample
LNAPL	light non-aqueous phase liquid
LPST	Leaking Petroleum Storage Tank
LSI	Limited Site Investigation
LTO/LTM	Long-term operations/long-term monitoring
$\mu\text{g/L}$	micrograms per Liter
mg/Kg	milligrams per Kilogram
mg/L	milligrams per Liter
MB	method blank
MDL	method detection limit
MEK	methyl ethyl ketone
MQL	method quantitation limit
MS	matrix spike
MSA	method of standard addition
MSD	matrix spike duplicate
msl	mean sea level
NAPL	non-aqueous phase liquid
NAS	Naval Air Station
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
NH ₄ OH	ammonium hydrochloride
NPDES	National Pollutant Discharge Elimination System
ORP	oxidation-reduction potential
OVM	organic vapor meter
PAH	polycyclic aromatic hydrocarbons
PARCC	precision, accuracy, representativeness, completeness and comparability
PCE	Tetrachloroethene
PD-680	Petroleum naphtha
PE	performance evaluation
PID	photoionization detector
POL	petroleum, oil, and lubricants
PQL	practical quantitation limit
QA/QC	Quality Assurance/Quality Control
QAL	Quality Analytical Laboratory
QAPP	Quality Assurance Project Plan

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

R	data qualifier indicating analyte is rejected for use
R ²	five point correlation coefficient
RAP	Remedial Action Plan
RBCA	Risk-Based Corrective Action
RCRA	Resource Conservation and Recovery Act
RD/RA	Remedial Design/Remedial Action
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
RPD	relative percent difference
RRS	Risk Reduction Rule Standards
RSD	relative standard deviation
S	spike
SAP	Sampling and Analysis Plan
SARA	1986 Superfund Amendments and Reauthorization Act
SCS ITIR	<i>Site Characterization Summary Informal Technical Information Report</i>
SD	spike duplicate
SDG	sample delivery group
SI	Site Investigation
SO ₄	sulfate
SWMU	Solid Waste Management Unit
TAC	Texas Administrative Code
TCE	Trichloroethene
TDS	total dissolved solids
TNRCC	Texas Natural Resource Conservation Commission
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
U	data qualifier indicating analyte was not detected at the specified detection limit
UJ	data qualifier indicating analyte was not detected and the detection limit is estimated
US	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USGS	United States Geological Survey
UST	Underground Storage Tanks
UTL	Upper Tolerance Limit
VOC	volatile organic compound
WP	Work Plan
WSA	Weapons Storage Area

TAB

Section 1.0

1.0 INTRODUCTION

Groundwater monitoring at Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), Carswell Field, Texas has been performed to provide a basis for development and implementation of remedial actions under the Air Force Installation Restoration Program (IRP). This report summarizes the third of four scheduled quarterly sampling events for 1997, performed in accordance with the draft Groundwater Sampling and Analysis Plan (GSAP) (CH2M HILL, 1996a) and the draft Basewide Quality Assurance Project Plan (CH2M HILL, 1996c), to characterize the presence and extent of groundwater and potential surface water contamination.

1.1 MONITORING OBJECTIVES

Objectives of the basewide quarterly monitoring program are: 1) to identify potential impacts to off-site receptors through perimeter monitoring; 2) to delineate the potential contaminant sources and the dissolved and non-aqueous phase plumes; and 3) to establish a process for collecting data to support closure of solid waste management units (SWMUs) and areas of concern (AOCs) at the base. These objectives include both short- and long-term plans based on several assumptions described in the sections below.

1.1.1 Assumptions

The objectives of quarterly monitoring program, as originally outlined in the draft GSAP (CH2M HILL, 1996a), were based on the following assumptions:

- There is a potential for impacts to off-site groundwater, which could potentially be used by off-site residents as a drinking water source, and which could migrate and discharge to surface water bodies (e.g., Farmers Branch Creek and the West Fork of the Trinity River).
- There is no current exposure to on-site groundwater (i.e., groundwater is not currently used for drinking water or irrigation), and future chronic exposure to on-site groundwater is unlikely, although exposure during future intrusive activities could occur.
- Natural attenuation of contaminants is likely occurring in soil and groundwater.

1.1.2 Short-term Objective

The short-term objective for the current groundwater sampling and analysis program is to identify potential impacts to off-site groundwater receptors. Perimeter wells selected for the program include wells located near the NAS Fort Worth JRB boundaries and/or immediately upgradient of surface water bodies where groundwater may discharge to the surface water (CH2M HILL, 1997).

1.1.3 Long-term Objective

The long-term objective of the current groundwater sampling and analysis program is to establish a process for collecting data to support closure of SWMUs and AOCs and to identify and/or confirm potential impacts to off-site receptors (CH2M HILL, 1997).

The groundwater sampling and analysis program has been structured to provide information to support the following activities in light of the long-term objective:

- Long-term monitoring to collect data for regulatory compliance issues associated with closure of SWMUs/AOCs;
- Additional source and plume delineation to define horizontal or vertical migration of contamination associated with miscellaneous hot spots and potential source areas where data are not currently available;
- Non-aqueous phase liquid (NAPL) delineation to determine the presence and thickness of light non-aqueous phase liquids (LNAPL) and dense non-aqueous phase liquids (DNAPL);
- Off-site monitoring program to monitor off-base or potential off-base contamination (surface water and/or groundwater);
- Paluxy aquifer (i.e., municipal water supply aquifer) investigation to monitor/identify bedrock contamination potential and review boring logs to identify locations for additional bedrock wells;
- Modeling to demonstrate that natural attenuation of contaminants is occurring and to approximate the extent of attenuation expected at the perimeter of the facility, particularly in the East Area groundwater;
- Monitoring of contaminants of concern (COCs) for comparison to alternative concentration limits (ACLs) that could potentially be applied to on-base sites for closures; and
- Development of a process for identifying wells to be closed because they are no longer needed for source identification or long-term monitoring.

The components of the quarterly monitoring and analysis program that were designed to support the long-term objective were based on a review of existing data from previous investigations and an understanding of the current remediation plans for SWMUs and AOCs. These components may require modification to accommodate new data resulting from ongoing and future investigations/remedial actions at NAS Fort Worth JRB. If necessary, the draft GSAP will be amended to reflect modifications to the long-term objective (CH2M HILL, 1997).

1.2 BACKGROUND

An Installation Restoration Program (IRP) was initiated in 1984 to investigate disposal sites at what was then Carswell Air Force Base. The IRP is the Department of Defense's (DoD) primary mechanism for response actions on U.S. Air Force installations affected by the provisions of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended and augmented by the Superfund Amendments and Reauthorization Act (SARA). It is designed to assess past hazardous waste disposal and spill sites and to develop remedial actions consistent with the National Contingency Plan (NCP) for sites that pose a threat to human health and welfare or the environment (CH2M HILL, 1997).

The IRP program involves: 1) determination of Applicable or Relevant and Appropriate Requirements (ARARs); 2) identification and screening of technologies; and 3) development of alternatives. The IRP may include multiple field activities and pilot studies prior to a detailed final analysis of alternatives. The alternatives that are proposed, and solutions that are developed, must protect public health and the environment, meet ARARs, and be technically feasible to implement at the evaluated site (CH2M HILL, 1997).

1.3 SITE DESCRIPTION

NAS Fort Worth JRB is located on 2,555 acres of land in Tarrant County, Texas, eight miles west of downtown Fort Worth (Figure 1.1). It consists of the main base and two noncontiguous parcels, identified as the Instrument Landing System (ILS) marker beacon and the Weapons Storage Area (WSA). The main base comprises 2,264 acres and is bordered by Lake Worth to the north, the West Fork of the Trinity River, River Oaks, and Westworth Village to the east, urban areas of Fort Worth to the northeast and southeast, White Settlement to the west and southwest, and AF Plant 4 (AFP-4) to the west (Figure 1.2). The ILS marker beacon and the weapon storage area are located west of the city of White Settlement. The area surrounding NAS Fort Worth JRB is mostly suburban. Land use in the immediate vicinity of the base is industrial, commercial, residential, and recreational (A.T. Kearney, 1989). Further details regarding NAS Fort Worth JRB can be found in Work Plan, RCRA Facility Investigation of Landfills, NAS Fort Worth JRB, Texas (HydroGeoLogic, 1997).

For the purposes of this groundwater investigation, the site has been separated into three distinct groundwater management areas: 1) the Landfill Area; 2) the Flightline Area; and 3) the East Area (Figure 1.3). These geographic areas, established and referenced in the GSAP (CH2M HILL, 1996a), are associated with observed groundwater contamination plumes. Historical and current trends in groundwater monitoring results indicate the presence of the following contaminants in each geographical area:

- Landfill Area: Trichloroethene, Cis-1,2-Dichloroethene, Vinyl Chloride, and benzene, toluene, ethylbenzene and xylenes (BTEX)
- Flightline Area: Trichloroethene, Cis-1,2-Dichloroethene, Vinyl Chloride
- East Area: BTEX

This report presents the sampling and analysis results site-wide, as well as for each geographical area.

1.3.1 Sources of Contamination

The majority of waste liquids generated at NAS Fort Worth JRB are associated with the servicing and maintenance of aircraft engines and equipment, and can be categorized as waste oils, recoverable fuels, and spent solvents and cleaners. Most hazardous waste generated through these activities has been disposed of in landfills, reused on base, or processed through the Defense Property Disposal Office (DPDO) for off-base recycling or disposal (CH2M HILL, 1997). Several of these disposal sites (including landfills, fire training areas, oil/water separators, and spills at waste accumulation areas) have been investigated via the IRP, which was initiated in 1984 at what was then Carswell Air Force Base (AFB), and were later identified as SWMUs and AOCs.

Air Force Plant 4 (AFP4) is a government-owned, contractor-operated facility consisting of 602 acres adjacent to the northwest border of the NAS Fort Worth JRB. The manufacturing operations and associated processes at the plant have resulted in the generation of waste oils, waste fuels, paint residues, used solvents, and process chemicals. Contamination from the disposal of these wastes exists in the soil beneath the site, in the surface water, and in the groundwater. Characterization activities have been on-going at the plant since 1982. Several interim remedial actions have been taken to mitigate the effects of contamination at the plant until final remedies are determined. These include, a vacuum-enhanced extraction system, french drains, a soil-vapor extraction system, and a groundwater treatment system. Six areas within the plant are potential sources of contamination to the NAS Fort Worth JRB (USAF, 1996).

1.3.2 Hydrogeology of Groundwater

The geologic units of interest for the region, from youngest to oldest, are as follows: 1) the Quaternary Terrace Alluvium (including fill material and terrace deposits); 2) the Cretaceous Goodland Limestone; 3) the Cretaceous Walnut Formation; 4) the Cretaceous Paluxy Formation; 5) the Cretaceous Glen Rose Formation; and 6) the Cretaceous Twin Mountains Formation. A generalized cross section of the geology beneath NAS Fort Worth JRB is presented in Figure 1.4 (Radian, 1989). The areal limits of surface exposure of these units at NAS Fort Worth JRB are shown in Figure 1.5. The regional dip of these stratigraphic units beneath NAS Fort Worth JRB is between 35 to 40 feet per mile in an easterly to southeasterly direction. NAS Fort Worth JRB is located on the relatively stable Texas Craton, west of the faults that lie along the Ouachita Structural Belt. No major faults or fracture zones have been mapped near the Base.

The water-bearing geologic formations located in the NAS Fort Worth JRB area may be divided into the following five hydrogeologic units, listed from the shallowest to the deepest:

- an upper perched-water zone occurring in the alluvial terrace deposits associated with the Trinity River;
- an aquitard of predominantly dry limestone of the Goodland and Walnut Formations;

- an aquifer in the Paluxy Formation;
- an aquitard of relatively impermeable limestone in the Glen Rose Formation; and
- a major aquifer in the sandstone of the Twin Mountains Formation.

Each of these units is examined in more detail in the following paragraphs.

1.3.2.1 Terrace Alluvium Aquifer

The uppermost aquifer consists of terrace alluvial material comprised of silt, clay, sand, and gravels deposited by the Trinity River. In some parts of Tarrant County, primarily in those areas adjacent to the Trinity River, groundwater from the terrace deposits is pumped for irrigation and residential use. Groundwater from the terrace deposits is rarely used as a source of potable water due to its limited distribution, poor yield (the estimated hydraulic conductivity of the alluvial aquifer is 4.57 gallons per day per square foot (gpd/ft²) [Radian, 1989]), and susceptibility to surface/stormwater pollution (CH2M HILL, 1984).

Recharge to the terrace alluvium deposits occurs through infiltration from precipitation and from surface water bodies. Extensive on-site pavement and construction limits this recharge. However, additional recharge comes from leakage in water lines, sewer systems, storm drains, and cooling water systems. This leakage has been calculated to be in excess of approximately 115.5 million gallons per year for NAS Fort Worth JRB and AFP-4 (GD Facility Management, 1992). This inflow of water to the shallow aquifer affects local groundwater flow patterns and contaminant transport.

Flow between aquifers is restricted by the Goodland/Walnut Formations; therefore, the terrace alluvium groundwater has no significant hydraulic connection to the underlying aquifers at NAS Fort Worth JRB. The primary water flow in the terrace deposits is generally eastward toward the West Fork of the Trinity River, although localized variations exist across the base. The hydraulic gradient across the base is variable, reflecting variations in the flow direction and localized recharge. Discharge from the aquifer occurs into surface water on-site, specifically Farmers Branch Creek (USGS 1996).

Groundwater elevation maps of the NAS Fort Worth JRB alluvial terrace aquifer for the first and third quarters of 1997 are presented in Section 3.

1.3.2.2 Goodland/Walnut Aquitard

The groundwater within the terrace deposits is isolated from groundwater within the lower aquifers by the low permeability rocks of the Goodland Limestone and Walnut Formations. The primary inhibitors to vertical groundwater movement within these units are the fine-grained clay and shale layers that are interbedded with layers of limestone. Some groundwater movement does occur between the individual bedding planes of both of these units, but the vertical hydraulic conductivity has been calculated to range from 1.2E-09 centimeters per second (cm/sec) to 7.3E-11 cm/sec for the NAS Fort Worth JRB and AFP-4 area. This corresponds to a vertical advective

velocity rate that ranges from 1.16E-03 feet per day (ft/d) to 5.22E-03 ft/d (ESE, 1994). At the AFP-4 "window area," the Goodland/Walnut Aquitard is breached, and the alluvial terrace groundwater is in direct hydraulic communication with the groundwater in the Paluxy Aquifer. A significant number of wells and borings have been advanced on NAS Fort Worth JRB, and there is no evidence that a similar window exists on the Base property. Additionally, no evidence of contamination of the Paluxy aquifer has been found beneath NAS Fort Worth JRB.

1.3.2.3 Paluxy Aquifer

The Paluxy aquifer is an important source of potable groundwater for the Fort Worth area. Many of the surrounding communities, particularly White Settlement, get their municipal water supplies from the Paluxy aquifer. Groundwater from the Paluxy aquifer is also used in some of the surrounding farms and ranches for agricultural purposes. Due to the extensive use of the Paluxy aquifer, water levels have declined significantly over the years. Water levels in the NAS Fort Worth JRB vicinity have not decreased as much as in the Fort Worth area due to its proximity to the Lake Worth recharge area and the fact that the Base does not develop water from the Paluxy aquifer. Drinking water at the base is supplied by the City of Fort Worth which uses Lake Worth as its water source. The groundwater of the Paluxy aquifer is contained within the openings created by gaps between bedding planes, cracks, and fissures in the sandstones of the Paluxy Formation. Just as the Paluxy Formation is divided into upper and lower sand members, the aquifer is likewise divided into upper and lower aquifers. The upper sand is finer grained and contains a higher percentage of shale than the lower sand. Radian (1989) estimated the hydraulic conductivity and transmissivity to be 130 to 140 gpd/ft² and 1,263 to 13,808 gallons per day per foot (gpd/ft), respectively.

1.3.2.4 Glen Rose Aquitard

Below the Paluxy aquifer are the fine-grained limestone, shale, marl, and sandstone beds of the Glen Rose Formation. The thickness of the formation ranges from 250 to 450 feet. Although the sands in the Glen Rose Formation yield small quantities of groundwater in the area, the relatively impermeable limestone acts as an aquitard restricting water movement between the Paluxy aquifer above and the Twin Mountains aquifer below.

1.3.2.5 Twin Mountains Aquifer

The Twin Mountains Formation is the oldest and deepest water supply source used in the NAS Fort Worth JRB area. The Twin Mountains Formation occurs approximately 600 feet below NAS Fort Worth JRB with a thickness of between 250 to 430 feet. Recharge to the Twin Mountains aquifer occurs west of NAS Fort Worth JRB where the formation crops out. Groundwater movement follows the regional eastward slope of the bedrock. The Twin Mountains aquifer is a confined aquifer except where the formation is near the surface (i.e., west of NAS Fort Worth JRB). Groundwater moves eastward in the downdip direction. Transmissivities in the Twin Mountain aquifer range from 1,950 to 29,700 gpd/ft and average 8,450 gpd/ft in Tarrant County. Permeabilities range from 8 to 165 gpd/ft² and average 68 gpd/ft² in Tarrant County (CH2M HILL, 1984).

1.3.3 Surface Water

NAS Fort Worth JRB is located within the Trinity River Basin adjacent to Lake Worth. The main surface water features of interest are Lake Worth, West Fort of the Trinity River, and Farmers Branch Creek. Lake Worth, which was constructed in 1941 as a source of municipal water for the City of Fort Worth, borders the base to the north of AFP-4. The surface area of the lake is approximately 2,500 acres. The Paluxy aquifer discharges to Lake Worth near its western extent. However, at the middle of the lake near Bomber Road, the top of the Paluxy aquifer is recharged by Lake Worth. There does not appear to be a hydraulic connection between the Paluxy aquifer and the lake in the eastern portion where the Walnut Formation separates the Paluxy aquifer and Lake Worth. The elevation of the lake is fairly constant at approximately 594 feet above National Geodetic Vertical Datum (NGVD), the fixed elevation of the dam spillway (USGS, 1996).

The West Fork of the Trinity River, a major river in north central Texas, defines the eastern boundary of the Base. The Trinity River flows southeast towards the Gulf of Mexico. Because the river has been dammed, the 100- and 500-year flood plains downstream of the dam do not extend more than 400 feet from the center of the river or any of its tributaries.

Storm water runoff from the NAS Fort Worth that is not routed to the Base or city sewer system is discharged into Lake Worth. The outfall is permitted under the National Pollution Discharge Elimination System (NPDES), and monitoring results document compliance with permit discharge limitations (IT, 1997b).

Surface drainage is mainly east towards the West Fork of the Trinity River. A portion of the base is drained by Farmers Branch Creek, a tributary into the West Fork of the Trinity River. Farmers Branch Creek begins within the community of White Settlement and flows eastward. Most of the flow in the creek is due to surface runoff, with some groundwater recharge from the Terrace Alluvium aquifer. Just south of AFP-4, Farmers Branch flows under the runway within two large culverts identified as an aqueduct. Two unnamed tributaries flow across the Flightline Area and discharge into Farmers Branch Creek. Most of the base drainage is intercepted by a series of storm drains and culverts, directed to oil/water separators, and discharged to the West Fork of the Trinity River downstream of Lake Worth. A small portion of the north end of the base drains directly into Lake Worth.

1.4 SUMMARY OF INVESTIGATION AND REMEDIATION ACTIVITIES

In addition to HydroGeoLogic's groundwater monitoring program discussed in this report, several other investigations/remediations have been conducted or are currently in progress at NAS Fort Worth JRB. The summary of these activities was obtained from a previous quarterly monitoring report (CH2M HILL, 1997).

1.4.1 Jacobs Engineering Group

As part of a quarterly groundwater monitoring program conducted since 1992 for AFP-4, Jacobs Engineering Group, Inc. (Jacobs) has been sampling groundwater wells located at AFP-4 and selected wells located at NAS Fort Worth JRB. The purpose of the monitoring program is to

determine the nature and extent of the AFP-4 COCs, and to monitor the migration of COCs from AFP-4 downgradient toward NAS Fort Worth JRB (Jacobs, 1996).

Jacobs also recently completed a Basewide Background Study (Jacobs, 1997) to provide data to facilitate decisions about future actions to be taken at sites at NAS Fort Worth JRB. The objectives of the study were to:

- Obtain samples representative of background levels;
- Establish background levels of constituents in groundwater, surface water, sediment, and soil; and
- Determine if, and to what degree, base contamination can be attributed to off-base sources.

Upon completion of this study, background concentrations were established for 24 inorganic constituents. Each background sample was also analyzed for volatile and semivolatile organic compounds; only a limited number of organic constituents were detected (Jacobs, 1997).

1.4.2 IT Corporation

IT Corporation (IT) has completed an investigation of benzene, toluene, ethylbenzene, and xylene (BTEX) contamination in the vicinity of the former Base Service Station (AOC 1) and in the downgradient area between AOC 1 and the Trinity River (IT, 1997a). IT also recently completed the field investigation portion of the basewide sanitary sewer system RCRA Facility Investigation (RFI) (IT, 1997b).

1.4.3 Parsons Engineering Science

Parsons Engineering Science (Parsons) has completed the investigative excavation and partial removal of the French underdrain system (SWMU 64) and removal of the associated oil/water separator (SWMU 67) as part of their remedial action plan for IRP Site ST-14 (Parsons, 1996). In-situ bioventing of the BTEX contaminated soil at the petroleum, oil, and lubricants (POL) tank farm is currently in progress (Parsons, 1996).

1.4.4 Geo-Marine

Geo-Marine is presently under contract to perform a remedial action for AOC 14 (Unnamed Stream) to address contaminated sediments that resulted from upgradient releases.

1.4.5 CH2M HILL

CH2M HILL recently completed a site characterization study for the purpose of summarizing and evaluating the status of each SWMU and AOC identified at NAS Fort Worth JRB (CH2M HILL, 1996b). Tables 1.1 and 1.2 list the SWMUs and AOCs at NAS Fort Worth JRB. Locations are shown on Figure 1.6.

The site characterization study focuses on possible impacts from individual SWMUs and AOCs by evaluating the site history, the wastes handled, the site activities, and the nature and extent of contamination, and provides recommendations for remedial actions based on these evaluations.

The GSAP addresses potential groundwater contamination issues on a basewide scale to characterize and evaluate basewide conditions. The data generated may then support the further evaluation or closure of individual SWMUs and AOCs.

Most recently, CH2M HILL summarized the latest four monthly free-product monitoring events for several wells in the vicinity of SWMU 67. Free-product levels were evaluated, and free-product was removed. No significant accumulation occurred in any monthly period (Memorandum to Mark Weegar, August 21, 1997).

TAB

Section 1.0 Tables

Table 1.1
Solid Waste Management Units at NAS Fort Worth JRB

SWMU No.	Description	Management
1	Pathological Waste Incinerator	BRAC
2	Pathological Waste Storage Shed	BRAC
3	Metal Cans	BRAC
4	Facility Dumpsters	BRAC
5	Building 1627 Waste Accumulation Area No.	DERA
6	Building 1628 Wash Rack and Drain	DERA
7	Building 1628 Oil Water Separator	DERA
8	Building 1628 Sludge Collection Tank	DERA
9	Building 1628 Work Station Waste Accumulation Area	DERA
10	Building 1617 Work Station Waste Accumulation Area	DERA
11	Building 1617 Waste Accumulation Area	DERA
12	Building 1619 Waste Accumulation Area	DERA
13	Building 1710 Waste Accumulation Area	DERA
14	Building 1060 Bead Blaster Collection Tray	DERA
15	Building 1060 Paint Booth Vault	DERA
16	Building 1060 Waste Accumulation Area	DERA
17	Landfill No. 7	DERA
18	Fire Training Area No. 1	BRAC
19	Fire Training Area No. 2	BRAC/DERA
20	Waste Fuel Storage Tank	BRAC/DERA
21	Waste Oil Tank	BRAC/DERA
22	Landfill No. 4	BRAC
23	Landfill No. 5	BRAC
24	Waste Burial Area	BRAC/DERA
25	Landfill No. 8	DERA
26	Landfill No. 3	DERA
27	Landfill No. 10	DERA
28	Landfill No. 1	DERA
29	Landfill No. 2	DERA
30	Landfill No. 9	DERA
31	Building 1050 Waste Accumulation Area	DERA
32	Building 1410 Waste Accumulation Area	DERA
33	Building 1420 Waste Accumulation Area	DERA
34	Building 1194 Waste Accumulation Area	DERA
35	Oil Water Separator System (Building 1194) Vehicle Refueling Shop	DERA
36	Building 1191 Waste Accumulation Area	DERA
37	Oil Water Separator System (Building 1191) Vehicle Maintenance Shop	DERA
38	Building 1269 PCB Transformer Building	DERA
39	Building 1641 Waste Accumulation Area	DERA
40	Building 1643 Oil Water Separator	DERA
41	Oil Water Separator System, Building 1414 Field Maintenance Squadron Aerospace Ground Equipment	DERA
42	Building 1414 Waste Accumulation Area	DERA
43	Building 1414 Non-Destructive Inspection (NDI) Waste Accumulation Area	DERA
44	Building 1027 Oil Water Separator System Aircraft Washing Hangar	DERA
45	Building 1027 Waste Oil Tank Vault, Aircraft Washing Hangar	DERA

Table 1.1 (continued)
Solid Waste Management Units at NAS Fort Worth JRB

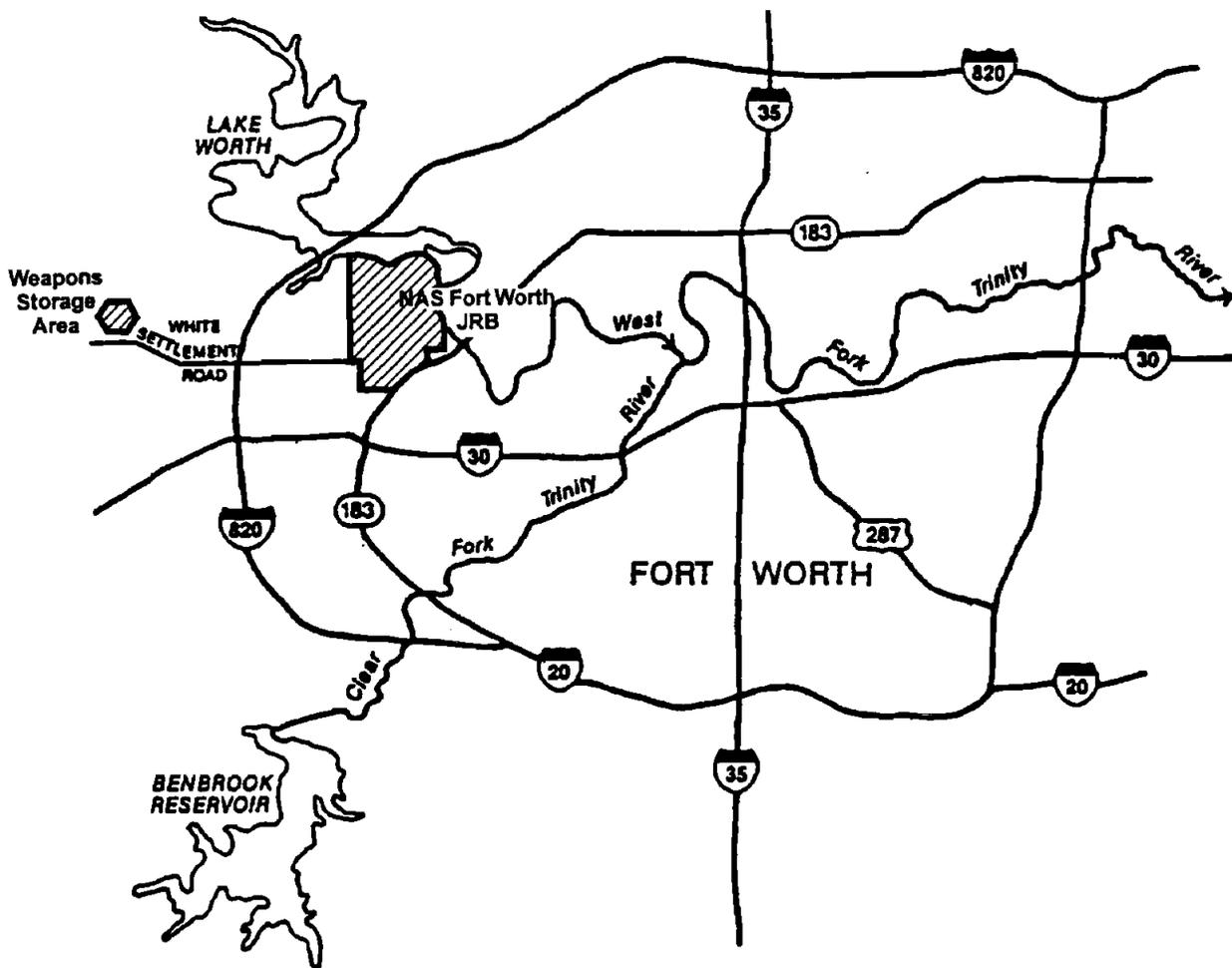
SWMU No.	Description	Management
46	Building 1027 Waste Accumulation Area	DERA
47	Building 1015 Oil Water Separator System, Jet Engine Test Cell	DERA
48	Building 1048 Fuel System Floor Drains	DERA
49	Aircraft Washing Area No. No. 1	DERA
50	Aircraft Washing Area No. No. 2	DERA
51	Building 1190 Central Waste Holding Area	DERA
52	Building 1190 Oil Water Separator System	DERA
53	Storm Water Drainage System	DERA
54	Storm Water Interceptors	DERA
55	East Gate Oil Water Separator	DERA
56	Building 1405 Waste Accumulation Area	DERA
57	Building 1432/1434 Waste Accumulation Area	DERA
58	Pesticide Rinse Area	BRAC
59	Building 8503 Weapons Storage Area Waste Accumulation Area	BRAC
60	Building 8503 Radioactive Waste Burial Site	BRAC
61	Building 1320 Power Production Maintenance Facility Waste Accumulation Area No.	DERA
62	Landfill No. 6	DERA
63	Entomology Dry Well	DERA
64	French Underdrain System	BRAC/DERA
65	Weapons Storage Area Disposal Site	BRAC
66	Sanitary Sewer System	BRAC/DERA
67	Oil Water Separator System associated with French Drain (SWMU 64)	BRAC/DERA
68	POL Tank Farm	BRAC/DERA

Table 1.2
Areas of Concern at NAS Fort Worth JRB

AOC No.	Description	Management
AOC 1	Building 1518 former Base Service Station/former Base Gas Station	BRAC/DERA
AOC 2	Airfield Groundwater	DERA
AOC 3	Waste Oil Dump	DERA
AOC 4	Fuel Hydrant System, Building 4150-4154 Fuel Hydrant System	DERA
AOC 5	Grounds Maintenance Yard	BRAC
AOC 6	RV Storage Area	DERA
AOC 7	Former Base Refueling Area No.	DERA
AOC 8	Aerospace Museum	BRAC
AOC 9	Golf Course Maintenance Yard	BRAC
AOC 10	Building 1064 Oil Water Separator System	DERA
AOC 11	Building 1060 Oil Water Separator System	DERA
AOC 12	Building 4208 Oil Water Separator System	DERA
AOC 13	Building 1145 Oil Water Separator System	DERA
AOC 14	Unnamed Stream	BRAC
AOC 15	Building 1190 Storage Shed	DERA
AOC 16	Family Camp	BRAC

TAB

Section 1.0 Figures



HYDRO
Geologic
INC.



