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FINAL WORK PLANS FOR RCRA FACILITY INVESTIGATION OF LANDFILLS NAS FORT WORTH TX

3/1/1998

HYDROGEOLOGIC

File: 17G
A.F.

NAVAL AIR STATION FORT WORTH JRB CARSWELL FIELD TEXAS

ADMINISTRATIVE RECORD COVER SHEET

AR File Number 418

File: 17A-79
A.F.
418

HYDRO GeoLogic INC.

FINAL
WORK PLANS

RCRA FACILITY INVESTIGATION OF LANDFILLS
NAS FORT WORTH JRB, TEXAS

AF CENTER FOR ENVIRONMENTAL EXCELLENCE

Contract Number F41624-95-D-8005

Prepared for:
U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

March 1998

HydroGeoLogic, Inc.
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FINAL
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RCRA FACILITY INVESTIGATION OF LANDFILLS
NAS FORT WORTH JRB, TEXAS

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Prepared for:

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Prepared by:

HydroGeoLogic, Inc.
1155 Herndon Parkway, Suite 900
Herndon, VA 20170

March 1998

PREFACE

HydroGeoLogic, Inc. (HydroGeoLogic) was contracted on February 14, 1997, to perform Resource Conservation Recovery Act (RCRA) Facility Investigations (RFIs) at several Solid Waste Management Units (SWMUs) that require further investigation at the Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), Texas. Work will be conducted under Contract Number F41624-95-D-8005, Delivery Order Number 0005. SWMUs to be investigated during this project include SWMU 17 (Landfill No. 7 or LF-07), SWMU 27 (Landfill No. 10 or LF-10), SWMU 29 (Landfill No. 2 or LF-02), SWMU 30 (Landfill No. 9 or LF-09), and SWMU 62 (Landfill No. 6 or LF-06).

Responsible key HydroGeoLogic personnel are as follows:

John (Jack) B. Robertson, P.G.	Program Manager
James P. Costello, P.G.	Project Manager
Michael J. Rodtang, P.G.	Task Manager/Project Geologist
Christopher G. Spill	Corporate Health and Safety Officer
Gary M. Mayer	Corporate QA/QC Officer

HydroGeoLogic has also subcontracted with Law Environmental and Engineering Services, Inc. (Law) to provide support in specific areas that include Health and Safety Certified Industrial Hygienist (CIH), and toxicology.

The period of performance for this D.O. is from February 14, 1997, to April 30, 1998. This contract will be administered by DCMAO Baltimore, located at 200 Towsontown Blvd., West, Towson, Maryland 21204-5299. The Contracting Officer will be Ms. Diane C. Sharpe. The Contracting Officer's Representative (COR) will be Mr. Joseph Dunkle (210/536-5290) located at AFCEE/ERD, 3207 North Road Brooks AFB, Texas 78235-5363.

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13. ABSTRACT (Maximum 200 words)

This document presents the Work Plans for the RCRA Facility Investigation at Landfills at NAS Fort Worth JRB.

The Work Plans present detailed procedures for additional investigation required to evaluate the potential threat to human health and the environment posed by wastes handled at the subject sites.

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TAB

Work Plan

FINAL
WORK PLAN

RCRA FACILITY INVESTIGATION OF LANDFILLS
NAS FORT WORTH JRB, TEXAS

Contract Number F41624-95-D-8005

Prepared for:

U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

Prepared by:

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March 1998

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LIST OF ACRONYMS AND ABBREVIATIONS

1,2-DCE	1,2-Dichloroethene
1,1,1-TCA	1,1,1-Trichloroethane
ACC	Air Combat Command
AFB	Air Force Base
AFBCA	U.S. Air Force Base Realignment and Closure Agency
AFCEE	U.S. Air Force Center for Environmental Excellence
AFP-4	Air Force Plant 4
ARARs	Applicable or Relevant and Appropriate Requirements
BDAT	Best Demonstrated Achievable Technology
bgs	below ground surface
BLRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure Commission
BTEX	Benzene, toluene, ethylbenzene, and xylenes
CAFB	Carswell Air Force Base
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2,-DCE	cis-1,2,-Dichloroethene
CFR	Code of Federal Regulation
CLP	Contract Laboratory Program
CMI	Corrective Measures Implementation
CMS	Corrective measures study
COPC	Chemical of potential concern
DCE	Dichloroethene
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DoD	Department of Defense
DQO	Data quality objectives
DRMO	Defense Reutilization and Marketing Office
DTIC	Defense Technical Information Center
EM	Electromagnetic induction
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ESE	Environmental Science and Engineering Incorporated
FAR	Federal Acquisition Regulation
°F	Fahrenheit
FSP	Field Sampling Plan
FT-08	Fire Training Area 1
FT-09	Fire Training Area 2

LIST OF ACRONYMS AND ABBREVIATIONS

GC	Gas Chromatograph
HSP	Health and Safety Plan
ILS	Instrument Landing System
Inc.	Incorporated
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
IS	Internal Standard
ISM	Interim/Stabilization Measures
IT	International Technology Corporation
JP-4	Jet propulsion (grade 4) fuel
JRB	Joint Reserve Base
L	Liter
LAW	Law Environmental Incorporated
LCS	Laboratory Control Sample
LF-02	Landfill No. 2 (a.k.a. SWMU 29)
LF-04	Landfill No. 4 (a.k.a. SWMU 22)
LF-05	Landfill No. 5 (a.k.a. SWMU 23)
LF-06	Landfill No. 6 (a.k.a. SWMU 62)
LF-07	Landfill No. 7 (a.k.a. SWMU 17)
LF-09	Landfill No. 9 (a.k.a. SWMU 30)
LF-10	Landfill No. 10 (a.k.a. SWMU 27)
LOX	Liquid Oxygen Storage
MEK	Methyl ethyl ketone
μg/L	microgram per Liter
mg/L	milligram per Liter
MS	matrix spike
MSD	matrix spike duplicate
MSCs	Media Specific Concentrations
NAS	Naval Air Station
NCP	National Contingency Plan
NFA	No Further Action
NGVD	National Geodetic Vertical Datum
NIOSH	National Institute of Occupational Safety and Health
NPDES	National Pollution Discharge Elimination System
O & M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
OWS	Oil/Water Separator

LIST OF ACRONYMS AND ABBREVIATIONS

PA	Preliminary Assessment
PCB	Polychlorinated biphenol
PD-680	Petroleum naphtha
PQL	Practical Quantitation Limit
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RA	Remedial Action
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
RRS	risk reduction standards
S	spike
SAC	Strategic Air Command
SAP	Sampling and Analysis Plan
SARA	1986 Superfund Amendments and Reauthorization Act
SD	spike duplicate
SI	Site Investigation
SOW	Statement of Work
SVOCs	Semi-Volatile Organic Compounds
SW-846	Solid Waste EPA Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, 3rd edition, 1986
SWMU 17	Solid Waste Management Unit No. 17 (a.k.a. LF-07)
SWMU 22	Solid Waste Management Unit No. 22 (a.k.a. LF-04)
SWMU 23	Solid Waste Management Unit No. 23 (a.k.a. LF-05)
SWMU 27	Solid Waste Management Unit No. 27 (a.k.a. LF-10)
SWMU 29	Solid Waste Management Unit No. 29 (a.k.a. LF-02)
SWMU 30	Solid Waste Management Unit No. 30 (a.k.a. LF-09)
SWMU 62	Solid Waste Management Unit No. 62 (a.k.a. LF-06)
TCE	Trichloroethylene
TNRCC	Texas Natural Resource Conservation Commission
trans-1,2,-DCE	trans-1,2,-Dichloroethene
TRPH	Total Recoverable Petroleum Hydrocarbon
TSWQS	Texas Surface Water Quality Standards
US	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USCG	United States Coast Guard

LIST OF ACRONYMS AND ABBREVIATIONS

USEPA	United States Environmental Protection Agency
UTL	Upper Tolerance Limit
VOC	Volatile Organic Compound
WP	Work Plan
WP-07	Waste Burial Area No. 7 (a.k.a. SWMU 24)

1.0 INTRODUCTION

The following sections briefly describe the objective of the U.S. Air Force (USAF) and the rationale for implementing this RFI workplan.

1.1 BACKGROUND

Carswell AFB (CAFB) was officially closed on September 30, 1993. A parcel of the former Carswell AFB, Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), is in the process of being transferred from Air Force to Navy management. Before the property transfer can be completed, required environmental investigations of potential contamination related to Air Force activities at the NAS Fort Worth property are to be completed, and contaminated sites remediated.

On February 7, 1991, the former CAFB (NAS Fort Worth JRB), was issued a Resource Conservation and Recovery Act (RCRA) hazardous waste permit (HW-50289) by the Texas Natural Resource Conservation Commission (TNRCC). This permit requires a RCRA facility investigation of all Solid Waste Management Units (SWMUs) listed in Permit Provision VIII (as well as those SWMUs subsequently added to the list) in order to determine whether any of the hazardous constituents listed in 40 CFR Part 264, Appendix IX have been released into the environment.

SWMUs No. 17, 27, 29, 30, and 62 are the subject of this RCRA Facility Investigation (RFI). SWMU No. 62 was identified on the original list of RFI units in the permit. SWMUs No. 17, 27, 29, and 30 were added to the list of RFI units in the TNRCC letter dated March 2, 1995, to the Air Force Base Conversion Agency.

This investigation will be managed by the Air Force under the Environmental Restoration Account. Other portions of the former AFB that are not being transferred to the Navy remain under the Base Realignment and Closure (BRAC) funding and management.

The primary regulatory programs that govern the RFI and potential closure of these sites are RCRA and the TNRCC Risk Reduction Standards Program (RRS). The TNRCC is the lead regulatory agency for activities to be conducted at the subject sites.

This RFI has been designed to meet the requirements of Permit Provision VIII of the NAS Fort Worth HW-50289 permit. The RFI work plan (WP) has been prepared using guidance documents from the Air Force Installation Restoration Program (IRP), the Environmental Protection Agency (EPA), TNRCC RRS, and RCRA. The WP for this project consist of the following documents:

The Work Plan (WP), which describes the work to be performed, explains project objectives, and presents the rationale for conducting specific project activities. The WP describes the site history and setting along with a summary of environmental investigations on the Base. Each site is described, along with data needs and the proposed sampling program for each site. Technical reports and presentation formats are also discussed in the WP.

The Field Sampling Plan (FSP) describes the planned field sampling procedures. Each method to be used is described in detail, including mobilization activities, environmental sampling procedures record keeping, and a field quality control program.

The Health and Safety Plan (HSP) provides guidance and procedures to satisfy health and safety regulations and procedures. The HSP describes required monitoring procedures, personal protection, and site safety protocols. Medical surveillance procedures, site control, and emergency response procedures are also described. Potential health and safety risks for the investigation are identified.

1.2 HISTORY OF PAST IRP WORK AT THE INSTALLATION

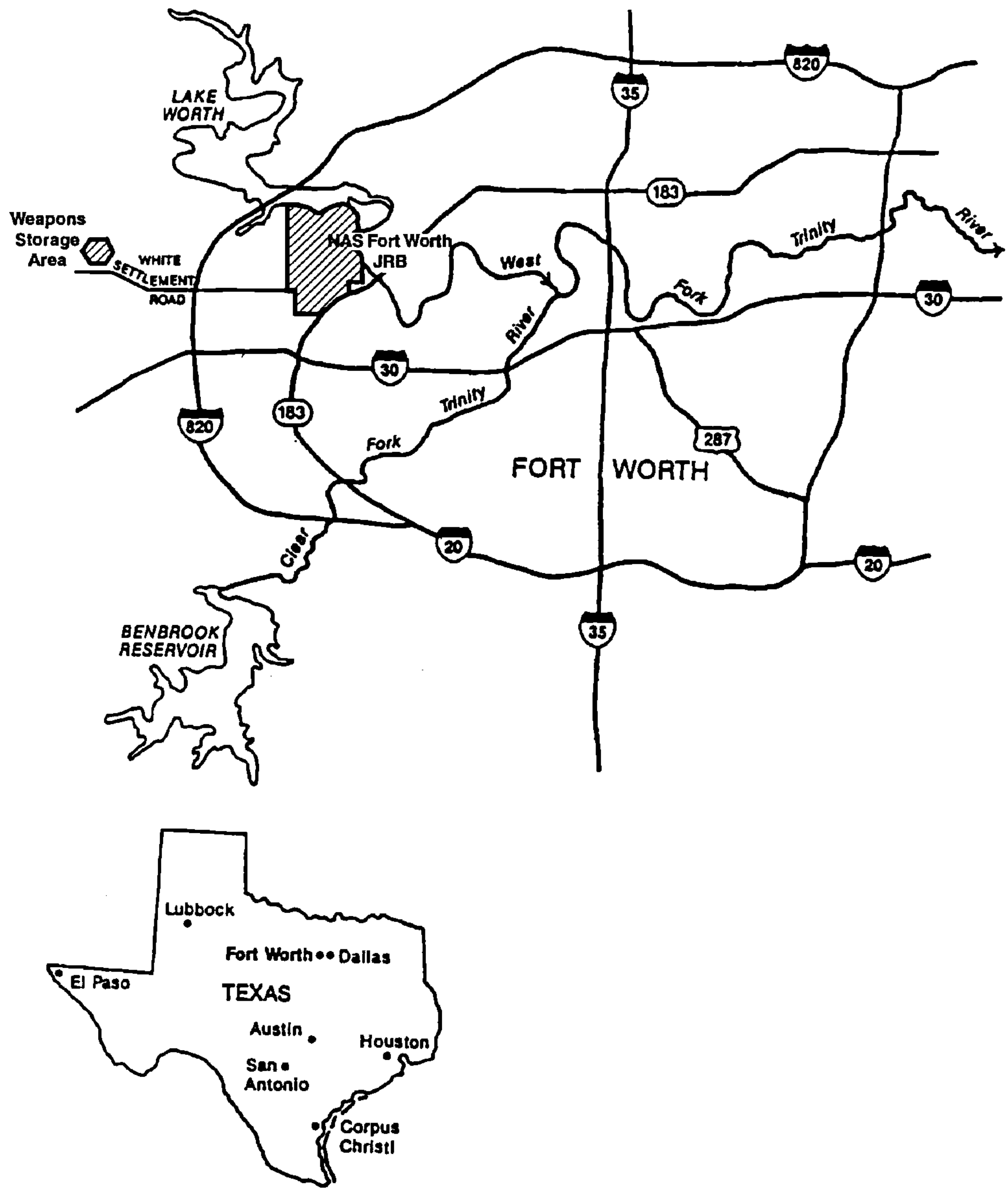
This section describes the location, physical setting, operational history, and previous environmental investigations at the NAS Fort Worth JRB.

1.2.1 Installation 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 (the Instrument Landing System (ILS) marker beacon and the Weapons Storage Area) located west of the city of White Settlement. 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 the town of Westworth Village to the east, other urban areas of Fort Worth to the northeast and southeast, the city of White Settlement to the west and southwest, and AF Plant 4 (AFP-4) to the west. 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).

1.2.2 Installation History and Present Mission

Prior to initial Base construction in 1941, the area that is now occupied by the NAS Fort Worth JRB consisted of woods and pasture in an area called White Settlement. The NAS Fort Worth JRB started as a modest dirt runway built to service the aircraft manufacturing plant located where AFP-4 is now. Figure 1.2 presents the relationship between AFP-4 and the NAS Fort Worth JRB. In August 1942, the Base was opened as Tarrant Field Airdrome and used to train pilots to fly the B-24 under the jurisdiction of the Gulf Coast Army Air Field Training Command. In May 1943, the field was re-designated as Fort Worth Army Air Field with continued use as a training facility for pilots. The Strategic Air Command (SAC) assumed control of the installation in 1946 and the Base served as the headquarters for the Eighth Air Force.



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Site

SCALE IN MILES

0 2 4

Figure 1.1
NAS Fort Worth JRB
SITE LOCATION MAP

[From Radian, 1989]

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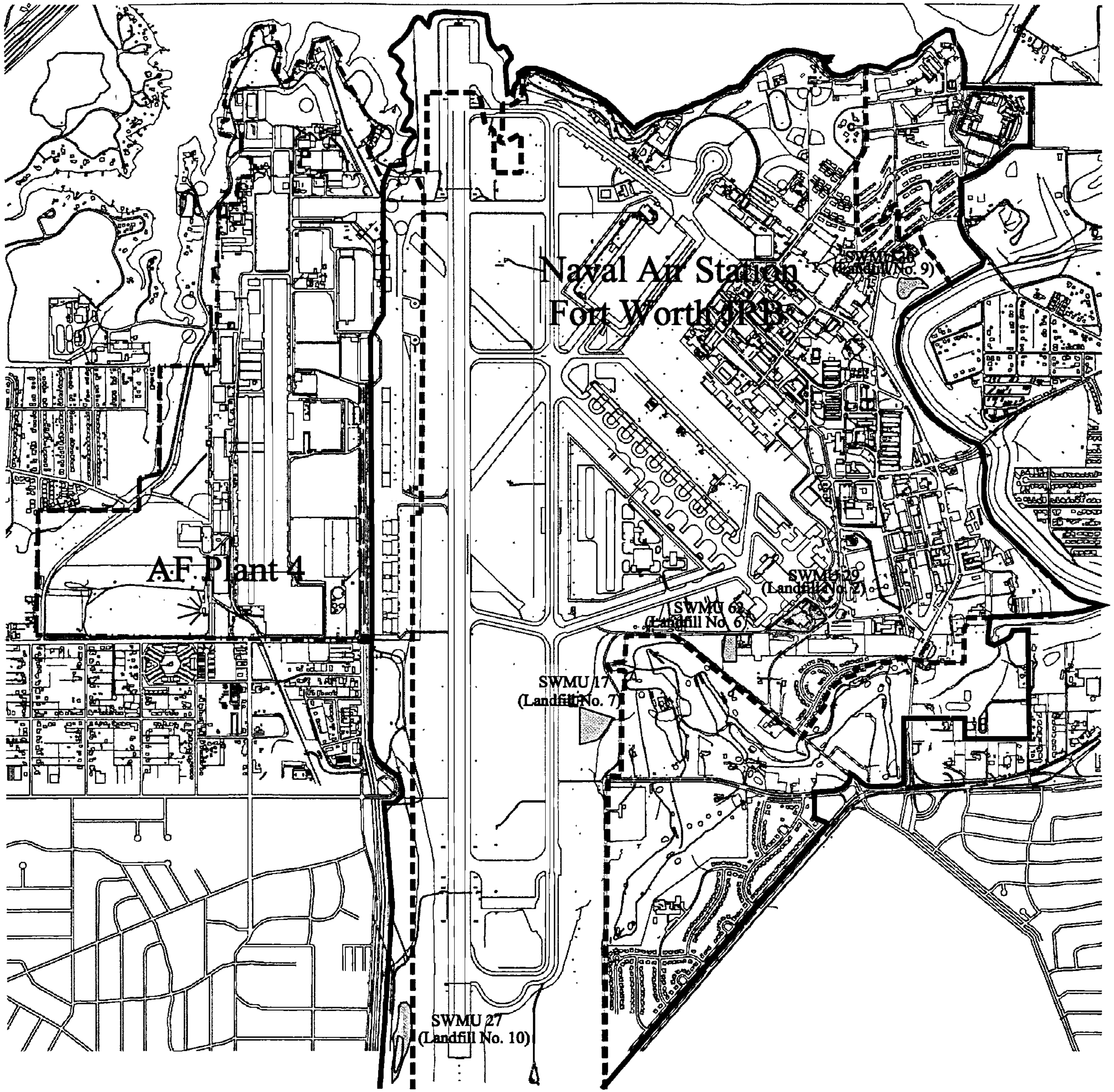

Figure 1.2

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
- SWMU's Locations

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG1-2.DWG		

Map Source: JACOBS, 1996

It was renamed Carswell AFB (CAFB) In 1948, and the 7th Bomber Wing became the Base host unit. The Headquarters 19th Air Division was located at CAFB in 1951 where it remained until September 1988 (A.T. Kearney, 1989).

The SAC mission remained at CAFB until 1992 when the Air Combat Command (ACC) assumed control of the Base upon disestablishment of SAC. In October 1994, the U.S. Navy assumed responsibility for much of the facility, and its name was changed from CAFB to NAS Fort Worth JRB. The NAS Dallas and elements of Glenview and Memphis NASs were combined into the NAS Fort Worth JRB to streamline naval operations into one central area. The principal activities on the Base have been maintaining and servicing bombers, fuel tankers, and fighter jet aircraft. (A.T. Kearney, 1989).

1.2.3 Site Operational History

A summary of past and current industrial activities and waste disposal operations conducted at the NAS Fort Worth JRB is presented in the following sections.

1.2.3.1 Industrial Activities

Major industrial operations at the NAS Fort Worth JRB include maintenance of jet engines, aerospace ground equipment, fuel systems, weapons system, and pneudraulic systems, maintenance of general and special purpose vehicles, aircraft corrosion control, and non-destructive inspection activities. Most of the liquid wastes that have been generated by industrial operations can be characterized as waste oils, recoverable fuels, spent solvents, and spent cleaners (CH2M HILL, 1996a).

Waste oils generally refer to lubricating fluids/oils and to a lesser extent, hydraulic fluids. Recoverable fuels refer to fuels drained from aircraft tanks and other Base vehicles, such as Jet Propulsion grade 4 (JP-4) and unleaded gasoline. Spent solvents and cleaners refer to stripping liquids used for degreasing and cleaning of aircraft, aircraft systems and parts, electronic components, and vehicles. Included in this category are PD-680 (petroleum naphtha) and various chlorinated organic compounds. Specific types of degreasing solvents used by the U.S. Air Force have changed over the years. In the 1950s, carbon tetrachloride was commonly used until it was replaced by trichloroethylene (TCE) in about 1960. Since then, TCE and 1,1,1-trichloroethane (1,1,1-TCA) have been used though TCE usage has decreased in favor of 1,1,1-TCA. Today, PD-680 Type II, 1,1,1-TCA, and to a limited extent, TCE are used. Waste paint solvents and strippers are also generated on-site from corrosion control activities. Typical paint solvents include compounds like isobutyl acetate, toluene, methyl ethyl ketone, isopropanol, naphtha, and xylene. Paint strippers generally contain such compounds as methylene chloride, toluene, ammonium hydroxide, and phenolics. Servicing and maintenance of the engines and equipment of the B-52 and KC-135 aircraft generated the majority of waste liquids at NAS Forth Worth JRB (CH2M HILL, 1996a).

1.2.3.2 Waste Disposal Operations

Wastes have been generated and disposed of at the NAS Fort Worth JRB since the beginning of industrial operations in 1942. Historical waste management practices at the NAS Fort Worth JRB were presented in the Phase I Initial Assessment Report (CH2M HILL, 1984), the Phase I Remedial Investigation Report (Radian, 1989), and the Site Characterization Summary Informal Technical Information Report (CH2M HILL, 1996b), and are summarized in the following paragraphs:

1942-1970: The majority of waste oils, recovered fuels, spent solvents, and cleaners were burned at the fire department training areas during practice exercises. Some waste oils and spent solvents were disposed of through contractor removal, while some waste paints (contaminated with thinners and solvents), waste oils, and PD-680 are suspected of having been disposed of in the Base landfills. Some waste oils, recovered fuels, spent solvents, and cleaners were also discharged to sanitary and storm sewers. These discharges occurred primarily at the washracks. In 1955, an oil/water separator (OWS) (Facility 1190) was installed to recover waste materials discharged from the washracks. Non-aqueous materials from OWSs were pumped out and disposed of through contractor removal. Aqueous discharge from OWSs was, and still is, pumped into the sanitary sewers.

1971-1975: During this period, most waste oils, spent solvents, and cleaners were disposed of by contractor removal. A private contractor would pump the materials from oil/water separators, 55-gallon drums, and bowsers. Recovered JP-4 was still stored at the fire training area and burned in practice exercises. Recovered JP-4 was also reused in aerospace ground equipment operations. Some waste paints (contaminated with thinners and solvents), waste oils, and PD-680 are suspected of having been disposed of in the Base landfills. Some waste oils, solvents, and cleaners were discharged into sanitary sewer drains, primarily at the washracks that discharge to the Facility 1190 OWS. This OWS was routinely pumped out by a private contractor, and the recovered materials were removed from the Base by the contractor.

1976-1982: The majority of waste oils, spent solvents, and cleaners were disposed of by service contract either directly or through the Defense Reutilization and Marketing Office (DRMO). Recovered JP-4 was stored at the fire department training area and burned during practice exercises. Recovered JP-4 was also used in aerospace ground equipment operations. PD-680 used at the washracks was discharged to the Facility 1190 OWS, which discharged to the sanitary sewers.

1983-Present: Waste oils, solvents, and cleaners are collected in 55-gallon drums and temporarily (less than 90 days) stored at 12 hazardous waste accumulation points located throughout the Flightline Area of the Base. They are subsequently disposed of by contractor removal through DRMO. Recovered JP-4 and other fuels (Mogas - unleaded gasoline) are stored at the fire department training area for subsequent burning in practice exercises or reuse in aerospace ground equipment operations. Waste paint solvents or thinners and strippers such as toluene, isobutyl acetate, methyl ethyl ketone (MEK), isopropanol, naphtha, and xylene are also temporarily stored prior to removal. Removal of waste oils and PD-680 (Type II) from OWSs is also handled by off-base contractor through DRMO.

1.3 SWMU IDENTIFICATION AND DESCRIPTION

The areas of interest for this RFI are five landfills located throughout the NAS Fort Worth JRB Installation. These landfills are identified as SWMU 17 (Landfill No. 7 or LF-07), SWMU 27 (Landfill No. 10 or LF-10), SWMU 29 (Landfill No. 2 or LF-02), SWMU 30 (Landfill No. 9 or LF-09), and SWMU 62 (Landfill No. 6 or LF-06). The locations of the SWMUs in relation to the Base are presented on Figure 1.3. Table 1.1 provides a summary description of each SWMU and lists the current status of each site.

SWMU 17 is approximately 3.4 acres and is located in the Flightline Area, east of Taxiway 197, adjacent to the south side of building 4146. The period of official operation of this SWMU was from 1978 to 1983. Unauthorized dumping may have continued for several years after 1983. This area reportedly received construction debris in the form of concrete, asphalt, wood, trees, and potentially small amounts of undocumented hazardous materials.

SWMU 27 is approximately 4.5 acres and is located in the southwestern portion of NAS Fort Worth JRB, east of the perimeter road and west of Overrun 51. Based on aerial photographic interpretation, the period of operation for this SWMU began around 1988, and continues to the present day. The SWMU currently receives concrete rubble, tree limbs, and street sweepings.

SWMU 29 originated as a borrow pit located in the center portion of NAS Fort Worth JRB between Haile Drive and the perimeter road. These 4.4 acres were converted to a landfill in 1952 and accepted construction debris and moderate quantities of unspecified hazardous wastes. In 1956, the landfill was no longer needed and was covered.

SWMU 30 is located approximately 300 feet southeast of Building 2570 and occupies approximately 1.7 acres. The SWMU received construction debris in the form of concrete, asphalt, and wood from 1978 through 1983. The site is currently covered by vegetation.

SWMU 62 is approximately 1.5 acres and is located southwest of SWMU 29 between Roaring Springs Road, Haile Drive and the perimeter road. This area served as an active landfill from 1975 through 1978. It was documented that in addition to construction debris, the landfill also received three drums of hydraulic fluid (USACE, 1993) and moderate quantities of unspecified hazardous wastes.