Legend



Site

SCALE IN MILES



Figure 1.1
Site Location Map
NAS Fort Worth JRB, Texas

[From Radian, 1989]

Figure 1.2

NAS Fort Worth JRB BASE BOUNDARIES

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

— Former Property Boundary
of Carswell AFB

- - - Approximate NAS
Fort Worth JRB
Site Boundary

- · - · - Property Boundary
of AF Plant 4



0 500 1000 2000
SCALE IN FEET

HYDRO GEOLOGIC

Map Source:
JACOBS, 1996

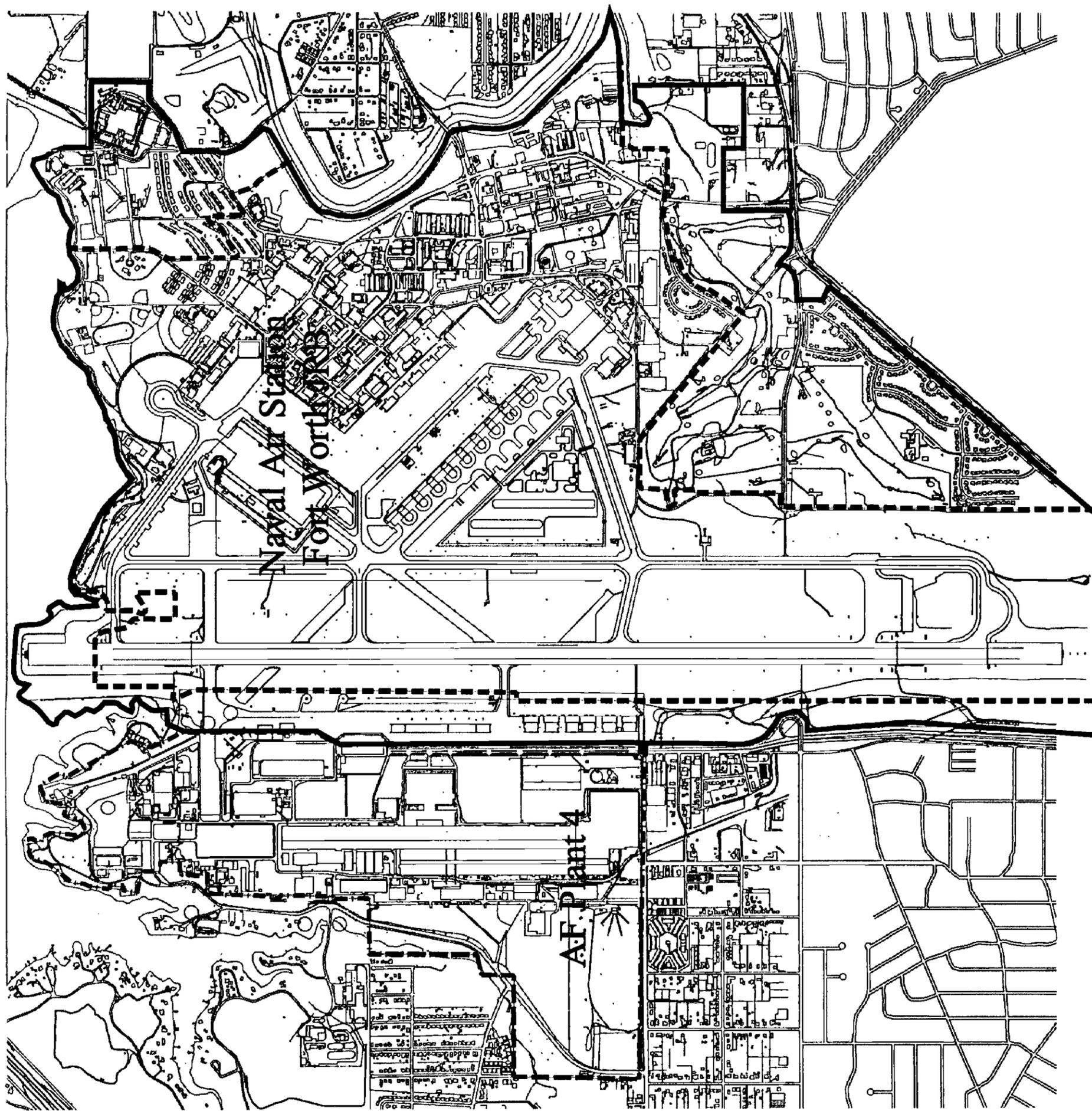


Figure 1.3

NAS Fort Worth JRB GROUNDWATER MANAGEMENT AREAS

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

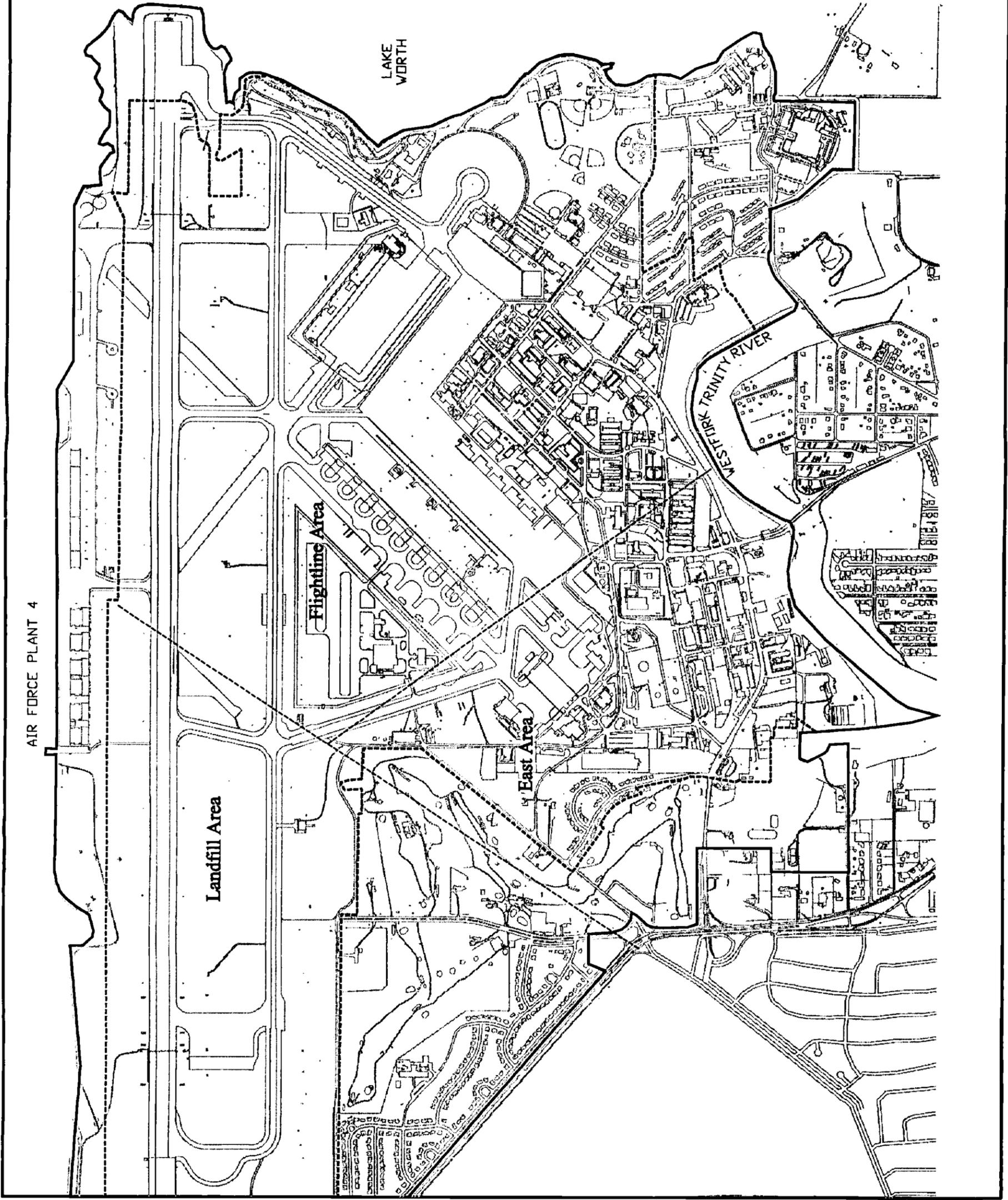
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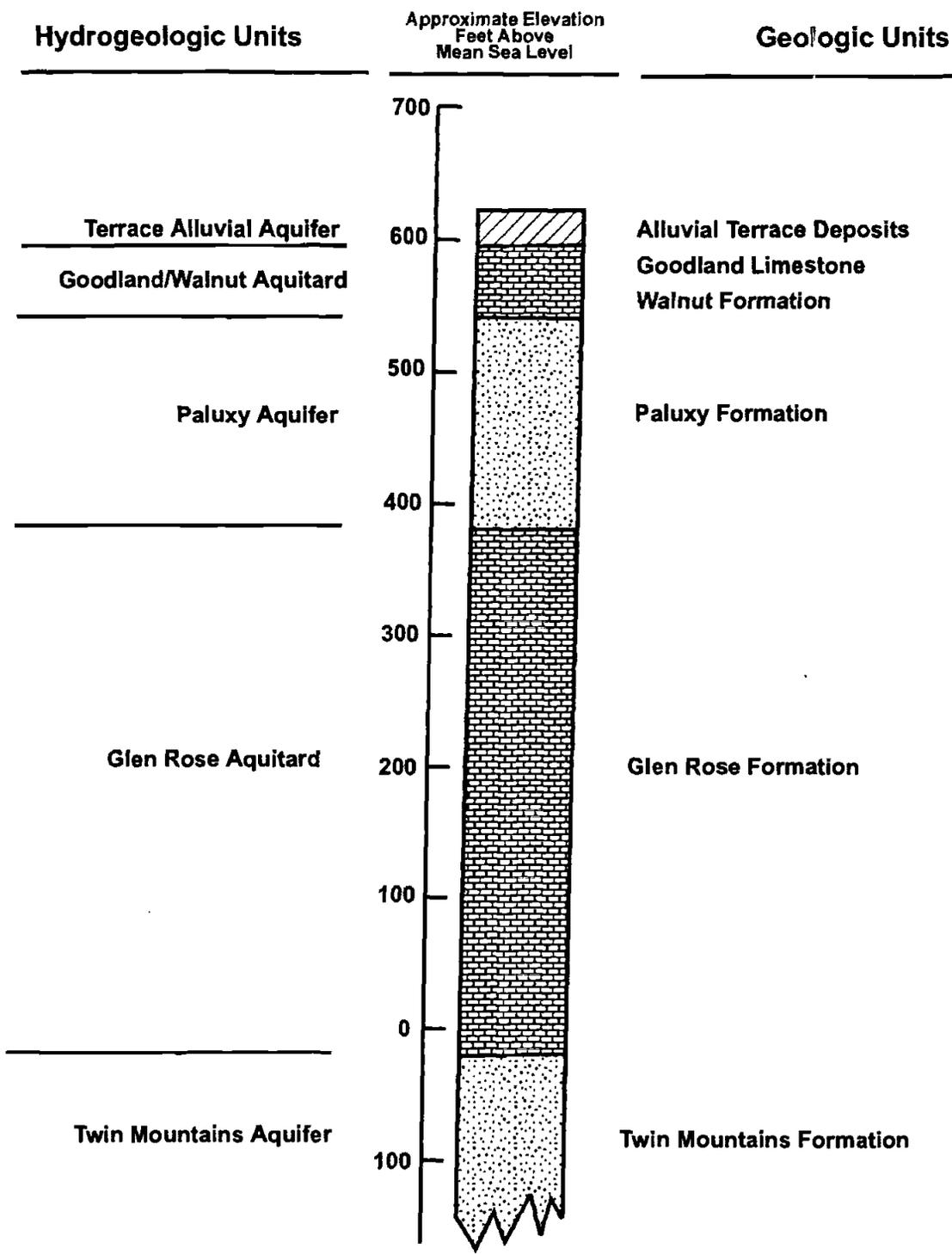
- Approximate Groundwater Management Areas
- Approximate NAS Ft. Worth JRB Site Boundary



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Map Source:
JACOBS, 1996





- Legend**
-  Alluvium
 -  Limestone
 -  Sandstone

Figure 1.4
Stratigraphic Column Correlating
Hydrogeologic Units and Geologic Units
at NAS Fort Worth JRB, Texas
[From Radian, 1989]

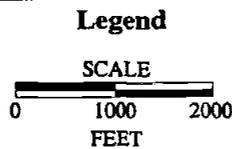
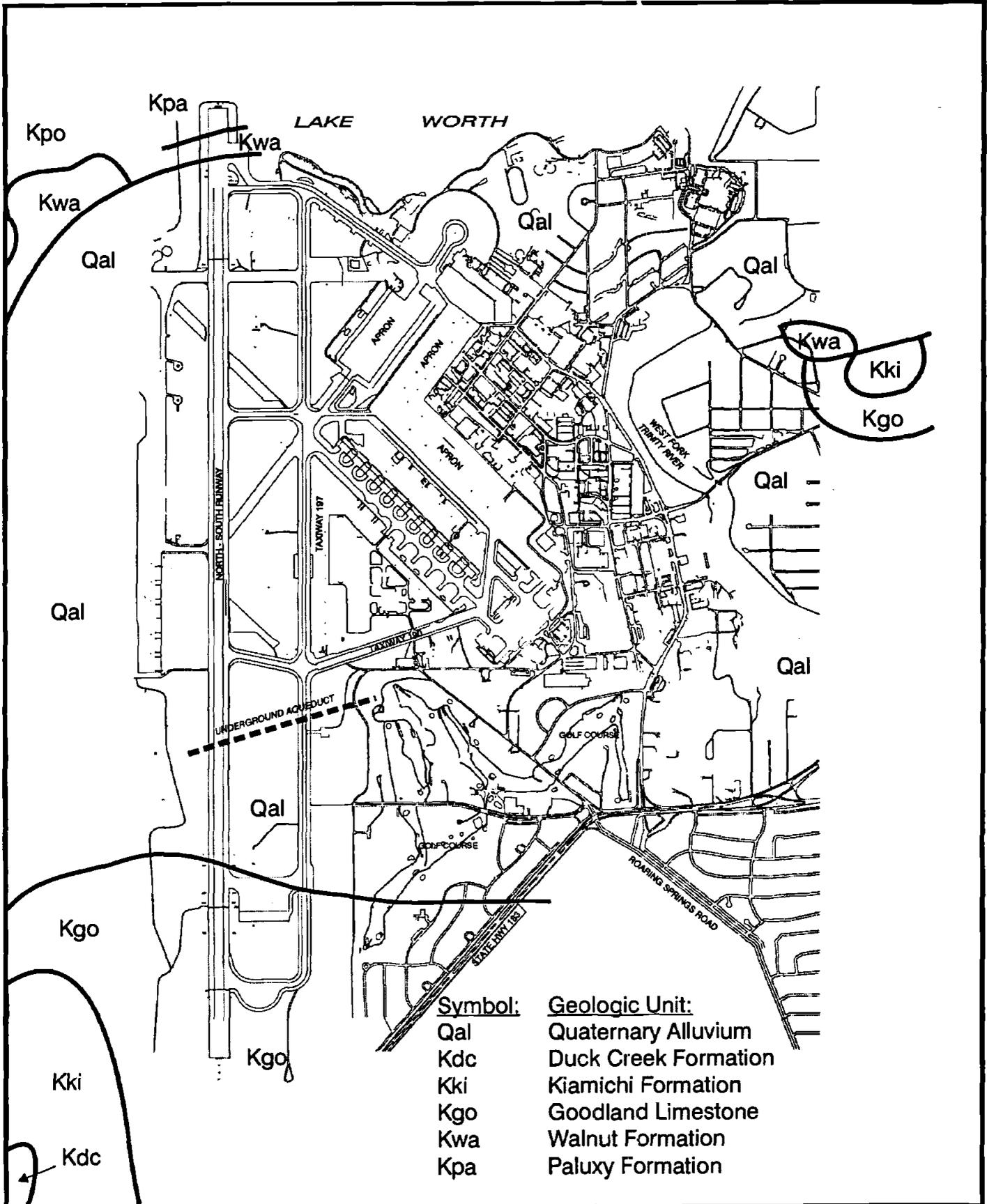


Figure 1.5
Areal Distribution of Geologic Units
NAS Fort Worth JRB, Texas

[From Radian, 1989]

Figure 1.6

NAS Fort Worth JRB

LOCATIONS OF SWMUS AND AOCs

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

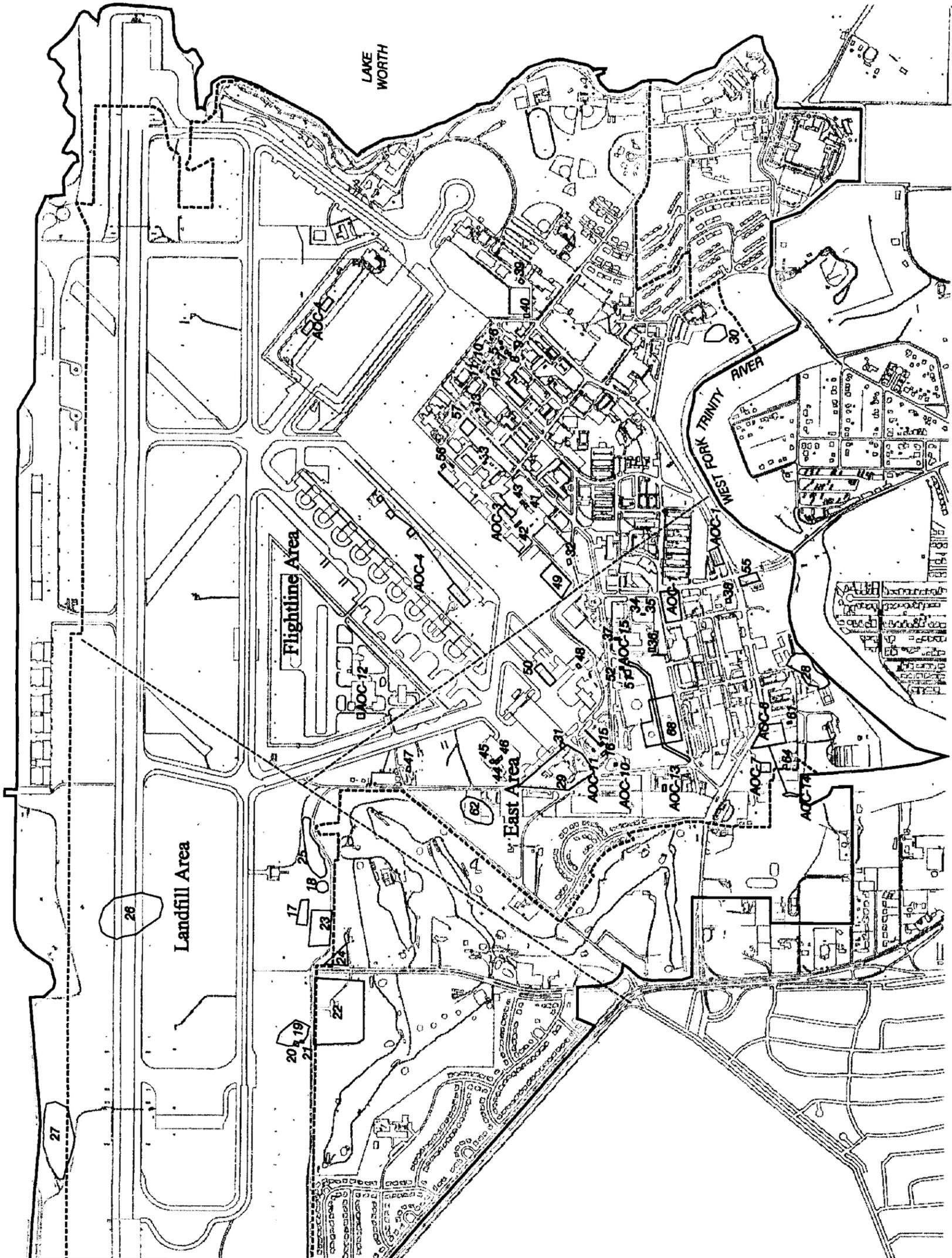
-  Approximate Groundwater Management Areas
-  Approximate NAS Ft. Worth JRB Site Boundary
-  Solid Waste Management Unit AOC-4
-  Area Of Concern



HYDRO Geologic INC

Map Source:
JACOBS, 1996

AIR FORCE PLANT 4



TAB

Section 2.0

2.0 MONITORING ACTIVITIES

This section describes the monitoring activities performed during the July 1997 quarterly groundwater sampling event at NAS Fort Worth JRB. The work was performed in accordance with the draft GSAP (CH2M HILL, 1996a) and draft Basewide QAPP (CH2M HILL, 1996c). Monitoring activities included:

- Well inspection and water-level measurements;
- Well purging and analytical sampling;
- Investigation-derived waste (IDW) management; and
- Laboratory and field analysis

2.1 WELL INSPECTION AND WATER-LEVEL MEASUREMENTS

In order to evaluate existing groundwater flow patterns, 152 wells were selected for water level measurements during the July 1997 sampling event (Figure 2.1). Of the 152 wells selected, 150 wells were located; two wells, HM114 and HM126, were not found due to tall grass. All located wells were inspected; two wells, USGS02T and MW-1A, were found completely destroyed, and water level measurements could not be obtained. During a 3-day period from July 8 to July 10, the remaining 148 wells were inspected, and water levels and total depths were measured. The water level measurements and total depths were taken several days prior to purging and sampling the wells in order to minimize water column disturbance.

A visual inspection of each monitoring well was conducted to determine the well's condition and integrity (e.g., pad condition, lock integrity, etc.). Following the visual inspection of each well, an organic vapor meter (OVM) was used to measure the levels of organic vapors in the background area, breathing zone, and at the top of each well casing immediately after the well cap had been removed. An electronic oil-water interface device was used to determine the presence and depth of NAPL, depth to water, and total well depth. All well inspection and measurement data were recorded in the field notes and on the groundwater field sampling data sheets (Appendix A) and are summarized on Table B.1 in Appendix B.

The well inspections, water level readings, and NAPL thickness measurement results are discussed further in Section 3.3.

2.2 SAMPLE WELL SELECTION

Fifty-two of the 152 monitoring wells selected for water level measurements were also selected for analytical sampling. These wells met the following criteria:

- The well was not located within 50 feet of another well constructed within the same geologic strata;
- The well was not recorded as being a dry well during construction or subsequent sampling or monitoring events;

- The well did not have a screened interval greater than 20 feet, or was not screened within two or more separate geologic strata (exceptions include Paluxy wells); and
- The well did not contain free-product with a documented thickness greater than 0.01 feet (the thickness of the free-product, if encountered, was measured as described in Section 2.2.1 and in the draft GSAP [CH2M HILL, 1996a]).

Exceptions to these criteria were monitoring wells SD13-07, MW-1, MW-2, and GMI-04-01M. These wells were selected to provide additional vertical flow data or critical chemical data near base boundaries. Well SD13-07 was selected even though LAW had detected free product in this well during their previous sampling round (LAW, 1996). A product recovery program implemented by LAW in January 1996 reduced product thickness in this well to 0.01 feet. Monitoring wells MW-1 and MW-2 have screened intervals greater than 20 feet; however, MW-1 was selected for its proximity to the documented contaminant plume, and MW-2 was selected due to its location near the base boundary. Well GMI-04-01M was also selected even though it was found to be dry during LAW's last sampling event (CH2M HILL, 1997).

The wells selected for analytical sampling were further divided based on whether the wells were selected primarily to evaluate the potential for off-site migration or the extent of natural attenuation. The reason for selection of the well dictated the chemical parameters selected for analysis at each well. Table 2.1 includes a list of the wells selected for sampling, the rationale for their selection, and the chemical parameters analyzed at each well (CH2M HILL, 1997).

Perimeter monitoring wells were selected from each groundwater management area in order to meet the short-term objective of identifying potential impacts to off-site groundwater receptors. Perimeter wells include wells screened in the alluvium and located near the NAS Fort Worth JRB boundaries and/or immediately upgradient of surface water bodies where groundwater may discharge to surface water bodies.

Natural attenuation wells were selected for evaluating and monitoring the extent of natural chemical attenuation that may be occurring in groundwater. The four well types are as follow:

- **Upgradient** - wells located upgradient of the impacted groundwater; results were used to evaluate background conditions.
- **Plume** - wells located within or at the lateral edges of the dissolved contaminant plume; results were used to evaluate the rate of contaminant removal by natural attenuation.
- **Sentry** - wells located at the edge or downgradient of the contaminant plume; results were used to verify that natural attenuation is reducing contaminant concentrations.
- **Perimeter** - wells located at the boundaries of NAS Fort Worth JRB and/or surface water boundaries where groundwater may discharge to surface water; results were used to monitor potential off-site migration.

2.3 WELL PURGING AND ANALYTICAL SAMPLING

Purging and sampling of the 52 selected wells began on July 11, 1997, and was completed July 24, 1997. The wells were sampled using a low-flow purge technique (CH2M HILL, 1996a), the procedure recommended for AFCEE projects (AFCEE, 1996a). The wells were purged with 2 inch stainless steel Grundfos Redi-Flo submersible pumps. Pumping rates were kept between 0.1 to 2.0 liter/minute to minimize turbidity and oxygenation, mixing of chemically distinct zones, and potential loss of volatile organic compounds (VOCs).

During purging, water quality stabilization criteria (pH, temperature, oxidation-reduction potential [Eh], turbidity, dissolved oxygen [DO], and electrical conductance [EC]) were continuously monitored and recorded on the well sampling field data sheets (Appendix A) using a flow-through cell. If the sampled well was not experiencing significant drawdown while purging (i.e., the water column did not drop more than 2 feet or 10 percent of the screened interval length), the criteria for sample collection was the stabilization of water quality parameters as follows:

- Temperature $\pm 0.1^{\circ}\text{C}$
- pH ± 0.1 units
- EC $\pm 5\%$ full scale range
- DO ± 0.10 mg/L or 10% of value (whichever is greater)
- Eh $\pm 10\%$
- Turbidity $\pm 1\%$ and less than 10 NTUs

A well was sampled when the water quality stabilization criteria were met, and the well did not experience a significant drawdown while purged (i.e., > 2 ft or 10% of the screen length interval).

If these parameters did not stabilize, the sample was collected after three to five well volumes had been removed. If the sampled well was exhibiting excessive drawdown while being purged at the lowest possible flow rate for that well, the well was purged dry and the sample collected when a sufficient volume of water had accumulated in the well.

Samples for VOC analysis were collected first at each well. The remaining samples were collected based on the approximate order of susceptibility to artificial aeration (i.e., total metals, TOC, methane, ferrous iron, alkalinity, and anions). Required sample containers, preservation methods, volumes, and holding times are provided in Section 5 of the Basewide QAPP (CH2M HILL, 1996c) and on Table B.2 of the GSAP.

Groundwater sampling and field parameter results are discussed further in Section 3.3.

2.4 INVESTIGATION-DERIVED WASTE (IDW) MANAGEMENT

IDW management procedures were followed as outlined in Section B.4.3 of the GSAP (CH2M HILL, 1996a). All drums are stored at SWMU 22. The purge water will be bulked, and samples will be collected and analyzed for the parameters necessary for profiling and disposal. The waste will be manifested using the Uniform Hazardous Waste Manifest to ensure a complete paper trail to document disposal, and transported to the disposal facility(s).

2.5 LABORATORY AND FIELD ANALYSIS

The methods selected for the chemical analyses are summarized in the following paragraphs. They are also summarized on Table 2.2 and Table B.2 in the GSAP (CH2M HILL, 1996a). All samples, excluding those for ferrous iron analyses, were delivered by overnight courier to Quanterra Environmental Services in Tampa, Florida. Ferrous iron analyses were conducted on-site.

2.5.1 Laboratory Analysis

Fifty-two wells were sampled as part of the quarterly sampling program. Nineteen wells were analyzed for benzene, toluene, ethylene, and total xylenes (BTEX) using EPA Method SW8020 and 33 wells were sampled for volatile organic compounds (VOCs) including BTEX using EPA Method SW8260. Thirty wells were selected for natural attenuation monitoring and sampled for common anions using EPA Method SW9056, methane using EPA Method RSK-175, alkalinity using EPA Method E310.1, and total organic carbon (TOC) using EPA Method SW9060. Additionally, 14 samples collected from the perimeter wells and four samples collected from the natural attenuation wells were analyzed for metals using EPA Method SW6010 (silver was analyzed using EPA Method SW7761, mercury was analyzed using EPA Method SW7470, and thallium was analyzed using EPA Method SW7841).

2.5.2 Field Analysis - Ferrous Iron

The method used for on-site analysis of samples for ferrous iron (Fe^{+2}) was (HACH) method 8146. This method is described in detail in the GSAP (CH2M HILL, 1996a).

Samples collected from the 30 wells selected for natural attenuation monitoring (including the field quality control samples associated with these wells as discussed in Section 2.3.3) were analyzed on-site for ferrous iron (Fe^{2+}), one of the parameters necessary to evaluate the potential presence of natural attenuation. A HACH Method 8146 spectrophotometer with a 1,10-phenanthroline reagent was used. The reagent reacts with the Fe^{2+} in the sample to produce an orange color in proportion to the iron concentration. Ferric iron (Fe^{3+}) does not react in this test. All ferrous iron analyses were performed on the day of sample collection. All results of the on-site analyses were recorded in a field laboratory log book and are listed in Table B.2 in Appendix B. The results are discussed further in the data quality summary in Section 3.3 and in the ST-14 area natural attenuation analysis found in Section 3.5.

2.6 QUALITY ASSURANCE/QUALITY CONTROL PROGRAM

The field quality control (QC) program for the collection of samples and the laboratory QC program for sample handling, laboratory control samples, and reporting are fully documented in the Basewide QAPP (CH2M HILL, 1996c).

Field QC samples were collected to evaluate sampling technique and decontamination procedures. These samples included field duplicates, trip blanks and field equipment blanks. Documentation of the sampling was performed in the field to ensure that the sample collected, labeling, chain-of-

custody and request for analysis were in agreement. Custody seals were placed on each cooler before shipment by common carrier.

In the laboratory, sample handling included documentation of sample receipt, placement in storage, lab personnel use of the sample, and disposal. The laboratory control consisted of instrument calibration and maintenance, laboratory control samples, method blanks and matrix spikes. Reporting of the laboratory control data was planned prior to the collection of the data, allowing the laboratory to place the appropriate information into the data package so that the data quality evaluation (DQE) could be performed in a timely manner.

2.6.1 Quality Control Sample Preparation and Collection

2.6.1.1 Equipment Blanks

Equipment blanks are collected by pouring ASTM Type II reagent grade water over the Redi-Flo pumps used for purging and sampling. The water is collected in sample containers and transported along with the other samples to the laboratory for analysis. Equipment blanks are collected immediately after the equipment has been decontaminated; these blanks are analyzed for the same parameters as the field sample collected from the equipment from which they are obtained.

2.6.1.2 Trip Blanks

The trip blanks are prepared in the laboratory with ASTM Type II reagent grade water. They are transported to the sampling site, handled as an environmental sample, and returned to the laboratory for analysis. The trip blanks are not opened in the field and are only included when VOC samples are taken. One trip blank accompanied each cooler samples sent to the laboratory for analysis of VOCs.

2.6.1.3 Field Duplicates

Field duplicate samples are collected as a second sample at the same location as the original sample. Duplicate samples are collected in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis.

2.6.2 Sample Tracking Protocol

Each sample was assigned a unique identification number that described where the sample was collected. The number consists of a maximum 12 digit alphanumeric code as follows:

xxxx-yyyyzz-aa

where:

xxxx represents the site identification (e.g., LF04, LF06, LF07, LF09, LF10)

yyyy represents the location number (e.g., 01, 02)

- zz represents the medium (WG=water-ground, SO=soil, WS = water-surface, SD=sediment)

- aa represents the sample number for the round numbers for groundwater, surface water, and soil (e.g., 01, 02, 03, etc.)

For example, the first groundwater sample collected from LF04 will be identified as "LF04-04FWG-01." The locations from which field duplicate samples were to be collected were determined prior to mobilization. Unique sample identification numbers, which do not associate the duplicate with its parent sample, were assigned to field duplicates. Documentation was maintained in the field sampling logbook to track these field duplicate samples.

2.6.3 QC Sample Tracking Protocol

Field quality control samples collected during the third quarterly groundwater sampling event include blanks and duplicates, and are summarized in Table 2.2.

QC samples were identified by use of a similar system of identifiers with a maximum of 10 characters. The QC sampling number system is summarized below:

xyyyyyyy

where:

xx represents medium (EB=equipment blank, TB=trip blank, AB=ambient blank)

yyyyyy represents date (month, day, year)

For example, an equipment blank obtained on September 22, 1997 would be identified as EB092297.

The Project Geologist/Field Coordinator maintained a list that described the connection between each QC sample and specific environmental samples. For instance, each trip blank was correlated with a particular set of samples shipped to the laboratory, and each equipment blank was correlated to those samples collected using a particular set of sampling tools.

After the laboratory data were received and validated, the data were loaded into IRPIMS. An electronic deliverable report in the IRPIMS format will be provided as specified by the Statement of Work for Site Characterization of NAS Fort Worth JRB (CH2M HILL, 1996d) for this project.

TAB

Section 2.0 Tables

Table 2.1 Monitoring Wells Selected for Current Sampling Program
Quarterly Groundwater Sampling
NAS Fort Worth JRB
July 1997

AREA	DESCRIPTION	WELL	OBJECTIVE	RATIONALE	CHEMICAL PARAMETERS / METHOD OF ANALYSIS									
					BTEX	VOCs	DO ⁵	COMMON ANIONS	FE(II) ²	ALKALINITY	EH ²	CH4	TOC	METALS
Landfill Area	DERA: Landfill 6, Landfill 7, Fire Training Area 2, Waste Burial Area	LF04-4F	3	Plume	SW8020A	SW8260A		SW8056	E310.1	EPA8-RSK175	RSK175	SW9080	SW6010A	
		WP07-10B	3	Plume		X					X			
		WP07-10C	3	Plume		X					X			
		LF05-5G	3	Plume		X					X			
		GM104-01M	3	Plume		X					X			
		LF04-10	3	Plume		X					X			
		LF05-18	1	Perimeter			X				X		X	
		LF05-19 ¹	1	Perimeter			X				X			X

- Symbol**
X Parameter Tested
X** Parameter Untested
1 Objective is to identify potential impacts to off-site groundwater receptors
2 Objective is to support closure of SWMUs/AOCs; Model natural attenuation
3 Objective is to support closure of SWMUs/AOCs; perform LTM for regulatory closure requirements.

- Chemical Parameters**
Definition
BTEX Benzene, Toluene, Ethylbenzene, Xylene
VOCs Volatile organic compounds
DO Dissolved oxygen
FE(II) Ferrous iron
EH Oxidation-reduction potential
CH4 Methane (also includes ethane and ethene)
TOC Total organic compounds

- Superscripts**
Definitions
1 TNRCC requested wells for monitoring (TNRCC, 1988)
2 Field parameters
3 These wells are scheduled for sampling by Jacobs Engineering
4 Free product encountered during sampling, No sample collected
5 Dry well, no field parameters collected

Table 2.2
Field Quality Control Samples

Type of Sample	Frequency	Total Number	Time	Analysis
Ambient Blank ¹	1/sampling event	0 ²	During non-ambient conditions	All laboratory analysis consistent with sampling event
Equipment Blank ³	1 day	11	Immediately after equipment had been decontaminated	All laboratory analyses consistent with daily sampling
Trip Blank ⁴	1 blank/sample cooler containing VOC, methane, and TOC	8	When VOC, methane, and TOC samples were collected	VOC, methane, and TOC analysis
Field Duplicates (blind) ⁵	1 duplicate for 10% of the total number of samples	5	Collected at the same time and location of original sample	Same as original sample

¹Used to assess the impact of non-ambient events.

²An ambient blank was not collected. This was an oversight during the third quarterly sampling event. An ambient blank will be collected as planned in all future events.

³Used to assess the effectiveness of equipment decontamination procedures.

⁴Used to assess the potential contaminants from sample containers or other foreign sources during the transportation and storage procedures.

⁵The duplicate sample is assigned a unique identification number in the field in order to trace the sample analyses to each duplicate.

TAB

Section 2.0 Figures

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Figure 2.1

NAS Fort Worth, JRB WELL LOCATION MAP

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

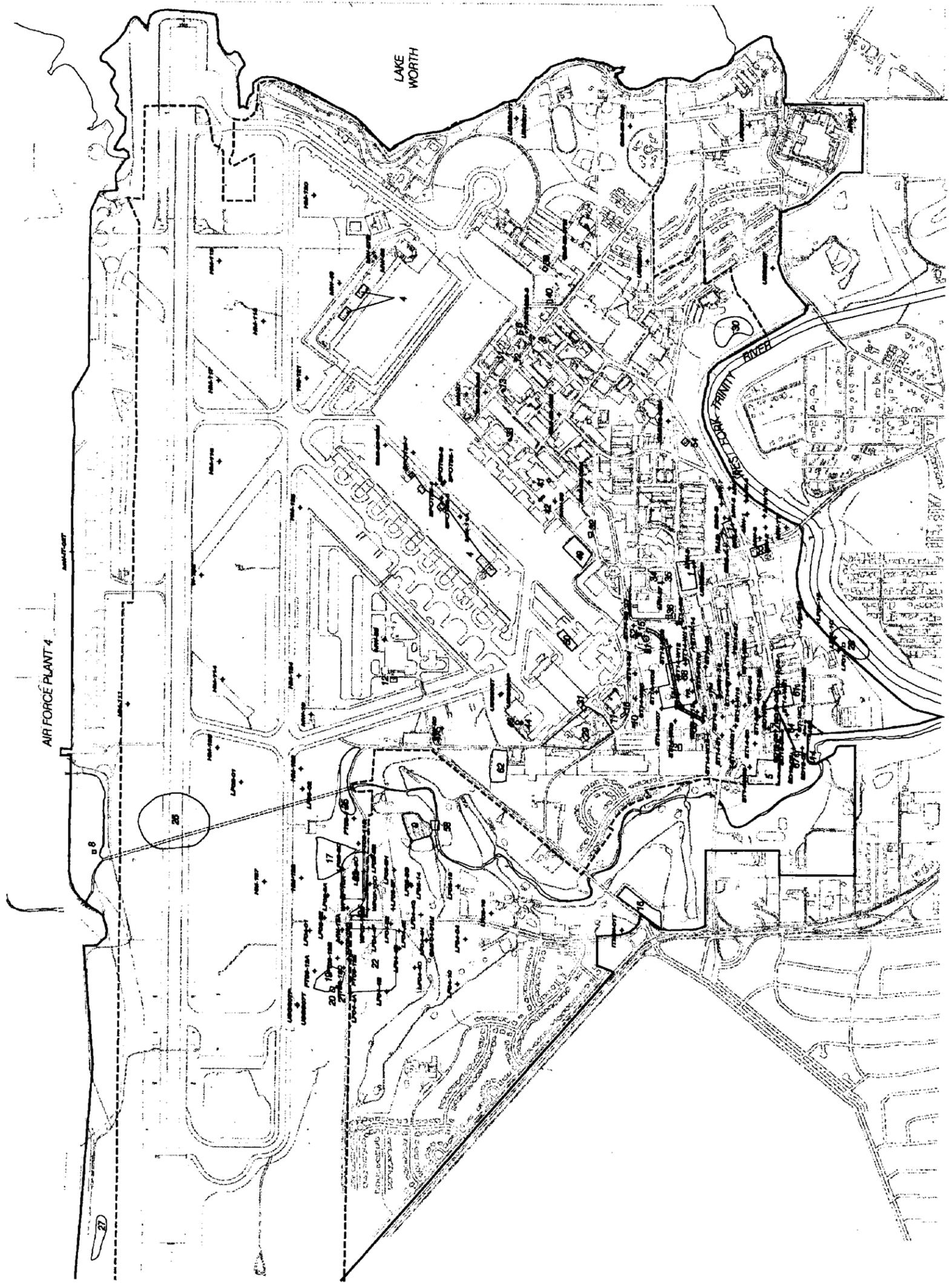
- — — — — NAS Fort Worth JRB (Campbell Field)
- — — — — Premier Control Air Force Base
- ↓ Air-177 Building Monitoring Well Location

Area of Concern (AOC)

- 1 Premier Base Building Military Service Base One Station
- 2 Air Force Center Building (Remains to be Determined)
- 3 Air Force Center Building (Remains to be Determined)
- 4 Storage Area
- 5 PW Storage Area
- 6 Power Base Building Area
- 7 Power Base Building Area
- 8 Cold Storage Area
- 9 Cold Storage Area
- 10 Cold Storage Area
- 11 Cold Storage Area
- 12 Cold Storage Area
- 13 Cold Storage Area
- 14 Cold Storage Area
- 15 Storage Area
- 16 Storage Area

Solid Waste Management Unit (SWMUD)

- 1 Building 1002 Waste Accumulation Area
- 2 Building 1002 Waste Accumulation Area
- 3 Building 1002 Waste Accumulation Area
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TAB

Section 3.0

3.0 SAMPLING AND ANALYSIS RESULTS

3.1 FIELD DATA RESULTS

Field data results are presented in the following sections and include results of well inspections and groundwater elevation measurements.

3.1.1 Well Inspections

During the visual well inspection and water-level survey, the integrity and condition of each monitoring well was noted in the field logbook. A copy of the field notes is provided in Appendix A, along with copies of the groundwater field sampling data sheets. A summary of all field observations is provided in Table B.1 of Appendix B.

Most of the observations were consistent with previous 1st and 2nd quarterly events. Observations not noted in previous quarterly events and/or unique to this quarterly event are summarized below.

- Seven wells were noted to be emitting petroleum odors (BSS-B, 17L, ST14-W12, LF0-04, Spot 35-7, ST14-W15, SD13-05). Two of the seven (LF04-04, SD13-05) had measurable free product (>0.01 feet) thickness. SD13-07 had measured free product thickness of 0.015 feet.
- Seven wells were noted as being damaged. Five were found with cracked pads (USGS01T, SD13-05, ST14-W31, ST14-W22, LF01-1B), and three had casing damage (USGS01T, Spot35-4, ST14-W20).
- Two wells were observed to be completely destroyed (USGS02T and MW-1A). The source of the damage is unknown and made this quarter's and any future monitoring impossible.
- Two wells were not found due to tall grass (HM114 and HM126).

3.1.2 Groundwater Elevations

One hundred and fifty-two wells were selected to provide groundwater elevation measurements in order to construct a potentiometric map for the uppermost aquifer (i.e., Terrace Alluvium). Of the selected wells, seventeen wells did not have surveyed elevation points available, so the elevations could not be calculated. Two wells were not located (HM114, HM126); four wells were eliminated because they were screened in the Paluxy Aquifer; and one well (HM127) had an erroneous water-level measurement, likely due to field measurement error.

Groundwater elevations from the remaining 128 on-site wells screened in the Terrace Alluvium, provided in Table 3.1, were used to construct the potentiometric map presented in Figure 3.1. In general, the regional groundwater flow direction is from west to east. Groundwater elevation varied from 625 feet NGVD along the western border to 513 feet NGVD in the eastern portion of the site. The head gradients toward the eastern end of the site are approximately double those

on the western portion. The groundwater gradient ranges from approximately 0.05 ft/ft to 0.003 ft/ft. Comparison between groundwater elevation measured in January 1997 (Figure 3.2) and July 1997 (Figure 3.1) indicates a 1 to 5 foot increase in elevation throughout the site.

Some local variations in groundwater direction are reflected on the potentiometric map. Monitoring well data on groundwater elevations in the central portion of Landfill Area indicate that the local groundwater flow is toward the north-eastern direction towards Farmers Branch Creek. Monitoring data from the East Area suggest that the local flow is from west to east. However, contours at the southern portion of East Area indicate possible flow bifurcation toward the downgradient.

Groundwater ranges from 610 feet NVDG to 590 feet NVDG along the northern border adjacent to Lake Worth. The terrace alluvial aquifer (0-60 -ft thick) is discharged by evapotranspiration, and seepage to Lake Worth, Meandering Road Creek and Farmers Branch (USGS 1996). Based on groundwater contour maps generated by the USGS (1996) and for quarterly gauging (Figure 3.2), flow from the terrace alluvial aquifer (in the vicinity of the Base) also appears to be discharging to the West Fork Trinity River.

3.2 QUALITY CONTROL ELEMENTS

The basis for assessing each element of data quality (precision, accuracy, representativeness, completeness and comparability) is discussed in the following subsections.

3.2.1 Precision

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. Analytical precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses. AFCEE uses the laboratory control sample (LCS) to determine the precision of the analytical method. If the recoveries of analytes in the LCS are within established control limits, then precision is within limits. In this case, the comparison is not between a sample and a duplicate sample analyzed in the same batch; rather, the comparison is between the sample and samples analyzed in previous batches. Total precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate samples and matrix duplicate spiked samples shall be analyzed to assess field and analytical precision, and the precision measurement is determined using the relative percent difference (RPD) between the duplicate sample results. For replicate analyses, the relative standard deviation (RSD) is determined.

3.2.2 Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and system error. It, therefore, reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the

true value or known concentration of the spike or standard. Analytical accuracy is measured by comparing the percent recovery of analytes spiked into an LCS to a control limit. For volatile and semivolatile organic compounds, surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed. Analysis of performance evaluation (PE) samples shall also be used to provide additional information for assessing the accuracy of the analytical data being produced.

Both accuracy and precision are calculated for each AFCEE analytical batch, and the associated sample results are interpreted by considering these specific measurements. The formula for calculation of accuracy is percent recovery (%R) from pure and sample matrices.

3.2.3 Representativeness

Objectives for representativeness are defined for each sampling and analysis task and are a function of the investigative objectives. Representativeness shall be achieved through use of the standard field, sampling, and analytical procedures. Representativeness is also determined by appropriate program design with consideration of elements such as proper well locations, drilling and installation procedures, and sampling locations. Decisions regarding sample/well/ boring locations and numbers and the statistical sampling design are documented in the Field Sampling Plan (FSP).

3.2.4 Completeness

Completeness is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples. Completeness is calculated and reported for each method, matrix and analyte combination. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness requirements, valid results are all results not qualified with an "R" flag (see Section 8 for an explanation of flagging criteria). The requirement for completeness is 95 percent for aqueous samples and 90 percent for soil samples. For any instances of samples that could not be analyzed for any reason (holding time violations in which resampling and analysis were not possible, samples spilled or broken, etc.), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported.

The formula for calculation of completeness is presented below:

$$\% \text{ completeness} = \frac{\text{number of valid (i.e., non-R-qualified) results}}{\text{number of possible results}}$$

3.2.5 Comparability

Comparability is the confidence with which one data set can be compared to another data set. The objective for this QA/QC program is to produce data with the greatest possible degree of comparability. The number of matrices that are sampled and the range of field conditions encountered are considered in determining comparability. Comparability is achieved by using standard methods for sampling and analysis, reporting data in standard units, normalizing results

to standard conditions and using standard and comprehensive reporting formats. Complete field documentation using standardized data collection forms shall support the assessment of comparability. Analysis of PE samples and reports from audits shall also be used to provide additional information for assessing the comparability of analytical data produced among subcontracting laboratories. Historical comparability shall be achieved through consistent use of methods and documentation procedures throughout the project.

3.3 DATA QUALITY EVALUATION

The objective of the data quality evaluation (DQE) was to provide a review of the chemical data packages submitted by the laboratory and to qualify that data relative to the data quality objectives (DQOs) stated in the GSAP (CH2M HILL, 1996a). The DQE consisted of review of laboratory quality control data and field quality control parameters; and flagging of the data as usable, usable with qualification, or unusable. The application of the results of the DQE are discussed in Section 3.4.

3.3.1 Laboratory Quality Control

The data quality relative to laboratory analyses was evaluated using criteria stated in the GSAP for each analytical method performed (CH2M HILL, 1996a). The following information was reviewed:

- Sample Integrity
- Sample Completeness
- Sample Holding Times
- Laboratory Methods for Extraction and Analysis
- Method Accuracy and Precision (Matrix Spike/Matrix Spike Duplicate)
- Laboratory Performance Criteria (Blanks, LCS Recoveries)
- Instrument Calibrations

One MS/MSD pair was collected from each area of investigation and submitted for analysis. The results for each MS/MSD pair were used to assess method accuracy and precision across all results for the associated area. The laboratory also provided results for additional MS/MSDs which were analyzed as batch QC. These data were not used to evaluate project precision and accuracy as they were not uniformly performed on samples submitted by HydroGeoLogic and cannot be used to evaluate matrix effects on samples from NAS Fort Worth.

3.3.2 Field Quality Control

Field quality control parameters were evaluated through field duplicates, field blanks, field documentation, and shipping criteria.

The field duplicates collected for the Third Quarterly Monitoring Investigation are identified below with their corresponding field samples.

<u>Duplicate</u>	<u>Field Sample</u>
DUP01WG01	LF05-19WG01
DUP02WG01	GMI-22-05MWG01
DUP03WG01	ST14-WG01
DUP04WG01	LF01-1CWG01
DUP05WG01	ST14-26WG01

Equipment blanks were submitted for analysis only for those analyses which corresponded to the analyses requested for the field sample collected by that piece of equipment. Consequently, only the equipment blanks EB-072297 and EB-072397 were submitted for metal analysis. Calcium, copper, and zinc in EB-072297, and copper and potassium in EB-072397, were detected at concentrations below the PQL but above the MDL. Based on these results, it is possible that samples collected on days where the equipment blank was not analyzed for metals were affected by inadequate decontamination of the field equipment, possibly leading to biased high or false positive results. Of the four metals detected, only copper exceeded background concentrations; however, the RRS2 value for copper was not exceeded in the samples collected at NAS Fort Worth JRB.

Equipment blanks collected during future sampling events will be analyzed for the same parameters as target samples collected that day.

Those analytes detected in all blanks associated with this quarterly investigation (both laboratory and field blanks) are summarized in Table 3.3.2.

3.4 QUALIFICATION OF FIELD DATA

The DQE was used to apply data qualifiers ('flags') which indicate to the user that a datum being considered has been qualified using the established criteria. The specific reason for each qualification is documented on the evaluation forms maintained in the project file. A brief explanation is provided on Table 3.2. Those data for each investigation area requiring qualification are discussed in the following subsections.

3.4.1 Landfill Area Groundwater

Ten groundwater samples and one field duplicate were collected from the Landfill Area and analyzed for one or more of the following parameters: VOCs, metals by Inductively Coupled Plasma (ICP), silver and thallium by graphite furnace atomic absorption (GFAA) and mercury. No data were rejected. The Landfill Area groundwater data are usable with qualification as described below.

VOCs - The relative percent difference between sample LF05-19WG01 and its field duplicate DUP01-WG01 exceeded control limits for trichloroethene. The trichloroethene results for both samples were qualified with a "J" flag.

ICP Metals - The aluminum result in sample LF05-18WG01 was affected by contamination in the continuing calibration blank; however, aluminum was detected below the practical quantitation limit (PQL). The sample result retains an "F" qualifier.

GFAA Metals - The analytical result for thallium is qualified as estimated and flagged "UJ" in sample LF05-18WG01 due to a low post digestion spike recovery.