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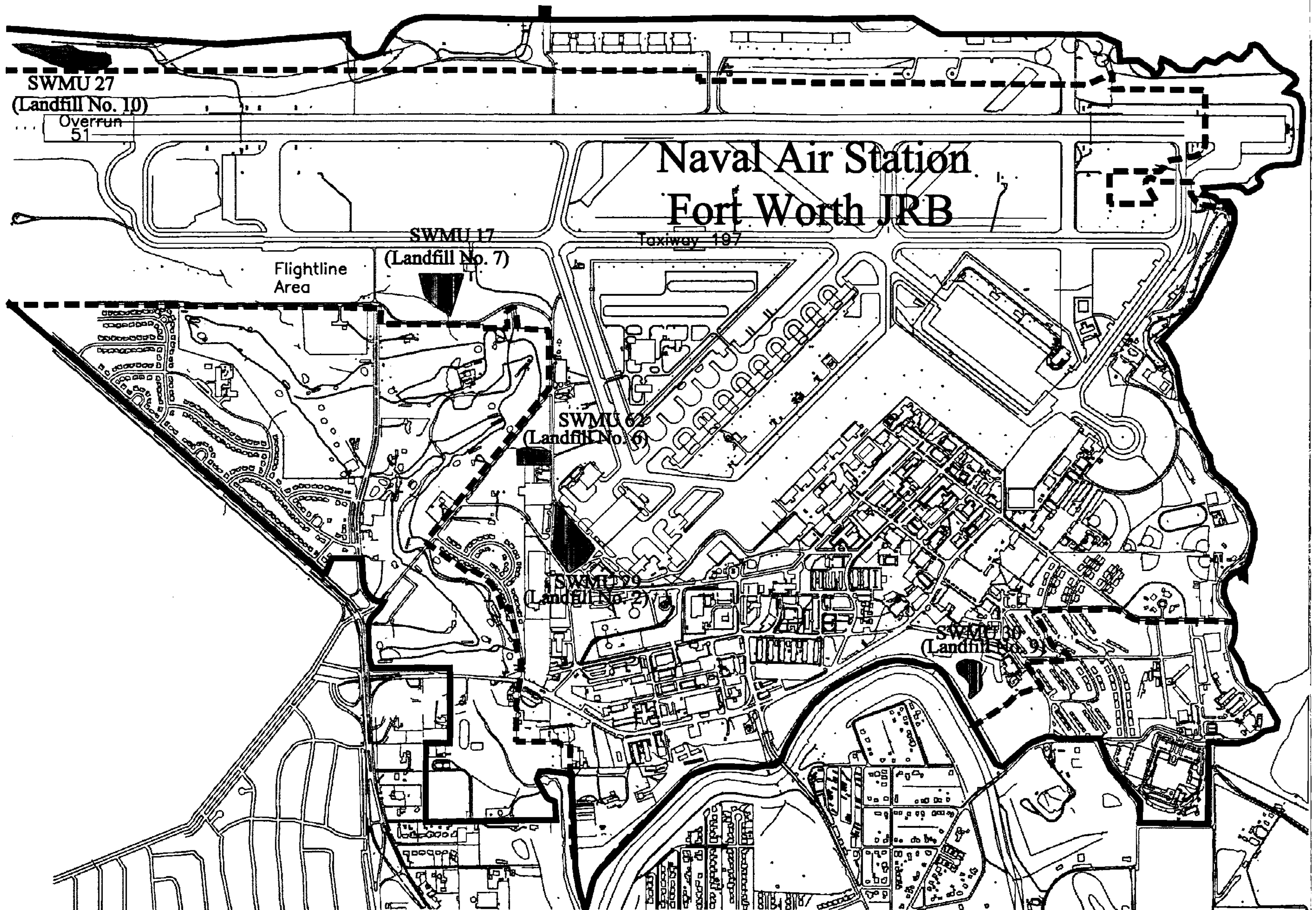

Figure 1.3

NAS Fort Worth JRB

SWMU Locations to be Investigated Under Delivery Order 0005

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

Former Property Boundary of Carswell AFB

Approximate NAS Fort Worth JRP Site Boundary

SWMU's Investigated Under Delivery Order

0 500 1000 2000
SCALE IN FEET

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG1-3.DWG		

Map Source: JACOBS, 1996

Table 1.1
Current SWMU Summary Table
NAS Fort Worth JRB, Texas

IRP Site ID	SWMU No.	Description	Materials Received	Operation Dates	Status
LF02	29	Landfill 2	Construction rubble and materials, moderate quantities of unspecified hazardous wastes	1952-1956	RCRA Facility Investigation
LF06	62	Landfill 6	Construction rubble, drums of hydraulic fluid, and small quantities of hazardous materials	1975-1978	RCRA Facility Investigation
LF07	17	Landfill 7	Construction waste and rubble; possibly small amounts of hazardous wastes	1978-1983	RCRA Facility Investigation
LF09	30	Landfill 9	Construction rubble and trees; possibly small amounts of hazardous materials	1978-1983	RCRA Facility Investigation
LF10	27	Landfill 10	Concrete rubble, tree limbs, and street sweeping debris	Origination unknown; currently operational	RCRA Facility Investigation

Source(s): Management Action Plan, Carswell AFB (October 28, 1993)
RCRA Facility Investigation Statement of Work, Annex A (January 21, 1997).

1.4 SITE INVESTIGATION HISTORY

This RCRA RFI is being conducted at the NAS Fort Worth JRB to satisfy CERCLA requirements for federal facilities and also to comply with Provision VIII of Permit HW-50289. This permit was issued by the TNRCC on February 7, 1991. In the permit, SWMU No. 62 was identified on the original list of RFI units. SWMUs No. 17, 27, 29, and 30 were added to the list of RFI units by the TNRCC in a letter to the USAF dated March 2, 1995. The IRP effort to characterize the SWMUs at the NAS Fort Worth JRB was initiated in 1984. These investigations have resulted in analytical data associated with two of the subject SWMUs. Investigations conducted at other sites near SWMU 17 have resulted in groundwater data that is relevant to characterizing this site. A preliminary site investigation was conducted for the U.S. Army Corps of Engineers (USACE) at SWMU 62. In addition, a geophysical survey was performed for the Navy in the vicinity of SWMU 62. Previous investigations have not been conducted at SWMUs 27, 29 and 30.

The following IRP investigations have been performed at the NAS Fort Worth JRB:

- CH2M HILL, 1984, Installation Records Program for Carswell Air Force Base.
- Radian Corporation, 1986, Installation Restoration Program Phase II - Confirmation/Quantification, Stage 1, Final Report
- Radian Corporation, 1989, Installation Restoration Program RI/FS, Stage 2 Draft Final Technical Report, Carswell Air Force Base, Volumes 1&2
- Radian Corporation, 1991, Installation Restoration Program RI, Stage 2 Final Report, Carswell Air Force Base.
- International Technology Corporation, 1994, Draft Phase III Summary Report of Field Sampling, Analysis, and Testing at Carswell Air Force Base.
- U.S. Army Corps of Engineers, Fort Worth District, 1993, Preliminary Assessment/Site Investigation for Site LF-06 Landfill Number 6, SWMU No. 62.
- EnSafe/Allen & Hoshall, 1995, Geophysics Investigation of SWMU No. 62. Naval Air Station Fort Worth, Texas
- EnSafe/Allen & Hoshall, 1995, Final Summary Report, Second Phase of SWMU No. 62. Investigation, Naval Air Station Fort Worth, Texas
- CH2M HILL, 1997, Draft RCRA Facility Investigation Work Plan for Area of Concern 2, (TCE Groundwater Plume).
- HydroGeoLogic, Inc, 1997, RCRA Facility Investigation/Corrective Measures Study Draft Work Plans for WP-07, Landfills 4,5, and 8, Carswell AFB, Texas.

Each of the following sections will summarize the results of previous investigation results from the subject sites. Remedial Actions (RA) have not been initiated at any of the sites included in this WP.

1.4.1 SWMU 17

Although SWMU 17 is located within the Flightline Area, it has never been directly investigated. Previous investigations of the Flightline Area have centered around SWMUs 22, 23, 24, and 25 as well as several other areas of interest. The following paragraphs provide an overview of previous investigations that have been conducted in the vicinity of SWMU 17.

Sampling of the alluvial terrace groundwater beneath the Flightline Area began during the Site Investigation (SI) (Radian, 1986) and has continued periodically until the most recent sampling conducted by CH2M Hill in April, 1997. The results of this most recent investigations are not yet available, so the most current analytical data used in preparing this WP is from the Law Environmental, Inc. January 1996 Sampling (LAW, 1996). The following list is a summary of the investigations conducted in the Flightline Area:

- **Site Investigation (Phase II, Stage I), February/March 1985 (Radian, 1986).** This investigation involved the initial installation and sampling of monitoring wells in the Flightline Area. The results of this investigation showed that TCE contamination was present in the groundwater beneath the site and that the center of the portion of the plume associated with the Flightline Area paralleled White Settlement Road between Landfill No. 4 (LF-04) and Waste Burial Area No. 7 (WP-07). Chemicals other than TCE and its associated daughter products were detected, but not at significant levels.

- **Phase I RI/FS (Phase II, Stage II), February and April 1988 (Radian, 1989).** The Phase I RI/FS included two rounds of groundwater sampling in the Flightline Area. The results of these sample analyses show the Flightline Area portion of the chlorinated organic compound plume remained centered around WP-07. The concentrations of the Flightline Area portion of the plume did not change appreciably between the SI and Phase I RI/FS sampling. Several inorganic compounds including antimony, arsenic, lead, and selenium exceeded comparison criteria by greater than an order of magnitude. Subsequent sampling events, however, did not confirm these elevated concentrations suggesting these results may be anomalous readings.

- **Phase II RI/FS (Phase II, Stage II), April/May 1990 (Radian, 1991).** The Phase II RI/FS was initiated to further investigate the TCE plume in the Flightline Area. The results showed the Flightline Area portion of the TCE plume centered at monitoring well LF04-4G, further east than previous sampling events (groundwater flow is in an easterly direction). Additional downgradient wells were installed which showed the plume extending farther north than previous investigations. The installation and sampling of additional wells to the east also showed the plume to extend farther east, perpendicular to groundwater flow. Only TCE and cis-1,2,-Dichloroethene (DCE) exceeded comparison criteria by greater than one order of magnitude. The elevated inorganic results present in the earlier Phase I RI/FS study were not confirmed during this sampling event.

- **Recovery Well Sampling, April 1993 (IT, 1993), July 1994 (IT, 1994).** IT Corporation (IT) conducted sampling of the groundwater recovered during testing of extraction wells installed for the groundwater remediation system in the Flightline Area. The results of these analyses showed the maximum TCE concentration at recovery well CAR-RW7, just east of the WP-07. It should be noted that IT collected dynamic samples for remediation system design. Dynamic samples collected from recovery wells are generally obtained at much higher flow rates than samples collected from monitoring wells. Therefore, the results of the recovery well sampling may not correlate well with samples collected during other sampling events.

- **Quarterly Groundwater Sampling, CAFB (LAW, 1996a, 1996b).** LAW conducted quarterly groundwater sampling in April 1995, July 1995, October 1995, and January 1996 in the Flightline Area. The results of these four sampling events showed that the magnitude and extent of the TCE plume changed little between the first and fourth quarter. The center of the Flightline Area portion of the plume continued to be along White Settlement Road between LF-04 and WP-07. Several inorganic chemicals exceeded comparison criteria during the four quarterly sampling events, but the concentrations were either within an order of magnitude of the comparison criteria or appeared to be isolated anomalous results.

- **Quarterly Groundwater Sampling, AFP-4 (Jacobs, 1996).** Jacobs Engineering Group has been conducting quarterly groundwater sampling at AFP-4 and NAS Forth Worth JRB to monitor the nature and extent of the TCE plume that originates in the East Parking Lot Area at AFP-4. The downgradient portion of this plume is commingled with the TCE plume originating in the Flightline Area. Jacobs Engineering samples several Flightline Area wells on a quarterly basis to monitor this plume. Figure A.1 of Appendix A illustrates the AFP-4 TCE plume.

The Flightline Area portion of the TCE plume is defined in the upgradient (southwestern) direction based on the consistently low reading obtained in groundwater samples collected from LF04-4A, LF04-4B, and FT09-12A. The western extent of the TCE plume cannot be accurately delineated since the AFP-4 TCE plume originates in this direction and it is commingled with the Flightline Area TCE plume. The eastern (downgradient) extent of the TCE plume is not well defined based on the results from LF04-04 and LF05-18 during the October 1995 Jacobs Engineering sampling. These same wells, however, sampled by Law in January 1996, were below detection limits. The alluvial terrace deposits thin out and are exposed along stretches of Farmers Branch Creek. Therefore, Farmers Branch Creek can be considered the northern extent of the Flightline Area portion of the TCE plume. A more detailed presentation of the Flightline Area portion of the TCE plume during the January 1996 sampling is presented in Figure A.2 of Appendix A. The extent of the Flightline Area portions of the cis-1,2-DCE and the trans-1,2-DCE plumes during this same period are presented on Figures A.3 and A.4 of Appendix A, respectively.

1.4.2 SWMU 62

During the Preliminary Assessment (PA) conducted in 1993 (USACE, 1993), the soil and groundwater were sampled and analyzed for lead, benzene, toluene, ethyl benzene, and xylenes (BTEX), and total recoverable petroleum hydrocarbons (TRPH). Figure 1.4 shows the location of the five soil borings (LF06-1 through LF06-5) that were drilled and sampled. Of those five, only three borings were sampled for groundwater due to caving conditions caused by gravel in two boreholes. Hydrocarbon contamination in the soils was found in three of the soil borings at depths consistent with debris identified during drilling operations. Table 1.2 is a list of the laboratory analyses performed on the samples collected during this investigation. Analytical results for soil samples collected during the PA/SI are presented in Table 1.3, and groundwater analytical results from soil borings are presented in Table 1.4. The PA reported soil concentrations of toluene, xylene, and TRPH at concentrations up to 0.006 mg/kg, 0.0042 mg/kg, and 5,160 mg/kg, respectively. Groundwater concentrations of lead and TRPH were also reported at concentrations up to 0.361 mg/L and 0.3 mg/L, respectively. These contaminants were identified from LF06-1. No evidence of buried debris in this boring was noted during the investigation.

In 1995, EnSafe/Allan & Hoshell (1996) conducted a geophysical survey for the Navy in the vicinity of former Landfill 6, but not within the actual landfill. This work was done to support the construction of a Van Pad Facility and Liquid Oxygen Storage (LOX) Facility at NAS Fort Worth JRB. The geophysical study indicated that approximately 90 percent of the area surveyed did not exhibit any evidence of burial; however, a class A (significant anomaly) was detected adjacent and to the west of Landfill 6. This anomaly may be an extension of the former landfill. In 1996, two soil borings (LF6-001 and LF6-002) were completed approximately 300 feet to the east of Landfill 6 in the area selected for construction of the LOX Facility. Results of the geophysical survey and the locations the two soil borings are depicted in Figure 1.5.

LF6-001 was completed to a depth of 14 feet, and LF6-002 was completed to a depth of 11 feet. Examination of continuous cores from these borings did not reveal the presence of landfilled materials. A native caliche hardpan was detected a depth of approximately 9 feet in both borings. Soil samples for chemical analysis were collected from each boring at depths of 2, 4, and 9 feet, stopping at the first encountered water zone. Soil samples from these borings were analyzed for the full suite of 40 CFR Part 264, Appendix IX constituents. Analytical results from these borings with concentrations above detection limits are presented in Table 1.5. All of the results for metals are at or below background levels based on the Jacobs background level study for NAS Fort Worth JRB. Only one sample was positive for Volatile Organic Compounds (VOCs) (LF6-S-00102 at 3 ppb), and that value is well below the TNRCC RRS 2 (511 mg/kg).

Figure 1.4

Previously Installed Soil Borings at SWMU 62

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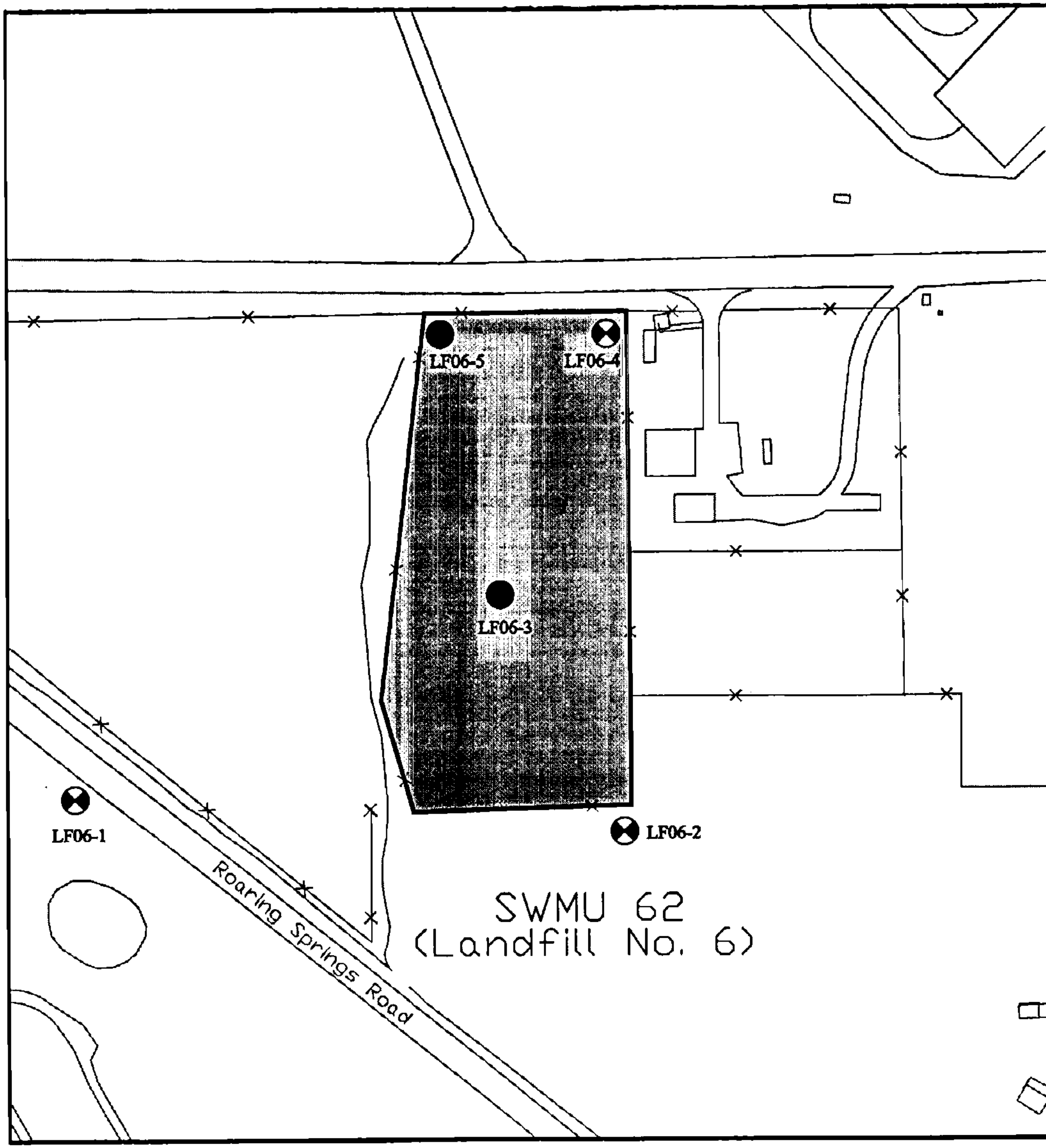

LEGEND

SWMU Area

Building

Fence

Road

Soil Boring Location (Soil Samples)

Soil Boring Location (Soil and Groundwater Samples)

0 150
SCALE IN FEET

N

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG1-8.DWG		

Map Source: USACE, 1993

Table 1.2
Sampling Analysis From Previous Investigations
SWMU 62
NAS Fort Worth JRB, Texas

Well Name	TDS[1]	BTEX[2]	TRPH[3]	TOX[4]	TCLP Lead[5]	TCLP Benzene[6]	Lead[7]
Soil							
LF06-1	NA	X	X	X	X	X	NA
LF06-2	NA	X	X	X	X	X	NA
LF06-3	NA	X	X	X	X	X	NA
LF06-4	NA	X	X	X	X	X	NA
LF06-5	NA	X	X	X	X	X	NA
Groundwater							
LF06-1	X	X	X	NA	NA	NA	X
LF06-2	X	X	X	NA	NA	NA	X
LF06-3	X	X	X	NA	NA	NA	X
LF06-4	X	X	X	NA	NA	NA	X
LF06-5	X	X	X	NA	NA	NA	X

Notes:

NA - Not Analyzed
[1] TDS - Total Dissolved Solids analyzed using EPA Method 160.3
[2] BTEX - Benzene, Toluene, Ethylbenzene and Xylenes measured using EPA Method 8020.
[3] TRPH - Total Recoverable Petroleum Hydrocarbons analyzed using EPA Method 418.1.
[4] TOX - Total Halogenated Organics analyzed using EPA Method 9020.
[5] TCLP Lead - Toxicity Characteristic Leaching Parameter for Lead using EPA Method 6010.
[6] TCLP Benzene - Toxicity Characteristic Leaching Parameter for Benzene using EPA Method 1311/8020.
[7] Lead analyzed using EPA Method 6010.

Source: PA/SI Landfill No. 6, SWMU No. 62 (USACE, 1993)

Table 1.3
Analytical Results of Soil Samples - SWMU 62
January 28, 1993 to February 4, 1993
NAS Fort Worth JRB, Texas

Parameter (mg/Kg)	TNRCC Risk Reduction Standard #2[1]	Sample Location and Depth									
		LF06-1				LF06-3		LF06-4			
		1.0-1.5 ft	7.0-7.5 ft	9.0-9.5 ft	1.0-2.5 ft	7.5-8.0 ft	15.0-15.5 ft	1.0-1.5 ft	4.0-4.5 ft	6.0-6.5 ft	14.5-15.0 ft
Toluene	100	ND	ND	ND	ND	ND	0.0023	ND	0.006	ND	ND
Xylenes	1,000	ND	ND	ND	ND	ND	0.0042	ND	0.002	ND	ND
TRPH	NA	23	30	40	23	5,160	34	401	ND	86	225

Notes:

Soil samples were analyzed for benzene, toluene, ethyl benzene, xylenes (BTEX), TPRH, and TOX; one soil sample was arbitrarily selected at a suspected burial depth in each boring for TCLP lead and benzene analyses. Unless otherwise noted, all parameters were ND.

ND = Not Detected above the detection limit of 0.002 mg/Kg (benzene, toluene, ethyl benzene, and xylenes), 10 mg/Kg (TRPH and TOX), 0.2 mg/L (TCLP lead), or 0.005 mg/L (TCLP benzene).
TCLP = Toxic Characteristic Leach Procedure
TOX = Total Halogenated Organics.
TRPH = Total Recoverable Petroleum Hydrocarbons.

[1]Maximum Concentration of Groundwater Protection Standard for Industrial Use
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission

Source: PA/SI for Landfill No. 6, SWMU No. 62 (USACE, 1993)

Table 1.4
Groundwater Analytical Results from Soil Borings - SWMU 62
January 28, 1993 to February 4, 1993
NAS Fort Worth JRB, Texas

Parameter (mg/L)	TNRCC Risk Reduction Standard #2[1]	Background UTLs Groundwater[2]	Sample Location		
			LF06-1	LF06-2	LF06-4
TRPH	NA	NA	0.3	ND (0.2)	ND (0.2)
TDS	NA	NA	356	474	736
Lead	0.015	ND (0.0016)	0.361	0.068	NA

Notes:
Groundwater samples were analyzed for benzene, toluene, ethyl benzene, xylenes (BTEX), TPRH, TDS, and lead. Unless otherwise noted, all parameters were ND.
Borings LF06-3 and LF06-5 were not sampled due to borings caving.
ND = Not Detected above the detection limit of 0.001 mg/L (benzene, toluene, ethyl benzene, and xylenes).
TDS = Total Dissolved Solids
TRPH = Total Recoverable Petroleum Hydrocarbons.

[1]Maximum Concentration of Groundwater Protection Standard for Industrial Use
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission

[2]Basewide Background Study, Volume 1 (Jacobs, 1997).

Source: PA/SI for Landfill No. 6, SWMU No. 62 (USACE, 1993)

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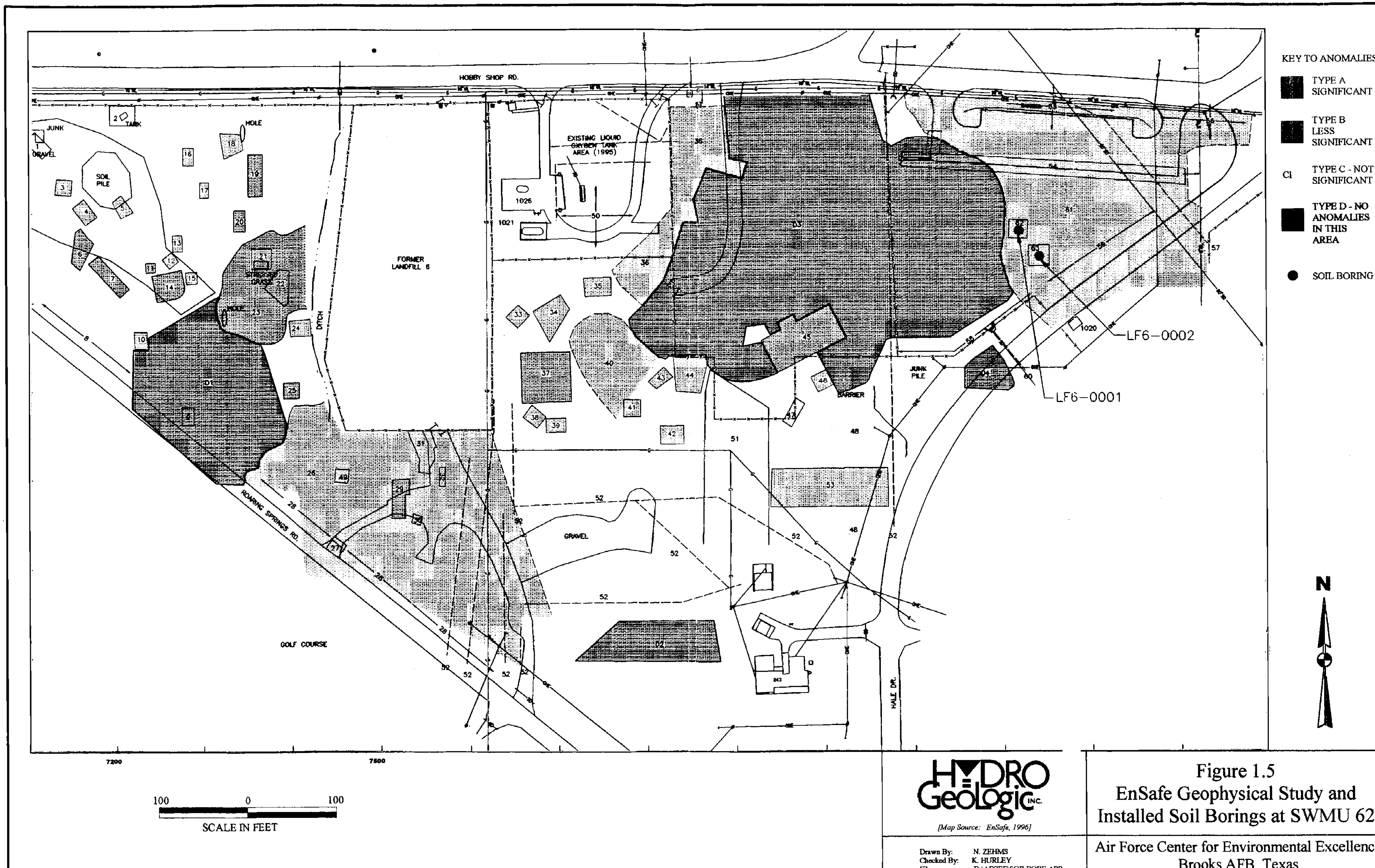

Figure 1.5
EnSafe Geophysical Study and Installed Soil Borings at SWMU 62

Air Force Center for Environmental Excellence
Brooks AFB, Texas

Table 1.5
Analytical Results of Soil Samples - SWMU 62
February 6, 1996
NAS Fort Worth JRB, Texas

Compounds	LF6-S-000102	LF6-S-000104	LF6-S-000109	LF6-S-000202	LF6-S-000204	LF6-S-000209
Metals (ppm)						
Arsenic	4.0	4.8	5.9	4.5	6.3	5.2
Barium	73.5	109	33.3	99.1	70.9	24.7
Beryllium	0.75	0.89	0.66	0.84	0.96	0.5
Cadmium	ND	ND	0.19	0.09	0.13	0.14
Chromium	16.4	21	18.2	17.4	23.4	13.3
Cobalt	4.7	4.9	2.8	5.6	4.8	2.7
Copper	6.9	6.9	5.4	10.7	5.8	3.5
Lead	10.6	9.0	6.3	11.2	9.0	5.3
Nickel	9.9	11.5	8.0	12.2	12	5.7
Thalium	ND	ND	ND	ND	1.0	1.4
Vanadium	25.4	31.6	29.2	27.2	36.5	22.5
Zinc	20.8	25.5	22.0	26.5	27.7	13.5
VOCs (ppb)						
MIBK	3	ND	ND	ND	ND	ND

Note: Table shows "hits" only
ND - Non Detect

1.4.3 SWMUs 27, 29, and 30

Previous investigations have not been conducted at SWMUs 27, 29 and 30. Therefore, no data exists as to whether media at these SWMUs are contaminated as a direct result of past activities during their respective periods of operation.

1.5 DESCRIPTION OF CURRENT STUDY

An investigation will be conducted at five landfills at NAS Fort Worth JRB in an effort to obtain closure of the units under TNRCC RRS Program. The results of previous investigations, and the results of the investigation outlined in these WPs, will be used to determine which RRS is appropriate for closure of each of the subject SWMUs.

Sampling results from previous investigations at SWMU 17 and 62 exceed RRS2. Additional sampling will be conducted during this RFI to further evaluate the source of this contamination, and also to delineate the extent of this contamination. If the RRS2 media specific concentrations (MSCs) are exceeded during this investigation, then, 1)"hot spot" remediation to achieve RRS2 levels will be performed, or 2) closure under RRS3, including preparation of a Baseline Risk Assessment (BLRA), and if necessary, a Corrective Measures Study (CMS), will be initiated.