Mercury - The mercury data are usable without qualification.

3.4.2 Flightline Area Groundwater

Ten groundwater samples and one field duplicate were collected from the Flightline Area and analyzed for one or more of the following parameters: methane, ethane and ethene, VOCs, metals by ICP, silver and thallium by GFAA, mercury, organic anions, TOC and alkalinity. In addition, sample GMI-22-02MWG01 was analyzed for total dissolved solids (TDS). No data were rejected. The Flightline Area groundwater data are usable with qualification as described below.

The cooler temperature associated with sample USGA04TWG01 exceeded 8° Celsius. Consequently, all sample results, excluding ICP and GFAA metals, which were above the PQL or below the MDL received either "J" or "UJ" qualifiers. Those sample results with concentrations between the MDL and PQL were affected, but retain their "F" flags.

Methane, Ethane and Ethene - The methane results in samples GMI-22-02MWG01 and GMI-22-07MWG01 are affected by contamination in the corresponding method, field equipment and trip blanks; however, sample results are detected below the PQL, and therefore, retain their "F" flags.

VOCs - A matrix spike/matrix spike duplicate (MS/MSD) was performed on sample GMI-22-02MWG01. The relative percent difference (RPD) between the MS and MSD exceeded control limits for naphthalene. The naphthalene results for samples located within the Flightline Area (GMI-22-02MWG01, GMI-22-04MWG01, DUP02-WG01, GMI-22-06MWG01, GMI-22-07MWG01, LSA1628-3WG01, SPOT35-2WG01, SPOT35-4WG01, SPOT35-5WG01 and USGA04TWG01) are qualified as estimated and flagged either "J" or "UJ". The naphthalene result in sample GMI-22-05MWG01 is affected by the high RPD; however, this result is reported below the PQL and retains its "F" flag.

The field duplicate samples GMI-22-05MWG01 and DUP02-WG01 exhibited high RPDs for ethylbenzene, toluene, o-xylene and m,p-xylene. These compounds are qualified as estimated and flagged "J" in sample GMI-22-05MWG01. Toluene and m,p-xylene are qualified "J" in duplicate sample DUP02-WG01. Ethylbenzene and o-xylene are reported below the PQL, and therefore, retain their "F" flags.

ICP Metals - The copper result in samples DUP02-WG01, GMI-22-05MWG01 and USGA04TWG01, and the aluminum result in sample GMI-22-05MWG01 are affected by CCB contamination; however, these analytes are reported below the PQL and remain qualified with "F" flags.

GFAA Metals - Samples DUP02-WG01 and GMI-22-05MWG01 received "UJ" qualifiers for silver due to low post digestion spike recoveries. Sample USGA04TWG01 received "UJ" qualifiers for silver and thallium due to poor post digestion spike recoveries.

Mercury - The mercury data are usable without qualification.

Common Anions - Sulfate is qualified "U" in sample SPOT35-5WG01 due to possible contamination from the laboratory method and field equipment blanks.

TOC - Samples GMI-22-04-MWG01 and GMI-22-06MWG01 received "U" qualifiers for total organic carbon due to contamination in their associated field equipment blanks.

Alkalinity - The alkalinity data are usable without qualification.

TDS - The analytical holding time for TDS was exceeded by seven days in sample GMI-22-02MWG01. The TDS result for this sample received a J-qualifier.

3.4.3 East Area Groundwater

Thirty-two groundwater samples and three field duplicates were collected from the East Area and analyzed for one or more of the following parameters: methane, ethane and ethene, BTEX, VOCs, ICP, silver and thallium by GFAA, mercury, organic anions, total organic carbon (TOC) and alkalinity. No data were rejected. The East Area groundwater data are usable with qualification as described below.

The cooler temperature associated with samples LF01-1CWG01, DUP04-WG01, LF01-1EWG01, MW-5WG01, MW-8WG01, MG-9WG01, MW-12WG01, OT-15CWG01, SD13-01WG01, SD13-02WG01, SD13-04WG01, SD13-06WG01, ST14-03WG01, ST14-26WG01, DUP05, WG01, and ST14-28WG01 exceeded 8° Celsius. Consequently, all sample results above, excluding ICP and GFAA metals, which were the PQL, or below the MDL, received either "J" or "UJ" qualifiers. Those sample results with concentrations between the MDL and PQL were affected, but retain their "F" flags.

Methane, Ethane and Ethene - The methane results in samples MW-3WG01 and ST14-W31WG01 were affected by contamination in the field equipment blank and trip blank; however, both results were below the PQL. Hence, both samples retain their "F" flags.

Sample BSS-AWG01 received a "U" qualifier for methane due to contamination in the associated trip blank. Methane was present at reportable concentrations in the trip blank associated with samples DUP05-WG01 and ST14-26WG01. However, both sample results are less than the PQL. Methane remains qualified with an "F" flag.

A relative percent difference (RPD) exceedance was observed for methane between field duplicate samples ST14-26WG01 and DUP05-WG01. Since both sample results were reported below the PQL, methane retains "F" qualifiers.

BTEX - The following qualifications pertain to percent difference exceedances between the analytical results detected on the initial and confirmation columns. Sample BSS-BWG01 received "J" qualifiers for ethylbenzene and xylenes (total). Sample MW-1WG01 received "J" qualifiers for benzene and toluene. Sample MW-5WG01 received "J" qualifiers for benzene, toluene and xylenes (total). Sample SD13-04WG01 received a "J" qualifier for xylenes (total). Benzene results in samples ST14- W16WG01 and ST14-W18WG01 are qualified as estimated and flagged "J". Sample ST14-W21WG01 received a "J" qualifier for benzene.

Samples MW-8WG01 and ST14-03WG01 were affected by the toluene contamination in their associated trip blanks; however, both analytical results are below the PQL. Toluene results remain qualified with "F" flags.

The RPD for toluene exceeded control limits between field duplicate samples ST14-04WG01 and DUP03-WG01. Since both results were below the PQL, toluene retains the "F" flags. A positive result for xylene was detected in the field duplicate sample, and a non-detect result was reported in the field sample. Xylene is qualified "UJ" in sample ST14-04WG01; however, the field duplicate, DUP03-WG01, exhibited a concentration below the PQL and remains qualified an "F" flag.

VOCs - Sample OT-15CWG01 received a "U" qualifier for chloroform due to contamination in the field equipment blank.

ICP Metals - Iron results in samples DUP05-WG01 and ST14-26WG01 are affected by contamination in their associated continuing calibration blanks (CCB). However, these analytes are reported below the PQL; therefore, blank qualification is not rendered.

The analytical results for copper were affected by contamination in the associated CCBs and/or field equipment blanks. However, the following sample results were reported below the PQL; hence, blank qualification was not rendered: DUP04-WG01, LF01-1CWG01, LF01-1DWG01, LF01-1EWG01, OT- 15CWG01, MW-9WG01, MW-10WG01, MW-11WG01, MW-12WG01, ST14-W21WG, ST14- 24WG, DUP05-WG01, and ST14-26WG01.

Potassium was detected in either the corresponding CCBs, laboratory method blanks and/or field equipment blanks associated with samples OT-15CWG01, MW-11WG01, SD13-06WG01, ST14-W21WG, DUP05-WG01 and ST14-26WG01. However, sample results were below the PQL, and potassium retains its "F" qualifiers.

Sample MW-12WG01 contained zinc at a concentration below the PQL. Therefore, the contamination in the associated field equipment blank is not applied.

GFAA Metals - Low post digestion spike recoveries were observed for silver and thallium. Samples DUP04-WG01, LF01-1CWG01, LF01-1DWG01, LF01-1EWG01, OT-15CWG01, MW-9WG01, MW- 10WG01, MW-11WG01, MW-12WG01, SD13-06WG01, ST14-W21WG, ST14-24WG, DUP05- WG01, and ST14-26WG01 received "UJ" qualifiers for silver. Samples MW-9WG01, MW-10WG01, and MW-11WG01 received "UJ" qualifiers for thallium.

A method of standard addition (MSA) was performed for silver in sample ST14-02WG01. The slope of the MSA curve was greater than twenty percent of the slope from the standard curve. Accordingly, silver was qualified as estimated and flagged "J" in sample ST14-02WG01.

Mercury - The mercury data are usable without qualification.

Common Anions - The sulfate results in samples MW-1WG01 and SD13-01WG01 are affected by blank contamination in the initial calibration blank, laboratory method blank and/or field equipment blank; however, the results are detected below the PQL. Sulfate results remain qualified with "F" flags.

Samples MW-5WG01, ST14-02WG01, DUP03-WG01, ST14-04WG01, ST14-W18WG01, ST14-W21WG01, ST14-28WG01, ST14-29WG01 and 17MWG01 received "U" qualifiers for sulfate due to possible contamination from the laboratory method blank and/or field equipment blank.

TOC - Samples DUP03-WG01, ST14-04WG01, ST14-W21WG01, and ST14-29WG01 received "U" qualifiers for total organic carbon due to contamination in their associated field equipment blanks.

Alkalinity - Samples DUP03-WG01 and ST14-04WG01 received "U" qualifiers for alkalinity due to contamination in the field equipment blank.

3.5 ANALYTICAL RESULTS FOR CONTAMINANTS OF CONCERN

For each VOC sampled, the concentrations were compared to the TNRCC Risk Reduction Rule Standards (RRS) (30TAC335, Subpart S.) These rules specify the information and procedures necessary to demonstrate compliance with one of three primary standards for the closure or remediation of sites to ensure protection of human health and the environment. RRS No. 2 (RRS2) utilizes conservatively applied, risk-based criteria to provide human health and environmental protection without relying upon engineering or institutional controls for site remediation. RRS2 provides options that allow a limited consideration of site-specific conditions.

For inorganic constituents, the concentration in the sample was also compared to the concentration in background samples. The tolerance interval method (EPA 1989, 1992) was used by Jacobs (1997) to establish reasonable background concentrations from collected field data. According to this method, the concentration of a given background constituent is expressed as an appropriate upper tolerance limit (UTL) of the distribution of the constituent in the background data population. Jacobs used the $UTL_{95,95}$ as the background value for comparison, which is a value that we can say, with 95 percent confidence, will exceed 95 percent of the background data. Any sample value greater than the $UTL_{95,95}$ has only a 5 percent chance of being drawn from the background population, and thus may indicate the presence of site-related constituents. In cases where the constituent was not detected in any of the background samples, the $UTL_{95,95}$ was equated to one half of the MDL.

A COC, as defined by the TNRCC, is any chemical present in a medium at a concentration level that would pose an unacceptable threat to human health or the environment. For the purpose of

the GSAP report, a COC is an inorganic constituent that exceeds background (Jacobs, 1997), or a VOC that exceeds Risk Reduction Rule Standards (RRS2).

All laboratory analytical data are provided in Appendix C. Table 3.3 provides a list of COCs and the range of concentrations that were detected. A more detailed discussion of the nature and extent of COCs detected in each groundwater management area is provided in the following sections.

3.5.1 Landfill Area Groundwater Analytical Results

Ten groundwater monitoring wells were sampled in the Landfill Area. Analysis of VOCs was performed on samples from all 10 wells, plus one field duplicate from well LF05-19. Analysis of inorganic compounds was performed on samples from two wells plus one field duplicate from well LF05-19. Table 3.4 summarizes the number of contaminants detected above MDL from samples collected at each well.

3.5.1.1 Volatile Organic Compounds

Eleven samples (including one duplicate) were collected from ten wells in the Landfill Area. Table 3.5 provides a complete list of all VOCs detected above the MDLs. TCE and cis-1,2-DCE concentrations in eight wells exceeded the RRS2 values of 5 $\mu\text{g/L}$ and 70 $\mu\text{g/L}$, respectively. The vinyl chloride concentration exceeded the RRS2 value in one well.

Figure 3.3 estimates the extent of concentrations of TCE in the Landfill Area. TCE was not detected above MDL in samples collected from LF04-10 only. TCE was detected above MDL in samples collected from the other 9 wells sampled in the Landfill Area. TCE was detected at its highest level (2,800 $\mu\text{g/L}$) at well WP07-10B located adjacent to SWMU 24, described as a waste burial area. TCE was also detected at high levels at LF04-4F (2,300 $\mu\text{g/L}$) located adjacent to Landfill 4 GMI-04-01M (1,400 $\mu\text{g/L}$) located downgradient from all SWMUs in the Landfill Area and WP07-10C (1,400 $\mu\text{g/L}$), located adjacent to Landfill 5. Samples from wells upgradient from the SWMUs in the Landfill Area, FT09-12C and LF05-02, contained lower levels of TCE still above MDL (3.3 $\mu\text{g/L}$ and 130 $\mu\text{g/L}$ respectively). Cis-1,2-DCE, a degradation product of TCE, was detected in samples collected from 9 wells in the Landfill Area. Cis-1,2-DCE was detected at its highest level (390 $\mu\text{g/L}$) at well LF04-4F, located adjacent to Landfill 4. Figure 3.4 estimates the extent of contaminants of Cis-1,2-DCE in the Landfill Area. Cis-1,2-DCE was not detected in samples collected from LF04-10.

Vinyl chloride, a degradation product of Cis-1,2-DCE, was detected above MDL in one sample collected from FT09-12C (6.6 $\mu\text{g/L}$). This well is near SWMU 19, 20, and 21 (fire training area and storage tanks).

3.5.1.2 Inorganic Constituents

Three samples (including one duplicate) were collected for inorganic analyses from two wells, LF05-18 and LF05-19, located downgradient from the SWMUs in the Landfill Area. The results of the analysis of inorganic constituents are presented in Table 3.6. The concentration of copper

in one sample was 0.0052 mg/L, which exceeded the background concentration of 0.0028 mg/L. No other concentrations exceeded background, and no concentrations exceeded the RRS2 value.

3.5.2 Flightline Area Groundwater Analytical Results

Ten groundwater monitoring wells were sampled in the Flightline Area. Analysis of VOCs was performed on samples from all 10 wells plus one field duplicate from well GMI-22-05M; a total of 11 samples were analyzed for VOCs. Analysis of inorganic compounds was performed on samples from two wells plus one field duplicate from well GMI-22-05M; a total of three samples were analyzed for inorganic compounds. Table 3.7 summarizes the number of contaminants detected above MDL from samples collected at each well.

3.5.2.1 Volatile Organic Compounds

Table 3.8 for a complete list of VOCs detected above MDLs in the Flightline Area. TCE was detected above MDL in samples collected from 3 wells sampled in the Flightline Area. TCE was detected at its highest level (440 $\mu\text{g/L}$) at well GMI-22-04M, located downgradient from AOC 4, described as a fuel hydrant system. TCE was also detected at levels above MDL at LSA1628-3 (400 $\mu\text{g/L}$) located adjacent to SWMU 5 and 6, and GMI-22-06M (220 $\mu\text{g/L}$), located downgradient from all AOCs and SWMUs in the Flightline Area.

The distribution of TCE concentrations in the Flightline Area is presented in Figure 3.5. Samples collected from GMI-22-02M, located upgradient from the AOCs, SWMUs in the Flightline Area, contained levels of TCE below MDL (0.097 $\mu\text{g/L}$). Also, TCE was not detected above MDL in samples collected from GMI-22-05M and USGA04T located near the eastern border of the site, downgradient from all AOCs and SWMUs in the Flightline Area.

Cis-1,2-DCE, a degradation compound of TCE, was also detected in GMI-22-04M (55F $\mu\text{g/L}$), GMI-22-06M (99 $\mu\text{g/L}$) and LSA1628-3 (25F $\mu\text{g/L}$). Only one of these detection was above the RRS2 value of 70 $\mu\text{g/L}$. Trans-1,2-DCE, a degradation compound of cis-1,2-DCE, was detected in GMI-22-06M (67 $\mu\text{g/L}$) and LSA1628-3 (17F $\mu\text{g/L}$). Neither of these detection was above the RRS2 value of 100 $\mu\text{g/L}$. The distribution of Cis-1,2-DCE in the Flightline Area is presented in Figure 3.6.

Fuel and petroleum related compounds, including isopropylbenzene (38 $\mu\text{g/L}$), naphthalene (140 $\mu\text{g/L}$), n-butylbenzene (3.5 $\mu\text{g/L}$), n-propylbenzene (38 $\mu\text{g/L}$), and sec-butylbenzene (13 $\mu\text{g/L}$), were detected in samples collected from three wells located adjacent to AOC4, the former fuel hydrant system.

Other fuel related compounds, including ethylbenzene (0.7J $\mu\text{g/L}$), toluene (1.9J $\mu\text{g/L}$), m&p-xylenes (3J $\mu\text{g/L}$), o-xylene (1.3J $\mu\text{g/L}$) were detected in samples collected at GMI-22-05M located near the eastern border of the Flightline Area.

3.5.2.2 Inorganic Constituents

Three samples (including one duplicate) were collected from two wells, GMI-22-05M and USGA04T, and analyzed for inorganic constituents. Both of these wells are located downgradient from all SWMUs and AOCs in the Flightline Area. Table 3.9 provides the results of the analysis for all constituents which were detected above the MDLs and Figure 3.7 provides a graphical presentation of those constituents above background concentrations.

Copper and iron were found to be above background concentrations in both wells sampled. Manganese was above the background concentration in well USGA04T, and cobalt was slightly above the background concentration in well GMI-22-05M. None of the constituents sampled at these two wells were found at a concentration above the RRS2 values.

3.5.3 East Area Groundwater Analytical Results

Thirty-two groundwater monitoring wells were sampled in the East Area. Analysis of VOCs was performed on samples from 13 wells plus field duplicates from wells LF01-1C and ST14-26; a total of 15 samples were analyzed for VOCs. Analysis of inorganic compounds was performed on samples from 16 wells plus field duplicates from wells LF01-1C and ST14-26; a total of 18 samples were analyzed for inorganic compounds. Table 3.10 summarizes the number of contaminants detected above MDL from samples collected at each well.

3.5.3.1 Volatile Organic Compounds

Table 3.11 provides a complete list of VOCs detected above MDLs in the East Area. Concentrations of 1,2,4-trimethylbenzene, benzene, ethylbenzene, and toluene in the sample from well MW-10 exceeded the RRS2s for these compounds.

3.5.3.2 Aromatic Volatile Organics (BTEX)

Twenty samples (including one duplicate) were collected from 19 wells in the East Area and analyzed for benzene, toluene, ethylbenzene, and toluene using EPA Method SW8020. Table 3.12 provides the results of the analysis. Benzene was detected in five wells at concentrations above the RRS2 value of 5 $\mu\text{g}/\text{L}$. The estimated extent of benzene in the Terrace Alluvium Aquifer is presented in Figure 3.8. Ethylbenzene was detected in wells BSS-B and MW-1 at concentrations above the RRS2 value of 700 $\mu\text{g}/\text{L}$. Toluene was detected in well BSS-B at a concentration of 9,100 $\mu\text{g}/\text{L}$, over 9 times greater than the RRS2 value of 1,000 $\mu\text{g}/\text{L}$. Total xylenes were not detected in any well above the RRS2 value of 10,000 $\mu\text{g}/\text{L}$; the highest concentration detected was 8,500J $\mu\text{g}/\text{L}$ at well BSS-B.

3.5.3.3 Inorganic Constituents

Eighteen samples (including two duplicates) were collected from 16 wells in the East Area and analyzed for inorganic constituents. Table 3.13 provides the results of the analysis for all constituents which were detected above the MDLs and Figure 3.9 provides a graphical presentation of those constituents above background concentrations.

Many of the constituents analyzed appeared in at least one well at concentrations above background. However, only arsenic, cobalt, copper, iron, lead, manganese, and silver were above background concentrations in more than one well. Chromium and nickel concentrations were above RRS2 in well LF01-1B, and the arsenic concentration was above RRS2 in well ST14-W18. No other constituents were found at a concentration above the RRS2 values.

3.6 HISTORICAL CONCENTRATION TRENDS

Concentrations of TCE and cis-1,2-DCE in groundwater from selected wells in the Landfill Area and the Flightline Area were plotted against the date of sample collection for four quarters of 1995 sampling and January, April, and July 1997 sampling events. These plots are displayed in Figure 3.10 and Figure 3.11 in order to characterize the historical trends of these key contaminants. In addition, BTEX concentrations in groundwater were plotted for two wells near the East Area (POL Tank Farm and former Base Service Station) and are shown on Figure 3.12.

3.6.1 Chlorinated Hydrocarbons

The Landfill Area (near Landfills 4 and 5 and the Waste Burial Area) and the Flightline Area (at wells GMI-22-04M, GMI-22-06M, and Building 1628) exhibited the highest TCE concentrations base-wide during the July 1997 sampling event. In the past, at least some of the TCE contamination observed in groundwater at NAS Fort Worth JRB is believed to be the result of a TCE migration from AFP4. The data, collected during this quarterly sampling event, do not point to a specific on- and/or off-site source area.

Monitoring wells LF04-4F, LF05-5G, and WP07-10B (Figure 3.10) located in the Landfill Area, and GMI-22-04M, GMI-22-06M, and LSA 1628-3 (Figure 3.11), located in the Flightline Area, known to have consistently high levels of TCE, were used to evaluate the historical trends in chlorinated hydrocarbon concentrations. As expected, a distinct correlation is observed between the relative concentrations of TCE and cis-1,2-DCE. Vinyl chloride, the sequential degradation product of cis-1,2-DCE, was also detected at several of these locations. Previous reported concentrations of vinyl chloride were below MDLs.

In the Landfill Area, the historical trends of TCE and cis-1,2-DCE concentrations generally parallel each other. Concentrations of both compounds decreased slightly from the April 1995 levels to October 1995, then appeared to have gradually increased to January 1997 levels. The trend continued in some instances two-fold or more, between January 1997 and April 1997. TCE levels of July 97 are lower than the corresponding values of January and April 97. When compared to April 1997 values, concentration levels of July 1997 dropped as much as 47% and 66% at wells LF04-4F and LF05-5G, respectively. Concurrently, cis-1,2-DCE concentrations dropped more than 67% at these two wells. However, TCE and cis-1,2-DCE levels of July 1997 followed the historical trends more closely excluding abrupt peaks such as April 1997. In July 1997, maximum TCE concentration in the Landfill Area was observed in well WP07-10B (2800 $\mu\text{g/L}$), where as April 1997 measurements detected maximum concentration in well LF04-4F (4340 $\mu\text{g/L}$).

In the Flightline Area, as in the Landfill Area, the historical trends of TCE and cis-1,2-DCE parallel each other. Similarly, concentrations of both have increased moderately from mid- 1995 (after a significant decrease from April 1995 levels) to January 1997, then increased significantly (more than two-fold for all three wells plotted) between January 1997 and April 1997. Concentration levels dropped significantly (49 to 59%) between April 1997 and July 1997. However, the April and July 1997 trend closely followed the historical trends observed until January 1997. As observed in April 1997, well GMI-22-04M had the maximum TCE concentration during July 1997 event.

3.6.2 BTEX

AOC 1 (former Base Service Station) yielded the highest BTEX concentrations base-wide for July 1997. Contamination at AOC 1 has been attributed to former leaking underground storage tanks (USTs) containing Mogas and waste oil which were removed in May 1993, and May 1996, respectively (CH2M HILL, 1996e). Lower concentrations of BTEX were also detected in the East Area at Site ST-14. Contamination at Site ST-14 was most likely the result of surface spills and subsurface leaks of JP-8 jet fuel and related fuels from pipelines underlying the fueling area of the SMWU 68 (POL Tank Farm). Low concentrations of BTEX detected in the Flightline Area near the AOC 4 (former fuel hydrant system) are believed to be the result of JP-4 jet fuel releases from the fuel hydrant system (USACOE, 1994).

Concentrations of BTEX constituents from the last five base-wide sampling events were plotted for two wells (Figure 3.12). Monitoring well ST14-W16 is located in SWMU 68 and well BSS-B is located downgradient of AOC 1. January 1997 concentrations of BTEX constituents for well MW-10 were not reported.

After an increase in benzene concentrations between April 1995 and July 1995, SMWU 68 (Figure 3.13 by well ST14-W16), benzene concentrations have decreased to their present levels. This decrease is believed to be attributed, in part, to remedial activities associated with the BTEX plume at this site.

No significant historical trends in the concentrations of BTEX compounds are apparent in the data plotted on Figure 3.10 for well BSS-B. The concentrations, although relatively high compared to those in the SMWU 68, have remained relatively stable over the monitoring period except for toluene levels in well BSS-B over the 1995 monitoring period.

3.6.3 Inorganic Constituents

Previously, inorganics detected above RRS2 during the April 1997 sampling event included lead, antimony, arsenic, chromium, and nickel. Since January 1997, the concentrations of lead, antimony, and arsenic concentrations have decreased slightly. The elevated concentrations of nickel and chromium this quarter appear to be isolated incidences. Prior sampling events do not indicate levels of nickel and chromium. In general, the levels of inorganic constituents were higher in 1979 than April 1997. This is likely due to different sampling techniques used by LAW (bailer sampling instead of micropurging and low-flow sampling). Inorganic concentrations in groundwater sampled by bailer tend to result in higher concentrations.

The 1995 monitoring data indicated three areas of elevated lead concentrations on base: SWMU 68, AOC 1, and SWMU 8 (Sludge Collection Tank). However, different wells, and a greater number of wells were sampled for inorganics analysis during other monitoring events as compared to the present monitoring program. Therefore, the change of lead concentration over time can not be characterized.

3.7 NATURAL ATTENUATION PARAMETER RESULTS

In 1994, natural attenuation data from the POL Tank Farm/Site ST-14 area were collected (Parsons, 1996) to support the premise that BTEX compound are being naturally attenuated in the study area. This effort is consistent, as outlined in the GSAP (CH2M HILL, 1996a), with the long-term objectives to establish a process for collecting data in support of SWMU/AOC closure, and to identify and confirm potential impacts to off-site receptors. Specifically, the impact of natural attenuation processes on the migration of contamination needs to be established. Evaluation of natural attenuation data from the Landfill and Flightline Areas will be conducted after study of the East Area data is concluded.

Twenty-five monitoring wells were selected for analysis of natural attenuation parameters. Table 3.14 lists all natural attenuation parameter data, and Figures 3.13 through 3.15 show the distribution of natural attenuation parameters for the East Area only.

3.7.1 Dissolved Oxygen

During aerobic biodegradation, dissolved oxygen (DO) concentrations decrease due to the biological oxygen demand (BOD). After DO depletion, anaerobic microbes use nitrate as an electron acceptor, followed by iron (III), sulfate, and finally carbon dioxide, which leads to the production of methane (methanogenesis). Each sequential reaction further decreases the oxidation-reduction potential, or Eh of the groundwater (AFCEE, 1996). DO concentrations measured in selected wells in the East Area are shown on Figure 3.13. There appears to be a correlation between fuel hydrocarbon contamination and DO depletion in the East Area. DO appears to be depleted at sampling locations in the Flightline Area associated with contamination of TCE (wells GMI-22-04M, GMI-22-06M, and LSA1628-3) and BTEX (wells SPOT-35-2, SPOT-35-4, and SPOT-35-5).

3.7.2 Ferrous Iron

In some cases, ferric iron is used as an electron acceptor during anaerobic biodegradation, and during the process is reduced to ferrous iron. Elevated ferrous iron concentrations are indicative of natural attenuation. Figure 3.14 shows ferrous iron concentrations for selected wells in the East Area. The range of these analytical results (below detection to 10.56 mg/L) are much lower than previous ferrous iron results (ranging from below detection to 680 mg/L) (Parsons, 1996). A field analytical method (Hach 8146) was used for both events. However, a change in the dilution factors may explain the significant differential in concentration.

3.7.3 Sulfate

After depletion of DO, nitrate, and Fe^{3+} , sulfate may be used as an electron acceptor for anaerobic biodegradation. During this process, sulfate is reduced to sulfide. The presence of decreased concentrations of sulfate may indicate the occurrence of sulfate reduction. In general, sulfate concentrations are low (up to 4.7 mg/L) in areas of Site ST-14 characterized by BTEX contamination as compared to uncontaminated areas which are up to 49.9 mg/L. These results are consistent with previous findings (Parsons, 1996) where background sulfate concentrations were approximately 0.57 mg/L and as high as 120 mg/L in uncontaminated areas. In areas associated with BTEX contamination, sulfate concentrations also appear to be relatively low in the Flightline Area near the SPOT 35 wells (Table 3.14).

3.7.4 Methane

During methanogenesis, carbon dioxide is used as an electron acceptor and methane is produced. The presence of methane indicates that methanogenesis has occurred and may have resulted in biodegradation of contaminants. This process generally occurs after depletion of DO, nitrate, Fe^{3+} , and sulfate. Methane concentrations, shown on Figure 3.15, are high relative to background levels at Site ST-14, with the highest detection at well SD13-01 (4,400 $\mu\text{g/L}$). Elevated methane concentrations also were encountered in wells downgradient of the AOC1, and in the Flightline Area near the SPOT-35 wells. The highest concentration was exhibited by well MW-1 (7,500 $\mu\text{g/L}$).

3.7.5 Alkalinity

Alkalinity is an indicator of the buffering capacity of the groundwater (i.e., against acids generated during both aerobic and anaerobic biodegradation) (AFCEE, 1996b). Areas contaminated with fuel hydrocarbons usually exhibit a higher total alkalinity relative to background areas. Well MW-1 exhibited the highest alkalinity concentration (490 mg/L). Alkalinity concentrations also appear to be slightly elevated in areas of the Tank Farm and the Flightline Area, both areas associated with VOC contamination.

3.7.6 Oxidation-Reduction Potential

The oxidation-reduction potential (Eh) measures the relative tendency of a solution or reaction to transfer or accept electrons. Since some biological processes operate only within a prescribed range of Eh conditions, Eh can be an indicator of the type of processes that are occurring. Each sequential degradation process will progressively decrease the Eh of the groundwater. Negative Eh levels are measured during sulfate reduction and methanogenesis. Negative Eh values correspond with wells that exhibit low sulfate concentrations and high methane concentrations. This relationship is exhibited in some cases in the samples collected from on-site wells (Table 3.14).

The oxidation-reduction potential values recorded for this quarterly monitoring event are inconsistent with other natural attenuation data. The inconsistency is due to a malfunctioning meter, as referenced in the field notes. The meter was returned to the vendor after experiencing

fluctuations in the readings. The vendor confirmed the problem after testing the instrument. Interpretation of the natural attenuation data should focus on alternate parameters.

3.7.7 Total Organic Carbon

Total organic carbon (TOC) has been used to classify contaminant plumes and to determine whether anaerobic metabolism of chlorinated solvents is possible in the absence of anthropogenic carbon (AFCEE, 1996b). Table 3.14 lists the TOC results for selected wells.

TAB

Section 3.0 Tables

**Table 3.1 Water Table Elevations
January and July 1997**

	Well_ID	Easting	Northing	Top of Casing Elevation	Groundwater Elevation January 1997	Groundwater Elevation July 1997
<i>East Area Wells</i>	15B	2301032.08	6963338.735	567.589	559.139	559.62
	17I	2299626.674	6963642.662	578.129	567.019	568.35
	17J	2299584.431	6963780.053	579.943	568.323	569.83
	17K	2299799.209	6963578.343	575.469	565.359	566.73
	17L	2299741.167	6963812.735	577.321	566.511	567.97
	17M	2300037.82	6963761.95	NA	NA	NA
	BSS-A	2300115.431	6965491.098	566.493	561.433	561.88
	BSS-B	2300085.914	6965811.954	569.405	559.645	560.20
	LF01-1B	2301057.008	6964700.806	560.182	546.592	550.44
	LF01-1C	2301376.05	6964438.037	562.148	544.788	548.74
	LF01-1D	2301412.716	6964268.176	563.909	545.359	549.73
	LF01-1E	2301174.3	6964606.025	562.113	545.153	548.95
	MW-1	2300345.606	6965853.592	560.635	548.725	553.37
	MW-2	2300555.919	6965704.96	557.55	546.26	549.63
	MW-3	2299750.342	6965242.674	576.475	564.875	566.23
	MW-5	2300138.608	6965803.452	563.687	560.447	560.63
	MW-6	2300173.696	6965734.917	562.873	560.553	560.82
	MW-7	2300055.237	6965967.108	567.37	558.9	559.87
	MW-8	2300491.789	6965584.178	557.036	549.586	552.76
	MW-9	2300329.174	6966001.958	559.538	549.558	553.93
	MW-10	2300541.575	6965836.203	558.848	545.146	549.25
	MW-11	2300791.955	6965708.661	558.167	531.987	536.04
	MW-12	2300142.021	6966149.318	559.621	550.421	554.65
	MW-20	2296878.439	6963365.698	611.36	591.93	591.95
	MW-37	2299384.988	6965061.349	590.529	581.579	581.93
	MW1-16	2300068.63	6963755.16	NA	NA	NA
	PI-U9	2300053.58	6965632.91	NA	NA	NA
	SD13-01	2300621.423	6963391.743	573.089	560.829	561.41
	SD13-02	2300753.03	6963487.702	573.279	560.119	560.65
	SD13-03	2300699.63	6963362.921	571.414	560.244	560.75
	SD13-04	2300770.955	6963361.521	569.078	559.418	559.98
	SD13-05	2300775.292	6963904.275	571.535	562.405	562.72
	SD13-06	2300907.827	6963164.35	557.677	547.467	547.77
	SD13-07	2301009.342	6963167.041	560.438	542.576	543.86
	ST14-01	2300089.327	6963307.935	575.945	562.055	562.83
	ST14-02	2300089.486	6963524.076	575.513	563.363	564.24
	ST14-03	2299888.427	6964091.765	576.679	566.899	568.70
	ST14-04	2300342.951	6963656.498	575.607	563.047	563.91
	ST14-14	2299735.22	6964309.76	NA	NA	NA
	ST14-24	2299084.2	6964017.889	594.138	582.956	583.39
	ST14-25	2299065.36	6964583.76	NA	NA	NA
	ST14-26	2299557.04	6964593.25	NA	NA	NA
	ST14-27	2300212.35	6964257.94	NA	NA	NA
	ST14-28	2300495.99	6963728.32	NA	NA	NA
	ST14-29	2300512.775	6963527.787	571.446	561.846	562.57
ST14-30	2300466.182	6963211.534	588.872	561.252	561.67	
ST14-W05	2299093.85	6963726.062	593.632	585.092	585.83	
ST14-W06	2299330.792	6963806.563	581.417	571.757	573.13	
ST14-W07	2299393.809	6963614.609	579.96	568.11	569.76	
ST14-W08	2299479.591	6964323.981	580.535	569.695	571.30	
ST14-W09	2299550.097	6963471.685	575.54	567.07	568.65	
ST14-W10	2299730.125	6963949.34	573.985	567.505	568.93	
ST14-W11	2299657.972	6964128.603	576.308	569.018	570.46	
ST14-W12	2299581.062	6963953.266	575.517	569.777	571.19	
ST14-W13	2299776.442	6963695.163	574.487	568.177	567.54	
ST14-W15	2299923.113	6963315.787	573.474	562.984	563.63	
ST14-W16	2300128.304	6964064.608	573.62	565.21	566.55	
ST14-W18	2300162.474	6963906.725	573.789	564.599	565.71	
ST14-W19	2300203.607	6963899.799	573.312	563.662	564.53	
ST14-W20	2300275.355	6964009.08	573.48	564.31	565.13	
ST14-W21	2300242.02	6963417.822	572.884	562.614	563.33	
ST14-W22	2301016.385	6963649.635	571.301	561.311	561.74	
ST14-W23	2300410.368	6962949.056	565.601	559.551	560.21	
ST14-W31	2300830.861	6963549.672	571.234	560.704	561.22	
ST14-W32	NA	NA	NA	NA	NA	
USGS05P	2299736.772	6965287.814	576.77	NF	538.99	
USGS06P	2297557.582	6963772.044	606.713	NF	548.79	
USGS06T	2297542.147	6963763.468	606.673	588.313	589.46	
<i>Flightline Area Wells</i>	GMI-22-02M	2296186.804	6966618.858	619.129	608.789	610.12
	GMI-22-03M	2298536.703	6966206.079	608.034	587.294	587.83
	GMI-22-04M	2297339.007	6967235.898	610.702	590.662	591.61

Well_ID	Easting	Northing	Top of Casing Elevation	Groundwater Elevation January 1997	Groundwater Elevation July 1997
GMI-22-05M	2299431.878	6966928.352	584.28	572.58	575.08
GMI-22-06M	2298186.199	6966990.687	606.842	588.322	589.06
GMI-22-07M	2298321.676	6969004.353	605.66	589.89	591.48
GMI-22-08M	2298970.215	6970309.355	606.942	590.582	592.18
HM-116	2294283.721	6966412.381	634.06	610.48	612.95
HM-117	2294274.322	6967356.25	633.318	611.038	613.27
HM-118	2294780.422	6968036.082	626.234	610.244	612.48
HM-119	2294271.689	6968727.198	625.043	611.023	613.28
HM-120	2295343.029	6969490.055	616.838	611.648	614.02
HM-121	2295279.205	6967391.16	627.663	609.163	610.54
HM-124	2295223.46	6963958.786	623.258	607.868	611.40
HM-125	2295220.292	6965893.458	629.366	610.336	613.19
LSA1628-3	2297791.257	6967993.079	601.732	591.242	592.57
MW-1A	2301542.45	6970397.32	NA	NA	NA
MW-11A	2297057.278	6965810.342	612.171	589.391	590.11
MW-19	2295368.85	6963512.61	NA	NA	NA
MW-38	2298153.077	6965981.062	604.109	587.929	588.81
MW-48	2295643.543	6968478.952	619.326	608.916	610.23
MW-53	2296200.241	6964378.184	616.75	600.62	602.04
MW-58	2296055.932	6968789.529	614.321	606.291	606.95
MW-57	2297112.96	6967217.16	613.368	600.088	601.66
MW-57B	2296034.177	6968836.004	613.776	606.088	606.76
SPOT35-1	2296878.532	6966202.395	613.59	590.7	591.45
SPOT35-2	2296854.203	6966175.269	613.635	591.875	592.68
SPOT35-4	2296777.882	6966174.924	612.739	591.969	592.80
SPOT35-5	2296846.726	6966020.036	614.09	591.88	592.74
SPOT35-7	2296508.592	6966534.791	616.408	608.676	609.89
USGS01P	2297664.372	6970367.26	604.83	NF	574.39
USGS01T	2297660.422	6970383.919	604.785	593.255	594.43
USGS02T	2300335.041	6970326.57	604.206	585.906	NF
USGS03T	2300608.98	6968690.536	575.015	571.285	571.42
USGS04T	2299177.629	6968758.861	604.923	586.783	588.06
W-153	2294098.507	6965107.145	631.568	610.238	612.96
Landfill Area Wells					
FT08-11A	2295877.924	6962320.529	608.153	596.093	600.17
FT08-11B	2295930.494	6962033.727	608.047	597.407	600.39
FT09-12A	2295444.952	6960550.799	635.384	617.374	621.19
FT09-12B	2295702.537	6960711.211	627.364	595.294	598.42
FT09-12C	2295776.808	6960592.732	627.863	594.923	598.01
FT09-12D	2295747.783	6960889.736	627.26	595.51	598.72
FT09-12E	2295826.279	6960703.506	627.338	594.988	598.07
GMI-04-01M	2296728.134	6960931.26	613.768	NA	595.22
HM-111	2293265.658	6963623.549	636.494	610.204	614.07
HM-114	2294352.05	6963913.38	NA	NA	NA
HM-122	2295260.535	6962891.108	619.441	599.991	602.37
HM-123	2295273.071	6961639.474	624.852	597.392	601.12
HM-126	2294300.504	6963121.979	622.888	607.748	NF
HM-127	2294853.212	6961589.394	624.036	598.148	566.21
ITMW-01T	2298967.14	6961062.05	NA	NA	NA
LF04-01	2295382.891	6961027.715	629.164	596.864	600.17
LF04-02	2296313.704	6961116.666	623.441	593.721	596.31
LF04-04	2297169.758	6960947.279	611.954	592.414	592.57
LF04-10	2297084.938	6960417.453	626.472	592.722	595.21
LF04-4A	2295852.984	6960300.484	625.84	612.25	617.65
LF04-4B	2296274.338	6960323.911	619.853	600.353	602.47
LF04-4C	2296593.501	6960604.002	612.962	593.242	595.93
LF04-4D	2296416.385	6960831.587	615.128	593.638	596.35
LF04-4E	2296410.998	6961036.036	618.489	593.819	596.20
LF04-4F	2296058.767	6961061.85	625.28	594.69	597.62
LF04-4G	2296658.929	6961224.127	619.754	591.824	594.70
LF04-4H	2296721.26	6960928.75	NA	NA	NA
LF05-01	2294577.894	6962727.628	621.884	601.904	604.55
LF05-02	2295279.205	6962654.333	622.812	596.602	599.16
LF05-14	2296543.61	6961582.305	611.791	NA	594.96
LF05-18	2297077.935	6961560.048	611.708	592.018	593.56
LF05-19	2297465.123	6961246.474	608.05	591.37	592.78
LF05-5A	2295580.896	6961438.557	622.899	596.859	600.32
LF05-5B	2296078.246	6961901.555	597.174	592.474	593.73
LF05-5C	2295893.73	6961720.051	608.561	596.151	598.94
LF05-5D	2295757.035	6961740.466	611.397	597.247	601.92
LF05-5E	2295550.36	6961177.867	626.703	596.593	600.16
LF05-5F	2296336.36	6961288.64	NA	NA	NA
LF05-5G	2296536.324	6961581.317	615.279	593.309	594.92
LF05-5H	2296343.797	6961735.963	610.612	593.802	595.43
MW-12A	2295756.2	6961041.92	NA	NA	NA

Well_ID	Easting	Northing	Top of Casing Elevation	Groundwater Elevation January 1997	Groundwater Elevation July 1997
MW-IT-02T	2292816.01	6965366.41	NA	NA	NA
OT-15C	2300947.512	6963316.339	564.251	555.811	556.33
USGS07P	2295251.112	6960150.807	632.1	NF	545.26
USGS07T	2295245.824	6960168.183	632.426	620.646	624.24
WP07-10A	2295811.284	6961292.961	626.5	596.22	599.79
WP07-10B	2296044.506	6961280.516	624.223	594.683	597.12
WP07-10C	2296065.422	6961578.291	617.179	595.849	597.98

NA Data not available due to missing survey data
NF Well not found during monitoring event

Table 3.2
Data Qualification Flags
Quarterly Groundwater Sampling Event (July 1997)
NAS Fort Worth, JRB

Flag	Positive Results	Negative Results
<i>Flags for Data Within Acceptance Limits (Usable as Reported)</i>		
(no flag)	(Use datum without qualification)	(Not applicable)
U	(Not applicable)	The analyte was analyzed for, but not detected. The associated numerical value is at or below the method detection limit (MDL). (Use datum without qualification.)
<i>Flags for Data Within Action Limits (Usable with Qualification)</i>		
F	The analyte was positively identified, but the associated numerical value is below the practical quantitation limit (PQL).	(Not applicable)
J	The analyte was positively identified; the quantitation is an estimation.	(Not applicable)
UJ	(Not applicable)	The analyte was not detected; the quantitation limit is an estimation.
<i>Flags for Data Outside of Action Limits (Unusable)</i>		
R	The data were unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.	The data were unusable due to deficiencies in the ability to analyze the sample and meet QC criteria.
<p>NOTE: If the results suggest contradictory flags, the following hierarchy should be used to select the appropriate flag to assign:</p> <p style="text-align: center;">R > F > J/UJ > U</p>		

Table 3.3
Range of Contaminants of Concern (COCs)

Contaminant of Concern	Range Above MDL	Background Values ¹	RRS2 Values ²
<i>Volatile Organic Compounds (µg/L)</i>			
1,2,4-trimethylbenzene	0.74 - 2,600	-	8.4
TCE	3.3 - 2,800	-	5
cis-1,2-DCE	25 - 390	-	70
Benzene	0.24 - 4,200	-	5
Ethylbenzene	0.24 - 4,800	-	700
Tolulene	0.14 - 9,100	-	1000
Vinyl Chloride	6.6 - 16F	-	2
Xylene (total)	0.75 - 13,100	-	10000
<i>Inorganic Constituents (mg/L)</i>			
Antimony	ND - 0.0045	0.001	0.006
Arsenic	0.019 - 0.058	0.0025	0.05
Chromium	0.0057F - 1.4	0.006	0.1
Cobalt	0.005F - 0.07	0.0045	- ⁴
Copper	0.0033F - 0.024	0.0028	1.3
Iron	0.025 - 18.4	0.224	- ⁴
Lead	0.0035F - 0.014	0.0008	0.015
Manganese	0.46J - 5.9	0.175	8.4
Nickel	0.012F - 1.3	0.0204	0.14
Silver	0.00075J - 0.0041	0.0002	0.183
Vanadium	0.0071F - 0.025F	0.0123	0.256

¹ Risk Reduction Rule Standard No. 2 (RRS) from Texas Natural Resource Conservation Commission (TNRCC) 30TAL335, Subpart S.

² Background concentrations taken from Jacobs, 1997.

³ RRS2 not set for this constituent.

Note: Organic COCs are defined as those organic constituents with at least one sample reading above the Texas Natural Resource Conservation Commission (TNRCC) Risk Reduction Rule Standard No. 2 (RRS2). Inorganic COCs are defined as those inorganic compounds with at least one sample reading above the background concentrations (Jacobs, 1997).

Table 3.4
Landfill Area
Contaminants Detected Above MDL

Well ID	Location/Source Area	No. of VOCs above MDL	No. of Inorganics above MDL¹
FT09-12C	In Between Fire Training Area 2 and Landfill No.4 (SWMU 19 & 22)	7	NA
GMI-04-01M	Downgradient from SWMUs & AOCs	2	NA
LF04-10	Downgradient from SWMUs & AOCs	0	NA
LF04-4F	Northern Border of Landfill 4 (SWMU 22)	2	NA
LF05-02	Upgradient from SWMUs & AOCs	2	NA
LF05-18	Downgradient from SWMUs & AOCs	3	8
LF05-19	Downgradient from SWMUs & AOCs	2	6
LF05-5G	Downgradient from SWMUs & AOCs	2	NA
WP07-10B	Eastern Border of Waste Burial Area (SWMU 24)	3	NA
WP07-10C	Eastern Border of Landfill 5 (SWMU 23)	2	NA

¹ NA - Analysis was not performed at this well.

Table 3.5
Landfill Area
Analytical Results from EPA Method SW8260
(Volatile Organic Compounds)

Well ID	Volatile Organic Compounds (µg/L) ¹									
	1,2-DCB	1,4-DCB	Benzene	TCE	Vinyl chloride	cis-1,2-DCE	tert-Butylbenzene	trans-1,2-DCE	RRS2 Values ²	
FT09-12C	2.6	1.4	3	3.3	6.6	43	0.97 F	0.22 U	600	100
GMI-04-01M	20 U	21 U	16 U	1400	20 U	280	20 U	13 U		
LF04-10	0.13 U	0.14 U	0.11 U	0.097 U	0.13 U	0.13 U	0.13 U	0.088 U		
LF04-4F	26 U	28 U	22 U	2300	26 U	390	26 U	18 U		
LF05-02	6.5 U	7 U	5.5 U	130	16 U	370	6.5 U	35 U		
LF05-18	13 U	14 U	11 U	660	13 U	200	13 U	28 F		
LF05-19	3.2 U	3.5 U	2.8 U	310 J	3.2 U	85	3.2 U	2.2 U		
LF05-5G	6.5 U	7 U	5.5 U	420	6.5 U	140	6.5 U	4.4 U		
WP07-10B	32 U	35 U	28 U	2800	32 U	320	32 U	42 F		
WP07-10C	20 U	21 U	16 U	1400	20 U	230	20 U	13 U		

¹ Shaded blocks indicate sample concentrations greater than RRS2 value.

² Risk Reduction Rule Standard No. 2 (RRS2) from Texas Natural Resource Conservation Commission (TNRCC 30TAC335, Subpart S).

Table 3.6
Landfill Area
Analytical Results from EPA Method SW6010
(Inorganic Constituents)

Inorganic Constituents (mg/L)¹									
Well_ID	Aluminum	Barium	Calcium	Copper	Iron	Magnesium	Manganese	Potassium	Sodium
RRS2 Values²	36.5	2	NA	1.3	NA	NA	8.4	NA	NA
Background³	1.332	0.587	266.3	0.0028	0.224	37.8	0.175	15.03	167.2
LF05-18	0.11 F	0.14	165	0.0025 U	0.069 F	10.4	0.0016 F	1.7 F	59.1
LF05-19	0.082 U	0.14	173	0.0052 F	0.041	10.1	0.0094 F	1.9 F	35.9

¹ Bold blocks indicate values greater than background.

² Risk Reduction Rule Standard No. 2 (RRS2) from Texas Natural Resource Conservation Commission (TNRCC 30 TAC 335, Subpart S).

³ Background concentrations taken from Jacobs, 1997.

Table 3.7
Flightline Area
Contaminants Detected Above MDL

Well ID ¹	Location/Source Area	No. of VOCs above MDL	No. of Inorganics above MDL
GMI-22-02M	Upgradient from Fuel Hydrant System, Building 4150-4154 Fuel Hydrant System (AOC 4)	0	NA
GMI-22-04M	Upgradient from Waste Accumulation Areas (SWMUs 13 & 57)	2	NA
GMI-22-05M	Downgradient from SWMUs & AOCs	6	11
GMI-22-06M	Downgradient from SWMUs & AOCs	3	NA
GMI-22-07M	Downgradient from Building 1641 Waste Accumulation Area (SWMU 39)	0	NA
LSA1628-3	Adjacent to Wash Rack and Drain (SWMU 6)	3	NA
SPOT35-2	Fuel Hydrant System (AOC4)	3	NA
SPOT35-4	Fuel Hydrant System (AOC4)	5	NA
SPOT35-5	Fuel Hydrant System (AOC4)	3	NA
USGS04T	Downgradient from SWMUs & AOCs	3	8

¹ NA - Analysis was not performed at this well.

Table 3.8
Flightline Area
Analytical Results from EPA Method SW8260
(Volatile Organic Compounds)

Volatile Organic Compounds ($\mu\text{g/L}$) ¹													
Well ID	1,2,4-Trimethylbenzene	Ethylbenzene	Isopropylbenzene	Naphthalene	Toluene	Trichloroethene	cis-1,2-Dichloroethene	m-Xylene & p-Xylene	n-Butylbenzene	n-Propylbenzene	o-Xylene	sec-Butylbenzene	trans-1,2-Dichloroethene
RRS2 Values	8.4	700	NA ³	NA ³	1000	5	70	NA ³	NA ³	NA ³	10000	171	100
GMI-22-02M	0.12 U	0.16 U	0.13 U	0.088 UJ	0.14 U	0.097 U	0.13 U	0.27 U	0.14 U	0.12 U	0.11 U	0.14 U	0.088 U
GMI-22-04M	6 U	8 U	6.5 U	4.4 UJ	7 U	440	55 F	14 U	7 U	6 U	5.5 U	7 U	4.4 U
GMI-22-05M	1 F	0.7 J	0.13 U	0.38 F	1.9 J	0.097 U	0.13 U	3 J	0.14 U	0.12 U	1.3 J	0.14 U	0.088 U
GMI-22-06M	3 U	4 U	3.2 U	2.2 UJ	3.5 U	220	99	6.8 U	3.5 U	3 U	2.8 U	3.5 U	67
GMI-22-07M	0.12 U	0.16 U	0.13 U	0.088 UJ	0.14 U	0.097 U	0.13 U	0.27 U	0.14 U	0.12 U	0.11 U	0.14 U	0.088 U
LSA1628-3	6 U	8 U	6.5 U	4.4 UJ	7 U	400	25 F	14 U	7 U	6 U	5.5 U	7 U	17 F
SPOT35-2	1.2 U	1.6 U	24	140 J	1.4 U	0.97 U	1.3 U	2.7 U	1.4 U	24	1.1 U	1.4 U	0.88 U
SPOT35-4	1.2 U	1.6 U	38	72 J	1.4 U	0.97 U	1.3 U	2.7 U	3.5 F	38	1.1 U	13	0.88 U
SPOT35-5	1.2 U	1.6 U	29	76 J	1.4 U	0.97 U	1.3 U	2.7 U	1.4 U	31	1.1 U	1.4 U	0.88 U
USGA04T	0.12 UJ	0.23 F	0.13 UJ	0.088 UJ	0.14 UJ	0.097 UJ	0.13 UJ	0.37 F	0.14 UJ	0.12 UJ	0.4 F	0.14 UJ	0.088 UJ

¹ Shaded blocks indicate sample concentrations greater than RRS2 values.

² Risk Reduction Rule Standard No. 2 (RRS2) from Texas Natural Resource Conservation Commission (TNRCC 30TAC335, Subpart S).

³ RRS2 value not set for this compound.

Table 3.9
Flightline Area
Analytical Results from EPA Method SW6010
(Inorganic Constituents)

Inorganic Constituents (mg/L) ¹											
Well ID	Aluminum	Barium	Calcium	Cobalt	Copper	Iron	Magnesium	Manganese	Potassium	Sodium	Zinc
RRS2 Values ²	36.5	2	NA	NA	1.3	NA	NA	8.4	NA	NA	10.95
Background ³	1.332	0.587	266.3	0.005	0.003	0.224	37.8	0.175	15.03	167.2	0.118
GMI-22-05M	0.1 F	0.14	157	0.0051 F	0.007 F	0.28	14.6	0.17	4.7 F	56.9	0.025
USGA04T	0.082 U	0.032	110	0.0031 U	0.0053 F	0.61	14.7	0.25	4.9 F	35.3	0.012 U

¹ Bold blocks indicate values greater than background.

² Risk Reduction Rule Standard No. 2 (RRS2) from Texas Natural Resource Conservation Commission (TNRCC 30 TAC 335, Subpart S).

³ Background concentrations taken from Jacobs, 1997.