Previous investigations have not been conducted at SWMUs 27, 29 and 30. An initial assessment will be conducted at each of these sites, focusing on characterizing any potential contaminant sources and providing a preliminary evaluation of the nature and extent of any contamination detected. The results of the samples collected during these investigations will be compared to the draft background values (Jacobs, 1997) to determine if closure under RRS1 is appropriate. If background values are not available for organic chemicals, the investigation results will be compared to practical quantitation limits (PQLs) for closure under RRS1. The results of the investigations proposed in the RFI Work Plan may not provide a complete delineation of the nature and extent of the contamination present at each of the subject SWMUs. If further delineation of contamination is required at any of the SWMUs in this study, additional monitoring wells and/or soil borings will be installed to complete characterization of the contaminants. When delineation of the contamination is complete at each of the SWMUs, the data will be compiled and presented in an RFI Report with a discussion of the RRS standard that is appropriate for closure at each of the sites.

2.0 SUMMARY OF EXISTING INFORMATION

The climate, physiography, geology, hydrology, biology, demographics for the NAS Fort Worth JRB area is described in the following sections. These data have primarily been derived from the Summary of Remediation Projects at AFP-4 and CAFB (ESE, 1994) and the RI/FS Reports (Radian, 1989, 1991).

2.1 INSTALLATION ENVIRONMENTAL SETTING

2.1.1 Physiographic Province

The NAS Fort Worth JRB area is located along the border zone between two physiographic provinces. The southeastern part of the Base is situated within the Grand Prairie section of the Central Lowlands Physiographic Province. Most of NAS Fort Worth JRB is located within this province. This region is characterized by broad, eastward-sloping terrace surfaces that are interrupted by westward-facing escarpments. The land surface is typically grass covered and treeless except for isolated stands of upland timber. The northwestern part of the NAS Fort Worth JRB area is situated within the Western Cross Timbers Physiographic Province. This area is characterized by rolling topography and a heavy growth of post and blackjack oaks (Radian, 1989). Surface elevations for this region range from about 850 feet above National Geodetic Vertical Datum (NGVD), west of the Base, to approximately 550 feet above NGVD, along the eastern side of the Base. Figure 2.1 is a section of the Lake Worth, Texas U.S. Geological Survey Topographic Map showing the relief of the NAS Fort Worth JRB/AFP-4 region.

2.1.2 Regional Geology

The geologic units of interest for the region, from youngest to oldest, are as follows: (1) the Quaternary 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 2.2 (Radian, 1989). The areal limits of surface exposure of these units at NAS Fort Worth JRB are shown in Figure 2.3. Cross section locations and individual cross sections at NAS Fort Worth JRB are presented in Figure 2.4 - 2.7 (CH2M HILL, 1996b). 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.

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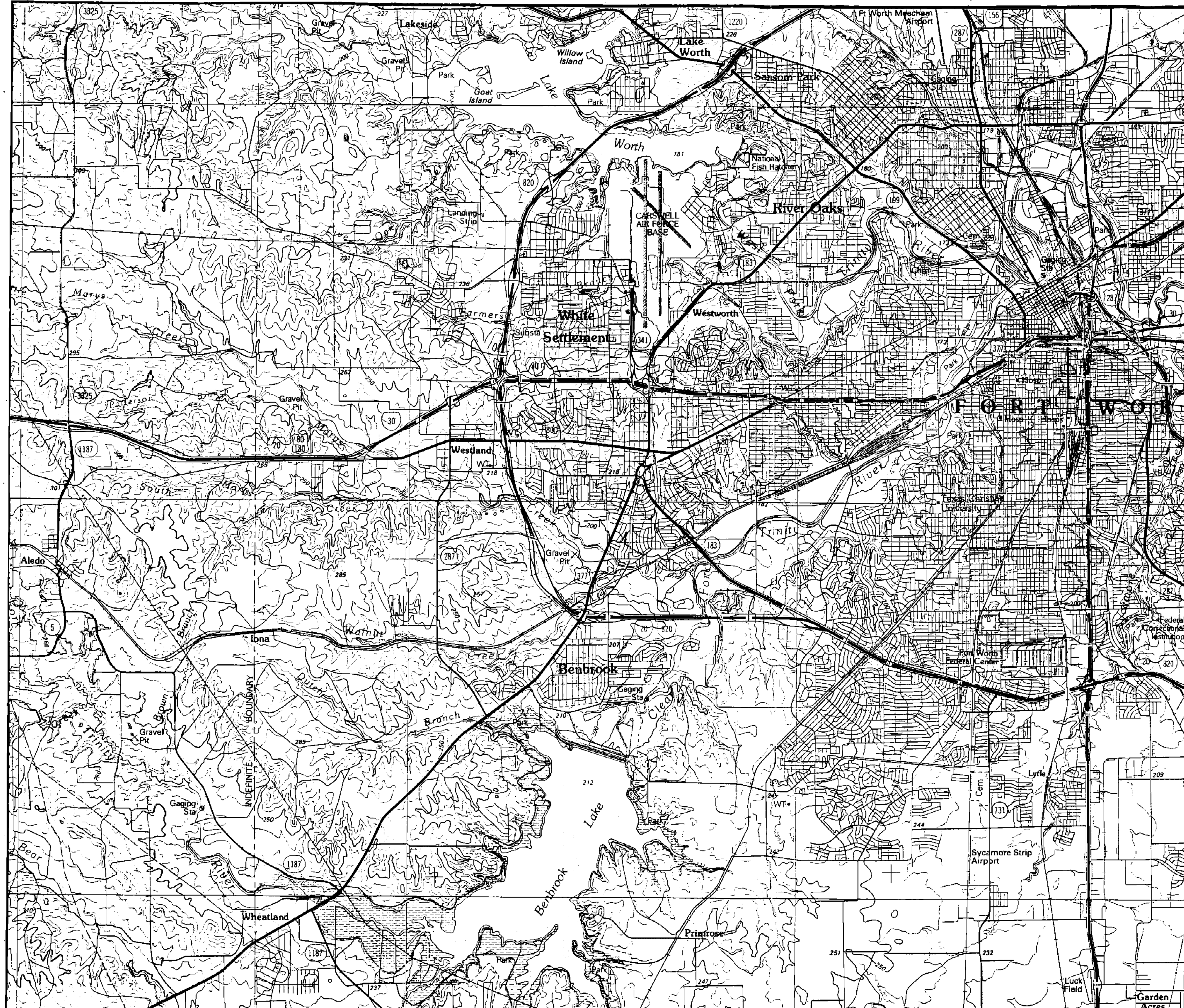

Figure 2.1
Lake Worth Topographic Map-Regional

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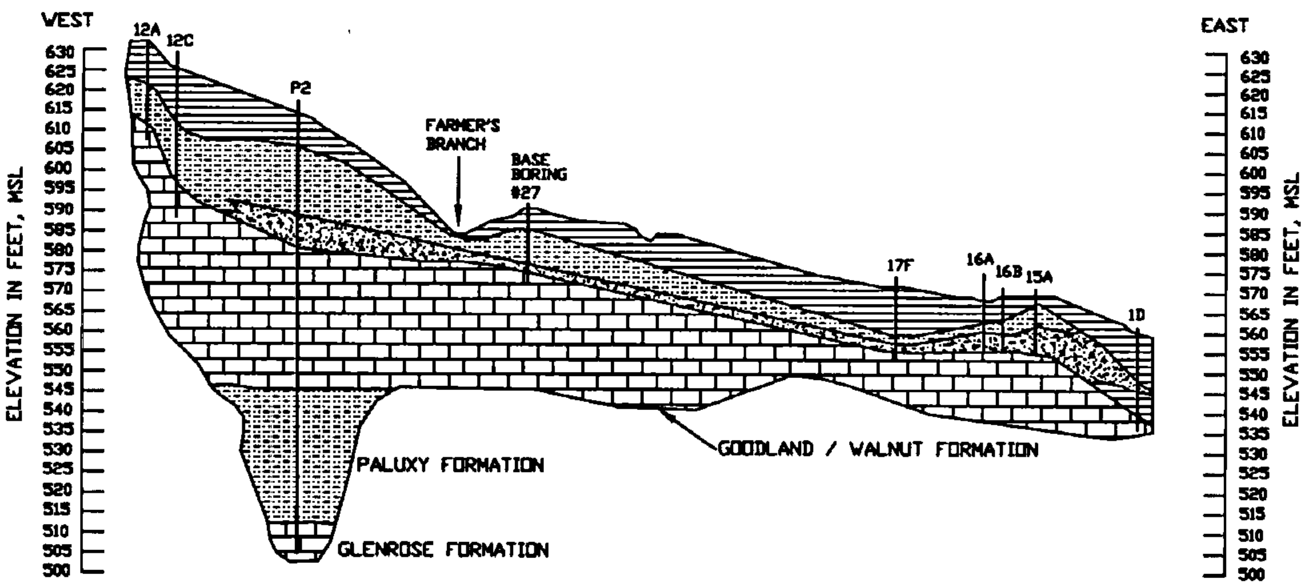
Brooks AFB, Texas

Contour Interval: 10 meters
Scale 1:100,000

SCALE IN MILES
0 1 2

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG2-1.CDR		

[Map Source: USGS, 1985]



NOTES
1. STRATIGRAPHIC CONDITIONS ARE KNOWN ONLY AT THE MONITOR WELLS AND BORINGS; CONTACTS ARE INTERPOLATED BETWEEN CONTROL POINTS.
2. HATCHURED ZONES ALONG MONITOR WELLS REPRESENT THE INTERVAL OF GRAVEL PACK AROUND EACH WELL SCREEN.

Figure 2.2

Generalized Geologic Cross Section
NAS Fort Worth JRB, Texas

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Brooks AFB, Texas

LEGEND

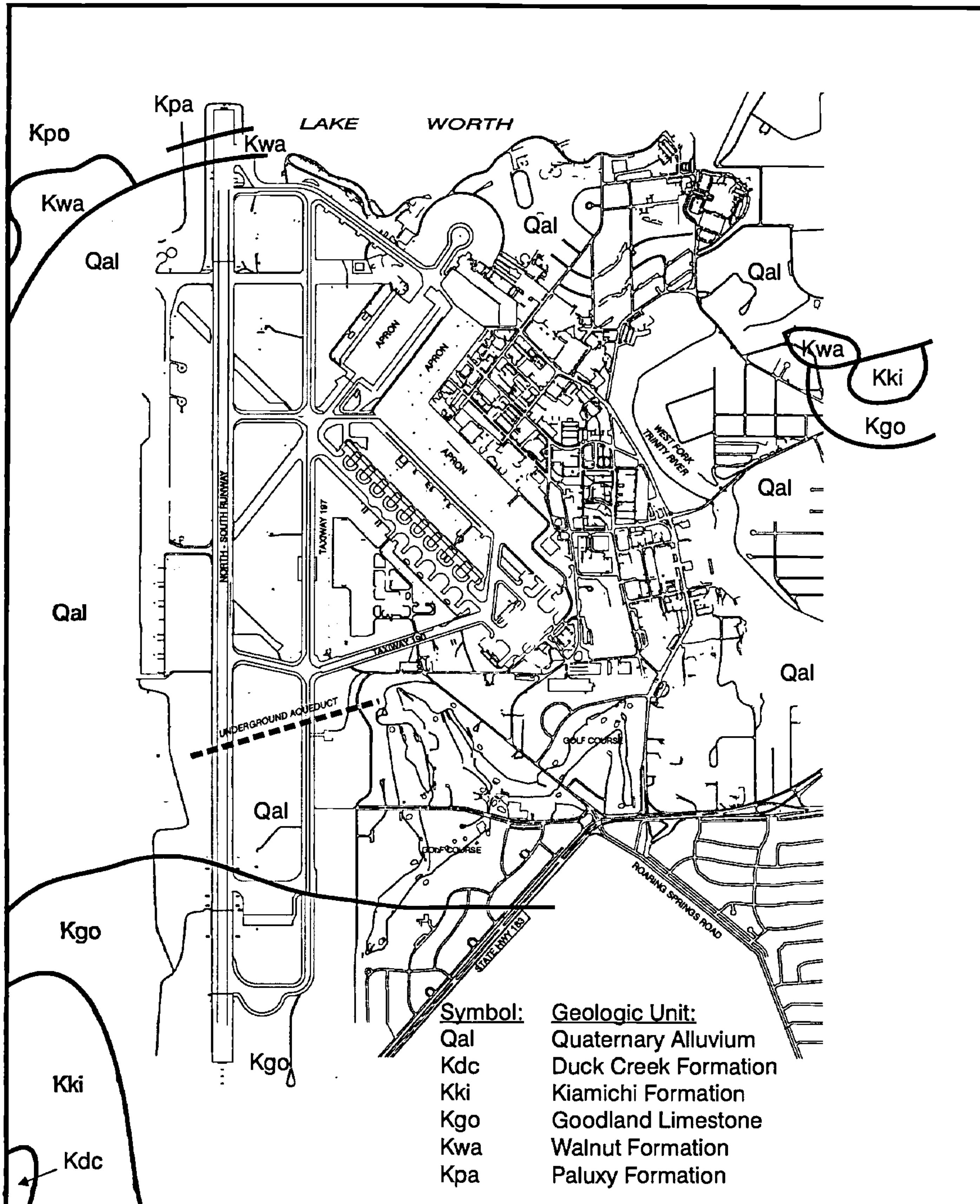
- CLAY AND FILL MATERIAL
- SAND
- GRAVEL
- LIMESTONE AND SHALE

N

800 400 0 800
HORIZONTAL SCALE IN FEET

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG2-2.DWG		

Source: USACE,1993



Drawn By: M.Lawlor	Date: 6/12/97	Legend SCALE 0 1000 2000 FEET N	**Figure 2.3** **Areal Distribution of Geologic Units NAS Fort Worth JRB, Texas** *[From Radian, 1989]*
Checked By: K.Hurley	Date: 6/12/97		
Filename: 2-3_2-14.cdr			

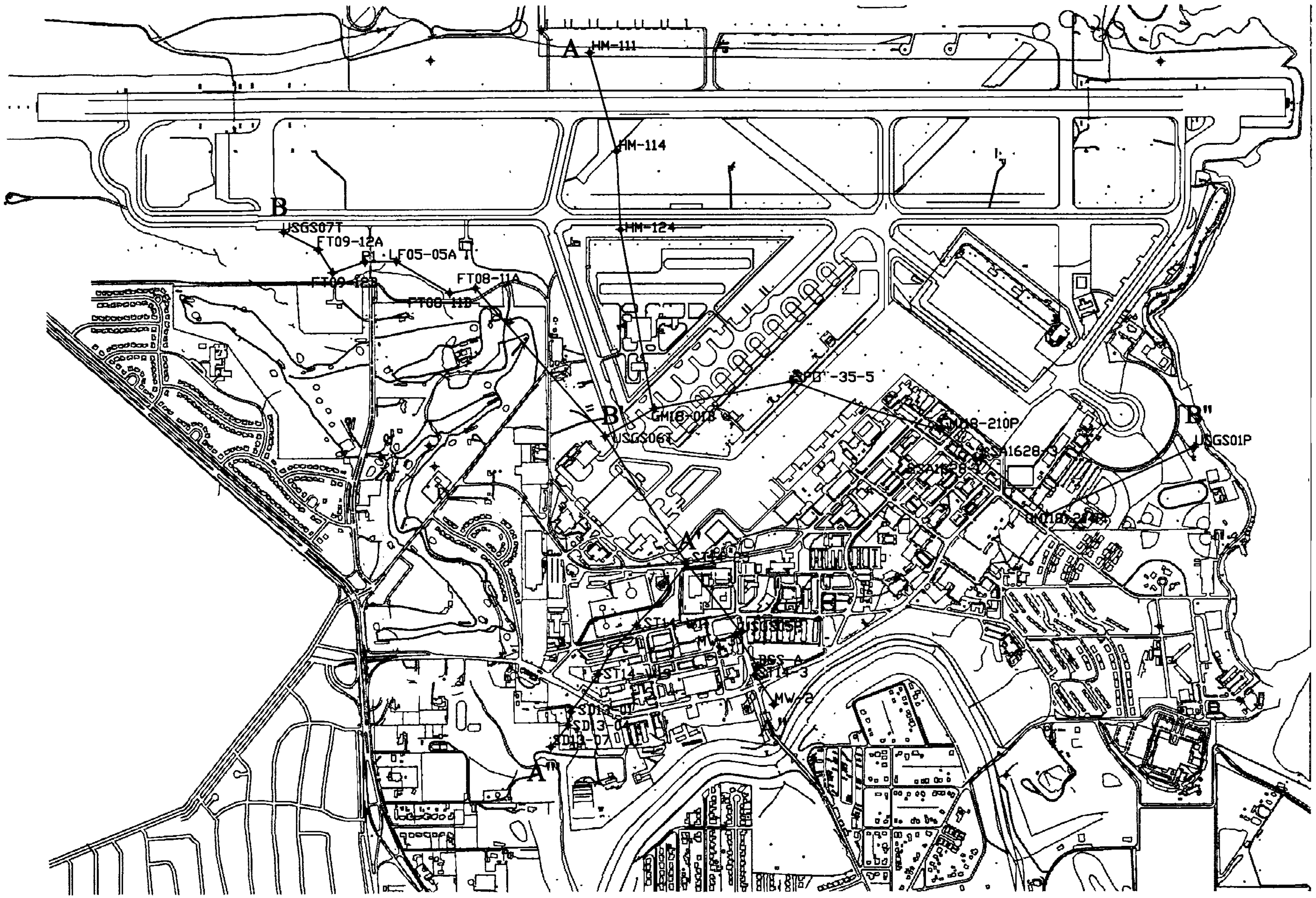


Figure 2.4

Cross Section Location Map

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LEGEND

USGS01P Boring Location

A___A' Cross Section Line

0 500 1000 2000
SCALE IN FEET

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG2-4.DWG		

Map Source:
JACOBS, 1996

Figure 2.5

Cross Sections A-A', A'-A'', and A'-A'''

**Air Force Center
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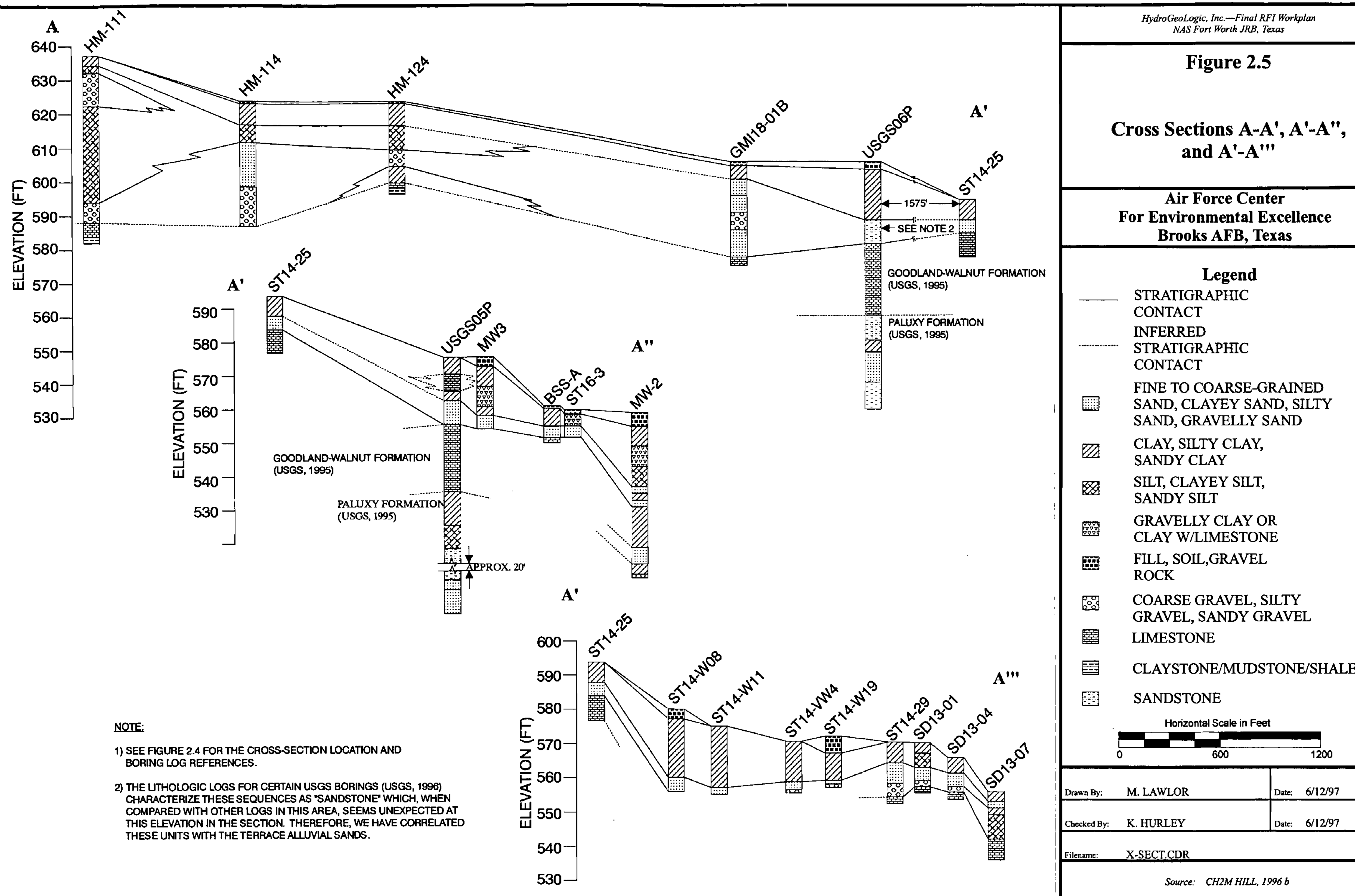
Brooks AFB, Texas**



NOTE:

1) SEE FIGURE 2.4 FOR THE CROSS-SECTION LOCATION AND BORING LOG REFERENCES.

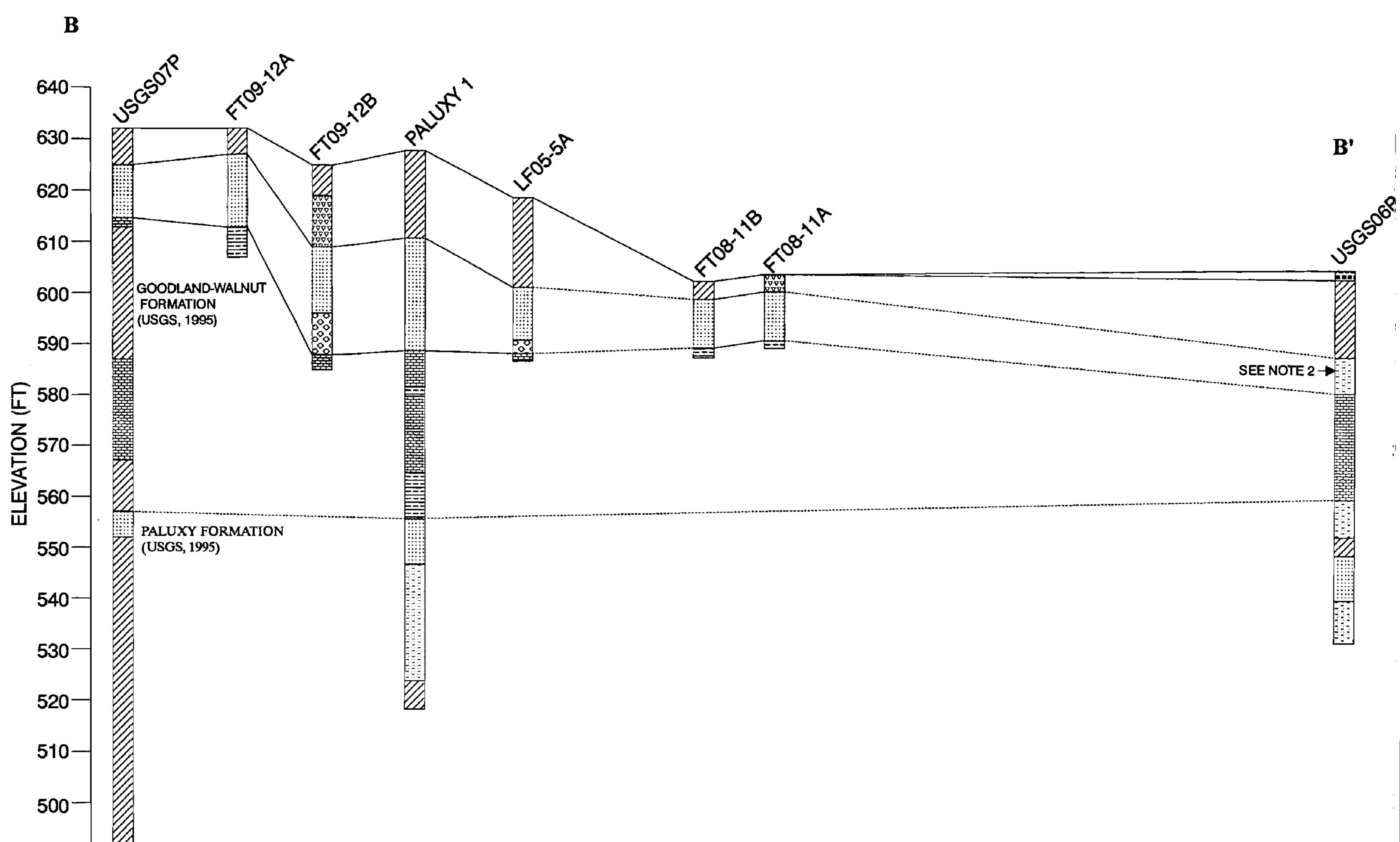
2) THE LITHOLOGIC LOGS FOR CERTAIN USGS BORINGS (USGS, 1996) CHARACTERIZE THESE SEQUENCES AS "SANDSTONE" WHICH, WHEN COMPARED WITH OTHER LOGS IN THIS AREA, SEEMS UNEXPECTED AT THIS ELEVATION IN THE SECTION. THEREFORE, WE HAVE CORRELATED THESE UNITS WITH THE TERRACE ALLUVIAL SANDS.

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	X-SECT.CDR		

Source: CH2M HILL, 1996 b

Figure 2.6

Cross Sections B-B'



NOTE:

1) SEE FIGURE 2.4 FOR THE CROSS-SECTION LOCATION AND BORING LOG REFERENCES.

2) THE LITHOLOGIC LOGS FOR CERTAIN USGS BORINGS (USGS, 1996) CHARACTERIZE THESE SEQUENCES AS "SANDSTONE" WHICH, WHEN COMPARED WITH OTHER LOGS IN THIS AREA, SEEMS UNEXPECTED AT THIS ELEVATION IN THE SECTION. THEREFORE, WE HAVE CORRELATED THESE UNITS WITH THE TERRACE ALLUVIAL SANDS.