Table 3.10
East Area
Contaminants Detected Above MDL

Well ID	Location/Source Area	No. of VOCs above MDLs ¹	No. of BTEX Constituents above MDLs ¹	No. of Inorganics above MDLs ¹
17M	Downgradient from POL Tank Farm	NA	4	NA
BSS-A	Adjacent to Building 1518 Former Base Service Station/Former Base Gas Station (AOC 1)	NA	0	NA
BSS-B	Adjacent to Building 1518 Former Base Service Station/Former Base Gas Station (AOC 1)	NA	4	NA
LF01-1B	Adjacent to Landfill No.1 (SWMU 28)	5	NA	18
LF01-1C	Adjacent to Landfill No.1 (SWMU 28)	3	NA	10
LF01-1D	Adjacent to Landfill No.1 (SWMU 28)	5	NA	10
LF01-1E	Adjacent to Landfill No.1 (SWMU 28)	2	NA	7
MW-1	Downgradient from SWMUs & AOCs	NA	4	NA
MW-10	Downgradient from SWMUs & AOCs	10	NA	10
MW-11	Downgradient from SWMUs & AOCs	7	NA	8
MW-12	Downgradient from SWMUs & AOCs	3	NA	8
MW-3	Former Base Service Station/Former Base Gas Station (AOC 1)	NA	3	NA
MW-5	Former Base Service Station/Former Base Gas Station (AOC 1)	NA	4	NA
MW-8	Downgradient from SWMUs & AOCs	NA	3	NA
MW-9	Downgradient from SWMUs & AOCs	0	NA	8
OT-15C	Adjacent to French Underdrain System (SWMU 64)	4	NA	8
SD13-01	Former Base Refueling Area (AOC 7)	NA	1	NA
SD13-02	In between RV Storage Area and Former Base Refueling Area (AOC 6 & 7)	NA	0	NA
SD13-04	Adjacent to Former Base Refueling Area (AOC 7)	NA	3	NA

Table 3.10 (continued)
East Area
Contaminants Detected Above MDL

Well ID	Location/Source Area	No. of VOCs above MDLs ¹	No. of BTEX Constituents above MDLs ¹	No. of Inorganics above MDLs ¹
SD13-06	Adjacent to the Unnamed Stream (AOC 14)	4	NA	9
ST14-02	Downgradient from SWMUs & AOCs	NA	1	10
ST14-03	Downgradient from SWMUs & AOCs	NA	1	NA
ST14-04	Downgradient from SWMUs & AOCs	NA	3	NA
ST14-14	Downgradient from SWMUs & AOCs	1	NA	9
ST14-24	Downgradient from SWMUs & AOCs	1	NA	11
ST14-26	Adjacent to Building 1190 Storage Shed (AOC 15)	0	NA	9
ST14-28	Downgradient from SWMUs & AOCs	NA	3	NA
ST14-29	Downgradient from SWMUs & AOCs	NA	3	NA
ST14-W16	Downgradient from SWMUs & AOCs	NA	2	NA
ST14-W18	Downgradient from SWMUs & AOCs	NA	3	12
ST14-W21	Downgradient from SWMUs & AOCs	NA	2	15
ST14-W31	In between French Drain System and RV Storage Area (SWMU 64 & AOC 6)	NA	2	NA

¹ NA - Analysis not performed at this well.

Table 3.11
East Area
Analytical Results from EPA Method SW8260
(Volatile Organic Compounds)

Well ID	Volatile Organic Compounds ($\mu\text{g/L}$) ¹																
	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	Benzene	Chlorobenzene	Chloroform	Ethylbenzene	Isopropylbenzene	Naphthalene	Tetrachloroethene	Toluene	Vinyl chloride	cis-1,2-Dichloroethene	m-Xylene & p-Xylene	n-Propylbenzene	o-Xylene	sec-Butylbenzene	tert-Butylbenzene
RRS2 Values ²	8.4	NA	5	100	100	700	NA ³	NA ³	5	1000	2	70	NA ³	NA ³	10000	171	NA ³
LF01-1B	0.7 F	0.15 U	0.11 U	0.14 U	0.097 U	0.49 F	0.13 U	0.088 U	0.13 U	1.8	0.13 U	0.13 U	2.1	0.12 U	0.86 F	0.14 U	0.13 U
LF01-1C	0.12 UJ	0.15 UJ	0.11 UJ	0.14 UJ	0.097 UJ	0.16 UJ	2 J	0.088 UJ	0.13 UJ	0.14 UJ	0.13 UJ	0.13 UJ	0.27 UJ	0.12 UJ	0.11 UJ	5.7 J	1.1 F
LF01-1D	0.32 F	0.15 U	0.11 U	0.14 U	0.097 U	0.24 F	0.13 U	0.088 U	0.13 U	0.75 F	0.13 U	0.13 U	0.94	0.12 U	0.36 F	0.14 U	0.13 U
LF01-1E	0.12 UJ	0.15 UJ	0.11 UJ	2 J	0.097 UJ	0.16 UJ	0.13 UJ	0.088 UJ	0.13 UJ	0.14 UJ	0.13 UJ	0.3 F	0.27 UJ	0.12 UJ	0.11 UJ	0.14 UJ	0.13 UJ
MW-10	2600	650	4200	70 U	48 U	4800	200 F	770	65 U	9000	65 U	65 U	9400	400	3700	70 U	65 U
MW-11	1.2 F	0.15 U	0.32 F	0.14 U	0.097 U	1.7	0.13 U	0.49	0.13 U	1.5	0.13 U	0.13 U	3.3	0.12 U	0.98 F	0.14 U	0.13 U
MW-12	0.12 UJ	0.15 UJ	0.11 UJ	0.14 UJ	0.097 UJ	0.32 F	0.13 UJ	0.088 UJ	0.13 UJ	0.14 UJ	0.13 UJ	0.13 UJ	0.56 J	0.12 UJ	0.19 F	0.14 UJ	0.13 UJ
MW-9	0.12 UJ	0.15 UJ	0.11 UJ	0.14 UJ	0.097 UJ	0.16 UJ	0.13 UJ	0.088 UJ	0.13 UJ	0.14 UJ	0.13 UJ	0.13 UJ	0.27 UJ	0.12 UJ	0.11 UJ	0.14 UJ	0.13 UJ
OT-15C	0.12 UJ	0.15 UJ	0.11 UJ	0.14 UJ	0.36 UJ	0.49 F	0.13 UJ	0.088 UJ	1.2 F	0.14 UJ	0.13 UJ	0.13 UJ	0.79 J	0.12 UJ	0.22 F	0.14 UJ	0.13 UJ
SD13-06	0.12 UJ	0.15 UJ	0.11 UJ	0.14 UJ	0.097 UJ	0.6 J	0.13 UJ	0.088 UJ	0.13 UJ	0.4 F	0.13 UJ	0.13 UJ	0.94 J	0.12 UJ	0.29 F	0.14 UJ	0.13 UJ
ST14-14	0.12 U	0.15 U	0.11 U	0.14 U	0.097 U	0.16 U	0.13 U	0.088 U	0.13 U	0.14 U	0.13 U	0.13 U	0.27 U	0.12 U	0.11 U	0.14 U	1.1 F
ST14-24	0.12 U	0.15 U	0.11 U	0.14 U	0.097 U	0.16 U	0.13 U	0.088 U	0.13 U	0.14 U	1.4	0.13 U	0.27 U	0.12 U	0.11 U	0.14 U	0.13 U
ST14-26	0.12 UJ	0.15 UJ	0.11 UJ	0.14 UJ	0.097 UJ	0.16 UJ	0.13 UJ	0.088 UJ	0.13 UJ	0.14 UJ	0.13 UJ	0.13 UJ	0.27 UJ	0.12 UJ	0.11 UJ	0.14 UJ	0.13 UJ

¹ Shaded blocks indicate sample concentrations greater than RRS2 values.

² Risk Reduction Rule Standard No. 2 (RRS2) from Texas Natural Resource Conservation Commission (TNRCC 30 TAC 335, Subpart S).

³ RRS2 value not set for this compound.

Table 3.12
East Area
Analytical Results from EPA Method SW8020 (BTEX)

Aromatic Volatile Organics (BTEX) ($\mu\text{g/L}$) ¹				
	Benzene	Ethylbenzene	Toluene	Xylenes (total)
RRS2 Value ²	5	700	1000	10000
17M	0.39 F	0.42 F	0.35 F	0.95 F
BSS-A	0.21 U	0.35 U	0.13 U	0.68 U
BSS-B	21 U ³	1600 J	9100	8500 J
MW-1	3200 J	1700	240 J	3100
MW-3	0.24 F	0.35 U	0.24 F	0.9 F
MW-5	65 J	360J	18 J	22 J
MW-8	0.21 UJ	0.46 F	0.4 F	1.3 F
SD13-01	0.21 UJ	0.35 UJ	0.13 UJ	1.8 F
SD13-02	0.21 UJ	0.35 UJ	0.13 UJ	0.68 UJ
SD13-04	0.21 UJ	0.43 F	1.3 F	3.4 J
ST14-02	6.1	0.35 U	0.13 U	0.68 U
ST14-03	0.21 UJ	0.35 UJ	0.14 F	0.68 UJ
ST14-04	0.63 F	0.35 U	0.31 F	0.92 F
ST14-28	0.48 F	0.54 F	0.13 UJ	1.5 F
ST14-29	0.41 F	0.35 U	0.24 F	1 F
ST14-W16	6.6 J	0.35 U	0.53 F	0.68 U
ST14-W18	2.7 J	0.35 U	0.63 F	1.5 F
ST14-W21	9.3 J	0.35 U	0.89 F	0.68 U
ST14-W31	0.21 U	0.35 U	0.23 F	0.85 F

¹ Shaded blocks indicate sample concentration greater than RRS2.

² Risk Reduction Rule Standard No. 2 (RRS2) from Texas Natural Resource Conservation Commission (TNRCC 30TAC335, Subpart S).

³ Below MDL due to dilution requirement.

Table 3.13
East Area
Analytical Results from EPA Method SW6010 (Inorganic Constituents)¹

Well ID	Inorganic Constituents (mg/L) ¹																		
	Aluminum	Antimony	Arsenic	Barium	Calcium	Chromium	Cobalt	Copper	Iron	Lead	Magnesium	Manganese	Molybdenum	Nickel	Potassium	Sodium	Vanadium	Zinc	Silver ²
RRS2 Values ³	36.5	0.006	0.05	2	NA	0.1	NA	1.3	NA	0.015	NA	8.4	NA	0.14	NA	NA	0.256	10.95	0.183
Background Values ⁴	1.332	0.001	0.0025	0.587	266.3	0.006	0.0045	0.0028	0.224	0.0008	37.8	0.175	NA	0.0204	15.03	167.2	0.0123	0.118	0.0002
LF01-1B	12.8	0.0046 F	0.0029 U	0.21	168	1.4	0.07	0.041 F	18.4	0.0081	12.2	2.3	0.25	1.3	2.5 F	22.2	0.025 F	0.051	0.0041
LF01-1C	0.082 U	0.0025 U	0.022	0.18	196	0.0023 U	0.0031 U	0.0053 U	12	0.0017 U	13.4	1.7	0.0071 F	0.01 U	1.2 F	26.8	0.0021 U	0.012 U	0.0002 UJ
LF01-1D	0.082 U	0.0025 U	0.0029 U	0.076	198	0.0023 U	0.0055 F	0.0043 F	2.9	0.0017 U	11.9	0.49	0.0065 U	0.012 F	2.4 F	23.3	0.0021 U	0.012 U	0.0002 UJ
LF01-1E	0.082 U	0.0025 U	0.0029 U	0.14	134	0.0023 U	0.0031 U	0.0041 U	0.26	0.0017 U	7.9	3.8	0.0065 U	0.01 U	0.3 U	21.7	0.0021 U	0.012 U	0.0002 UJ
MW-10	0.082 U	0.0025 U	0.019	0.18	179	0.0023 U	0.005 F	0.0047 F	6.3	0.005	13.6	5.9	0.0065 U	0.01 U	0.3 U	54.8	0.0021 U	0.012 U	0.0002 UJ
MW-11	0.082 U	0.0025 U	0.0029 U	0.17	189	0.0023 U	0.0031 U	0.0052 F	0.25	0.0017 U	14.7	0.14	0.0065 U	0.01 U	0.65 F	61.6	0.0021 U	0.012 F	0.0002 UJ
MW-12	0.082 U	0.0025 U	0.0029 U	0.057	294	0.0023 U	0.0031 U	0.0051 U	0.041 U	0.0017 U	9.2	0.084	0.0065 U	0.01 U	0.73	50	0.0021 U	0.019 U	0.0002 UJ
MW-9	0.082 U	0.0025 U	0.0029 U	0.14	180	0.0023 U	0.0031 U	0.0039 U	3.3	0.0017 U	13.5	3.7	0.0065 U	0.01 U	0.34	78.8	0.0021 U	0.012 U	0.0002 UJ
OT-15C	0.082 U	0.0025 U	0.0029 U	0.18	142	0.0023 U	0.0031 U	0.0052 F	0.041 U	0.0017 U	4.5	0.046	0.0065 U	0.01 U	2.4 F	21.1	0.0021 U	0.026	0.0002 UJ
SD13-06	0.082 U	0.0025 U	0.0029 U	0.25	203	0.0023 U	0.0031 U	0.024 F	1.6	0.0017 U	11.7	0.12	0.0065 U	0.01 U	0.4 F	31	0.0021 U	0.076	0.0002 UJ
ST14-02	0.082 U	0.0025 U	0.0078	0.12	129	0.0023 U	0.0031 U	0.0025 U	11.2	0.0017 U	6.4	0.27	0.0065 U	0.01 U	2 F	26	0.0021 U	0.013 F	0.00075 J
ST14-14	0.082 U	0.0025 U	0.0042 F	0.049	92.8	0.0023 U	0.0031 U	0.0026 F	1.5	0.0017 U	4.9	0.24	0.0065 U	0.01 U	0.78 F	27.2	0.0021 U	0.012 U	0.2 U
ST14-24	1.1	0.0025 U	0.0029 U	0.25	121	0.005 F	0.0031 U	0.0048 F	1.1	0.0017 U	9.2	0.097	0.0065 U	0.01 U	3.2 F	29.6	0.0021 U	0.018 F	0.2 UJ
ST14-26	0.082 U	0.0025 U	0.0029 U	0.13	141	0.0023 U	0.0031 U	0.0038 F	0.057 F	0.0017 U	7.3	0.055	0.0065 U	0.01 U	0.72 F	19.4	0.011 F	0.012 U	0.0002 UJ
ST14-W18	0.59	0.0025 U	0.058	0.22	153	0.0023 U	0.0031 U	0.0055 F	14	0.014	6.5	0.21	0.0065 U	0.01 U	1.3 F	21.8	0.0021 U	0.015 F	0.2 U
ST14-W21	3.2	0.0025 U	0.047	0.19	190	0.0057 F	0.0031 U	0.0058 F	10.2	0.0035 F	6.1	0.63	0.0065 U	0.017 F	1.3 F	12	0.0071 F	0.024	0.0002 UJ

¹ Shaded blocks indicate sample concentrations greater than RRS2, bold blocks indicate values greater than background.

² Silver analyzed using EPA Method SW7761.

³ Risk Reduction Rule Standard No. 2 (RRS2) from Texas Natural Resource Conservation Commission (TNRCC 30TAC335, Subpart S).

⁴ Background concentrations taken from Jacobs, 1997.

Table 3.14
Analytical Results for Natural Attenuation Parameters

Well_ID	Natural/Attenuation Parameters ¹						
	DO (mg/L)	Fe (mg/L)	Sulfate (mg/L)	Methane (ug/L)	TOC (mg/L)	Alkalinity (mg/L)	ORP (mV)
<i>East Area (SWMU 10,15,16,36,51,52,61,64,68, AOC 6,7,10,11,13,14,15)</i>							
SD13-01	0 ²	2.71	0.45J	4400J	6J	340J	4
SD13-02	0 ²	5.06	3.6J	380J	4J	360J	9.7
ST14-02	11.92	6.6	0.84	670	3	360	1.3
ST14-03	0 ²	1.87	31.5J	160J	2J	290J	-7.8
ST14-04	8.22	3.3	0.62	4000	9	360	8.8
ST14-14	5.24	0.82	4.2	870	2	290	-3.6
ST14-24	8.51	0.7	20.6	9.1	2	320	4.5
ST14-26	0 ²	0.0	24.7J	0.4J	2J	360J	-2.6
ST14-28	NA ³	10.56	0.95 UJ	3400J	15J	460	NA ³
ST14-29	0.69	0.6	0.82	3200	8	390	7.36
ST14-W16	10.94	6.5	16.4	600	3	320	3.7
ST14-W18	NA ³	2.46	1 U	1800	10	390	NA ³
ST14-W21	NA ³	2.38	1.1 U	690	7 U	470	NA ³
ST14-W31	0.99	0.01	28.1	0.11	1	320	-0.7
<i>East Area (AOC 1 - Former Base Service Station)</i>							
BSS-A	8.31	0.02	49.9	0.92	2	390	4.8
BSS-B	NA ³	3.00	4.7	2100	24	460	NA ³
MW-1	0.14	7.45	0.94	7500	14	490	6.4
MW-3	1.61	0.07	43.2	0.24	2	370	-1.8
MW-5	1.24	0.24	1.2J	3400J	13J	370J	15.8
MW-8	0.63	0.03	33.4J	20J	3J	250J	6.9
<i>Flightline Area</i>							
GMI-22-02M	9.28	0.02	5	0.25	1	280	-11.2
GMI-22-04M	0.82	NA ³	43.4	140	2	380	-4.3
GMI-22-06M	0.34	0.96	61.6	75	3	440	0.9
GMI-22-07M	2.57	NA ³	85.4	0.18 F	2	250	NA ³
LSA1628-3	0.39	0	51.2	3.1	2	370	2.6
SPOT35-2	0.61	5.6	5.5	4100	29	390	NA ³
SPOT35-4	1.78	NA ³	8.2 U	3400	4	390	-2.9
SPOT35-5	0.68	0.17	2.8 U	3500	12	430	NA ³

Superscript **Definition**

1 DO = Dissolved Oxygen, Fe = Ferrous Iron, ORP = Oxidation Reduction Potential, TOC = Total Organic Carbon

2 Value assumed to be zero; negative value recorded in the field

3 Not analyzed

TAB

Section 3.0 Figures

Figure 3.1

NAS Fort Worth JRB GROUNDWATER ELEVATIONS DURING THIRD QUARTER SAMPLING July 1997

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

Approximate Groundwater
Management Areas

Approximate NAS Ft. Worth
JRB Site Boundary

574.34

Groundwater Elevation
(ft. NVGD)

— 610.00 — Groundwater Contour Interval

NA = Data Not Available



Map Source:
JACOBS, 1996

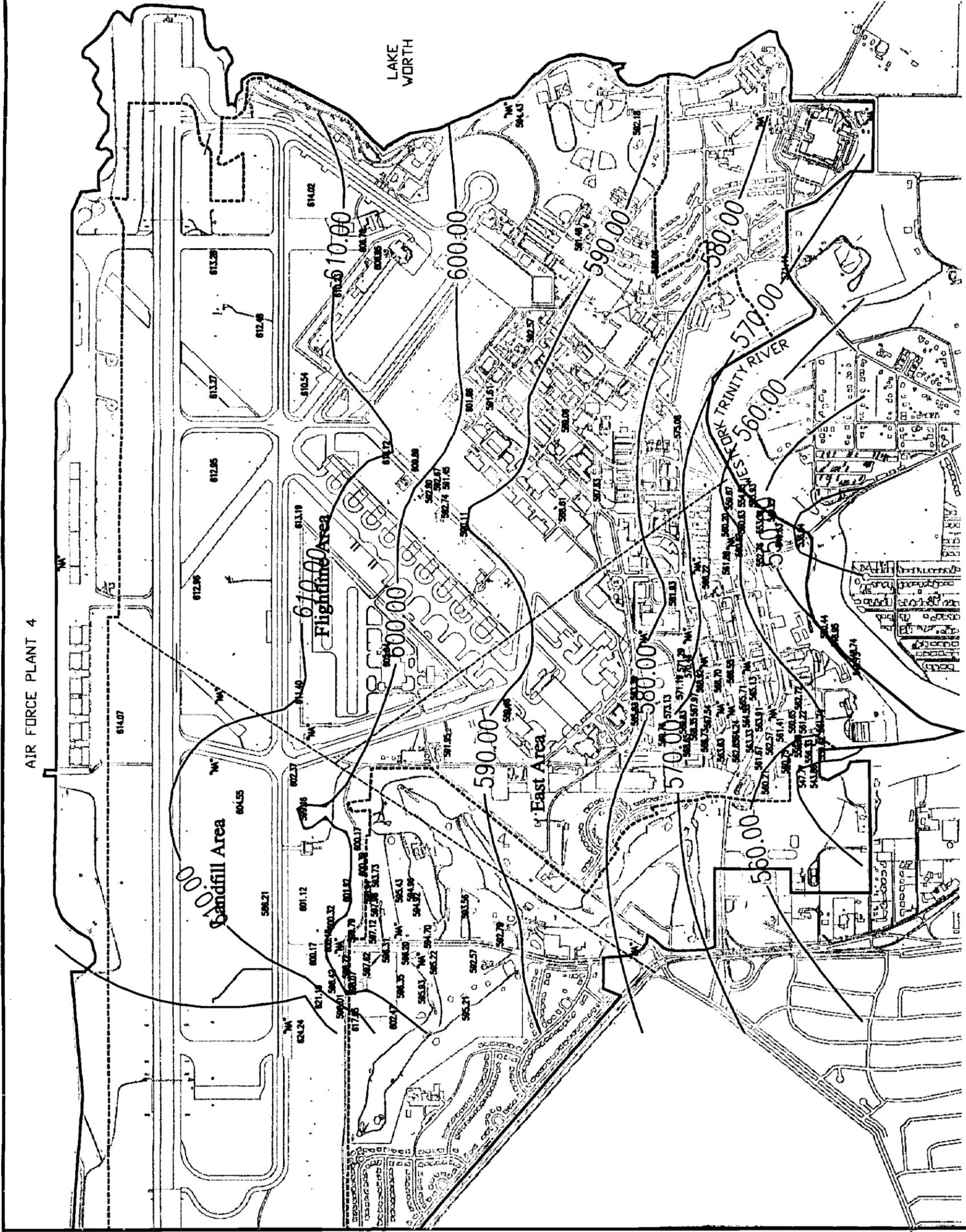


Figure 3.3
NAS Fort Worth JRB
LANDFILL AREA
DISTRIBUTION OF
TRICHLOROETHENE
IN TERRACE ALLUVIUM
AQUIFER

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- Approximate Groundwater Management Area
- - - Approximate NAS Ft. Worth JRB Site Boundary
- Former Carswell Property Boundary
- FT09-12C Well Identification
- 3.30 Concentration of TCE (ug/L)
- ~ TCE Contour
- ~ Estimated Concentration Contour for TCE
- Area of Concern
- Solid Waste Management Unit

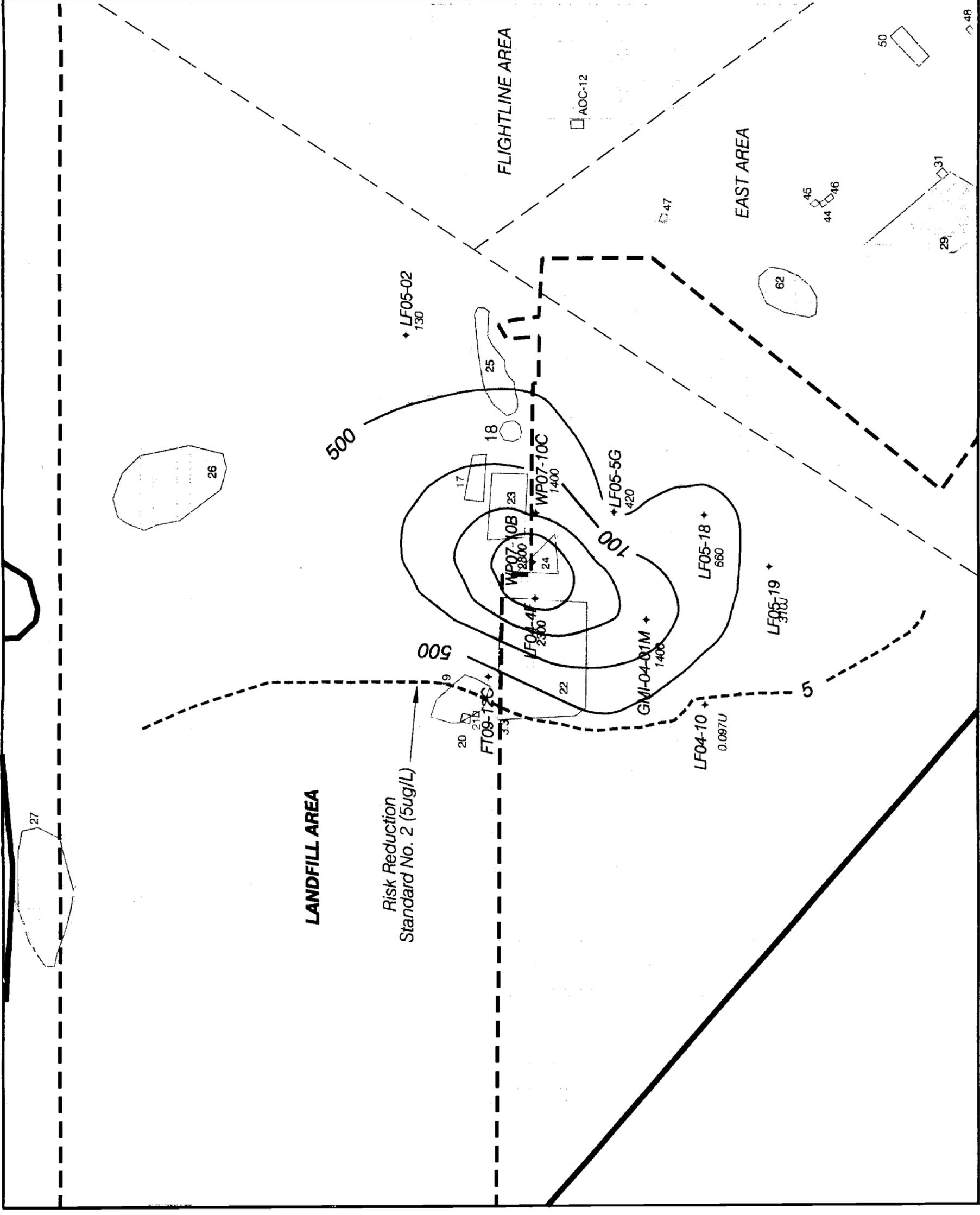
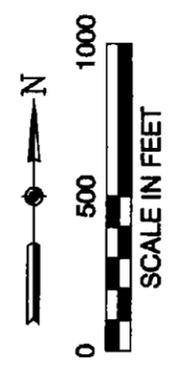
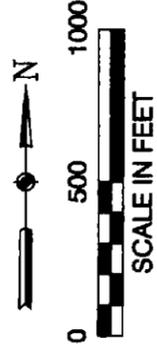


Figure 3.4
NAS Fort Worth JRB
LANDFILL AREA
DISTRIBUTION OF
cis-1,2-DICHLOROETHENE
IN TERRACE ALLUVIUM
AQUIFER

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- Approximate Groundwater Management Area
- - - Approximate NAS Ft. Worth JRB Site Boundary
- Former Carswell Property Boundary
- FT09-12C Well Identification
- 3.30 Concentration of DCE (µg/L)
- ~ DCE Contour
- - - Estimated Concentration Contour for DCE
- AOC-1
- AOC-12
- Area of Concern
- Solid Waste Management Unit