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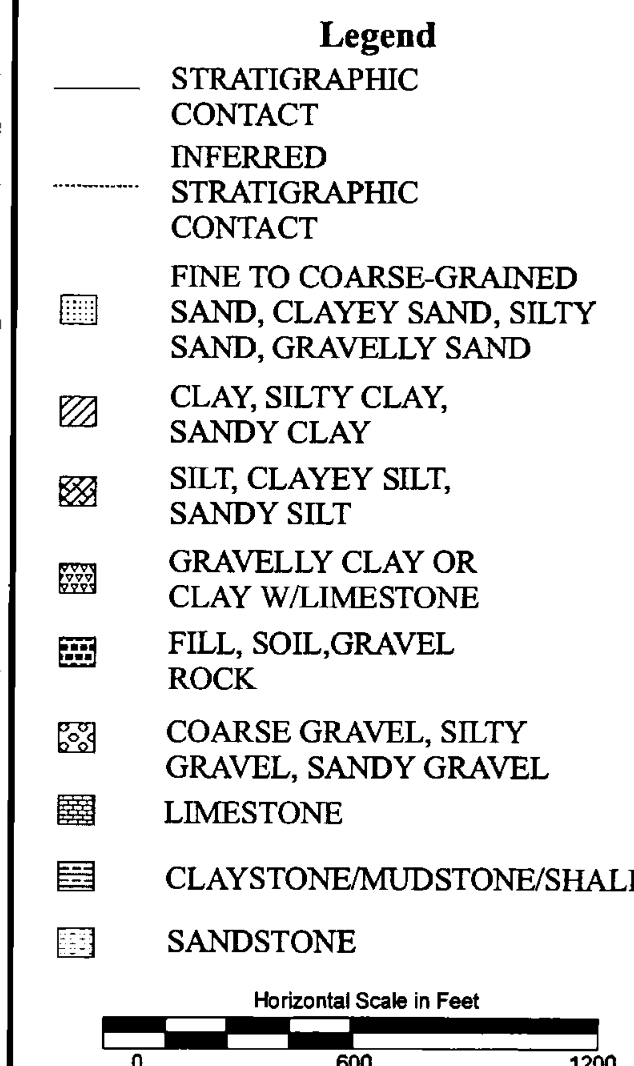
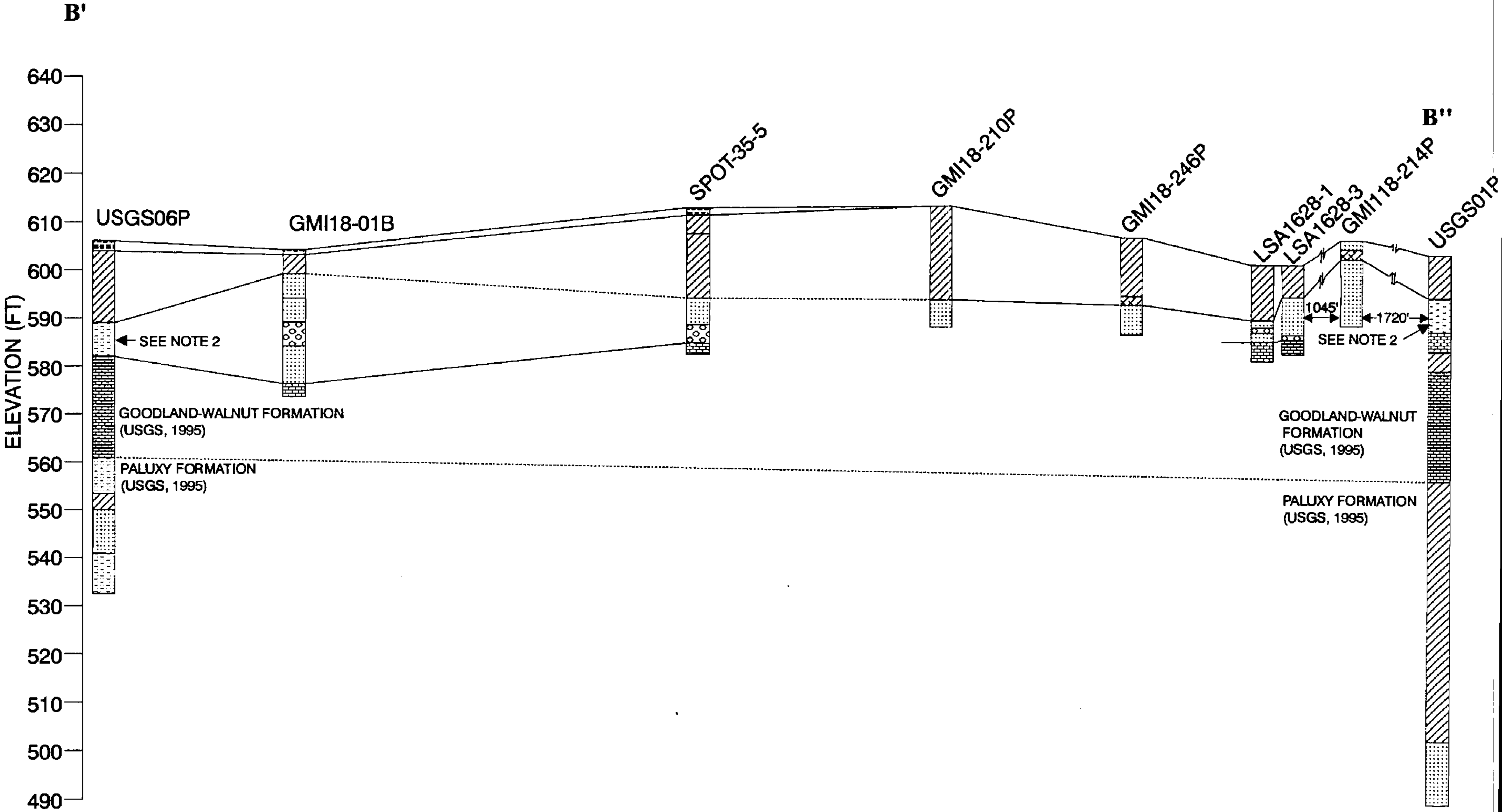


Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	X-SECT.CDR		

Source: CH2M HILL, 1996 b



NOTE:

1) SEE FIGURE 2.4 FOR THE CROSS-SECTION LOCATION AND BORING LOG REFERENCES.

2) THE LITHOLOGIC LOGS FOR CERTAIN USGS BORINGS (USGS, 1996) CHARACTERIZE THESE SEQUENCES AS "SANDSTONE" WHICH, WHEN COMPARED WITH OTHER LOGS IN THIS AREA, SEEMS UNEXPECTED AT THIS ELEVATION IN THE SECTION. THEREFORE, WE HAVE CORRELATED THESE UNITS WITH THE TERRACE ALLUVIAL SANDS.

Figure 2.7

Cross Sections B'-B''

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Brooks AFB, Texas

Legend

- STRATIGRAPHIC CONTACT
- INFERRED STRATIGRAPHIC CONTACT
- FINE TO COARSE-GRAINED SAND, CLAYEY SAND, SILTY SAND, GRAVELLY SAND
- CLAY, SILTY CLAY, SANDY CLAY
- SILT, CLAYEY SILT, SANDY SILT
- GRAVELLY CLAY OR CLAY W/LIMESTONE
- FILL, SOIL,GRAVEL ROCK
- COARSE GRAVEL, SILTY GRAVEL, SANDY GRAVEL
- LIMESTONE
- CLAYSTONE/MUDSTONE/SHALE
- SANDSTONE

Horizontal Scale in Feet: 0 — 600 — 1200

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	X-SECT.CDR		

Source: CH2M HILL, 1996 b

2.1.3 Groundwater

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: 1) an upper perched-water zone occurring in the alluvial terrace deposits associated with the Trinity River; 2) an aquitard of predominantly dry limestone of the Goodland and Walnut Formations; 3) an aquifer in the Paluxy Sand; 4) an aquitard of relatively impermeable limestone in the Glen Rose Formation; and 5) a major aquifer in the sandstone of the Twin Mountains Formation. Each of these units is examined in more detail in the following paragraphs. This relationship is illustrated in Figure 2.8.

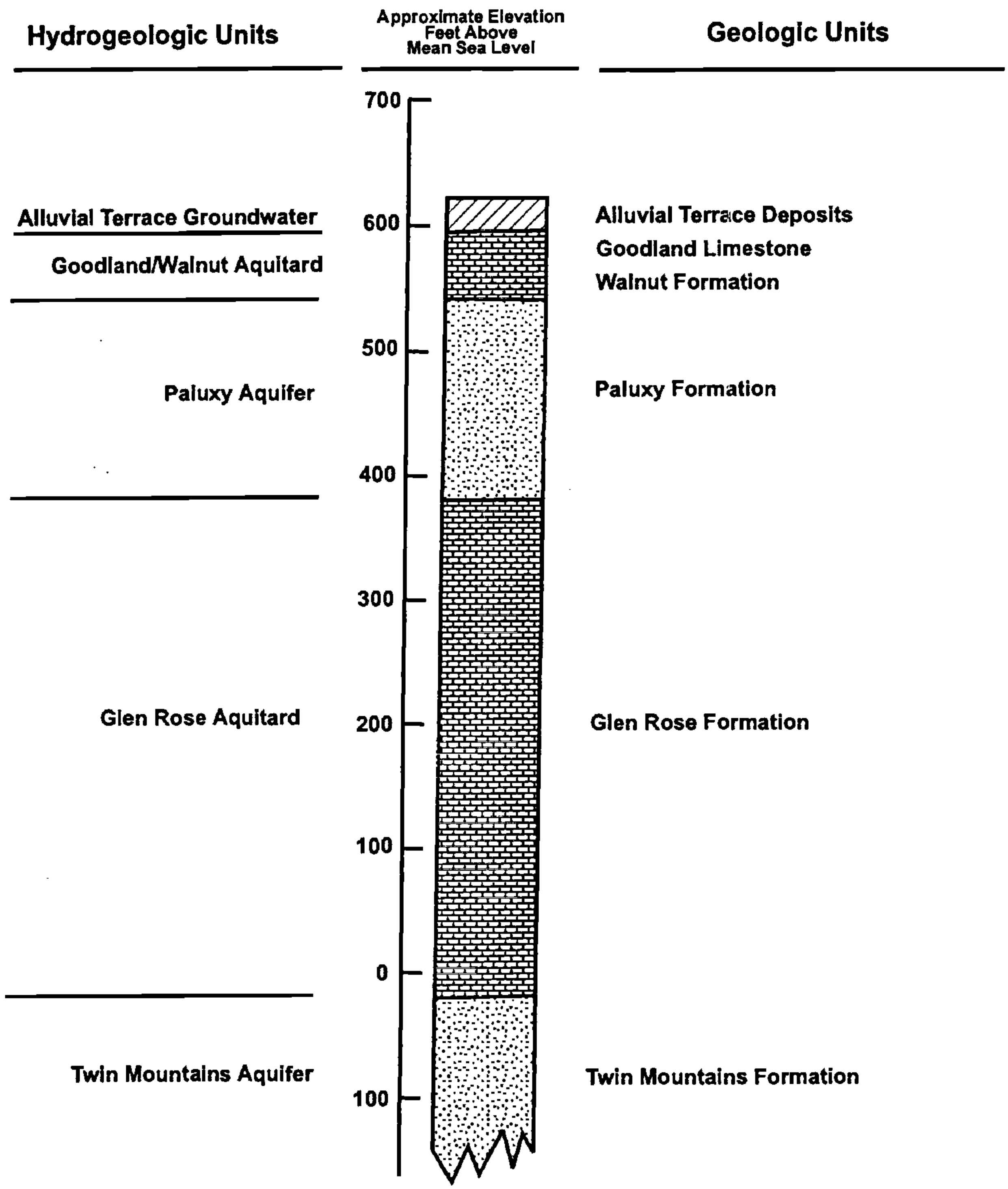
2.1.3.1 Alluvial Terrace Deposits

The uppermost groundwater in the area occurs within the pore space of the grains of coarse 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 used for irrigation and residential use. Groundwater from the terrace deposits is rarely used as a source of potable water due to its limited distribution and susceptibility to surface/stormwater pollution (CH2M HILL, 1984).

Recharge to the water-bearing deposits occurs through infiltration from precipitation and from surface water bodies. Extensive on-site pavement and construction restricts this recharge. Additional recharge, however, comes from leakage in water supply lines, sewer systems, storm drains, and cooling water systems. This leakage has been calculated to be in excess of approximately 115.5 million gallons for NAS Fort Worth JRB and AFP-4 in 1991 (GD Facility Management, 1992). This inflow of water to the shallow aquifer locally affects groundwater flow patterns and contamination transport, along with increasing hydraulic head, which acts as the force to potentially drive water into lower aquifer systems. The estimated hydraulic conductivity of the alluvial aquifer is 4.57 gpd/ft^2 (Radian, 1989)

This flow between aquifers is restricted by the Goodland/Walnut Formations, and therefore, the alluvial terrace groundwater is not hydraulically connected 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 entire site. 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.

Potentiometric maps of NAS Fort Worth JRB and AFP-4 alluvial terrace groundwater are presented in Figure 2.9 (Jacobs, 1996) and Figure 2.10 (CH2M HILL, 1997). The data is also presented in Tables 2.1 and 2.2. Both the January 1996, and January 1997, groundwater elevation data show an easterly trend in groundwater flow over the area of NAS Fort Worth JRB toward the West Fork of the Trinity River. This easterly trend varies slightly in the area of SWMU 17 where groundwater flow is towards the northeast into Farmers Branch Creek. The location of monitoring wells in the area of SWMU 17 are presented in Figure 2.11, and well construction specifications for wells that will be used in the investigation can be found in Table 2.3.



Drawn By: M.Lawlor	Date: 6/12/97	Legend	**Figure 2.8**
Checked By: K.Hurley	Date: 6/12/97	Alluvium; Limestone; Sandstone	**Stratigraphic Column Correlating Hydrogeologic Units and Geologic Units at NAS Fort Worth JRB, Texas**
Filename: Fig2-8.cdr			*[From Radian, 1989]*

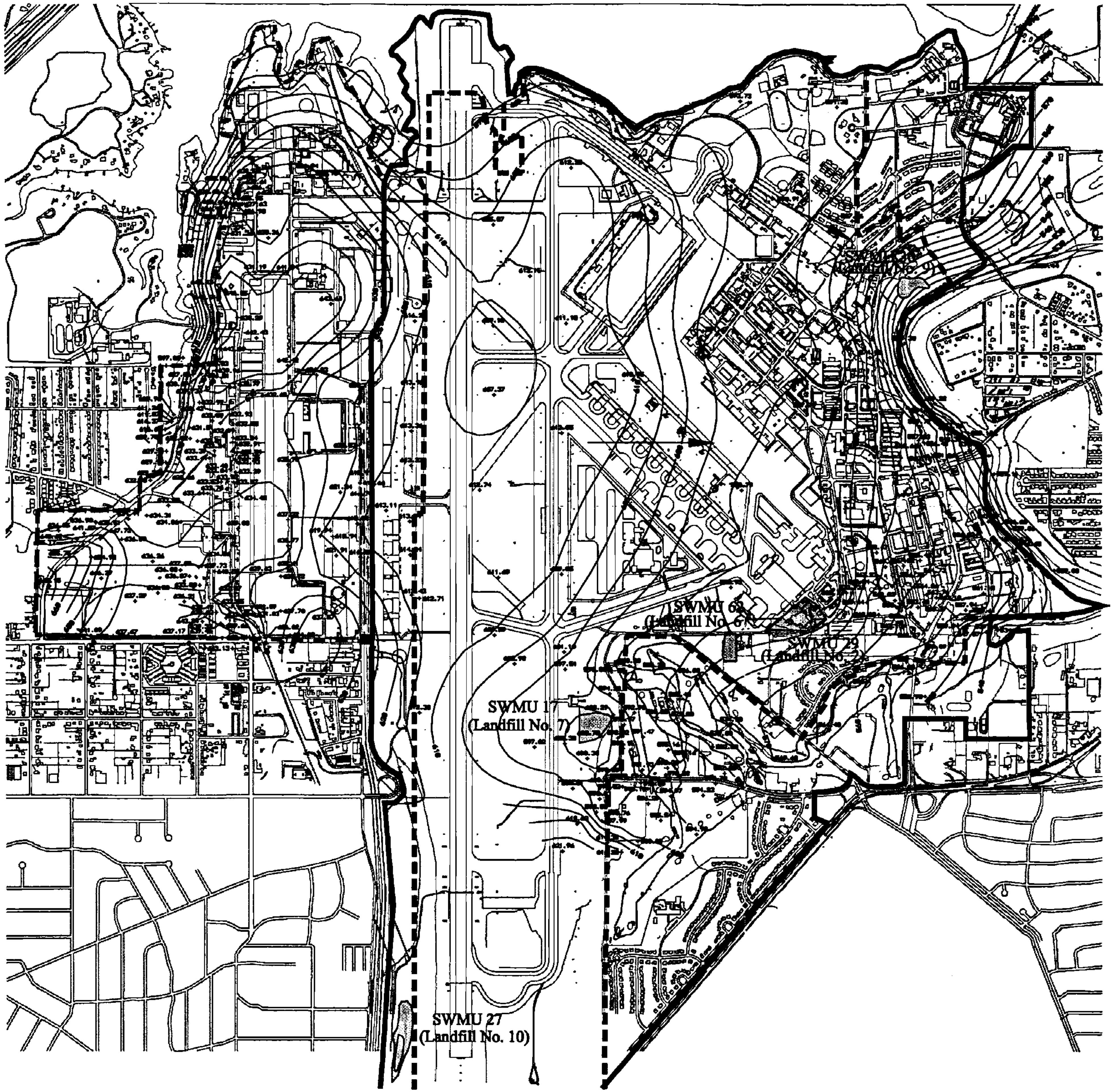


Figure 2.9

NAS Fort Worth JRB/AFP-4
Alluvial Terrace Groundwater Contour Map (June 1995)

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
- Groundwater Flow Direction
- Water Level Contour
- 612.15 + Water Level Elevation feet (NVGD)
- SWMU Locations

Note:
Water levels recorded by IT Corporation June 12-27, 1995
Contour Interval = 5 feet

0 300 1000 2000 SCALE IN FEET

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG2-9.DWG		

Map Source: JACOBS, 1996

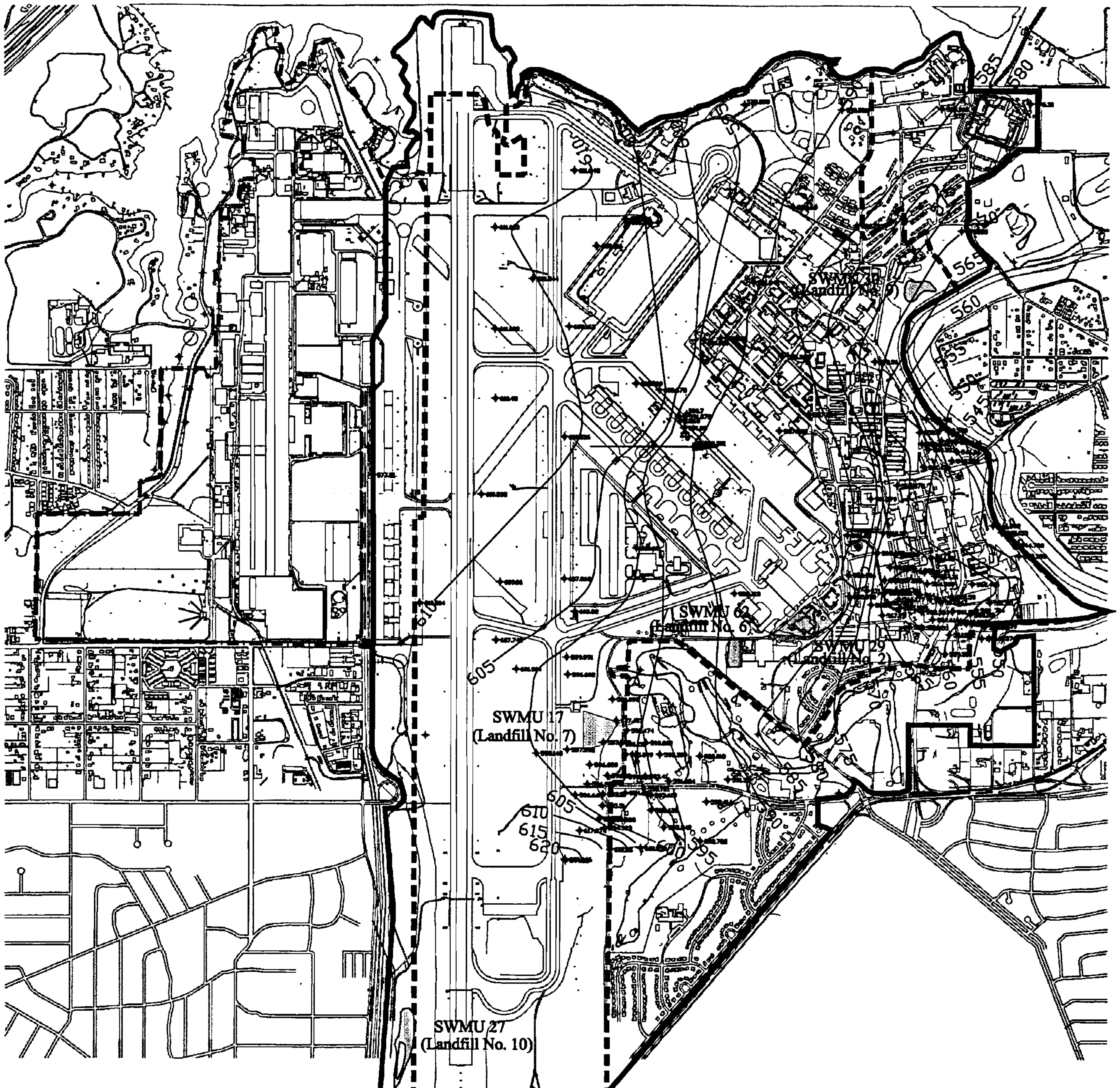


Figure 2.10

NAS Fort Worth JRB
Alluvial Terrace Groundwater Contour Map (January 1997)

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
- Groundwater Flow Direction
- Water Level Contour
- Water Level Elevation feet (NGVD)
- SWMU Locations

Note:
Water levels recorded by CH2M Hill January, 1997
Contour Interval = 5 feet

0 500 1000 2000
SCALE IN FEET

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG2-10.DWG		

Map Source: JACOBS, 1996

Table 2.1
Groundwater Elevation Summary - June 1995
NAS Fort Worth JRB, Texas

Well ID	Ground Surface Elevation[1] (NGVD)[2]	Top of Inner Casing Elevation (NGVD)	Depth to Water[3] (feet)	Groundwater Elevation (NGVD)
LF01-1A	566.62	570.27	17.43	552.84
LF01-1C	560.46	560.00	20.24	539.76
LF01-1D	560.46	563.93	21.46	542.47
LF01-1E	559.40	562.25	19.63	542.62
FT08-11A	604.8	608.22	13.05	595.07
FT08-11B	603.8	608.14	10.51	597.63
FT09-12A	632	635.66	18.64	617.02
FT09-12B	625.6	627.55	31.43	596.12
FT09-12C	625.5	628.05	32.45	595.70
LF04-04	609.4	612.07	19.22	592.85
LF04-10	626.9	626.54	33.42	593.12
LF04-4A	624.6	625.76	15.34	610.42
LF04-4B	618.4	619.9	21.82	598.08
LF04-4D	613.1	615.35	20.98	594.37
LF04-4E	617.5	618.54	24.25	594.29
LF04-4F	622.8	625.36	29.98	595.38
LF05-02	620	622.69	26.32	596.37
LF05-18	612.1	611.84	19.36	592.48
LF05-5C	606.8	608.68	11.85	596.83
LF05-5D	608.5	611.71	13.81	597.90
LF05-5G	612	615.39	21.38	594.01
WP07-10B	621.1	624.46	25.12	595.98
WP07-10C	615.4	617.24	19.24	596.16
SD13-01	570.30	573.24	13.07	560.17
SD13-02	570.64	573.39	15.22	558.17
SD13-03	568.60	571.54	11.96	559.58

Table 2.1 (continued)
Groundwater Elevation Summary - June 1995
NAS Fort Worth JRB, Texas

Well ID	Ground Surface Elevation[1] (NGVD)[2]	Top of Inner Casing Elevation (NGVD)	Depth to Water[3] (feet)	Groundwater Elevation (NGVD)
SD13-05	NA	571.40	9.75	561.65
SD13-06	NA	557.66	10.78	546.88
SD13-07	NA	556.30	17.60	538.70
ST14-01	573.20	575.89	14.36	561.53
ST14-02	572.70	575.64	12.73	562.91
ST14-03	574.83	576.60	10.87	565.73
ST14-04	572.90	575.74	13.19	562.55
ST14-W05	NA	593.75	9.05	584.70
ST14-W06	NA	581.33	13.55	567.78
ST14-W07	NA	579.98	13.64	566.34
ST14-W08	NA	580.43	11.99	568.44
ST14-W09	NA	575.51	9.94	565.57
ST14-W11	NA	576.21	8.88	567.33
ST14-W13	NA	574.35	9.63	564.72
ST14-W15	NA	573.35	10.98	562.37
ST14-W16	NA	573.46	9.03	564.43
ST14-W19	NA	573.11	10.33	562.78
ST14-W20	NA	573.44	9.63	563.81
ST14-W21	NA	572.76	10.86	561.90
ST14-W22	NA	571.16	10.76	560.04
ST14-W23	NA	564.97	6.65	558.32
OT15C	NA	567.87	8.81	559.06
P3A	NA	604.77	11.94	592.83
P6A	NA	632.45	12.57	619.88
T3	NA	575.11	4.36	570.75
T4A	NA	606.49	18.63	587.86

Table 2.1 (continued)
Groundwater Elevation Summary - June 1995
NAS Fort Worth JRB, Texas

Well ID	Ground Surface Elevation[1] (NGVD)[2]	Top of Inner Casing Elevation (NGVD)	Depth to Water[3] (feet)	Groundwater Elevation (NGVD)
T7	NA	604.88	18.35	586.53
MW-5	NA	563.90	5.05	558.85
MW-7	NA	567.88	8.67	559.21
MW-8	NA	556.91	9.02	547.89
MW-9	NA	560.30	12.02	548.28
MW-10	NA	559.53	15.08	544.45
MW-11	NA	558.90	26.68	532.22
MW-12	NA	560.38	11.40	548.98
LSA1628-1	NA	601.67	10.36	591.31
LSA1628-2	NA	601.93	10.72	591.21
LSA1628-3	NA	601.71	10.25	591.46
BSSA	566.90	566.38	5.29	561.09
BSSB	567.10	569.73	9.93	559.80
GMI22-02M	NA	619.19	9.44	609.75
GMI22-03M	NA	607.99	20.77	587.22
GMI22-04M	NA	610.71	19.84	590.87
GMI22-05M	NA	584.36	11.94	572.42
GMI22-06M	NA	606.77	18.60	588.17
GMI22-07M	NA	605.63	16.00	589.63
GMI22-08M	NA	606.92	16.90	590.02

Notes:

[1]Source: IRP Stage 2 RI Final Report (Radian, 1991)

[2]NGVD - Feet above National Geodetic Vertical Datum.

[3]Depth to Water 4th Quarter Water Level Survey conducted in January, 1996 in the three days prior to the start of Quarterly Groundwater Sampling (LAW, 1996).