HYDRO
Geologic INC

Map Source:
JACOBS, 1996

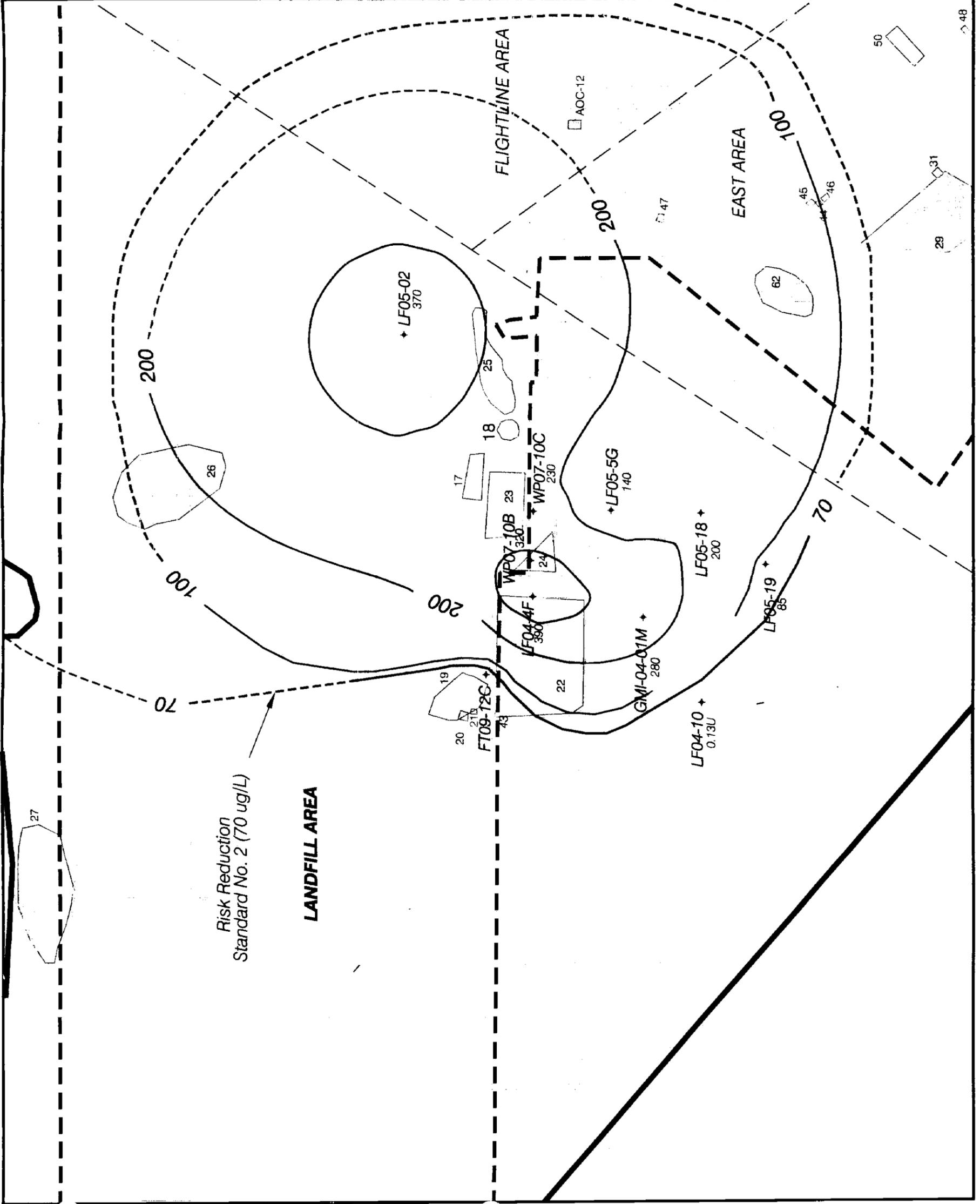


Figure 3.5
NAS Fort Worth JRB
FLIGHTLINE AREA
DISTRIBUTION OF TRICHLOROETHENE
IN TERRACE ALLUVIUM AQUIFER

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- Approximate Groundwater Management Areas
- - - Approximate NAS Ft. Worth JRB Site Boundary
- Approximate NAS Ft. Worth JRB Site Boundary
- 40 AOC-4
- ⊕ GMI-22-04M
- ⊕ <1.0
- 200.00 — Concentration Contour for TCE
- ⋯ 5.00 ⋯ Estimated Concentration Contour for TCE



Map Source:
JACOBS, 1996

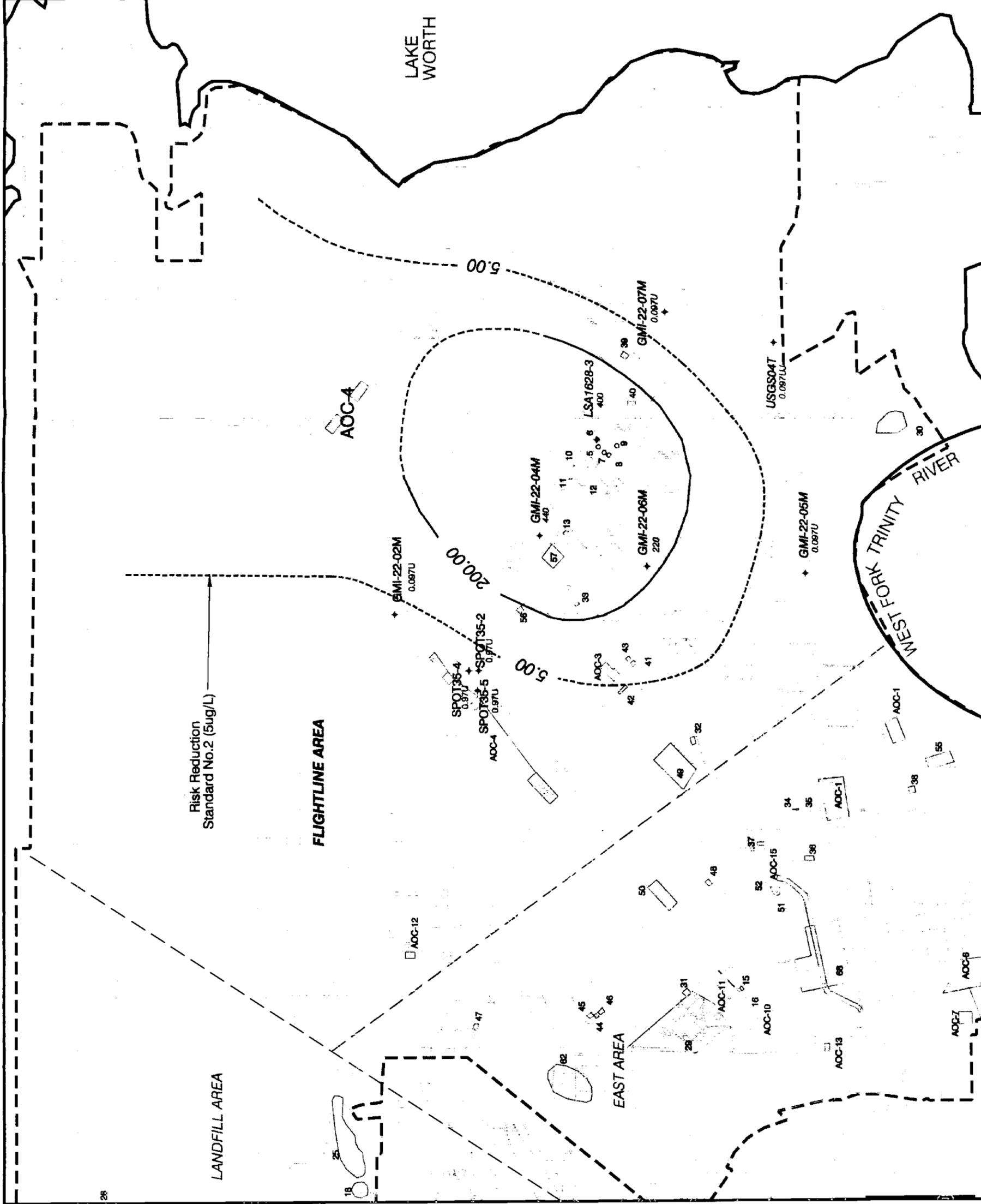


Figure 3.6
NAS Fort Worth JRB
FLIGHTLINE AREA
DISTRIBUTION OF
cis-1,2-DICHLOROETHENE IN
TERRACE ALLUVIUM AQUIFER

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- Approximate Groundwater Management Areas
- - - Approximate NAS Ft. Worth JRB Site Boundary
- Approximate NAS Ft. Worth JRB Site Boundary
- 40 Solid Waste Management Unit Area Of Concern
- AOC-4
- † GMI-22-04M Well Identification
- <12 Concentration of DCE (µg/L)
- 1.00 — Concentration Contour for DCE



Map Source:
JACOBS, 1996

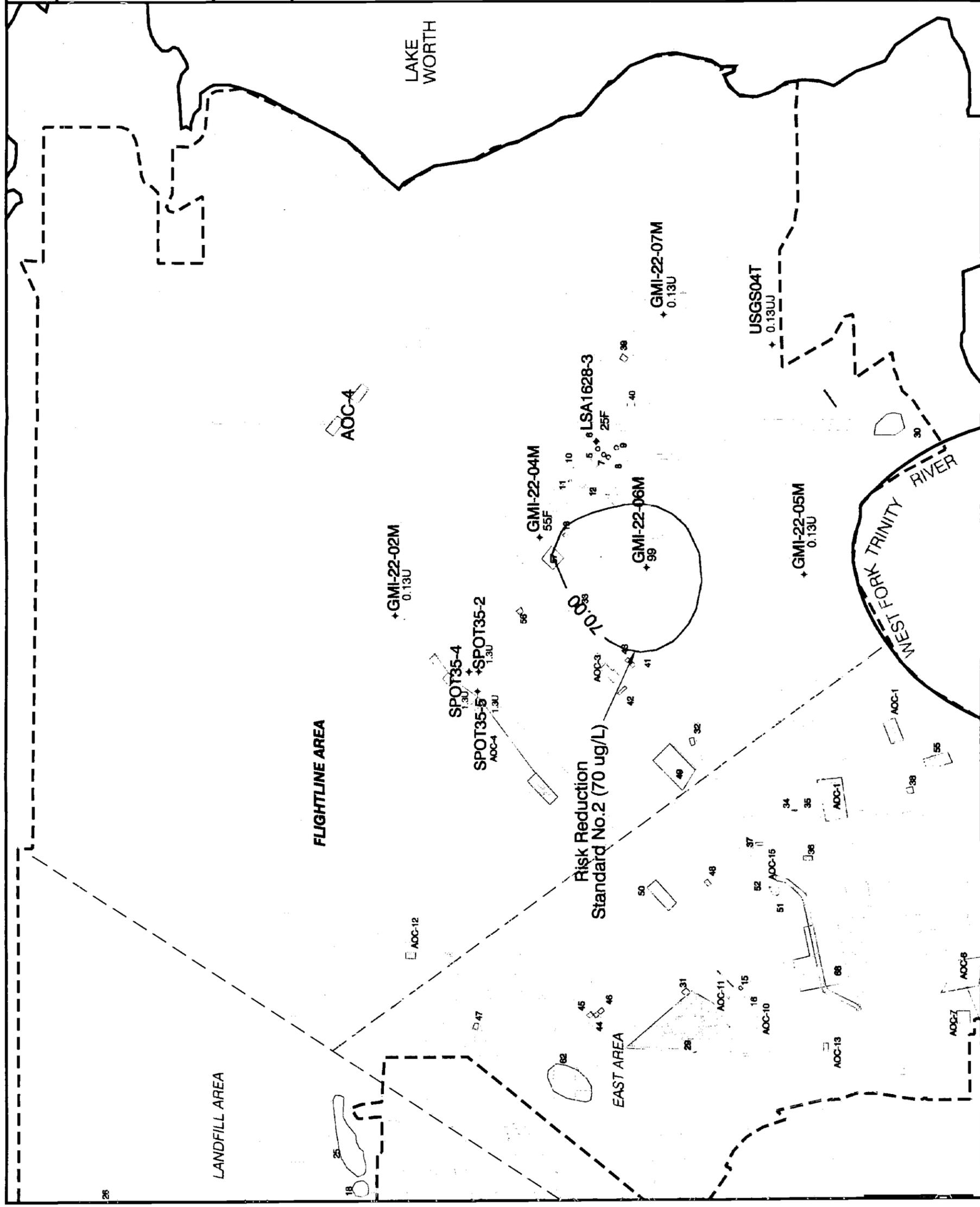
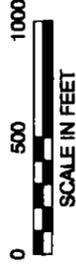


Figure 3.7
NAS Fort Worth JRB
FLIGHTLINE AREA
DETECTION OF DISSOLVED
INORGANICS ABOVE BACKGROUND
LEVELS IN TERRACE ALLUVIUM
AQUIFER

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- Approximate Groundwater Management Areas
- - - Approximate NAS Ft. Worth JRB Site Boundary
- Approximate NAS Ft. Worth JRB Site Boundary
- 40 AOC-4
- ★ GMI-22-04M Well Identification
- Cu = 0.0053 Copper Concentrations (mg/L)
- Fe = 0.61 Iron Concentrations (mg/L)
- Mg = 14.7 Magnesium Concentrations (mg/L)



Map Source:
JACOBS, 1996

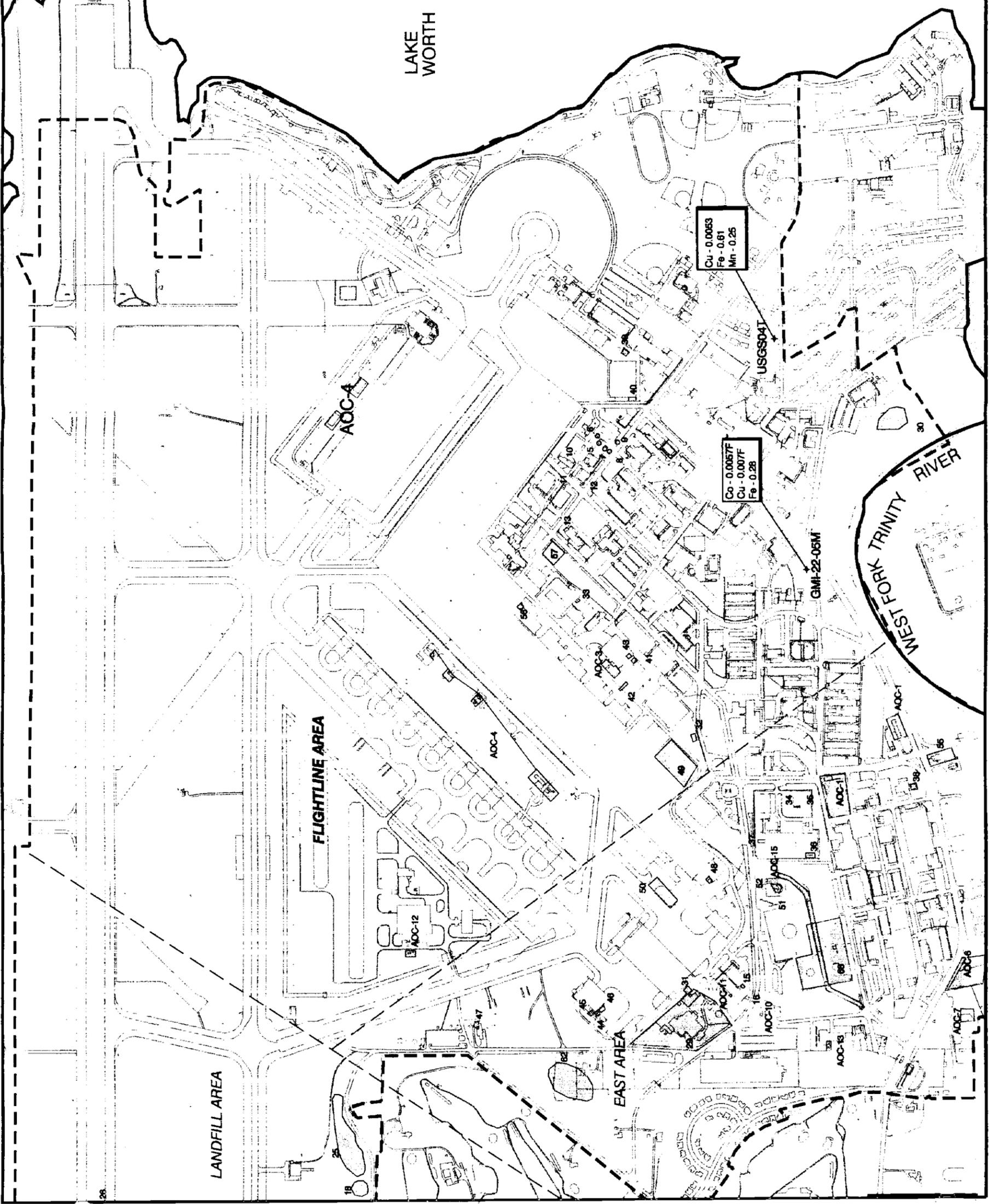
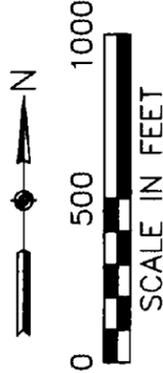


Figure 3.8 NAS Fort Worth JRB EAST AREA DISTRIBUTION OF BENZENE IN TERRACE ALLUVIUM AQUIFER

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- Approximate Groundwater Management Areas
- - - Approximate NAS Ft. Worth JRB Site Boundary
- Former Carswell Property Boundary
- ★ LFO1-1A Well Identification
- 0.00 Concentration of Benzene (ug/L)
- ~ 50 Benzene Contour
- ACC-1 Area of Concern
- SWM Solid Waste Management Unit



Map Source:
JACOBS, 1996

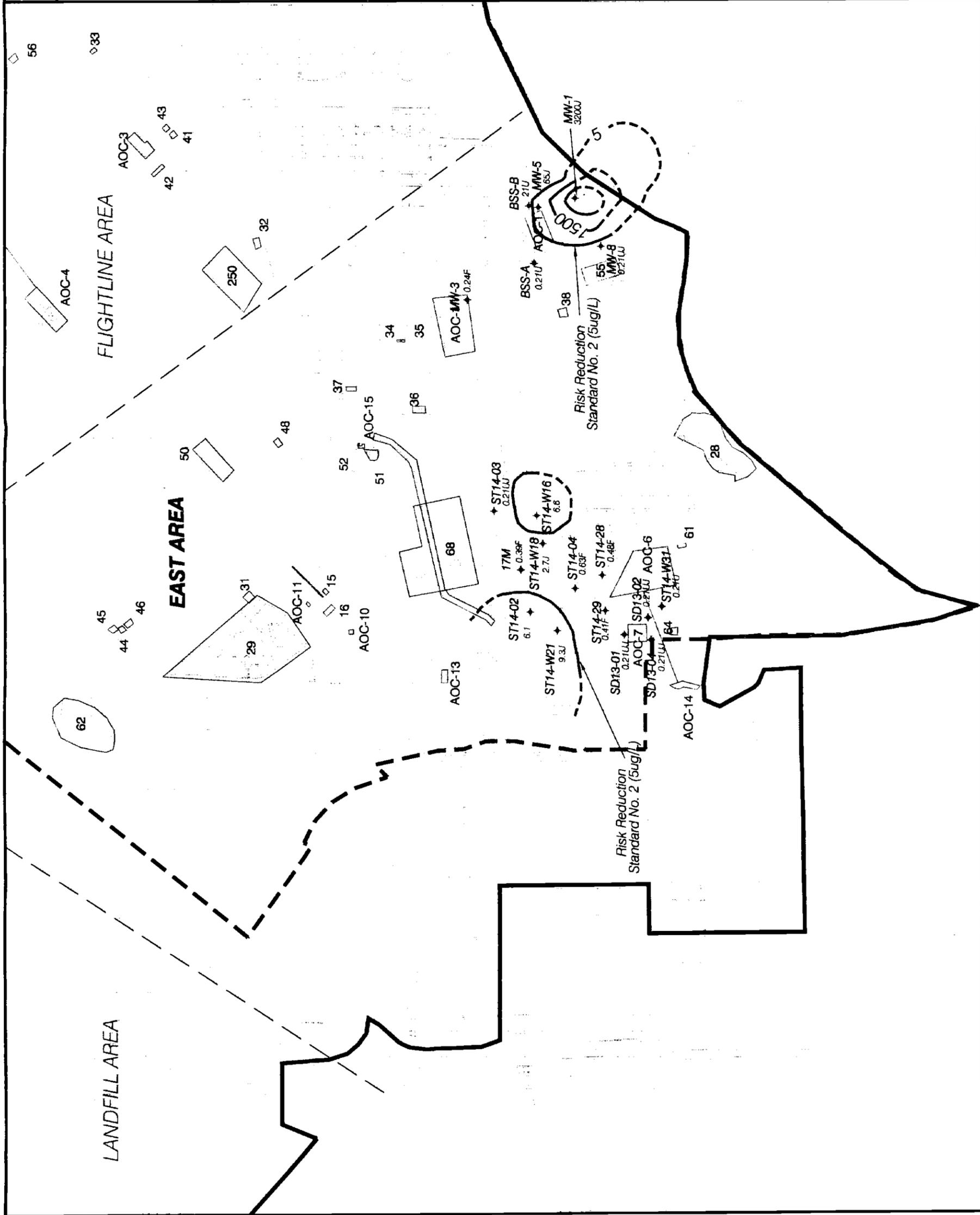


Figure 3.9
NAS Fort Worth JRB
EAST AREA
DISTRIBUTION OF DISSOLVED
INORGANICS ABOVE
BACKGROUND LEVELS IN
TERRACE ALLUVIUM AQUIFER

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- - - Approximate Groundwater Management Areas
- - - Approximate NAS Ft. Worth JRB Site Boundary
- Former Carswell Property Boundary
- ★ Well Identification
- LF01-1A Area of Concern
- AOC-1
- AOC-2
- Solid Waste Management Unit



HYDRO
Geologic INC.

Map Source:
JACOBS, 1996

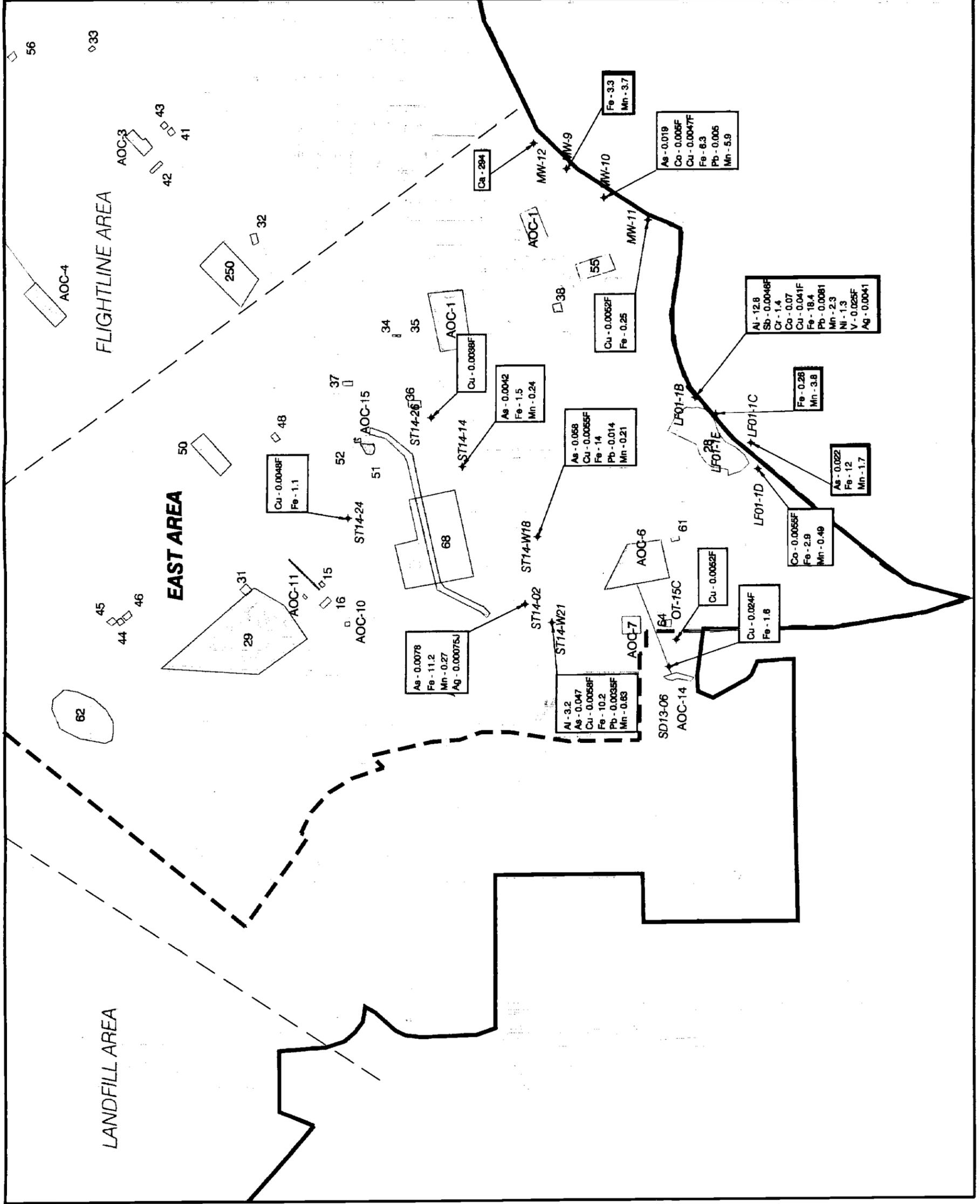
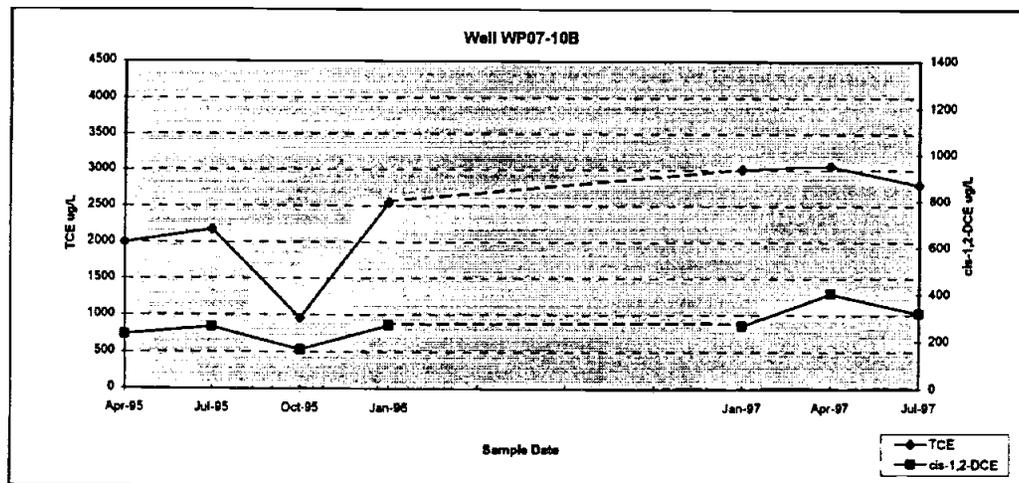
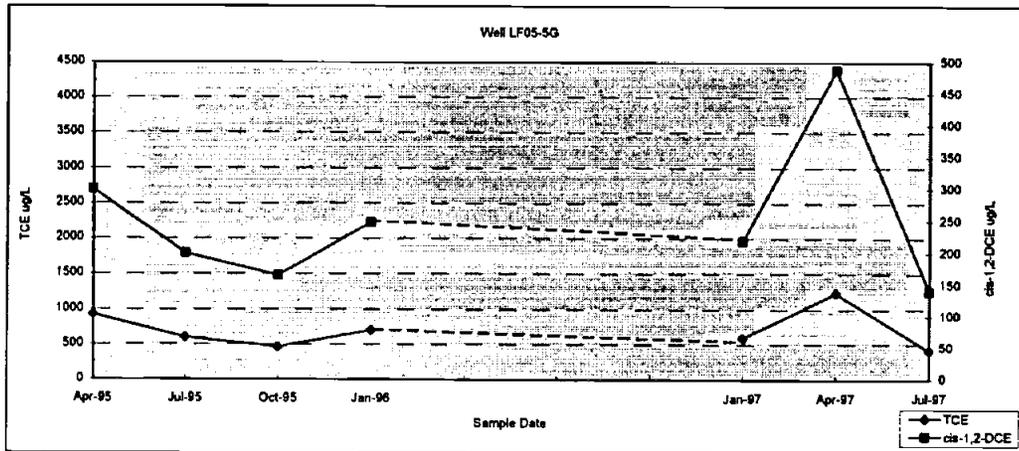
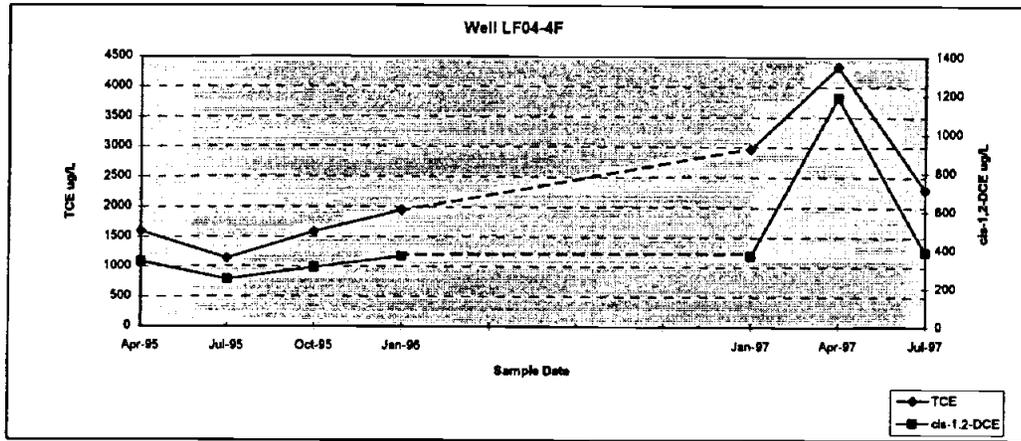
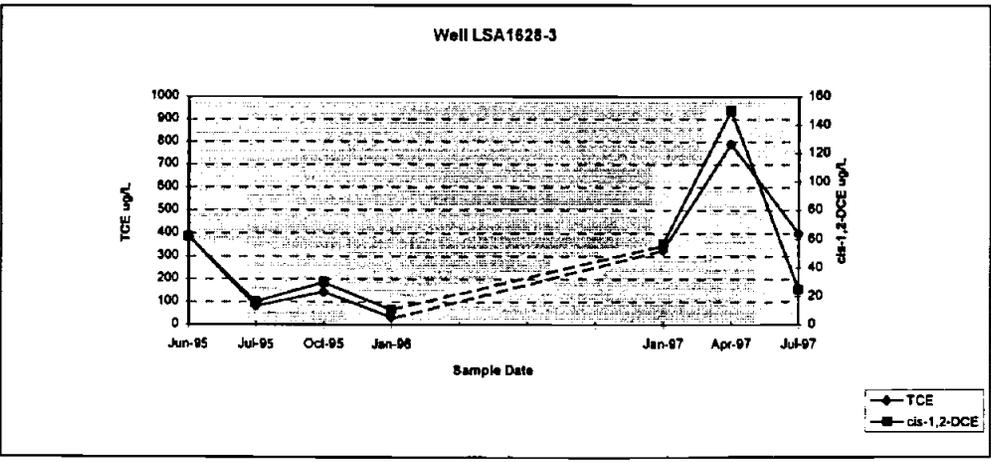
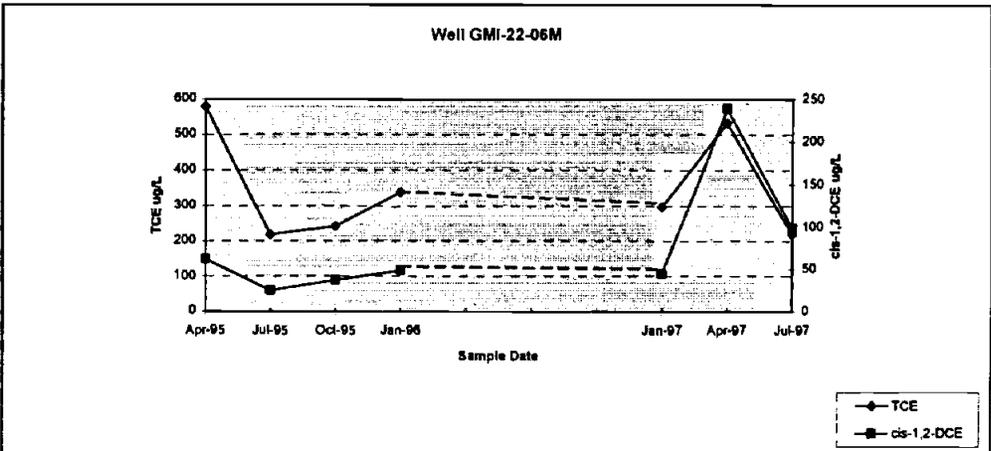
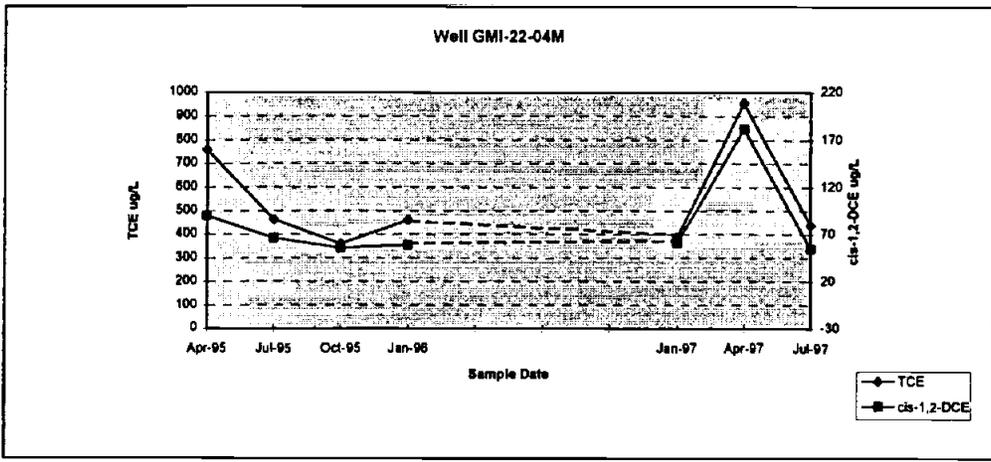