Table 2.2
Groundwater Elevation Summary - January 1997
NAS Fort Worth JRB, Texas

Well ID	Top of Casing (NGVD)	Depth to Water[3] (feet)	Total Depth of Well (feet)	Groundwater Elevation (NGVD)
15B	567.59	8.45	12.47	559.14
17I	578.13	11.11	19.82	567.02
17J	579.94	11.62	21.33	568.32
17K	575.47	10.11	18.61	565.36
17L	577.32	10.81	20.94	566.51
17M	N/A	9.94	16.13	N/A
BSS-A	566.49	5.06	10.25	561.43
BSS-B	569.41	9.76	12.84	559.65
FT08-11A	608.15	12.06	17.68	596.09
FT08-11B	608.05	10.64	17.03	597.41
FT09-12A	635.38	18.01	27.8	617.37
FT09-12B	627.36	32.07	37.75	595.29
FT09-12C	627.86	32.94	39.7	594.92
FT09-12D	627.26	31.75	37.02	595.51
FT09-12E	627.34	32.35	38.67	594.99
GMI-04-01M	613.79	0	20.61	613.79
GMI-22-02M	619.13	10.34	27.86	608.79
GMI-22-03M	608.03	20.74	35.3	587.29
GMI-22-04M	610.70	20.04	25.62	590.66
GMI-22-05M	584.28	11.72	13.82	572.56
GMI-22-06M	606.84	18.52	26.63	588.32
GMI-22-07M	605.66	15.97	23.34	589.69
GMI-22-08M	606.94	16.36	25.11	590.58
HM-111	636.49	26.29	47.55	610.20
HM-114	627.95	18.89	35.67	609.06
HM-116	634.06	23.58	31.55	610.48
HM-117	633.32	22.28	39.24	611.04
HM-118	626.23	15.99	26.34	610.24
HM-119	625.04	14.02	28.86	611.02
HM-120	616.84	5.19	17.57	611.65
HM-121	627.66	18.5	30.38	609.16
HM-122	619.44	19.45	27.8	599.99
HM-123	624.85	27.46	38.47	597.39
HM-124	623.26	15.39	24.41	607.87

Table 2.2 (continued)
Groundwater Elevation Summary - January 1997
NAS Fort Worth JRB, Texas

Well ID	Top of Casing (NGVD)	Depth to Water[3] (feet)	Total Depth of Well (feet)	Groundwater Elevation (NGVD)
HM-125	629.37	19.03	33.08	610.34
HM-126	622.99	15.24	38.78	607.75
HM-127	624.04	25.89	37.76	598.15
ITMW-01T	N/A	12.98	21.7	N/A
LF01-1B	560.18	13.59	19.76	546.59
LF01-1C	562.15	17.36	32.59	544.79
LF01-1D	563.91	18.55	27.91	545.36
LF01-1E	562.11	16.96	32.16	545.15
LF04-01	629.16	32.5	41.33	596.66
LF04-02	623.44	29.72	38.52	593.72
LF04-04	611.95	19.54	19.91	592.41
LF04-10	626.47	33.75	47.44	592.72
LF04-4A	625.84	13.59	24.97	612.25
LF04-4B	619.95	19.6	25.34	600.35
LF04-4C	612.96	19.72	27.84	593.24
LF04-4D	615.13	21.49	27.84	593.64
LF04-4E	618.49	24.87	30.68	593.62
LF04-4F	625.28	30.59	36.57	594.69
LF04-4G	619.75	27.93	33.04	591.82
LF04-4H	613.35	0	18.87	613.35
LF05-01	621.88	19.98	27.56	601.90
LF05-02	622.61	26.01	29.98	596.60
LF05-14	611.79	0	10.06	611.79
LF05-18	611.71	19.69	23.62	592.02
LF05-19	606.05	14.68	19.43	591.37
LF05-5A	623.00	26.14	30.32	596.86
LF05-5B	597.17	4.7	12.54	592.47
LF05-5C	608.56	12.41	21.27	596.15
LF05-5D	611.40	14.15	21.05	597.25
LF05-5E	626.70	30.11	35.55	596.59
LF05-5F	618.86	25.45	35.84	593.41
LF05-5G	615.28	21.97	30.29	593.31
LF05-5H	610.61	16.81	16.82	593.80
LSA1628-3	601.73	10.49	17.92	591.24

Table 2.2 (continued)
Groundwater Elevation Summary - January 1997
NAS Fort Worth JRB, Texas

Well ID	Top of Casing (NGVD)	Depth to Water[3] (feet)	Total Depth of Well (feet)	Groundwater Elevation (NGVD)
MW-1	560.64	11.91	42.93	548.73
MW-10	558.85	13.7	32.98	545.15
MW-11	558.17	26.18	32.43	531.99
MW-11A	612.17	22.78	26.12	589.39
MW-12	559.62	9.2	27.44	550.42
MW-12A	559.61	16.43	16.43	543.18
MW-19	621.19	17.97	19.68	603.22
MW-1A	582.42	6.11	18.4	576.31
MW-2	557.55	11.29	47.9	546.26
MW-20	611.38	19.45	19.72	591.93
MW-3	576.48	11.6	19.88	564.88
MW-37	590.53	8.95	19.8	581.58
MW-38	604.11	16.18	18.6	587.93
MW-48	619.33	10.41	13.82	608.92
MW-5	563.69	3.24	8.13	560.45
MW-53	616.75	16.13	19.66	600.62
MW-56	614.32	8.03	19.44	606.29
MW-57	613.37	13.28	14.35	600.09
MW-57B	613.78	7.69	19.58	606.09
MW-6	562.87	2.32	10	560.55
MW-7	567.37	8.47	16.68	558.90
MW-8	557.04	7.45	26.93	549.59
MW-9	559.54	9.98	27.95	549.56
MW-IT-02T	612.13	34.62	57.73	577.51
MW1-16	573.86	9.76	15.4	564.10
OT-15C	564.25	8.44	15.54	555.81
PI-U9	567.81	0	0	567.81
SD13-01	573.09	12.26	17.47	560.83
SD13-02	573.28	13.16	16.47	560.12
SD13-03	571.41	11.17	16.64	560.24
SD13-04	569.08	9.66	14.41	559.42
SD13-05	571.54	9.13	13.77	562.41
SD13-06	557.68	10.21	13.86	547.47
SD13-07	560.44	17.86	21.49	542.58

Table 2.2 (continued)
Groundwater Elevation Summary - January 1997
NAS Fort Worth JRB, Texas

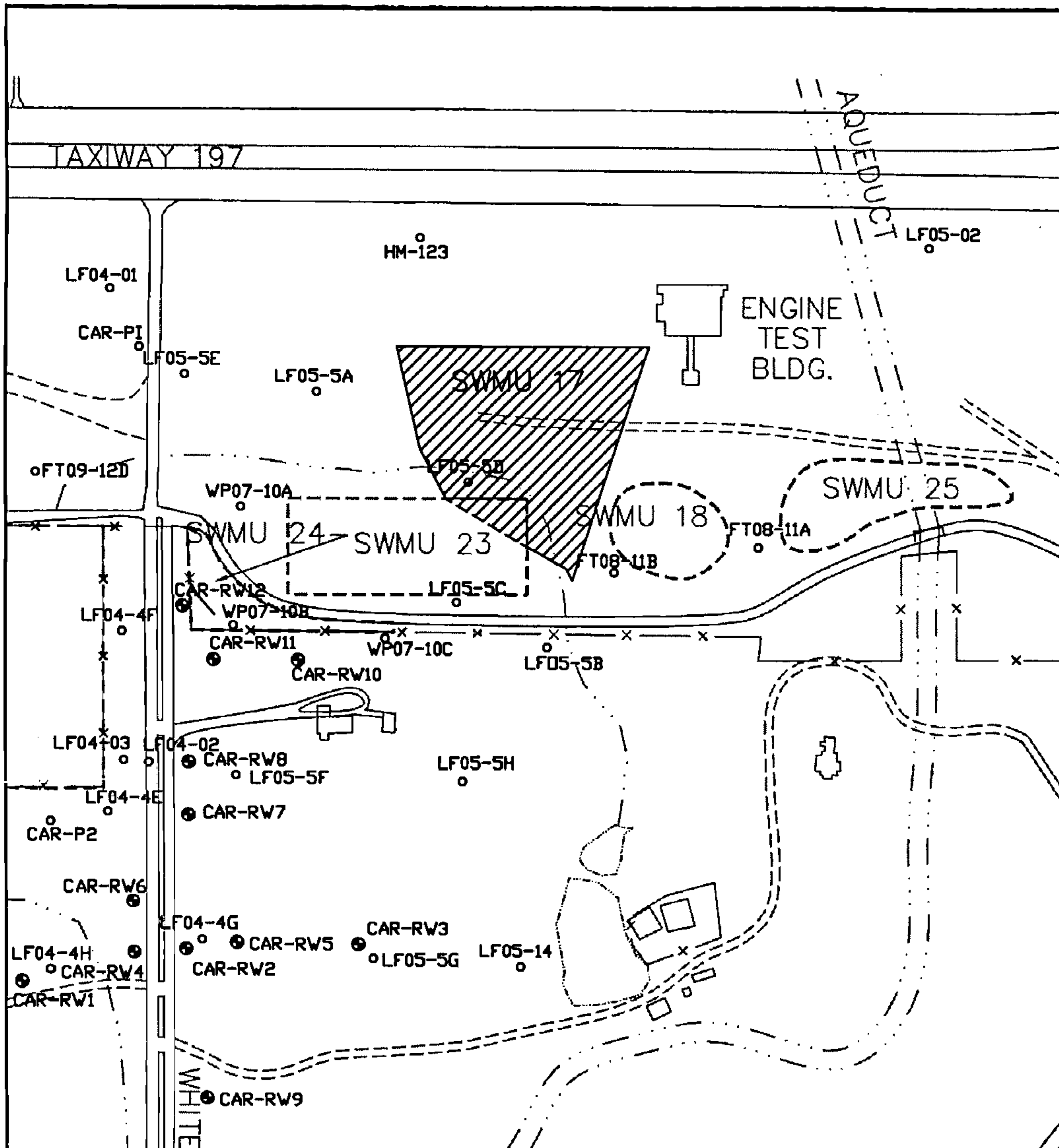
Well ID	Top of Casing (NGVD)	Depth to Water[3] (feet)	Total Depth of Well (feet)	Groundwater Elevation (NGVD)
SPOT35-1	613.59	22.89	36.62	590.70
SPOT35-2	613.64	21.76	26.36	591.88
SPOT35-4	612.74	20.77	24.5	591.97
SPOT35-5	614.09	22.21	27.55	591.88
SPOT35-7	616.41	7.73	20.42	608.68
ST14-01	575.95	13.89	18.4	562.06
ST14-02	575.51	12.15	19.45	563.36
ST14-03	576.68	9.78	19.88	566.90
ST14-04	575.61	12.56	18.08	563.05
ST14-14	575.64	7.29	20.72	568.35
ST14-24	594.14	11.18	17.04	582.96
ST14-25	592.93	6.1	16.89	586.83
ST14-26	581.09	11.72	27.46	569.37
ST14-27	573.85	8.93	15.92	564.92
ST14-28	574.44	11.85	17.13	562.59
ST14-29	571.45	9.6	15.78	561.85
ST14-30	566.87	5.62	14.06	561.25
ST14-W05	593.63	8.54	16.38	585.09
ST14-W06	581.42	9.66	22.7	571.76
ST14-W07	579.96	11.85	24.75	568.11
ST14-W08	580.54	10.84	25.21	569.70
ST14-W09	575.54	8.47	20.24	567.07
ST14-W10	573.99	6.48	19.6	567.51
ST14-W11	576.31	7.29	19.57	569.02
ST14-W12	575.52	5.74	17.75	569.78
ST14-W13	574.49	8.31	17.04	566.18
ST14-W15	573.47	10.49	18.85	562.98
ST14-W16	573.62	8.41	18.69	565.21
ST14-W18	573.79	9.19	17.58	564.60
ST14-W19	573.31	9.65	16.72	563.66
ST14-W20	573.48	9.17	15.98	564.31
ST14-W21	572.88	10.27	17.89	562.61
ST14-W22	571.30	9.99	11.08	561.31
ST14-W23	565.60	6.05	10.08	559.55

Table 2.2 (continued)
Groundwater Elevation Summary - January 1997
NAS Fort Worth JRB, Texas

Well ID	Top of Casing (NGVD)	Depth to Water[3] (feet)	Total Depth of Well (feet)	Groundwater Elevation (NGVD)
ST14-W31	571.23	10.53	13.81	560.70
ST14-W32	N/A	4.43	12.26	N/A
USGS01P	604.83	31.23	111.91	573.60
USGS01T	604.79	11.53	20.05	593.26
USGS02T	604.21	18.3	30.24	585.91
USGS03T	575.02	3.73	8.51	571.29
USGS04T	604.92	18.14	19.39	586.78
USGS05P	576.77	39.52	92.48	537.25
USGS06P	606.71	58.52	74.8	548.19
USGS06T	606.67	18.36	21.87	588.31
USGS07P	632.10	87.14	140.04	544.96
USGS07T	632.43	11.78	15.28	620.65
W-153	631.57	21.33	39.19	610.24
WP07-10A	626.50	30.28	37.81	596.22
WP07-10B	624.22	29.54	34.54	594.68
WP07-10C	617.18	21.33	29.65	595.85

Notes:

0 - Indicates a dry well.
NGVD - Feet above National Geodetic Vertical Datum.
N/A - Not available
Source: January 1997 Quarterly Monitoring (CH2M HILL, 1997)



HydroGeoLogic, Inc.—Final RFI Work Plan
NAS Fort Worth JRB, Texas

Figure 2.11

Well Locations in Vicinity of SWMU 17

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

ROAD
STREAM
FENCE
MONITORING WELL
RECOVERY WELL LOCATION
SWMU TO BE INVESTIGATED
SWMU NOT IN CURRENT RFI/CMS

SCALE IN FEET
0 300 600

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG2-11.DWG		

Map Source:
IT CORP., 1993

Table 2.3
Monitoring Well Construction Specifications—SWMU 17 Area
NAS Fort Worth JRB, Texas

Well ID	Borehole Depth (ft-bgs)	Screen Length (ft-bgs)	Screen Diameter (in)	Depth to Screen (ft-bgs)	Depth to Sand Pack (ft-bgs)	Sand Pack Thickness (ft-bgs)	Depth to Seal (ft-bgs)	Seal Thickness (ft-bgs)
LF05-5A	32.0	10.0	2.0	18.0	16.5	15.5	14.5	2.0
LF05-5B	9.0	5.0	2	4.0	3.5	5.5	2.0	1.5
LF05-5C	22.0	15.0	2.0	7.0	6.0	16.0	4.0	2.0
LF05-5D	24.0	9.0	2.0	10.5	8.0	16.0	6.0	2.0
FT08-11B	15.0	10.0	2.0	3.5	3.0	12.0	2.0	1.0
HM-123	38.38TOC	NA	NA	NA	NA	NA	NA	NA

NA = Not Available.
TOC = Top of Casing

Groundwater quality of the alluvial terrace is summarized in the tables and figures that comprise Appendix A. Table A.1 of Appendix A presents the results of the quarterly groundwater sampling conducted in January 1996. The analytical results from this sampling event are compared to draft background values (Jacobs, 1997) and TNRCC RRS2 MSCs. A summary of the January and April, 1997 quarterly groundwater analytical results are not currently available.

2.1.3.2 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 Formation. 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 between 1.2E-09 cm/sec to 7.3E-11 cm/sec for the NAS Fort Worth JRB and AFP-4 area. This corresponds to a vertical flow rate that ranges between 1.16E-03 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 communication with the groundwater in the Paluxy Aquifer. As shown in Figure 2.4 (Cross Section Location Map) and Figure 2.9 (Alluvial Terrace Groundwater Contour Map), a significant number of wells and borings have been advanced on NAS Fort Worth JRB. Based on Cross Section Figures 2.5-2.7, there is no evidence that a similar window exists on the Base property. All five (5) monitoring wells which fully penetrate the Paluxy aquifer on NAS Fort Worth JRB property are represented in the cross sections. These wells are USGS01P, USGS05P, USGS06P, USGS07P, and Paluxy 1 (P1). Locations and stratigraphic information for these wells are presented in Figures 2.4-2.7.

2.1.3.3 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, develop their municipal water supplies from the Paluxy aquifer. Groundwater from the Paluxy 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/ft^2 and 1263 to 13808 gpd/ft, respectively.

2.1.3.4 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.

2.1.3.5 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 is eastward in the downdip direction. Like the groundwater in the Paluxy aquifer, the Twin Mountains groundwater occurs under unconfined conditions in the recharge area and becomes confined as it moves downdip. 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/ft^2 and average 68 gpd/ft^2 in Tarrant County (CH2M HILL, 1984).

2.1.3.6 Water Well Survey Results

An inventory of water supply wells within a one mile radius of the NAS Fort Worth JRB Boundary was conducted (Radian, 1989). Figure 2.12 illustrates the locations of thirty-nine existing and abandoned wells, which were identified from Texas Water Commission records. All of these wells were installed and completed in the Paluxy Aquifer or the Twin Mountains Aquifer. Water to the Base is supplied by the city of Fort Worth which receives their water from Lake Worth.

2.1.4 Surface Water

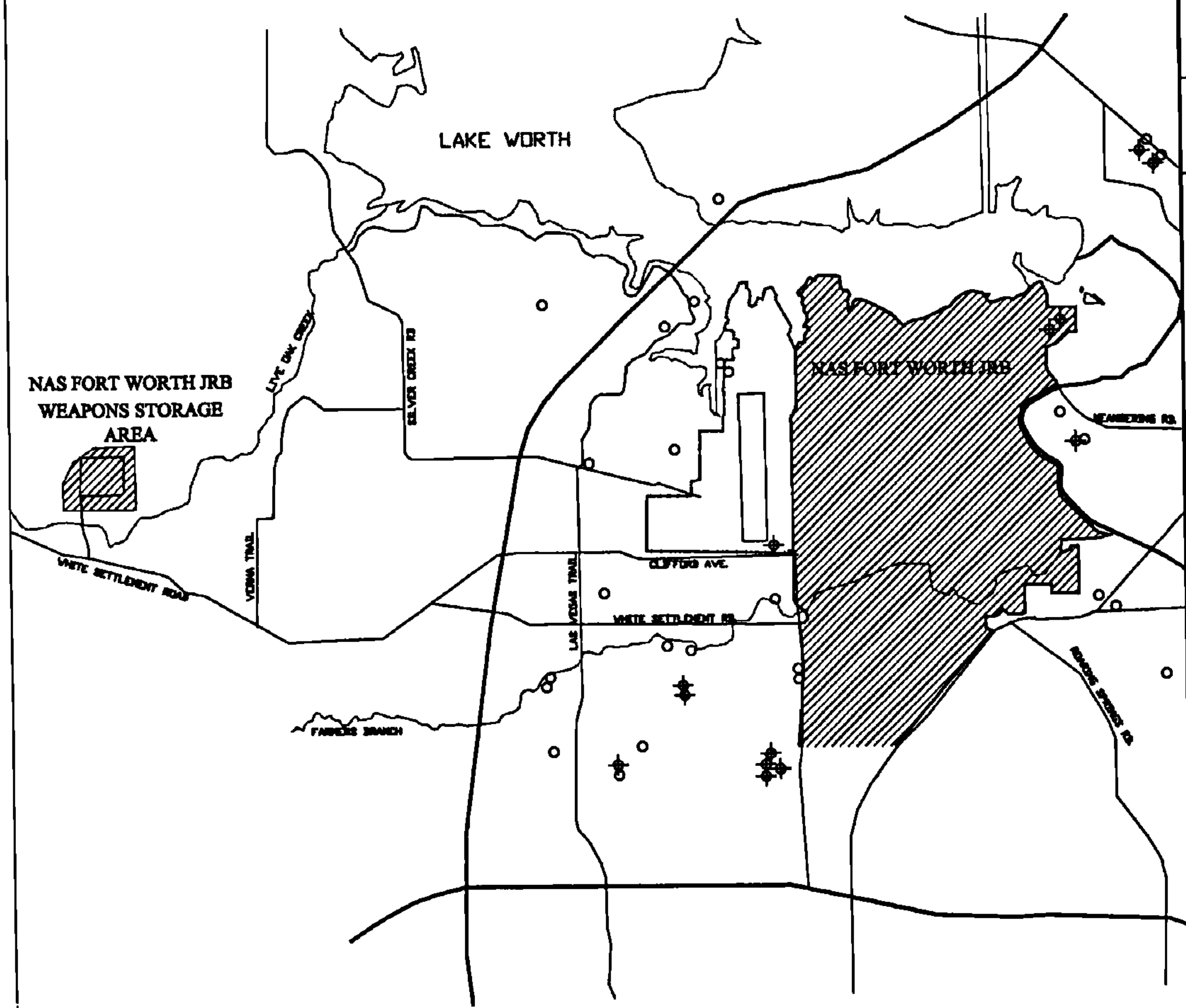
NAS Fort Worth JRB is located within the Trinity River Basin, adjacent to Lake Worth. The lake is a man-made reservoir, created by damming the Trinity River at a point just northeast of the Base. The surface area of the lake is a approximately 2,500 acres. Lake Worth receives a limited amount of stormwater runoff from NAS Fort Worth JRB during and immediately after rainfall events. Runoff from SWMUs currently under investigation do not discharge to Lake Worth. Elevation of the water surface is fairly consistent at approximately 594 feet above NGVD, the fixed elevation of the dam spillway. Part of the eastern boundary of NAS Fort Worth JRB is defined by the West Fork of the Trinity River, a major river in north central Texas. River flow is towards the southeast into the Gulf of Mexico. Because the Trinity River has been dammed, the 100- and 500-year flood plains do not extend more than 400 feet from the center of the river or any of its tributaries.

NAS Fort Worth JRB currently has three stormwater discharge points that are subject to the National Pollution Discharge Elimination System (NPDES) from the EPA. Each discharge point is monitored weekly for chemical oxygen demand, oil and

Figure 2.12

Location of Water Wells Within 1 Mile of NAS Fort Worth JRB, Texas

Air Force Center
For Environmental Excellence
Brooks AFB, Texas



LEGEND

- Former Property Boundary of Carswell AFB
- Property Boundary of AF Plant 4
- ○ Water Wells Currently in Use
- ✦ Water Wells Plugged, Abandoned, or Not Used

0 — 10000
SCALE IN FEET

N

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Map Source: Radian, 1989

grease, and pH. On numerous occasions, the permit has been violated. In 1979, these violations prompted the EPA to formally demand a corrective action (CH2M HILL, 1984). Several additional sampling points were established to determine the flow of pollutants onto and off the Base. Samples were collected for a variety of parameters (spills, fish kills, odors, and oil sheen) as circumstances dictate (Radian, 1989). Findings have included TCE, DCE,bromodichloromethane, and chloroform.

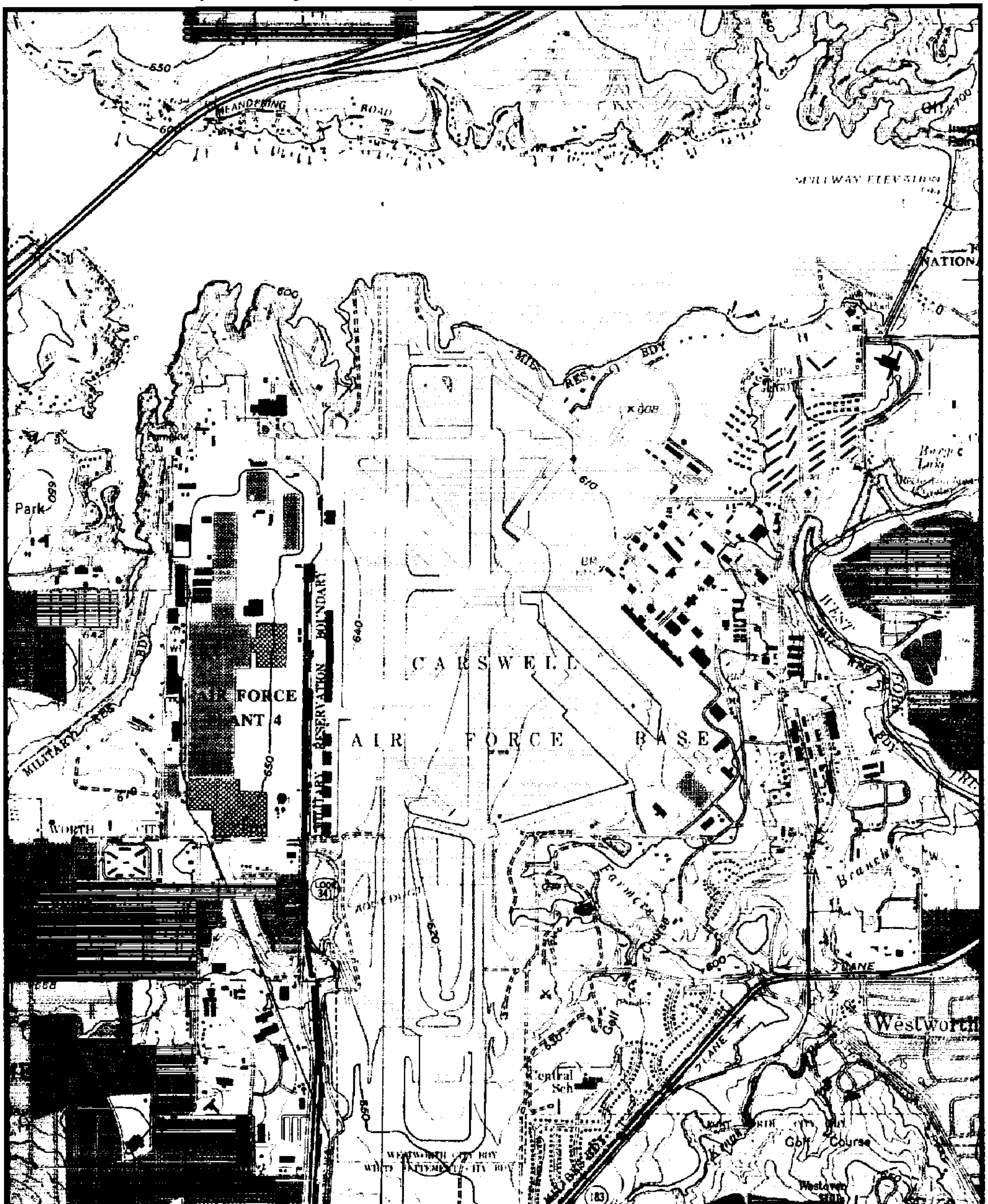
Surface drainage is mainly east towards the West Fork of the Trinity River. The Base is partly drained by Farmers Branch Creek, a tributary into the West Fork of the Trinity River. Farmers Branch Creek begins within the community of White Settlement and flows eastward. Just south of AFP-4, Farmers Branch 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. One flows along the south and east side of SWMU 22 and joins Farmers Branch Creek. The other runs along the west and north sides of SWMU 23 and east of SWMU 17, connecting with two small ponds on the golf course before joining Farmers Branch Creek. Most of the Base drainage is intercepted by a series of storm drains and culverts, directed to OWs, 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.

The topography of NAS Fort Worth JRB is fairly flat except for the lower lying areas along the tributaries of the Trinity River. The land surface slopes gently northeastward toward Lake Worth, and eastward, toward the West Fork of the Trinity River. Surface elevations range from about 690 feet above NGVD, at the southwest corner of the Base, to approximately 550 feet above NGVD, along the eastern side of the Base. Figure 2.13 is a smaller section of the Lake Worth, Texas U.S. Geological Survey Topographic Map showing the relief of the NAS Fort Worth JRB area.

2.1.5 Air

The climate in the Fort Worth area is classified as humid subtropical with hot summers and dry winters. Tropical maritime air masses control the weather during much of the year, but the passage of polar cold fronts and continental air masses can create large variations in winter temperatures. The average annual temperature in the area is 66 degrees Fahrenheit (°F) and monthly mean temperatures vary from 45°F in January to 86°F in July. The average daily minimum temperature in January is 35°F, and the lowest recorded temperature is 2°F. The average daily maximum temperature in July and August is 95°F, and the highest temperature ever recorded at the Base was 111°F in the month of June. Freezing temperatures occur at NAS Fort Worth JRB an average of 33 days per year.

Mean annual precipitation recorded at the Base is approximately 32 inches. The wettest months are April and May with a secondary maximum in September. The period from November to March is generally dry with a secondary minimum in August. Snowfall accounts for a small percentage of the total precipitation between November and March. Thunderstorm activity occurs at the Base an average of 45 days per year, with the majority of the activity between April and June. Hail may fall on two to three day per year. The maximum precipitation recorded in 24 hour period is 5.9 inches. On the average, measurable snowfall occurs two days per year.



Scanned By: C. Farmer	Date: 6/12/97	**Legend** Contour Interval 10 feet Scale 1:24,000 Scale in Feet 0 2000 4000	N	**Figure 2.13** **Lake Worth Topographic Map** **NAS Fort Worth JRB** *[From USGS, 1982]*
Checked By: K.Hurley	Date: 6/12/97			
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Lake evaporation near NAS Fort Worth JRB is estimated to be approximately 57 inches per year. Evapotranspiration over land areas may be greater or less than lake evaporation depending on vegetative cover type and moisture availability. Average net precipitation is expected to be equal to the difference between average total precipitation and average lake evaporation, or approximately minus 25 inches per year. Mean cloud cover averages 50 percent at NAS Fort Worth JRB with clear weather occurring frequently during the year. Some fog is present an average of 83 days per year. Wind speed averages 7 knots; however, a maximum of 80 knots has been recorded. Predominant wind direction is from the south-southwest throughout the year.

Air quality in the Dallas-Fort Worth area meets EPA National Ambient Air Quality Standards for carbon monoxide, nitrogen dioxide, sulfur dioxide and respirable particulate matter. However, ozone levels exceed national standards, and the ozone pollution level in the area has a federal classification of moderate. During 1996, ozone measurements showed an arithmetic mean concentration of 0.033 parts per million in North Tarrant County. Actual exceedances of the national standards for ozone concentrations was calculated to be two days for the measurement station in North Tarrant County. Additional control measures are being implemented as a result of 1990 Federal Clean Air Act mandates to bring the area into compliance with the national standard (TNRCC, 1996d).

2.1.6 Biology

Approximately 374 acres, or 14 percent, of NAS Fort Worth JRB is considered unimproved, indicating the presence of semi-natural to natural biological/ecological conditions. The Base lies in the Cross Timbers and Prairies Region of Texas where native vegetation is characterized by alternating bands of prairies and woodlands. The higher elevations on the Base are covered by native and cultivated grasses such as little bluestem, Indian grass, big bluestem, side oats, grama, and buffalo grass. Forested areas occur primarily on the lower land and along the banks of streams. Common wood species include oak, elm, pecan, hackberry, and sumac. Several non-native species such as catalpa and chinaberry are common (Radian, 1989).

Typical wildlife on the Base includes black-tailed jackrabbits in grassy areas along the runway. In addition, there are cotton-tail rabbits, gray squirrels, and opossums in the wooded areas. Common birds include morning doves, meadowlarks, grackles, and starlings. Hunting and trapping are not allowed on the Base, but in the nearby rural areas they are a very popular form of recreation (Radian, 1989).

Reported game fish include black bass, sunfish, and catfish, all of which can be found in Lake Worth, Farmers Branch Creek, and one small pond located on-base near the golf course equipment shed. According to the Texas Department of Parks and Wildlife and the United States Fish and Wildlife Service, there are no threatened or endangered species known to occur on NAS Fort Worth JRB. None of the federally-listed endangered plant species for Texas are known to occur within 100 miles of Tarrant County. Of the federally-listed endangered animals species, only the peregrine falcon, the bald eagle, and the whooping crane are known to occasionally inhabit the area; however, none of these is expected to reside in the vicinity of NAS Fort Worth JRB (Radian, 1989).

2.1.7 Demographics

The following sections describe the regional and site-specific demographics as they relate to the Fort Worth, Texas area and the NAS Fort Worth JRB.

2.1.7.1 Regional Demographics

Approximately 1,278,606 people reside within Tarrant County, Texas (U.S. Department of Commerce, 1996). Of this population, 485,650 reside within the city limits of Fort Worth. Several smaller cities and villages make up the remainder of the population. The communities of White Settlement, Lake Worth, Westworth Village, River Oaks, and Sansom Park lie within a 3 mile radius of the NAS Fort Worth JRB. The following populations that reside in the cities and villages are based on 1994 census data: White Settlement (city) - 16,502, Lake Worth (city) - 4,694, Westworth Village (town) - 2,502, River Oaks (city) - 6,747, and Sansom Park (city) - 4,136 (U.S. Department of Commerce, 1994). Six schools are within a 2-mile radius of NAS Fort Worth JRB; the closest is 0.5 miles south (RUST, 1995).