Figure 3.10
Landfill Area
Chlorinated Hydrocarbon Concentrations over Time in Selected Wells



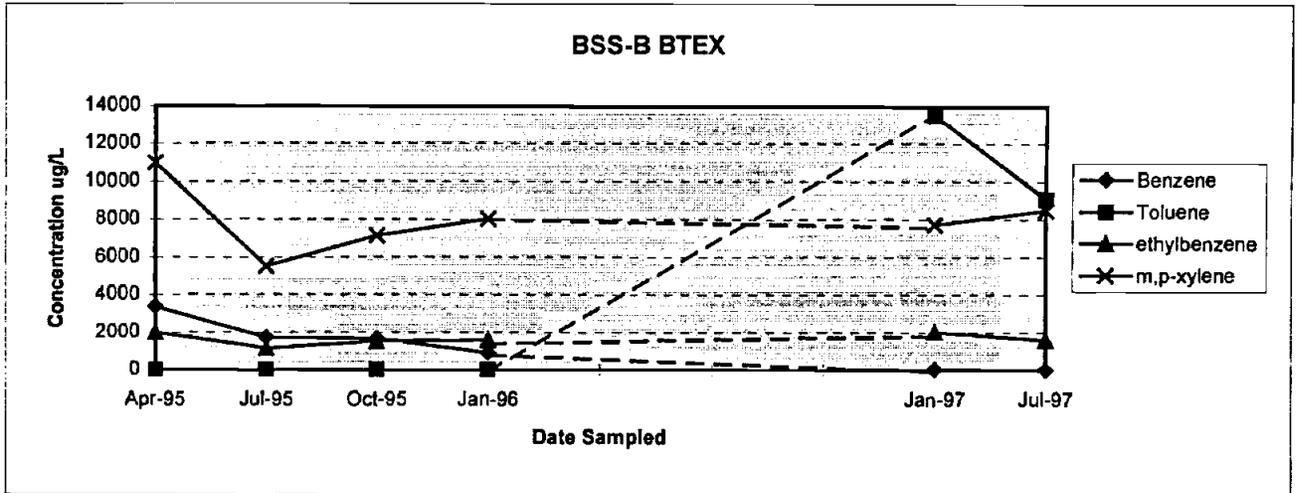
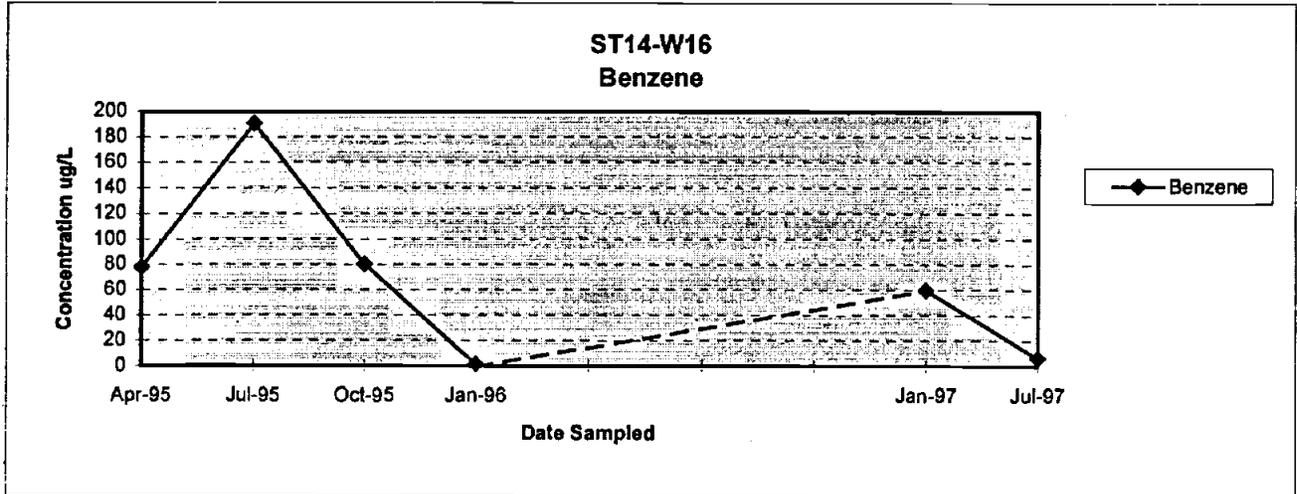
----- Values are estimated due to missing data

Figure 3.11
Flightline Area
Chlorinated Hydrocarbon Concentrations over Time in Selected Wells



----- Values are estimated due to missing data

Figure 3.12
East Area
Benzene and BTEX Concentrations over Time in Selected Wells



----- Values are estimated due to missing data

Figure 3.13
NAS Fort Worth JRB
EAST AREA
DISTRIBUTION OF DISSOLVED
OXYGEN CONCENTRATION IN
SELECTED WELLS

Air Force Center
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Brooks AFB, Texas

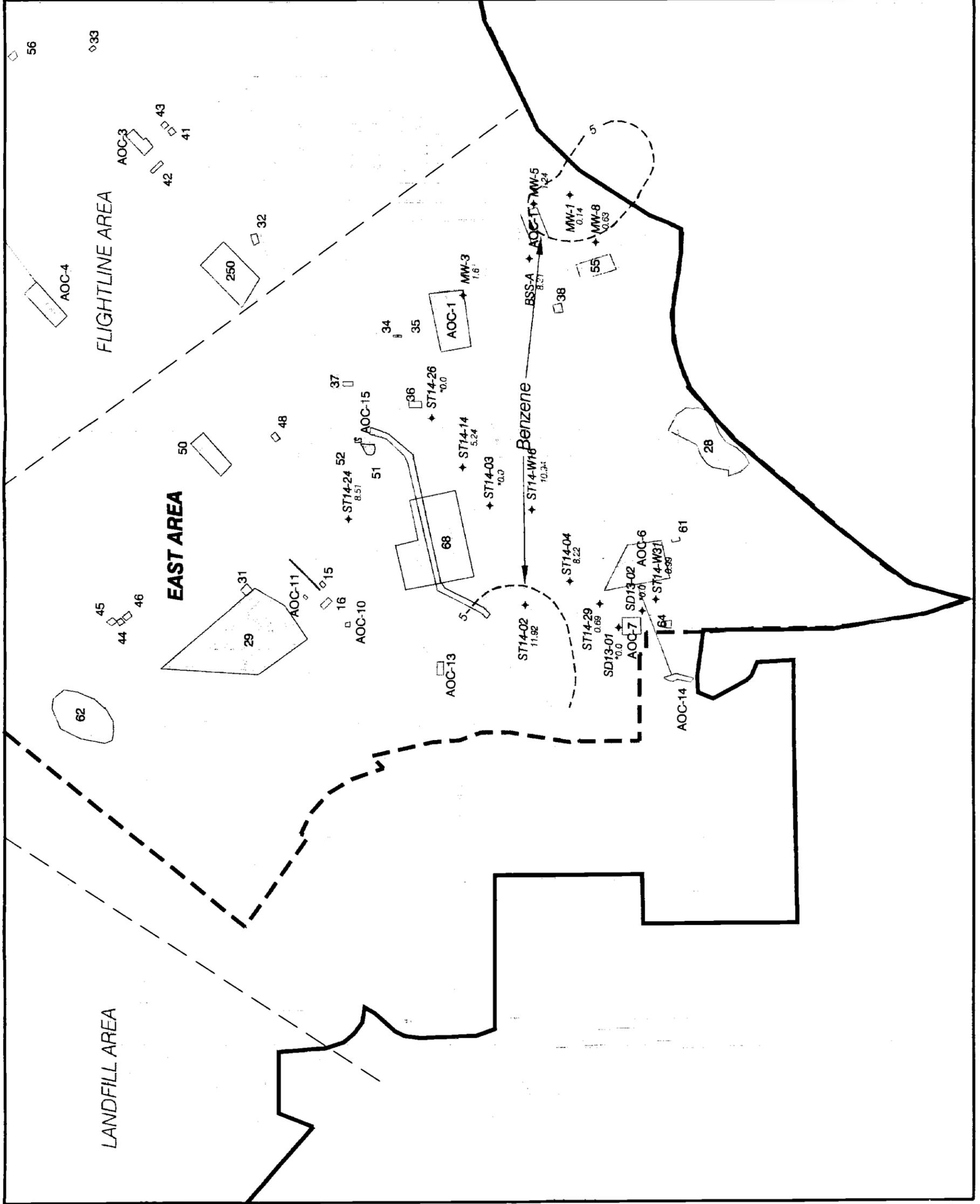
LEGEND

- Approximate Groundwater Management Areas
- - - Approximate NAS Ft. Worth JRB Site Boundary
- Former Carswell Property Boundary
- + Well Identification
- 1.24 Concentration of Dissolved Oxygen (mg/L)
- *0.0 Value Assumed to be Zero; Negative Value Recorded in Field
- - - Approximate Extent of Benzene Contamination Above RRS2 (5 µg/L)
- AOC-1 Area of Concern
- SW Solid Waste Management Unit



HYDRO
Geologic INC.

Map Source:
JACOBS, 1996



TAB

Section 4.0

4.0 SUMMARY AND RECOMMENDATIONS

This section summarizes monitoring activities conducted during the base-wide quarterly groundwater monitoring event for July 1997. The following paragraphs focus on groundwater elevations and flow direction, presence of free product, and overall trends of contamination throughout the site as compared to previous monitoring events.

4.1 MONITORING ACTIVITIES AND RESULTS

The third quarterly groundwater monitoring event was conducted from July 8 through July 25, 1997. Three previously defined groundwater management areas, Landfill Area, Flightline Area and East Area, were used as a basis for examining the extent of contamination. Figure 4.1 shows the known areas of contamination across the site.

4.1.1 Well Inspection and Water Level Measurement

A total of 148 wells were inspected, and water level measurements were obtained from each. All 148 wells were examined for the presence of free product. Measurable free product (LNAPL) was detected in three wells (LF04-04, SD13-05, and SD13-07). The thickness of free product in wells LF04-04 and SD13-05 was less than 0.01 feet. A free product thickness of 0.015 feet was measured in well SD13-07 (located in the southwest portion of the site); therefore, this well was not sampled.

4.1.2 Contaminant Concentration and Distribution

Groundwater samples were collected at 52 of the inspected wells. Each sample was analyzed for at least one of the following: VOCs, BTEX, inorganic constituents, and natural attenuation parameters (DO, nitrate, ferrous iron, sulfate, methane, alkalinity, and TOC). Overall, the analytical data quality was considered acceptable, and the results can be considered representative of the groundwater under investigation.

The concentrations of VOCs and inorganics detected in each groundwater management area were compared to the TNRCC Risk Reduction No. 2 Standards. COCs were identified as VOCs which exceeded the RRS2 and inorganic constituents, which exceeded background concentrations (Jacobs, 1997). COCs, which have been historically monitored on-site, were plotted on base maps for each groundwater management area to evaluate the lateral extent of contamination and compared with previous data to evaluate historical concentration trends. In some cases, chemicals which have historically been included as COCs but did not meet selection criteria established for this sampling event were still included in the list of COCs.

The COCs determined from this July 1997 sampling event are similar to those selected in January and April 1997. The COCs selected are as follows:

- Landfill Area - TCE, cis-1,2-DCE, and vinyl chloride
- Flightline Area - TCE, cis-1,2-DCE, vinyl chloride, cobalt, copper, iron, and manganese
- East Area - BTEX, 1,2,4-trimethylbenzene, antimony, arsenic, chromium, cobalt, copper, iron, lead, nickel, manganese, silver, and vanadium

Landfill Area

Detected concentrations of TCE in the Landfill Area range from 3.3 $\mu\text{g/L}$ to 2,800 $\mu\text{g/L}$; eight of the wells sampled contained TCE at concentrations above the RRS2 of 5.0 $\mu\text{g/L}$. Also in the Landfill Area, concentrations of cis-1,2-DCE (maximum concentration of 390 $\mu\text{g/L}$) and vinyl chloride (maximum concentration of 6.6 $\mu\text{g/L}$) show a distribution similar to the TCE plume. Eight of the cis-1,2-DCE detections and one of the vinyl chloride detections exceeded RRS2s for these contaminants (70 $\mu\text{g/L}$ and 2 $\mu\text{g/L}$, respectively).

Flightline Area

In the Flightline Area (near wells GMI-22-04M, GMI-22-06M, and SMWU Nos. 6, 7, 8, and 9), TCE concentrations found in groundwater ranged from 220 $\mu\text{g/L}$ to 440 $\mu\text{g/L}$. Three of these detections were above the RRS2. Cis-1,2-DCE was detected at a concentration of 99 $\mu\text{g/L}$, which exceeds the RRS2 of 70 $\mu\text{g/L}$. Cobalt, copper, iron, and manganese were all detected slightly above background concentrations.

East Area

BTEX contamination has remained virtually unchanged from previous quarterly sampling down gradient of SMWU 68 (POL Tank Farm) and down gradient of the AOC1 (former Base Service Station). The highest concentrations of total BTEX were detected in samples collected from wells near AOC1. In the sample exhibiting the highest total BTEX concentration (19,200 $\mu\text{g/L}$), eight BTEX compounds exceeded their respective RRS2.

Arsenic, chromium, and nickel (0.058, 1.4, and 1.3 mg/L , respectively) were detected in the East Area at concentrations exceeding their RRS2s (0.05, 0.1, and 0.14 mg/L , respectively). In addition, arsenic, cobalt, copper, iron, lead, and manganese were detected above background concentrations.

4.1.3 Historical Trends

Comparisons were made of the spatial distribution of COC concentrations between the July 1997 monitoring event and previous monitoring events. The plume of chlorinated hydrocarbons in the Landfill Area migrated toward the east, downgradient from one of the potential sources (AFP4). A decrease in the benzene concentrations has been observed over the past several quarters in the ST-14/SD-13 area. BTEX concentrations in the East Area plumes have remained consistently high over time. Although there were several locations where inorganics were detected above the RRSs,

historical inorganic sampling programs have not been consistent in the numbers and locations of sampling points to provide sufficient basis for comparison.

4.1.4 Natural Attenuation Parameters

Thirty wells were sampled for analysis of natural attenuation parameters. DO, Eh, and Fe²⁺ (field analysis), alkalinity, nitrate, sulfate, methane, and TOC were included in the sampling program in order to monitor the natural attenuation of chlorinated and aromatic hydrocarbon contaminants at NAS Fort Worth JRB. A clear historical correlation between natural attenuation parameters and BTEX in the East Area has yet to be established.

4.2 RECOMMENDATIONS

In general, the previous quarterly sampling events (January, April and July) have fulfilled the monitoring objectives of the groundwater sampling and analysis program. However, recommendations to enhance available resources and/or review available data are presented in this section. These recommendations include: 1) correlating between water level evaluations and contaminant concentrations; 2) accessibility to surveyed elevations points; 3) well rehabilitation; 4) adding/deleting wells from the existing groundwater monitoring network; 5) surface water sediment sampling and elevation measurements; 6) continued LNAPL monitoring and recovery; and 7) optimization of monitoring network.

- 1) Initial observations of chlorinated hydrocarbon (i.e., TCE and cis-1,2-DCE) concentrations plotted over time indicate a potential correlation between changes in concentration with seasonal water-level elevations. It is recommended that an assessment be made to quantify the correlation between changes in water levels and contaminant concentrations, and indicate the process(es) that potentially control a positive correlation (e.g., absorption, dilution).
- 2) Water elevations were not available for seventeen wells due to a lack of surveyed elevation points. It is recommended that the elevation of these wells be surveyed prior to the next sampling event.
- 3) During the July 1997 event, several items were noted during the field investigation regarding the condition and integrity of each monitoring well. Damage to monitoring wells that should be addressed include cracked or missing pads, missing bolts and locks, damaged manhole covers and casings, and missing ID plates. Several of these items will be repaired/replaced during the upcoming October 1997 quarterly sampling event.
- 4) Several site-specific concurrent investigations are occurring at NAS Fort Worth JRB. RCRA Facility Investigations (RFIs) are currently in the planning stages for the Landfill Area (HydroGeoLogic, Inc.) and the Flightline Area (CH2M HILL). Several wells were recently installed by IT Corporation as part of the Base-wide Sanitary Sewer RFI, and Parsons Engineering Science will be installing additional monitoring wells in the ST-14/SD-13 area as part of their Remedial Action Plan (RAP) activities. Selected wells installed, as part of these investigations, should be considered for inclusion in the

monitoring well network so that the data from these investigations can be incorporated into future groundwater monitoring programs. Conversely, unreliable wells should be considered for deletion from the monitoring network. As an example, monitoring well MW-12A has been dry during the past three quarterly sampling events, and it is not considered reliable for future monitoring.

- 5) It is recommended that free product monitoring and removal continue as part of this program and future groundwater investigations at NAS Fort Worth JRB.
- 6) Based on the current understanding and definition of the contaminant plumes, several monitoring wells could be added or deleted to the existing monitoring network to optimize the distribution of available analytical data. It is recommended that an optimization plan, based on a statistical analysis, be proposed after the last quarterly monitoring is complete.

TAB

Section 4.0 Figures

Figure 4.1

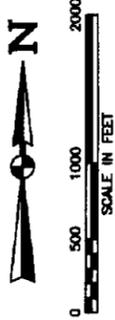
NAS Fort Worth JRB

**APPROXIMATE EXTENT OF
TCE, Cis-1,2 DCE, & BENZENE
CONTAMINATION ABOVE RRS2**

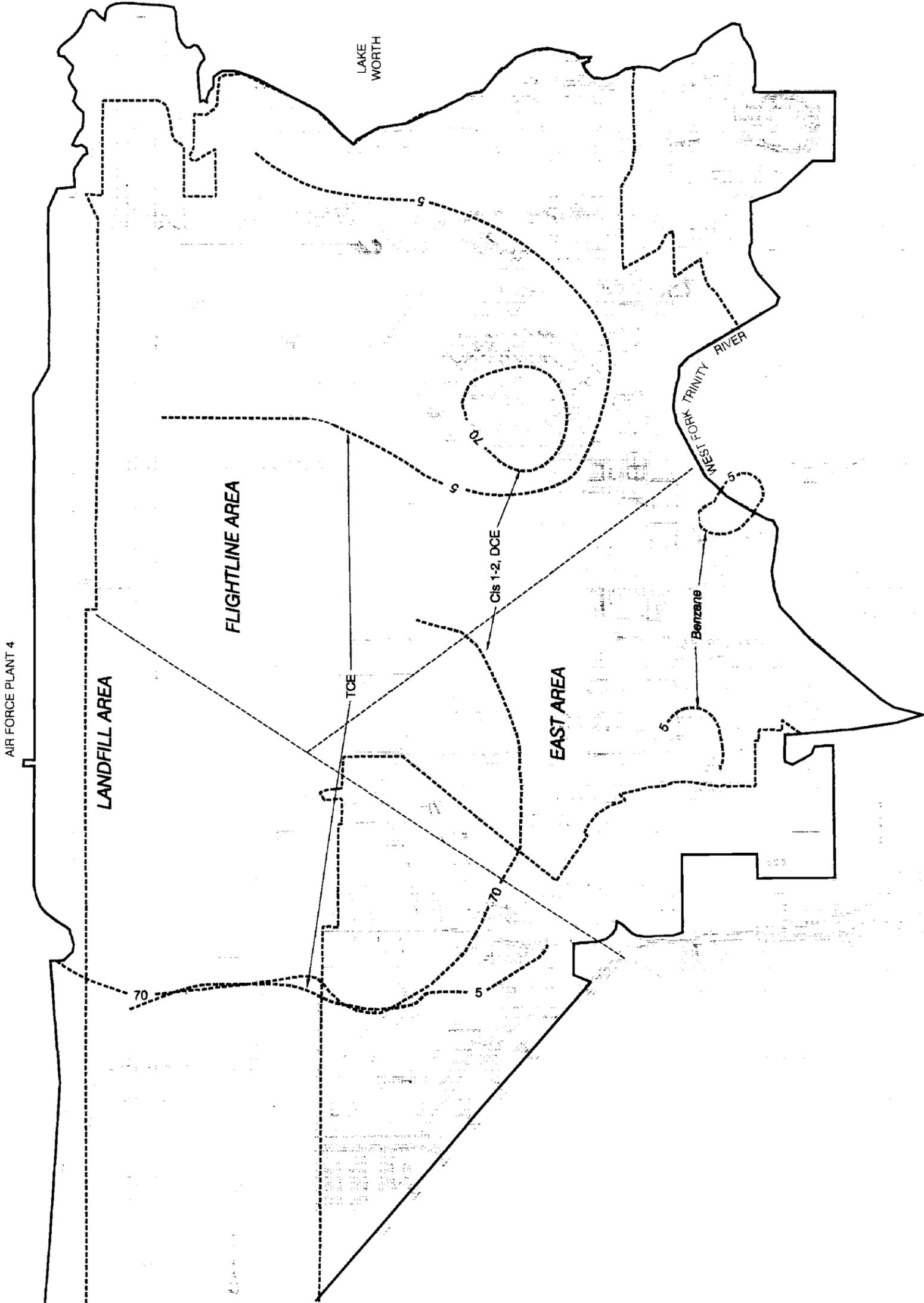
**Air Force Center
For Environmental Excellence
Brooks AFB, Texas**

LEGEND

-  Approximate Groundwater Management Areas
-  Approximate NAS Ft. Worth JRB Site Boundary
-  Former Carswell Property Boundary
-  Approximate extent of TCE contamination above RRS2 (5 µg/L)
-  Approximate extent of cis 1-2, DCE contamination above RRS2 (70 µg/L)
-  Approximate extent of Benzene contamination above RRS2 (5 µg/L)



Map Source:
JACOBS, 1996



TAB

Section 5.0

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