The area surrounding NAS Fort Worth JRB is highly urbanized due to its proximity to the city of Fort Worth. The area is comprised of a combination of residential, commercial, and light industrial properties, which employ the majority of local residents (RUST, 1995).

2.1.7.2 Site-Specific Demographics

The current full-time population at NAS Fort Worth JRB is approximately 3,600 people, which is comprised of 400 officers, 1,400 civilians, and 1,800 active reservists. Part time military reservists will increase this population to over 6,000 military personnel (CH2M HILL, 1997).

Approximately 86 percent of NAS Fort Worth JRB has been developed by way of buildings, roads, parking lots, runways, housing, or recreational areas. On-site activities include various maintenance and support activities for fuel systems, weapons, jet engines, areospace ground support equipment, maintenance of specialized ground equipment, and inspection activities (HydroGeoLogic, 1997).

2.2 SITE-SPECIFIC ENVIRONMENTAL SETTING

The following sections describe the site-specific environmental setting at each of the SWMUs to be investigated under this DO. Site-specific information at SWMUs 27, 29, and 30 is very limited since previous investigations have not been performed.

2.2.1 Site Specific Soils

The United States Soil Conservation Service has identified four major soil associations in the area of NAS Fort Worth JRB. The surficial soils of SWMUs 17, 29, and 62 include the nearly level to gently sloping Clayey soils of the Sanger-Purves-Slidell Association. SWMU 27 is located in the Aledo-Bolar-Sanger Association, which is located within the southwestern portion of the Sanger-Purves-Slidell Association, and is characterized as an increasingly Loamy clayey soil of gentle to moderate slope. Soil at SWMU 30 belongs to the Clayey soils of the Frio-Trinity Association, which is located along the flood plain of the West Fork of the Trinity River. The fourth association that is present at the site and separates the Sanger-Purves-Slidell Association from the Frio-Trinity Association is the Bastsil-Silawa Association. This association is characterized as a Sandy clay loam of nearly level slope. Each of these soil associations are summarized in Table 2.4 (ESE, 1994), and the areal limits of their occurrence on-site are shown in Figure 2.14 (ESE, 1994).

2.2.2 Site Specific Geology

The majority of NAS Fort Worth JRB is covered by alluvium deposited by the Trinity River during flood stages. The Quaternary Period alluvium (Holocene Epoch) occurs downstream from the Lake Worth Dam in the current flood plain of the West Fork of the Trinity River, on the east side of the facility. Older alluvial deposits and terrace deposits (Pleistocene Epoch) also occur on-site. The alluvium is composed of gravel, sand, silt, and clay of varying thicknesses and lateral extent. The thickness of these materials ranges from 0 to 60 feet. Fill material is also included within these deposits where landfills, waste pits, excavation sites, and other construction activities have altered the original land surface. This fill material is made up of clay, silt, sand, and gravel mixtures, but may also contain debris and other waste (Radian, 1989).

Below the alluvial terrace deposits are the Cretaceous-age Goodland and Walnut Formations which form the bedrock surface beneath NAS Fort Worth JRB. Both formations consist of interbedded, fossiliferous, hard limestone, and calcareous shale. The upper formation, the Goodland Limestone, is exposed on the southern portion of the Base, south of White Settlement Road. The Goodland is a chalky-white, fossiliferous limestone and marl. The thickness of the Goodland Limestone ranges from 20 to 25 feet. Below the Goodland Formation is the Walnut Formation (or Walnut Clay). The Walnut Formation is exposed in a small area along the shores of Lake Worth and Meandering Road Creek. This formation is a shell agglomerate limestone with varying amounts of clay and shale. It ranges in thickness from 25 to 35 feet across the site except where erosion has produced a few thinner areas. Subsurface investigations have located troughs and paleochannels that are eroded into the top of the bedrock at NAS Fort Worth JRB. These paleochannels are typical of an erosional surface modified by fluvial processes and are filled with sand and gravel deposits ranging in thickness from 15 to 35 feet (CH2M HILL, 1996b).

Below the Walnut Formation is the Paluxy Formation (or Paluxy Sand). The Paluxy Formation underlies all of NAS Fort Worth JRB. The Formation consists of several thick sandstone layers that are separated by thin, discontinuous shale and claystone layers. Sandstones in the formation are primarily a fine to coarse-grained sand with minor amounts of clay, sandy clay, pyrite, lignite, and shale. The lower section of the Paluxy is generally coarser-grained than the upper section (CH2M HILL, 1996b). Total Formation thickness ranges from 130 to 175 feet, with variable thickness and occurrence of individual layers across the site. Only one unit in this formation, a shale/silty shale, can be extensively mapped across the Base.

The older Glen Rose and Twin Mountains Formations are not exposed at NAS Fort Worth JRB. The Glen Rose Formation consists primarily of calcareous sedimentary rock and some sands, clays, and anhydrite. The Glen Rose caps the Twin Mountain Formation, which is the oldest

Table 2.4
Soil Associations at SWMUs 17, 27, 29, 30, 62
NAS Fort Worth JRB, Texas

Association	Description	Thickness (inches)	Percent Clay <2mm (%)	pH (S.U.)	Permeability (cm/sec)	Available Water Capacity (in/in)
Sanger-Purves-Slidell: Clayey soils of nearly level to gently sloping uplands.	Clay loam Clay over bedrock Silty clay	8 - 80	35 - 60	7.4-8.4	$<4.2\times10^{-5}$ to 3×10^{-4}	0.12 - 0.20
Aledo-Bolar-Sanger: Loamy and clayey soils of gently sloping to moderately steep uplands.	Clay loam over bedrock Clay loam	8 - 70	20 - 60	7.9-8.4	$<4.2\times10^{-5}$ to 9×10^{-4}	0.05 -0.18
Frio-Trinity: Clayey soil on nearly level flood plains.	Silty clay or loam Clay	25 - 75	35 - 80	7.4-8.4	$<4.2\times10^{-5}$ to 3×10^{-4}	0.11 - 0.20
Bastsil-Silawa: Loamy soils on nearly level to sloping stream terraces.	Sandy clay loam	40 - 80	7 - 35	4.5-7.8	9×10^{-4} to 3×10^{-3}	0.08 - 0.17

Sources: Summary of Hydrologic and Chemical Characterization Studies (ES&E, July 1994).
Soil Survey of Tarrant County, Texas, pps. 202-203 (USGS, 1981)

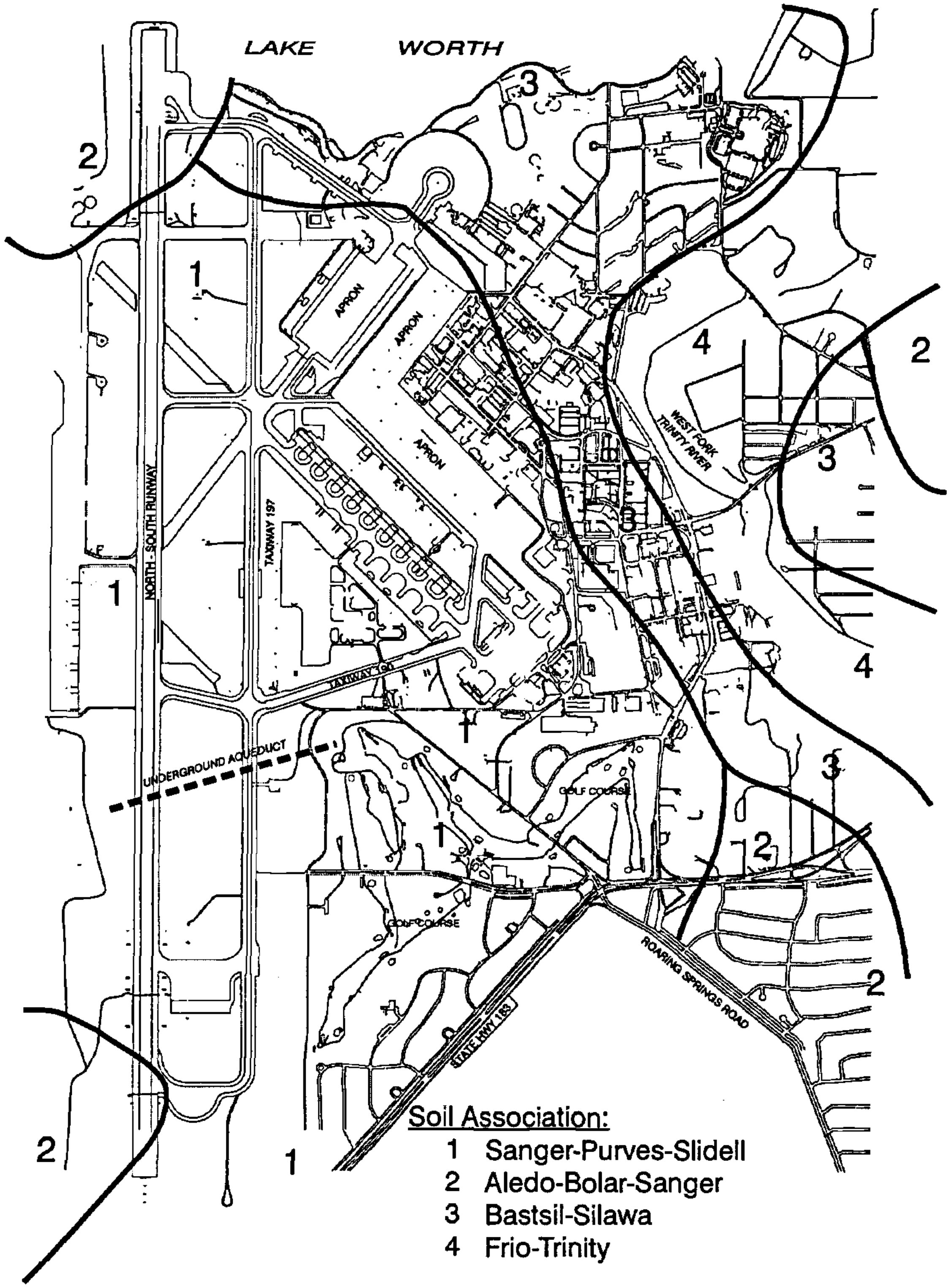

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Figure 2.14
Soil Association Map
NAS Fort Worth JRB, Texas

[From Radian, 1989]

Cretaceous Formation in the NAS Fort Worth JRB area. The Twin Mountain Formation consists of a basal conglomerate of chert and quartz, grading upward into coarse- to fine-grained sand interspersed with varicolored shale.

2.2.3 Contaminant Sources and Contamination

A summary of existing information from previous studies concerning the nature and extent of site contamination is presented in section 1.4 and Appendix A. The following sections describe the types of materials received and any documented hazardous constituents that may act as a source of contamination to the surrounding environment.

2.2.3.1 SWMU 17

The surface of the site is littered with small pieces of concrete, asphalt, and rocks that have weathered through the soil cover. The area is surrounded to the west and south by a drainage ditch. The northern extent of the SWMU is not defined other than where ground maintenance begins. SWMU 17 reportedly received solid wastes such as concrete, asphalt, wood, trees. Although it is not documented, it is suspected that this SWMU may have also received small amounts of hazardous materials typically associated with USAF activities during its period of operation. The area is currently covered by various grasses and weeds, which are not maintained.

2.2.3.2 SWMU 27

This site consists of a ditch approximately 8 feet deep by 20 feet wide and 400 feet long surrounded by a two acre graded area. This varies from the RFA description of the ditch, which was described as 20 feet wide by 80 feet long. The ditch typically has approximately 4- to 5-feet of water during the winter months, and eventually, dries out during the summer months due to evaporation and infiltration. Drums were observed in the ditch during HydroGeoLogic's visual site inspection. Since there is no documentation as to the source of these drums, they may have contained material which could act as a source of potential contamination. The site is partially covered with vegetation. This area has not been previously investigated.

2.2.3.3 SWMU 29

This inactive landfill is surrounded by an 8-foot chain link fence that provides security for Building 1055. This building occupies approximately one fourth of the 4.4 acre site. The remaining portion of the site is either occupied by temporary trailers, or is grass-covered. This former borrow pit was converted to a landfill in 1952, and accepted construction debris and moderate quantities of unspecified hazardous wastes (AFCEE, 1997). In 1956, the landfill was no longer needed, and the site was covered. This area has not been previously investigated.

2.2.3.4 SWMU 30

This inactive landfill received construction debris in the form of concrete, asphalt, steel, and wood. A ditch, which drains to the West Fork of the trinity River, has been created by runoff draining from an upgradient parking area located adjacent to Building 2570. In this ditch, concrete, asphalt, telephone poles, and reinforcing steel have washed out of the west bank. Given its proximity to industrial shops, this SWMU may have received hazardous materials associated with these operations. The site is covered by vegetation, and current land use is limited to maintenance workers. The future location of a water line has been staked for installation through the middle of the site. This area has not been previously investigated.

2.2.3.5 SWMU 62

SWMU 62 is located between Roaring Springs Road and Haile Drive, across from the golf course. The site consists of a sparsely grass-covered area that is currently being unofficially used for stock piling debris laden fill dirt. The site was first identified in the RFA conducted by A. T. Kearney, Inc. (1989) as a construction and debris landfill, but was not investigated until the PA/SI conducted by the USACE (1993). It was documented that "three drums of hydraulic fluid were placed in a centrally located pit, which collected groundwater that seeped into the landfill." It is not clear from this quote, taken directly from the RFA, whether the drums or the pit were designed to collect groundwater (A.T. Kearney, 1989). Debris that was reportedly accepted by the landfill included trees, construction rubble, and miscellaneous trash. Given the proximity of the site to the flightline shops, however, it is possible that small quantities of hazardous waste or hazardous constituents may have been buried.

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3.0 PROJECT TASKS

The following sections present the Applicable or Relevant and Appropriate Requirements, the TNRCC HW-50289 Permit Requirements for the site, the site's background characterization, the data needs, and the proposed field investigation tasks.

3.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

Applicable or Relevant and Appropriate Requirements (ARARs) will be considered during the remedy process (per the requirements of TAC 335.562(b)). Federal statutes that will be used for guidance include the Solid Waste Disposal Act, RCRA, Toxic Substances Control Act, Safe Drinking Water Act, Clean Air Act, Clean Water Act, Endangered Species Act, Fish and Wildlife Coordination Act, and the Marine Protection Research and Sanctuaries Act. The ultimate objective of this project is to obtain closure under the TNRCC RRS program.

There are three general types of ARARs:

- Chemical specific requirements are usually health- or risk-based numerical values or methodologies, which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment.

- Location specific requirements are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in special locations.

- Action specific requirements are usually technology based requirements or limitations on actions taken with respect to hazardous wastes.

Tables which present a preliminary list of ARARs to be considered during this investigation are included as Appendix B. As more information becomes available through the project, the ARARs will be further refined.

3.2 PERMIT HW-50289 REQUIREMENTS

As bearer of the TNRCC HW Permit (HW-50289), NAS Fort Worth JRB is subject to regulation under RCRA and the Texas Solid Waste Disposal Act, including the corrective action requirements of RCRA and the Texas Risk Reduction Rules (30 TAC §335 Subchapter S). The overall objective of this project is to obtain closure under the TNRCC RRS program. Specific RFI requirements of the HW-50289 permit call for:

- Provision VIII.A.2.b (1) requires a hydrogeologic assessment of the area to characterize the uppermost aquifer beneath the unit. Data on the strata encountered, saturated intervals, and groundwater flow must be collected. Soil samples from borings must be taken continuously from the surface to a depth of 20 feet and then at 5 foot intervals thereafter until groundwater is reached. Soil boring samples submitted for chemical analysis must be collected every 5 feet from the surface to the bottom of the boring and be analyzed in accordance with the US EPA SW-846 for all Appendix IX constituents, unless a shorter list can be justified.

- Provision VIII.A.2.b (2) requires the installation of a groundwater monitoring system, based on the soil boring program, consisting of a minimum of one background well located hydraulically upgradient of the unit, removed a sufficient distance so as to not be affected by the unit, and at least three wells located on the downgradient perimeter of the unit. The upper 20 feet of the upper flow zone of the uppermost aquifer must be sampled by wells.

- Provision VIII.A.2.b (4) requires the collection of groundwater samples from monitoring wells during three sampling events spaced at two month intervals. These samples will be analyzed in accordance with USEPA SW-846 for all Appendix IX constituents unless a shorter list can be justified.

3.3 CHARACTERIZATION OF BACKGROUND CONDITIONS

Jacobs Engineering (Jacobs, 1997) conducted a base-wide background study in 1996 to establish background concentrations of 24 inorganic constituents in surface soil, subsurface soil, alluvial terrace groundwater, surface water, and sediments at NAS Fort Worth JRB. The study quantified groundwater concentrations in the alluvial terrace using both low stress and bailer sampling techniques. All samples were collected and analyzed for metals, volatile, and semi-volatile compounds. Sampling locations were selected based on the proximity to known sources of contamination and contaminated media. Inorganic sample results were not included in the statistical determination of background concentrations at locations where organic compounds were detected above detection limits.

Results of the background study for each media are presented in Tables C.1 through C.6 of Appendix C. Jacobs (1997) used the Tolerance Interval method to estimate upper tolerance limits (UTLs) of the distribution of each constituent in the background data population. The $UTL_{95,95}$ values listed in the tables are the values that, with 95 percent confidence, will exceed 95 percent of the background concentrations. This RFI will use the $UTL_{95,95}$ values listed in Appendix C as background values for all investigative work until TNRCC review and approval of the Jacobs UTL study.

3.4 DATA NEEDS IDENTIFICATION

Information from previous investigations have indicated that contamination may be present as a result of past waste handling practices at SWMUs 17 and 62. The investigation at these sites will be performed to confirm the contamination detected in previous studies, identify the source of any potential contamination, and to define the magnitude and spatial extent of any impact to the soil or groundwater beneath the sites.

Because SWMUs 27, 29 and 30 have not been previously investigated, this investigation is intended to determine if the waste buried at the sites have resulted in impacts to the soil, groundwater, sediments, and surface water at the sites. If contamination is present in the samples collected during this investigation, the study will be expanded in order to determine the extent of the contamination. Physical and chemical properties of the soil and groundwater beneath the sites will also be obtained to better understand the properties of these media.

Four primary objectives have been identified for this project: 1)Fill data gaps with respect to the hydrogeological regime at each site. This will be accomplished by installing monitoring wells to determine depth to bedrock, the lithologic unit which represents bedrock, the depth to groundwater, and the direction of groundwater flow; 2) The physical boundaries of each SWMU must be identified. This will be determined by evaluating the vertical and lateral extent of buried wastes at the site. Field methods for determining the total of buried wastes include geophysical surveys, soil borings, and direct push soil probes; 3) If contamination is present, then the source must be determined. Field methods that will be utilized include geophysical surveys, direct push soil borings, installing and sampling additional monitoring wells, sampling existing monitoring wells, and collecting surface water samples (SWMU 27 only); and 4) The nature and extent of the contamination must be characterized. This will be accomplished by defining the vertical and lateral extent of chemicals that exceed RRS1. Field methods that will be utilized include geophysical surveys, soil boring installation, monitoring well installation, and groundwater sampling from monitoring wells. These project objectives are summarized in Table 3.1.

Table 3.1
Project Objectives and Data Needs
SWMU 17, 27, 29, 30, and 62
NAS Fort Worth JRB, Texas

Primary Objectives	Data Needs	Work Task
Characterize site specific geology/hydrogeology at each of the SWMUs	Depth to groundwater Depth to bedrock Unit represented by bedrock Groundwater flow direction	Installation of additional monitoring wells and direct push temporary piezometers Sampling/gauging of existing monitoring wells
Define physical boundaries of landfill	Lateral and vertical extent of buried waste	Geophysical survey Soil probes with visual waste classification
Characterize potential source of contamination	Identify if waste disposed in landfill has impacted the environment	Geophysical survey Direct Push Soil borings with surface and subsurface sampling (SWMU 17, 27, 29, 30, & 62) MW installation and MW sampling Surface water samples (SWMU 27 only)
Determine nature and extent of any detected contamination	Lateral and vertical extent of contamination in soil and groundwater	Geophysical survey Direct Push Soil borings with surface and subsurface sampling MW installation and MW sampling

3.5 FIELD INVESTIGATION TASKS

The proposed field tasks described in the following sections will be conducted to achieve the project objectives. As previously noted, each of the SWMUs received various types and amounts of construction debris throughout their respective periods of operation. Although suspected, documentation confirming unauthorized dumping of hazardous wastes and hazardous constituents has not been obtained. The field tasks described in the following sections were chosen by evaluating the type and purpose of data required to characterize the various SWMUs. Geophysical surveys, installation of direct push soil borings, installation of temporary narrow diameter piezometers, installation of monitoring wells, and direct push soil probes will serve as a cost-effective means for gathering samples for visual observation, field screening, and laboratory analysis.

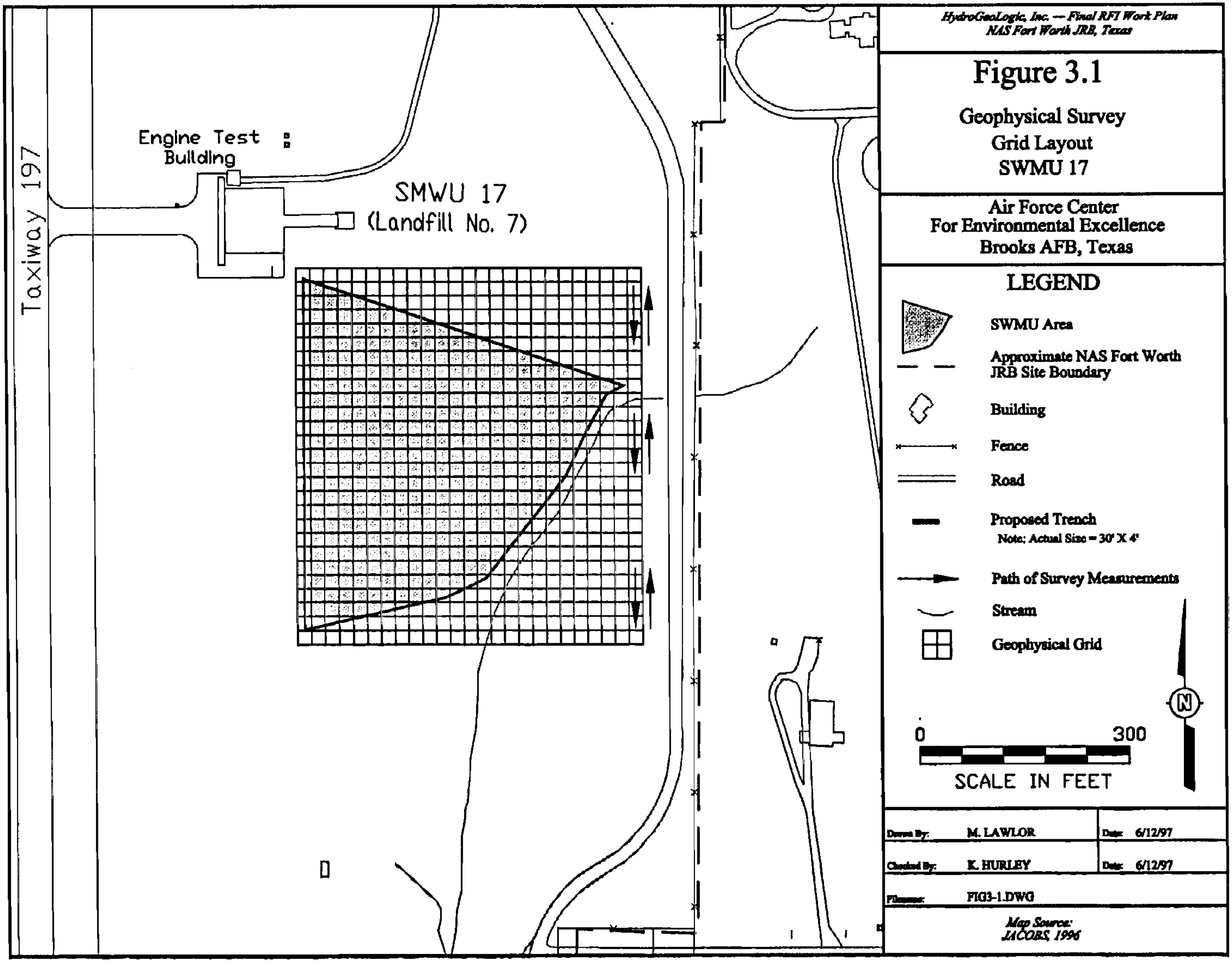
The following sections describe the tentative locations of the geophysical surveys, direct push soil borings, and temporary piezometers for each of the SWMUs. These locations may change due to site specific conditions such as utilities, fences, buildings, etc. encountered during the field implementation. At each SWMU, four monitoring wells will be installed in a pattern consisting of 1 upgradient and 3 downgadient wells. The location of these wells will be pinpointed after local groundwater flow patterns have been determined using temporary narrow diameter piezometers and existing monitoring wells.

3.5.1 SWMU 17

Proposed field activities to be conducted at SWMU 17 will include a geophysical survey to identify any potential "hot spots," defined as areas of conductivity anomalies. Figure 3.1 illustrates the SWMU and the spatial orientation of the grid to be surveyed. Figure 3.2 presents the intrusive sampling locations proposed at SWMU 17 during this investigation. Figure 3.3 depicts the groundwater flow patterns in the vicinity of SWMU 17.

Two geophysical tools will be used to conduct the geophysical survey. The survey grid will be tested using an electromagnetic induction tool that is designed to determine if conductivity anomalies are present. These anomalies may represent buried conductive material such as drums or tanks. Following completion of the electromagnetic induction survey, the grid will be resurveyed using a magnetometer/gradiometer. This tool will be used to evaluate magnetic anomalies which may also be associated with buried metallic objects. The magnetometer/gradiometer will also be used in an effort to determine the extent of undisturbed soil. The magnetic alignment of native earth will have a slightly different magnetic response than the soil disturbed during the operation of the landfill. This magnetic profile difference may register on the magnetometer/gradiometer. The layout of the projected geophysical survey grid is presented in Figure 3.1.

Four direct push soil borings will be advanced within SWMU 17 to test for soil contamination. Continuous cores will be collected at each boring location, and soil samples for chemical analysis will be collected every five feet from the surface to the water table. All of these borings will be continued into the water table and converted into temporary piezometers to collect data on groundwater elevations.



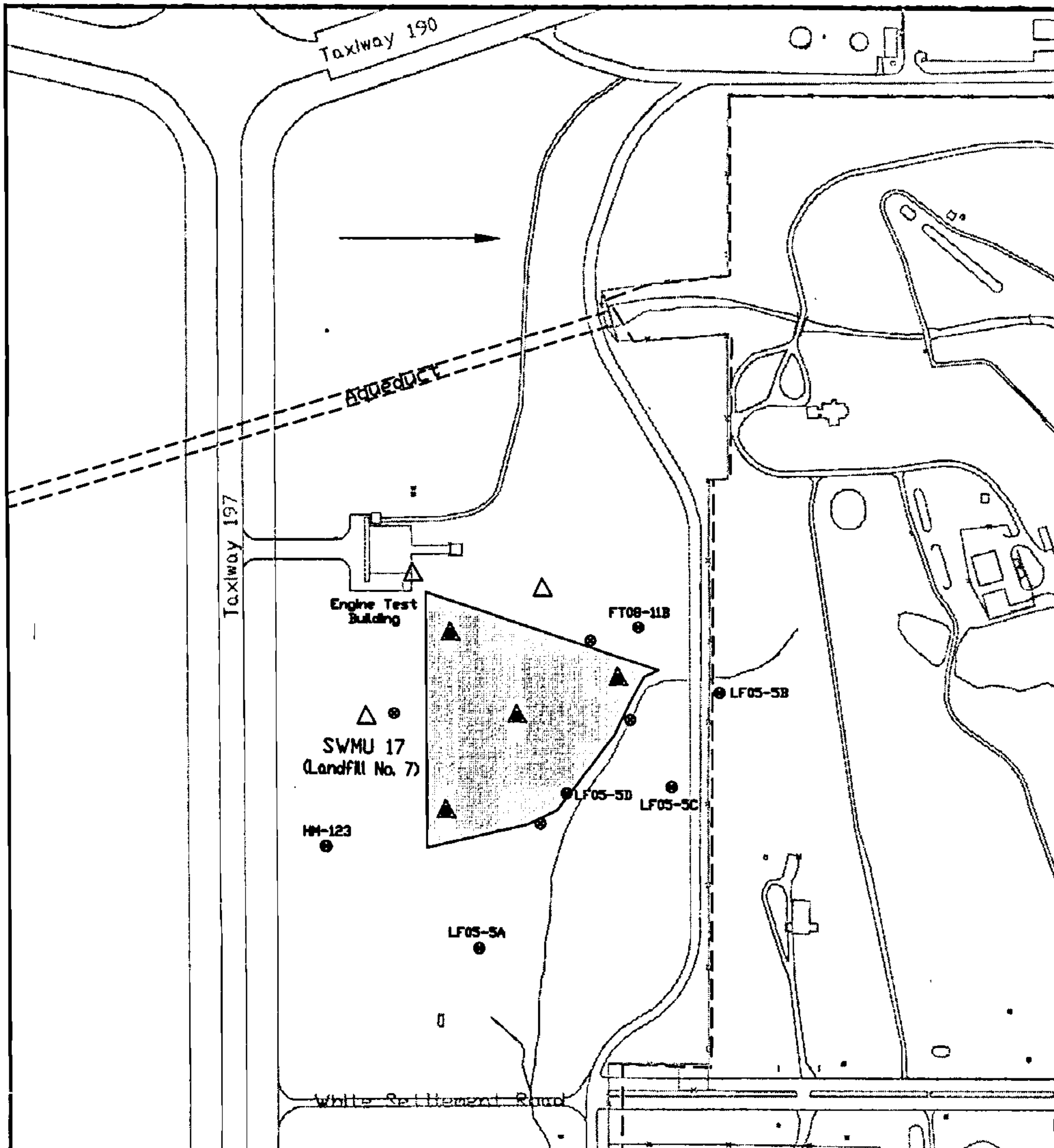
HydroGeoLogic, Inc. — Final RFI Work Plan
NAS Fort Worth JRB, Texas
Figure 3.1
Geophysical Survey
Grid Layout
SWMU 17
Air Force Center
For Environmental Excellence
Brooks AFB, Texas
LEGEND
SWMU Area
Approximate NAS Fort Worth JRB Site Boundary
Building
Fence
Road
Proposed Trench
Note: Actual Size = 30' X 4'
Path of Survey Measurements
Stream
Geophysical Grid
0
300
SCALE IN FEET
N
Drawn By:
M. LAWLOR
Date: 6/12/97
Checked By:
K. HURLEY
Date: 6/12/97
Filename:
FIG3-1.DWG
Map Source:
JACOBS, 1996
Taxiway 197
Engine Test
Building
SMWU 17
(Landfill No. 7)

HydroGeoLogic, Inc. — Final RFI Work Plan
NAS Fort Worth JRB, Texas

Figure 3.2

Proposed Investigation Activities SWMU 17

Air Force Center
For Environmental Excellence
Brooks AFB, Texas



LEGEND

- SWMU Area
- Approximate NAS Fort Worth JRB Site Boundary
- Proposed Monitoring Well
- Proposed Soil Boring
- Temporary Piezometer
- Fence
- Road
- LF05-5A Existing Monitoring Well
- Groundwater Flow Direction
- Stream

0 500
SCALE IN FEET

N

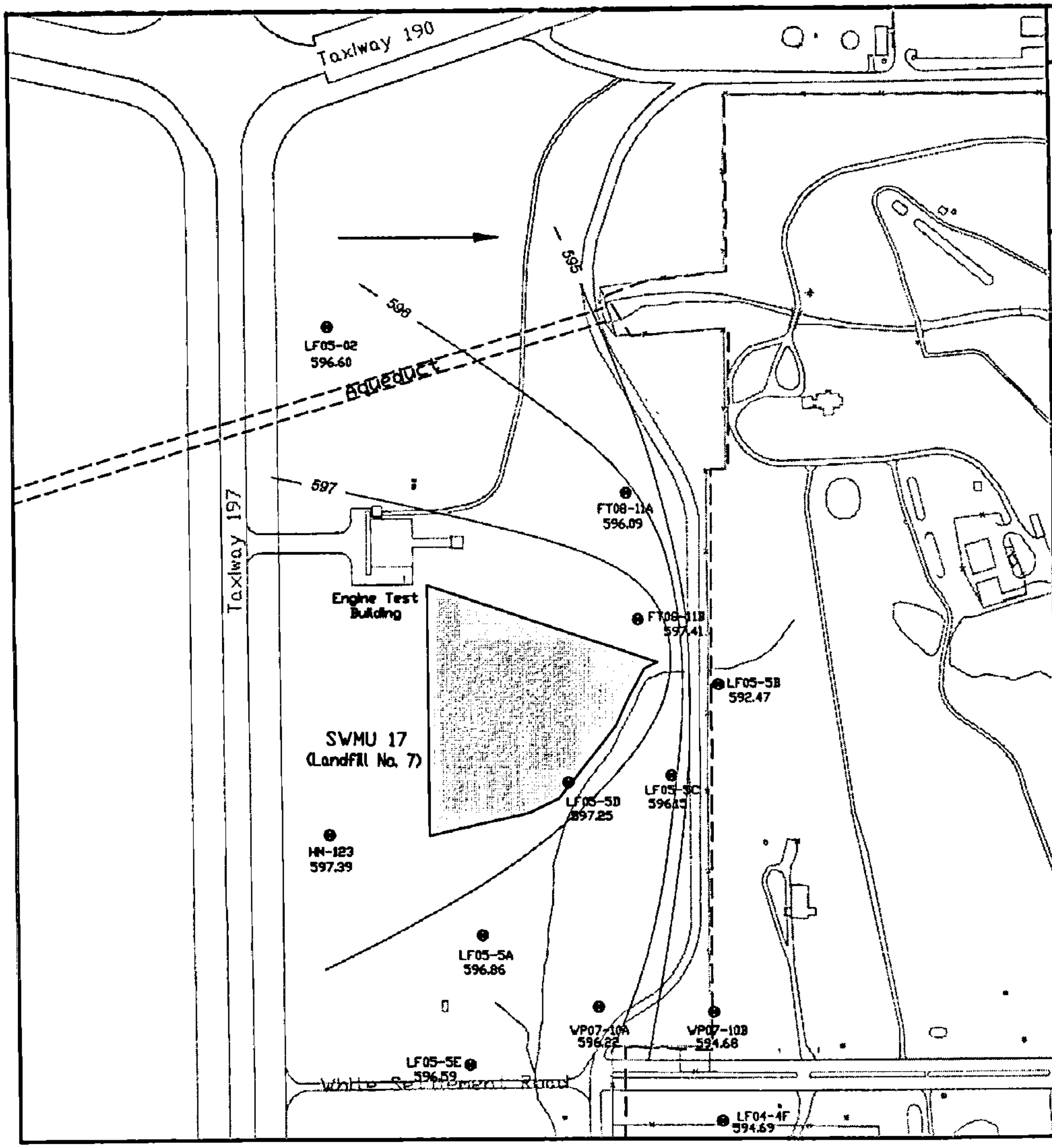
Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU17-PIA.dwg
Revised: 12/30/97
Map Source: Jacobs, 1996

HydroGeoLogic, Inc. — Final RFI Work Plan
NAS Fort Worth JRB, Texas

Figure 3.3

Potentiometric Surface Map in the Vicinity of SWMU 17 January, 1997

Air Force Center
For Environmental Excellence
Brooks AFB, Texas



LEGEND

- SWMU Area
- Approximate NAS Fort Worth JRB Site Boundary
- Fence
- Road
- LF05-5A Existing Monitoring Well
- Equipotential Line
- Groundwater Flow Direction
- Stream

0 500
SCALE IN FEET

N

Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU17-H2O.dwg
Revised: 12/30/97
Map Source: Jacobs, 1996

Groundwater elevation data will also be obtained from existing monitoring wells in the vicinity of SWMU 17. These wells are HM-123, LF04-01, LF05-5A, LF05-5D, LF05-5C, LF05-5B, FT08-11B, FT08-11A, and LF05-02.

Three soil probes will also be advanced outside the SWMU boundaries to install temporary piezometers. Information on groundwater elevation from these piezometers will be used to fill in data gaps in the west, north, and northeast. Continuous cores will be collected from these soil probes, and visual observations will be made to confirm the outer boundaries of the SWMU. Additional soil probes may also be installed to confirm the outer boundaries of the SWMU. The actual location of these soil borings and probes may be modified if results of the geophysical study provide evidence of "hot spots," or a larger area where wastes were buried.

Groundwater flow is generally west to east at NAS Fort Worth JRB. However, as depicted in Figure 3.3, a hydrogeologic ridge appears to run through SWMU 17 along a west to east axis. Groundwater flow around this ridge is to the east, southeast, and northeast. Groundwater flow patterns determined from temporary piezometers and existing wells will help to pinpoint the locations of any new perimeter monitoring wells. It will also assist in the evaluation of existing wells for use as potential SWMU 17 monitoring wells. The locations of potential new monitoring wells are shown on Figure 3.2.

The installation and sampling of new monitoring wells, and the sampling of existing monitoring wells, is designed to evaluate the relative quality of the groundwater upgradient of SWMU 17 versus the quality downgradient of the unit (Figure 3.2). Monitoring well HM-123, located west of the unit, will be used to evaluate the groundwater quality as it enters the unit. Monitoring wells LF05-5A, LF05-5D, FT08-11B, and LF05-5B will be evaluated as potential downgradient wells to determine the groundwater quality as it exits the unit. Additional monitoring wells may be sited to the west and north based on temporary piezometer groundwater elevation data. The difference between the physical and chemical characteristics of the groundwater upgradient versus downgradient of the unit will be used to determine if the waste buried within the unit has impacted groundwater quality.

The analytical results obtained from samples collected at soil borings and monitoring wells are intended to determine whether potential contamination in the SWMU is leaching to the underlying groundwater and potentially contributing to the existing TCE plume that originates at AFP-4. Due to a lack of historical records of waste buried within the unit, the full suite of Appendix IX constituents will be analyzed for all soil and groundwater samples collected at this unit. A summary of the proposed sampling is presented in Table 3.2. EPA Methods analytical methods proposed to cover the full Appendix IX suite of compounds include:

- SW8260A - Volatile Organics
- SW8270B - Semivolatile Organics
- SW8080A - Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)
- SW8140 - Organophosphorus Pesticides
- SW8151 - Chlorinated Herbicides
- SW8290 - Dioxins and Furans

Table 3.2
Proposed RFI Sampling Locations
NAS Fort Worth JRB, Texas

SWMU	Matrix	Sample Collection Method	Depth	Number of Locations/ SWMU	Analyses
17	Soil	Split Spoons	Soil samples collected every five feet from the surface to the water table.	4	VOC[1], SVOC[2], PP Metals[3], Mercury[6] Pesticides/PCB[4] Herbicides[5],Cyanide[7], Dioxins/ Furans[8], OP Pesticides[9], Sulfide[10]
17	Groundwater	Submersible Pump	Middle of well screen	4-5	VOC, SVOC, PP Metals, Mercury Pesticides/PCB Herbicides, Cyanide, Dioxins/Furans, OP Pesticides, Sulfide
27	Soil	Split Spoons	Soil samples collected every five feet from the surface to the water table.	4	VOC, SVOC, PP Metals, Mercury Pesticides/PCB Herbicides, Cyanide, Dioxins/Furans, OP Pesticides, Sulfide
27	Soil	Grab Samples	Top 4 inches of surface soil.	3	VOC, SVOC, PP Metals, Mercury Pesticides/PCB Herbicides, Cyanide, Dioxins/Furans, OP Pesticides, Sulfide
27	Surface Water	Grab Samples	Top of surface water	2	VOC, SVOC, PP Metals, Mercury Pesticides/PCB Herbicides, Cyanide, Dioxins/Furans, OP Pesticides, Sulfide
27	Groundwater	Submersible Pump	Middle of well screen	4	VOC, SVOC, PP Metals, Mercury Pesticides/PCB Herbicides, Cyanide, Dioxins/Furans, OP Pesticides, Sulfide
29	Soil	Split Spoons	Soil samples collected every five feet from the surface to the water table.	4	VOC, SVOC, PP Metals, Mercury Pesticides/PCB Herbicides, Cyanide, Dioxins/Furans, OP Pesticides, Sulfide
29	Groundwater	Submersible Pump	Middle of screen	4	VOC, SVOC, PP Metals, Mercury Pesticides/PCB Herbicides, Cyanide, Dioxins/Furans, OP Pesticides, Sulfide

Table 3.2 (continued)
Proposed RFI Sampling Locations
NAS Fort Worth JRB, Texas

SWMU	Matrix	Sample Collection Method	Depth	Number of Locations/ SWMU	Analyses
30	Soil	Split Spoons	Soil samples collected every five feet from the surface to the water table.	3	VOC, SVOC, PP Metals, Mercury Pesticides/PCB Herbicides, Cyanide, Dioxins/Furans OP Pesticides Sulfide
62	Soil	Split Spoons	Soil samples collected every five feet from the surface to the water table.	3	VOC, SVOC, PP Metals, Mercury Pesticides/PCB Herbicides, Cyanide, Dioxins/Furans, OP Pesticides, Sulfide
62	Groundwater	Submersible Pump	Middle of screen	4	VOC, SVOC, PP Metals, Mercury Pesticides/PCB Herbicides, Cyanide, Dioxins/Furans, OP Pesticides, Sulfide

Notes:

[1] Analytical method for VOCs are SW846 Method 8260A.
[2] Analytical method for SVOCs are SW846 Method 8270B.
[3] Analytical method for Metals are SW846 Methods 6010A/7000.
[4] Analytical method for Pesticides/PCBs are SW846 Methods 8080A.
[5] Analytical method for Herbicides are SW846 Methods 8150B.
[6] Analytical method for Mercury are SW846 Methods 7470A/7471A.
[7] Analytical method for Cyanide are SW846 Methods 9010A/9012.
[8] Analytical method for Dioxins/Furans are SW846 Methods 8290.
[9] Analytical method for OP Pesticides are SW846 Methods 8140.
[10] Analytical method for Sulfide are SW846 Methods 9030.

- SW9010A/SW9012 - Cyanide
- SW9030 - Sulfide
- SW6010A/7000 - Trace Elements (Metals)
- SW7470A/7471A - Mercury

Three rounds of groundwater sampling, collected at approximately two month intervals, are planned. If analytical results from the first round of sampling does not reveal contamination across the full suite of Appendix IX constituents, then a shorter list of analytes will be proposed for subsequent rounds of sampling.

Additional monitoring wells may be installed at a later date to delineate the extent of contamination originating from the SWMU if the proposed monitoring wells identify contamination above RRS.

3.5.2 SWMU 27

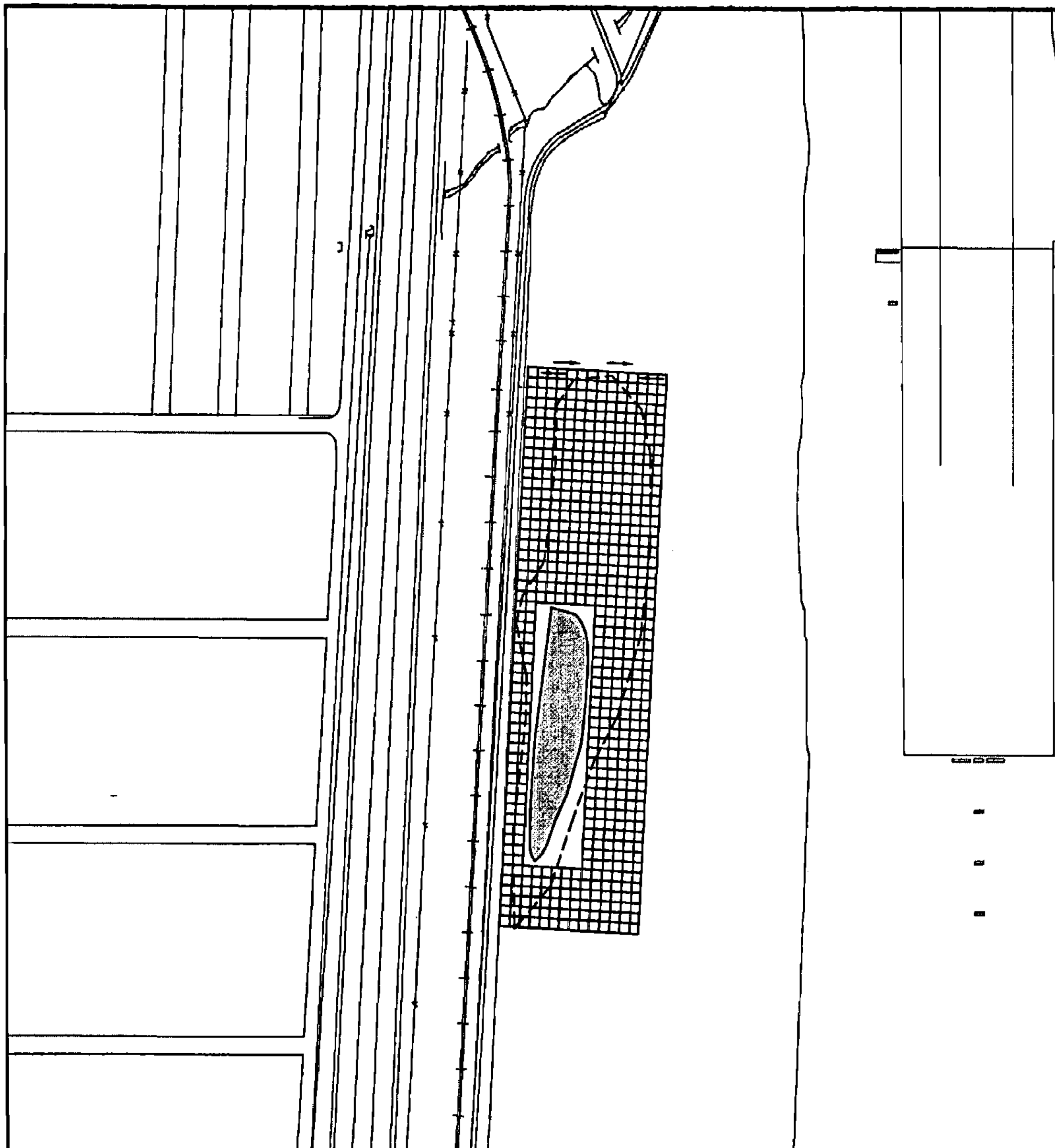
Field investigation tasks at this site include a geophysical survey, direct push soil borings, and monitoring well installation. A geophysical survey around the perimeter of the trench will be conducted to identify any potential "hot spots," defined as areas of conductivity anomalies. Figure 3.4 illustrates the SWMU and the spatial orientation of the grid to be surveyed.

Four direct push soil borings will be advanced within SWMU 27 to test for soil contamination. Continuous cores will be collected at each boring location. Soil samples for chemical analysis will be collected every five feet from the surface to the water table. Two of these borings will be continued into the water table and converted into temporary piezometers to collect data on groundwater elevations.

Three soil probes will also be advanced outside the SWMU boundaries to install temporary piezometers. Information on groundwater elevation from these piezometers will be used determine groundwater flow directions prior to the installation of monitoring wells. Continuous cores will be collected from these soil probes, and visual observations will be made to confirm the outer boundaries of the SWMU. Additional soil probes may also be installed to confirm the outer boundaries of the SWMU. The actual location of these soil borings and probes may be modified based on the results of the geophysical study.

After local groundwater flow directions have been determined with temporary piezometers, four monitoring wells will be drilled around the perimeter of the SWMU. These wells will be drilled to a depth of 1-foot into the bedrock to determine depth to bedrock, the lithologic unit which comprised bedrock, the depth to groundwater, and the direction of groundwater flow. One monitoring well will be installed upgradient of the unit, and three downgadient monitoring wells will be installed along the perimeter of the unit. Groundwater samples will be collected from these proposed locations to characterize the water quality entering and leaving the unit.

Three rounds of groundwater sampling, collected at approximately two month intervals, are planned for each monitoring well. If analytical results from the first round of sampling does not reveal contamination across the full suite of Appendix IX constituents, then a shorter list of analytes will be proposed for subsequent rounds of sampling.



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NAS Fort Worth JRB, Texas

Figure 3.4

Geophysical Survey Grid Layout SWMU 27

Air Force Center
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LEGEND

- Disposal Trench
- Area of Sparse Vegetation
- Proposed Monitoring Well
- Proposed Sediment Sampling Location
- Proposed Surface Water Sampling Location
- Building
- Fence
- Road
- Railroad
- Path of Survey Measurements
- Geophysical Grid

NOTE: Geophysical Investigation will not be performed in the disposal trench if water is present.

0 500
SCALE IN FEET

N

Filename: AFCEE\NAs Ft Worth\RFI\Final\SWMU27-geo.dwg
Revised: 12/30/97
Source: JACOBS, 1996

Three surface soil samples will be collected from the bottom of the trench to determine whether any of the wastes deposited at the site have impacted the soil along the bottom of the trench. Two surface water samples will be collected from standing water, if present, at the north and south ends of the trench to determine if wastes buried at the site have impacted the surface water. Surface water samples may not be able to be collected during summer months due to evaporation and infiltration.

Very little historical documentation of wastes buried at the unit is available. Therefore, all soil and surface water samples will be analyzed at the laboratory for full suite Appendix IX constituents. Proposed locations of soil borings, temporary piezometers, monitoring wells, surface soil samples, and surface water samples are depicted in Figure 3.5. A summary of the proposed sampling is presented in Table 3.2.

Additional soil borings and monitoring wells may be installed, at a later date, to delineate the extent of contamination originating from the SWMU, if the proposed locations identify contamination above RRS.

3.5.3 SWMU 29

Proposed field activities to be conducted at this SWMU include a geophysical survey to identify potential "hot spots," defined as areas of conductivity anomalies. The geophysical survey will also be used to determine the extent of the fill material in order to estimate the lateral extent of the former landfill. The success of this survey may be limited due to the presence of numerous buildings, trailers, roads, and associated utilities within the SWMU boundary. Figure 3.6 illustrates the SWMU and the spatial orientation of the grid to be surveyed.

Direct push soil probes will be driven around the perimeter of the SWMU in an effort to define the aerial extent of the SWMU. This method may be used to confirm the results of the geophysical survey, or it will be used as a stand alone method. If necessary, some of these soil probes will be converted to temporary piezometers.

Four soil borings will be installed inside the perimeter of the SWMU. Continuous soil cores will be used to evaluate the physical characteristics of the soil and waste. Soil samples from these continuous cores will be collected for chemical analysis every 5 feet from the ground surface to the water table. These samples will be used to assess the nature of potential chemical contamination of the soil beneath the unit. All four of the soil borings will be advanced into the water table and converted to temporary piezometers to determine local groundwater flow directions prior to the installation of monitoring wells.

Groundwater flow at the Base is generally west to east. Three of the monitoring wells are proposed in what appears to be the downgradient direction. These wells are designed to evaluate quality of the groundwater as it leaves the unit. The other monitoring well is proposed to evaluate the groundwater quality as it enters the unit. The relative difference in the groundwater quality upgradient versus downgradient of the unit will be used to determine if the waste buried in the unit is negatively impacting groundwater quality.

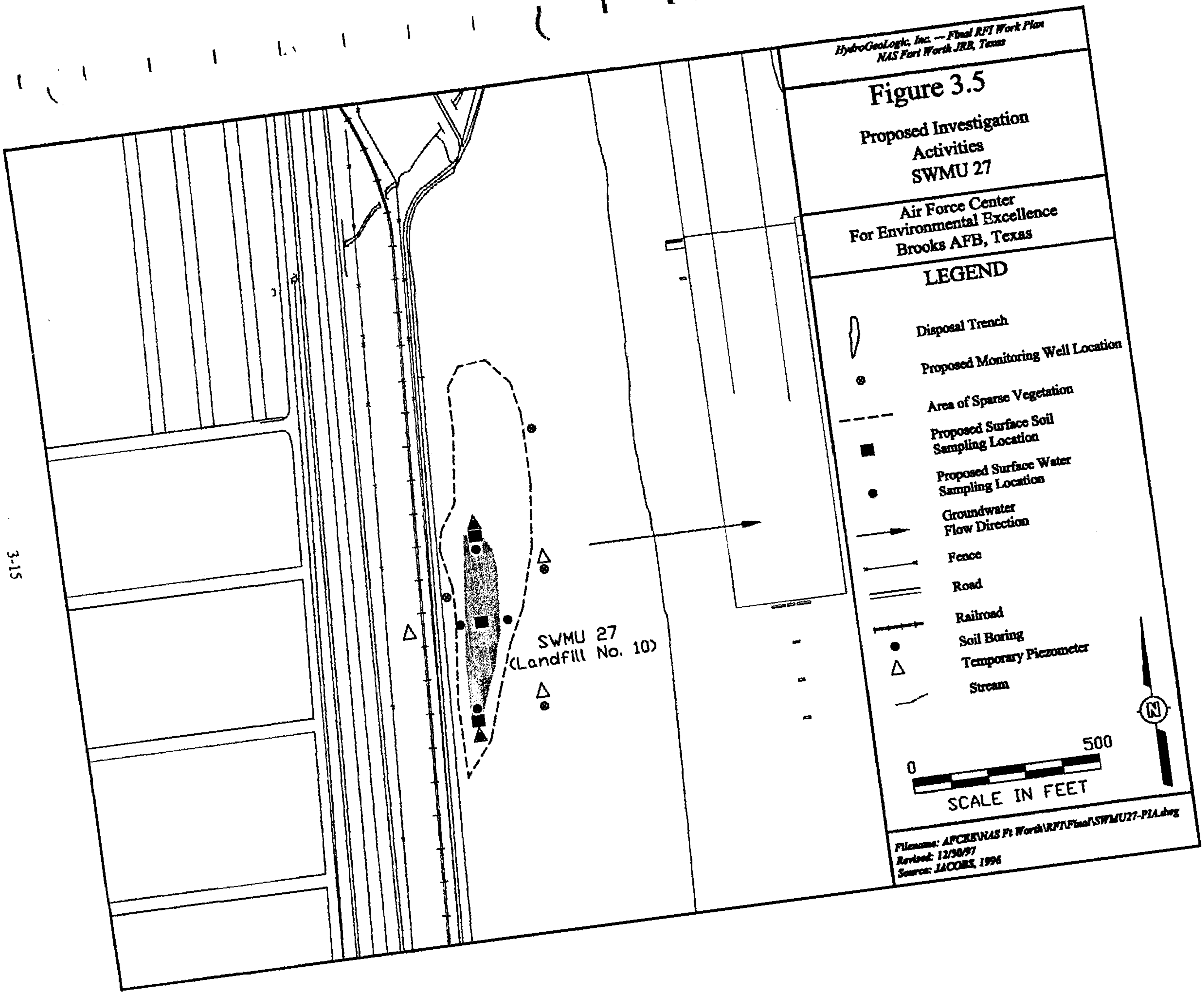


Figure 3.5
Proposed Investigation Activities
SWMU 27

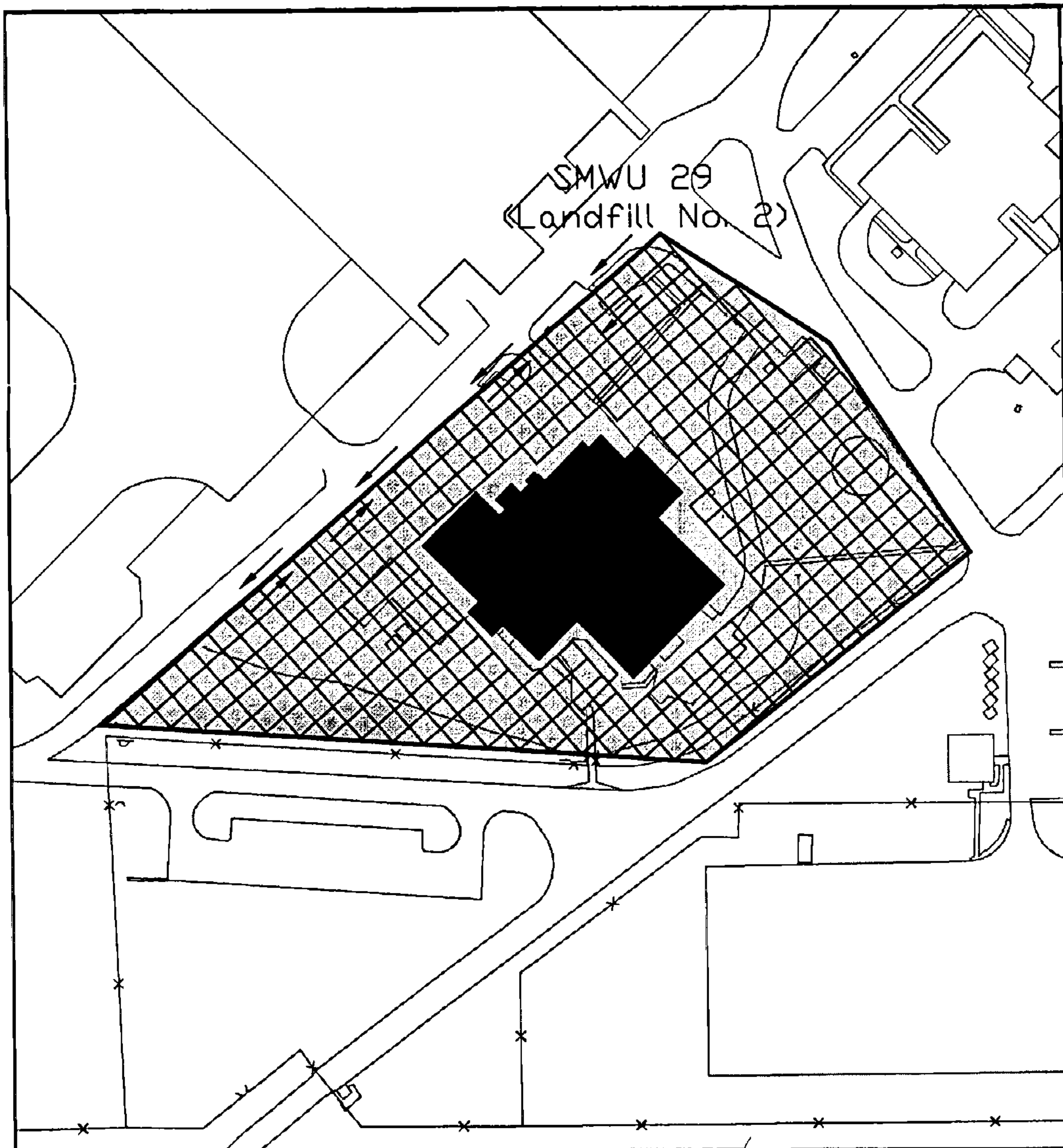


Figure 3.6

**Geophysical Survey
Grid Layout
SWMU 29**

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

LEGEND

- SWMU Area
- Building
- Fence
- Road
- Path of Survey Measurements
- Geophysical Grid

0 — 200
SCALE IN FEET

N

Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU29-geo
Revised: 12/30/97
Source: JACOBS, 1996

The monitoring wells will also provide valuable information as depth to bedrock, the lithologic unit represented as bedrock, and the depth to groundwater. These borings will be advanced deeper and terminated 1-foot into the bedrock. Some of the boring locations may need to be shifted based on accessibility and utility clearance.

Based on the lack of available historical records of buried debris and suspected contaminants associated with the SWMU, all soil and groundwater samples will be analyzed for a full suite of Appendix IX constituents. Three rounds of groundwater sampling are planned for the new wells. Analytical results of the first round of sampling may be used to justify a shorter Appendix IX analyte list in subsequent rounds of sampling.

Proposed locations for soil borings and monitoring wells are presented in Figure 3.7. A summary of the proposed locations and analyses are presented in Table 3.2. Additional soil borings and monitoring wells may be installed at a later date to delineate the extent of contamination originating from the SWMU if the proposed monitoring wells identify contamination above RRS.

3.5.4 SWMU 30

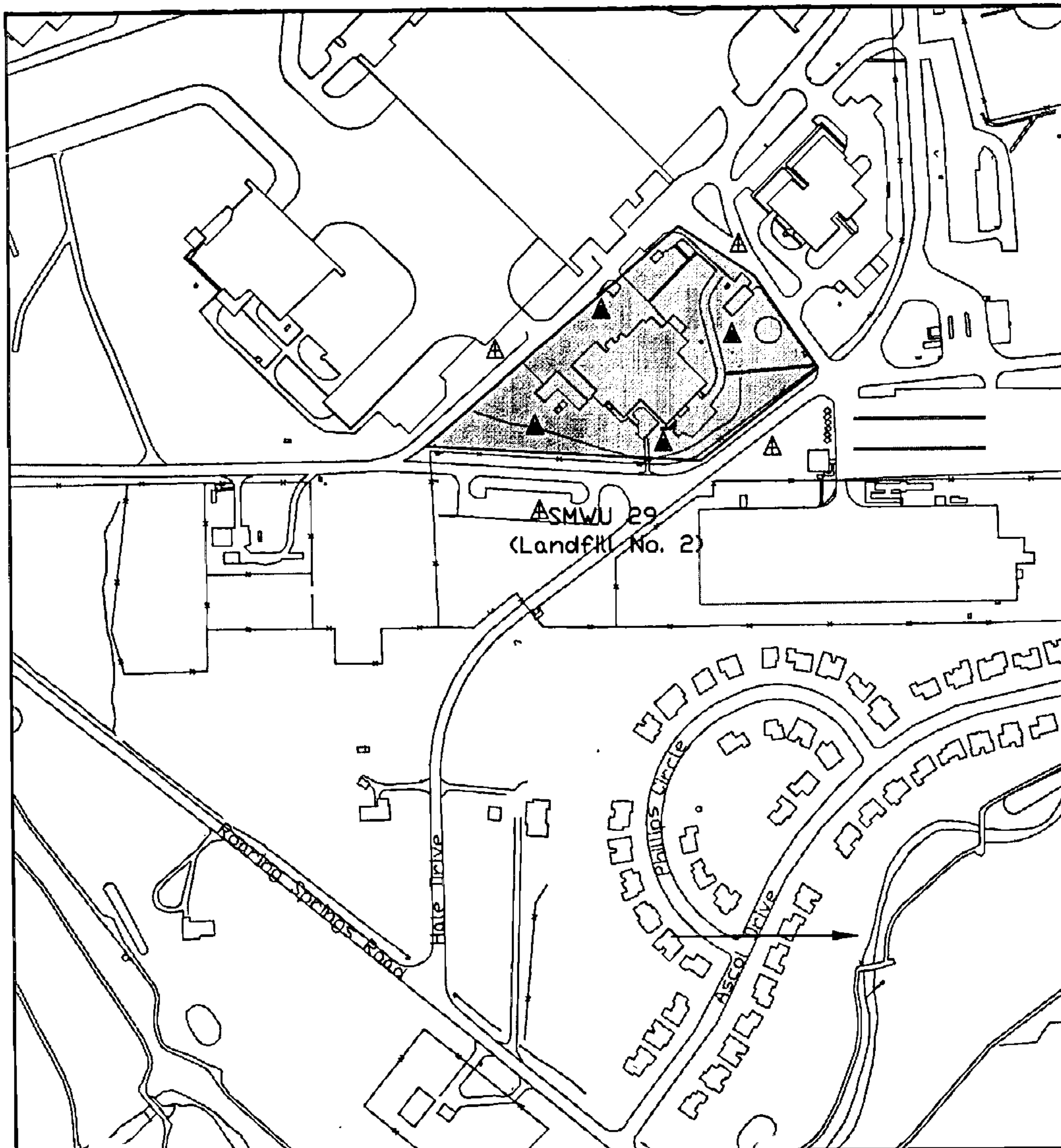
A geophysical survey will be conducted at this site to identify any potential "hot spots," defined as areas of conductivity anomalies. Figure 3.8 illustrates the SWMU and the spatial orientation of the grid to be surveyed.

Three soil borings will be driven to evaluate the soil and waste characteristics beneath this unit. Continuous cores will be used to evaluate the physical characteristics of the soil and waste. Soil samples from these continuous cores will be collected for chemical analysis every 5 feet from the ground surface to the water table. This information will be used in an attempt to determine if the waste buried at the unit has adversely impacted the environment.

Each of these soil borings will be advanced into the water table and converted to temporary piezometers. Two soil probes, located north and west of the SWMU, will be used to install temporary piezometers. Local groundwater flow directions will be determined from this piezometer nest prior to the installation of monitoring wells.

Groundwater flow in the vicinity of this unit is estimated to be to the southeast toward the West Fork of the Trinity River. One upgradient and three downgradient monitoring well locations are proposed to evaluate the depth to bedrock, the lithologic unit represented as bedrock, the depth to groundwater, the groundwater flow direction, and the chemical/physical characteristics of the groundwater. The relative groundwater quality between the upgradient samples and the downgradient samples will be used to evaluate the impact resulting from waste buried in the unit.

Since little historical data of debris buried in the landfill is available, all soil and groundwater samples will be analyzed for the full suite of Appendix IX constituents. Proposed locations for soil borings, temporary piezometers, and monitoring wells are presented in Figure 3.9. Proposed analyses for soil and groundwater are presented in Table 3.2. Three rounds of groundwater sampling are planned for the new wells. Analytical results of the first round of sampling may be used to justify a shorter Appendix IX analyte list in subsequent rounds of sampling.



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NAS Fort Worth JRB, Texas

Figure 3.7

Proposed Investigation
Activities
SWMU 29

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

SWMU Area

Proposed Monitoring Well

Proposed Soil Boring

Building

Fence

Road

Groundwater
Flow Direction

Temporary Piezometer

Potential Soil Probes & Piezometer

0 500
SCALE IN FEET

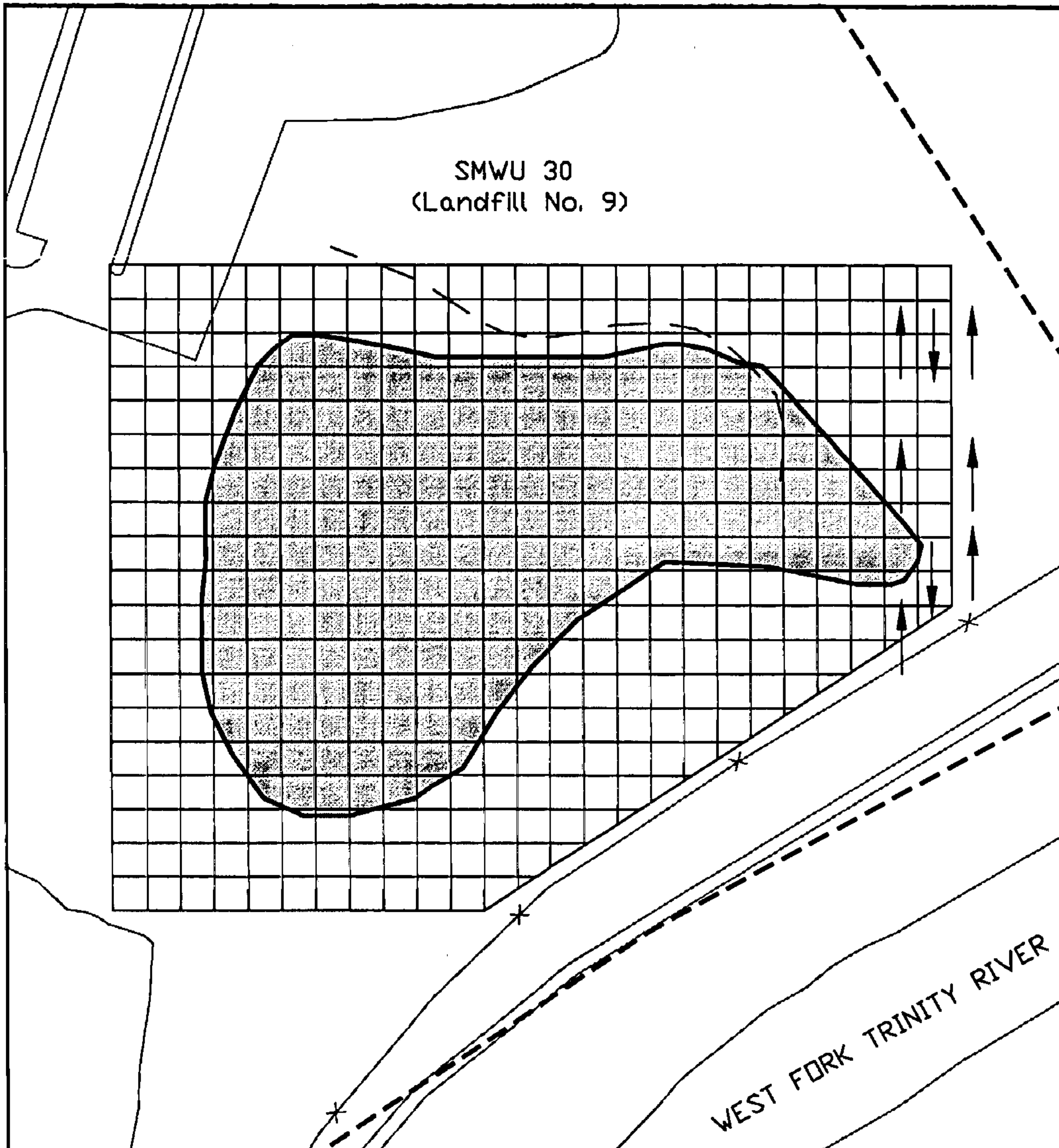
N

Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU29-PIA
Revised: 12/30/97
Source: JACOBS, 1996

Figure 3.8

Geophysical Survey Grid Layout SWMU 30

Air Force Center For Environmental Excellence Brooks AFB, Texas



LEGEND

- SWMU Area
- Approximate NAS Fort Worth JRB Site Boundary
- Building
- Fence
- Road
- Trench
- Path of Survey Measurement
- Geophysical Grid

0 150
SCALE IN FEET

N

Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU30-geo
Revised: 12/30/97
Source: JACOBS, 1996

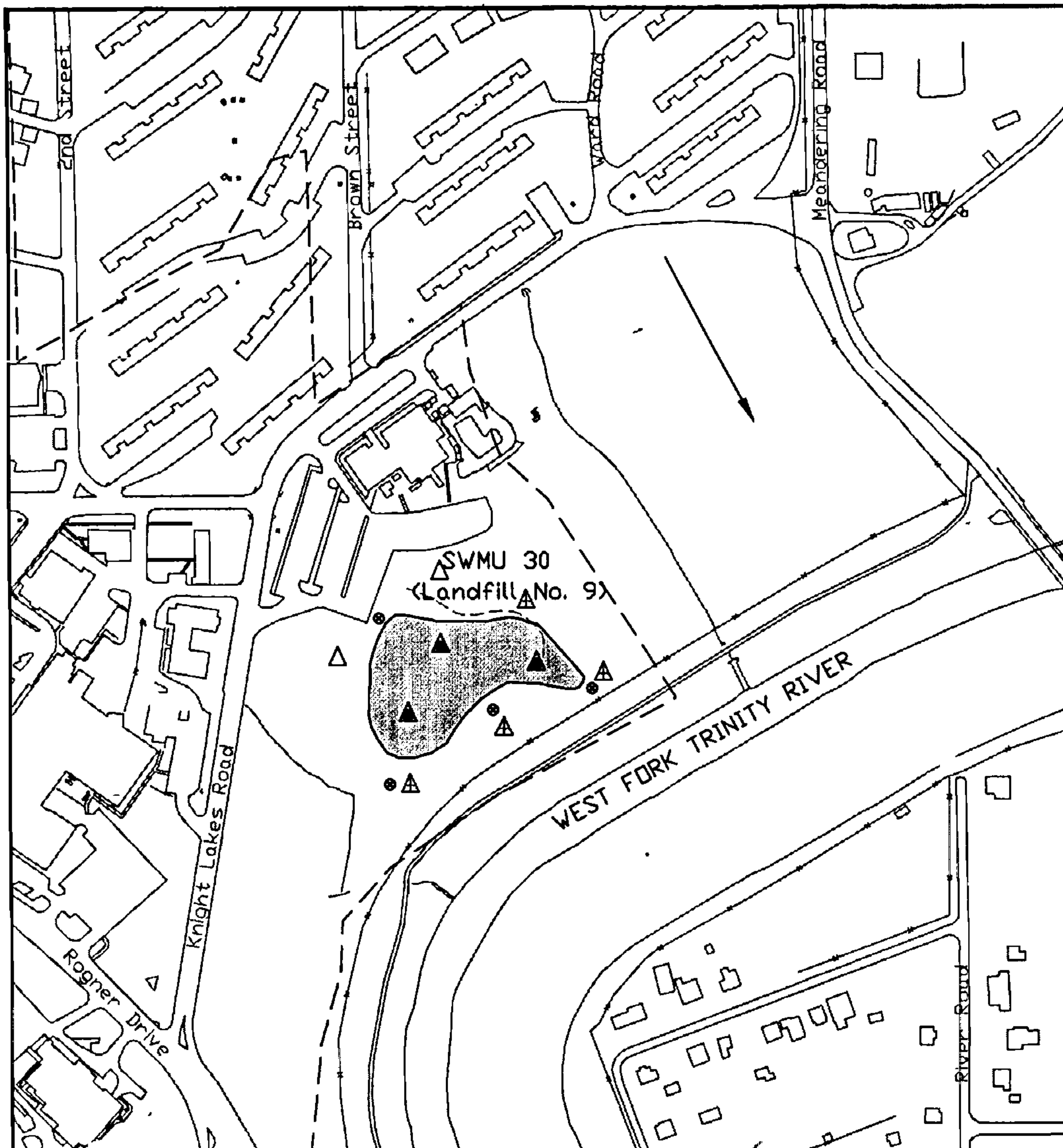


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Figure 3.9

Proposed Investigation Activities SWMU 30

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- SWMU Area
- Approximate NAS Fort Worth JRB Site Boundary
- Proposed Monitoring Well
- Proposed Soil Boring
- Building
- Fence
- Road
- Trench
- Stream
- Groundwater Flow Direction
- Temporary Piezometers
- Potential Piezometers

0 500
SCALE IN FEET

Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU30-PIA
Revised: 12/30/97
Source: JACOBS, 1997

Additional soil borings and monitoring wells may be installed at a later date to delineate the extent of contamination originating from the SWMU, if the proposed monitoring wells identify contamination above RRS.

3.5.5 SWMU 62

Proposed field activities to be conducted at this SWMU include a geophysical survey to identify any potential "hot spots," or areas of conductivity anomalies. Figure 3.10 illustrates the SWMU and the spatial orientation of the grid to be surveyed.

Three soil borings will be installed inside the perimeter of the unit as presented on Figure 3.11. Continuous cores will be used to evaluate the physical characteristics of the soil and waste. Soil samples from these continuous cores will be collected for chemical analysis every 5 feet from the ground surface to the water table. This information will be used in an attempt to determine if the waste buried at the unit has adversely impacted the environment.

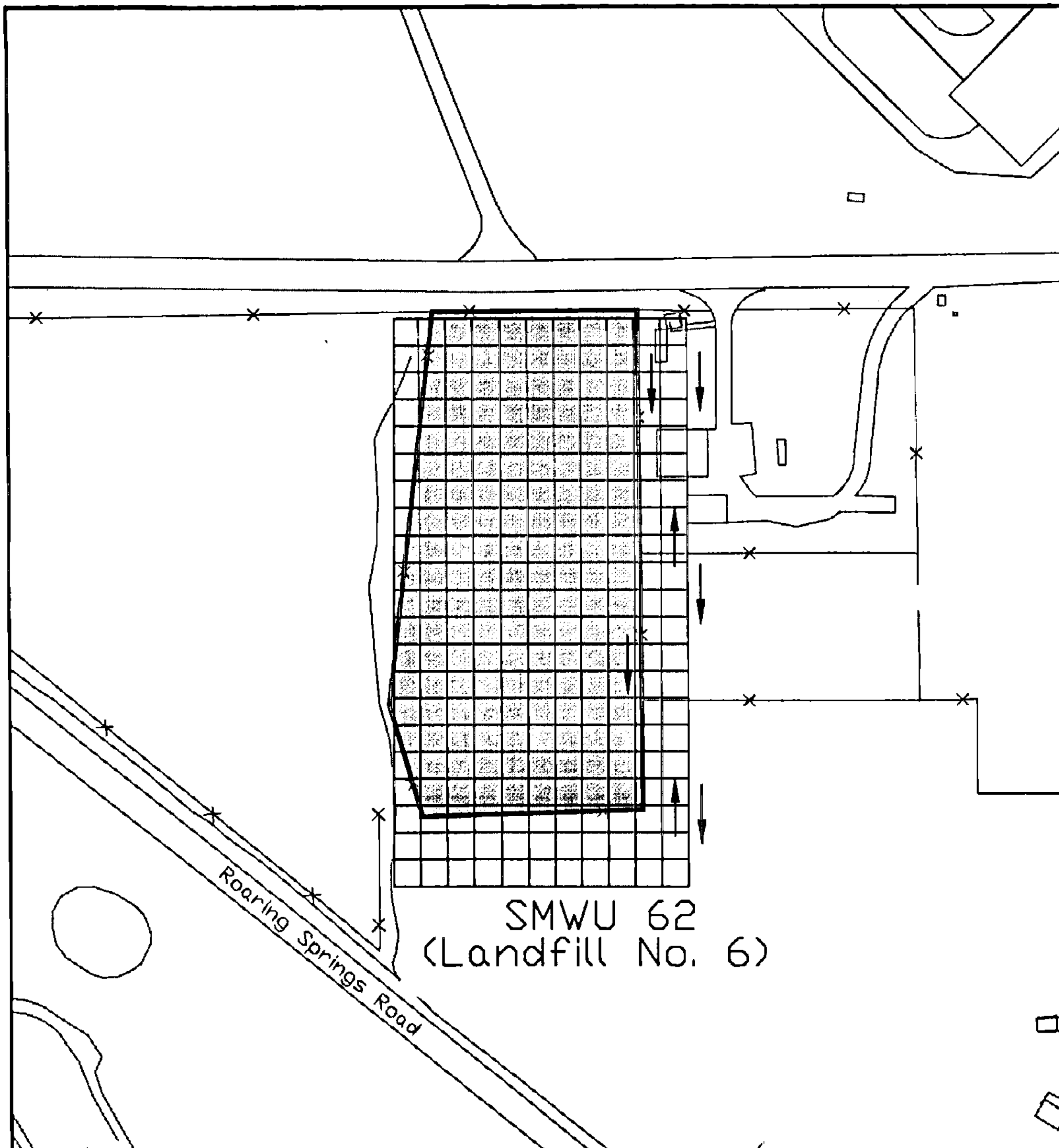
The central soil boring will be advanced into the water table and converted to temporary piezometer.

Four soil probes, located northwest, southwest, and east and southeast of the SWMU, will be used to install additional temporary piezometers. Groundwater flow is generally from the west to the east in the alluvium beneath NAS Fort Worth JRB. The temporary piezometers are proposed to determine local groundwater flow directions prior to the installation of monitoring wells.

Four monitoring wells will then be installed around the perimeter of the SWMU. The borings will be drilled to 1-foot into bedrock and completed as 2-inch monitoring wells. These wells will be used to determine depth to bedrock, evaluate the unit represented as bedrock, determine depth to groundwater, and characterize the physical/chemical characteristics of groundwater beneath the unit. Potential locations for monitoring wells are presented in Figure 3.11. A comparison of the groundwater quality upgradient of the unit with the quality of the groundwater downgradient of the unit will be used to determine if the waste buried in the unit has impacted groundwater quality beneath the site.

Based on the lack of historical records of buried debris and suspected contaminants associated with the SWMU, all soil and groundwater samples will be analyzed for a full suite of Appendix IX constituents. Proposed analyses for soil and groundwater are summarized in Table 3.2. Three rounds of groundwater sampling are planned for the new wells. Analytical results of the first round of sampling may be used to justify a shorter Appendix IX analyte list in subsequent rounds of sampling.

Additional soil borings and monitoring wells may be installed at a later date to delineate the extent of contamination originating from the SWMU, if the original suite of monitoring wells identify contamination above RRS.



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NAS Fort Worth JRB, Texas

Figure 3.10

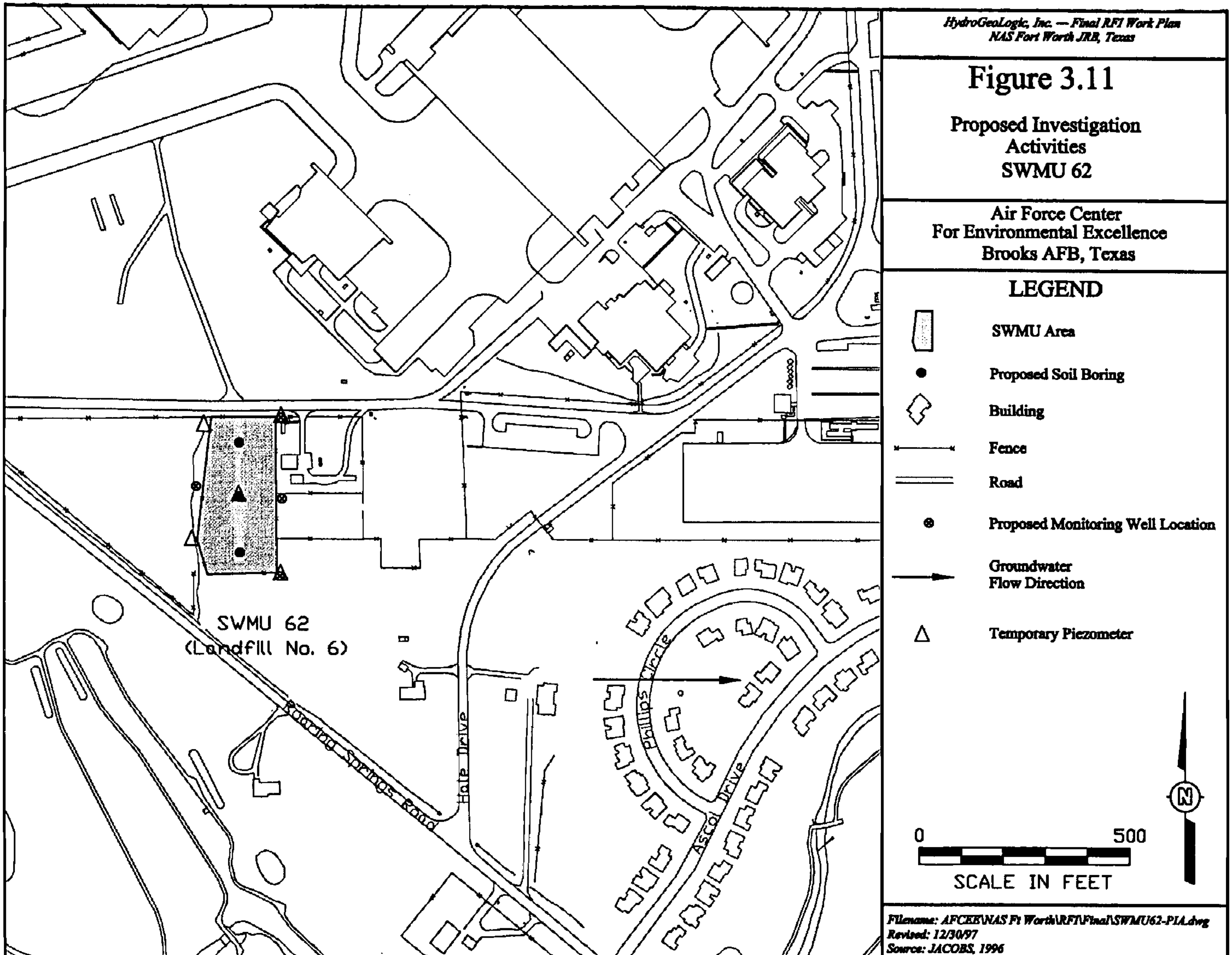
Geophysical Survey
Grid Layout
SWMU 62

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

SWMU Area
Proposed Monitoring Well
Building
Fence
Road
Path of Survey Measurements
Geophysical Grid

Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU62-geo.dwg
Revised: 12/30/97
Source: JACOBS, 1996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NAS Fort Worth JRB, Texas
Figure 3.11
Proposed Investigation
Activities
SWMU 62
Air Force Center
For Environmental Excellence
Brooks AFB, Texas
LEGEND
SWMU Area
Proposed Soil Boring
Building
Fence
Road
Proposed Monitoring Well Location
Groundwater
Flow Direction
Temporary Piezometer
0
500
SCALE IN FEET
N
Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU62-PIA.dwg
Revised: 12/30/97
Source: JACOBS, 1996
SWMU 62
(Landfill No. 6)
Roaring Springs Road
Hale Drive
Phillips Circle
Ascot Drive

3.5.6 Mobilization

Mobilization to the field is expected to begin as soon as relevant portions of the WP are approved. Several basic requirements for conducting field activities have already been established. Contractor photographic identification badges have already been obtained for lead personnel who will escort subcontractors to and from restricted areas. Field equipment will be stored in the Former Radar Building 4100, atop SWMU 22, located at the west end of White Settlement Road. This area is surrounded by a fence that will restrict access and provide security for drilling rigs, associated support vehicles, and materials. During field activities, uncharacterized wastes will be containerized and stored within this fenced area for security. These materials will be segregated from existing materials already being stored at the site. Building 4100 will also provide work areas, a source of potable water for the decontamination of equipment, and electricity for the recharging of equipment. A designated decontamination pad will also be located within the fenced area surrounding Building 4100.

3.5.7 Aquifer Testing

Aquifer testing will not be conducted during this field effort. Existing aquifer data collected by Radian (1991) is sufficient for this study.

3.5.8 Geophysical Surveys

Two geophysical tools will be used during each survey. One tool will be used to evaluate electromagnetic induction (EM), and the other tool will be used to conduct a magnetometer/gradiometer survey. These surveys will be conducted to evaluate the extent of the former landfills by identifying where soils have been disturbed (i.e., anomalous lows) and "hot spots" caused by ferromagnetic constituents such as drums (i.e., anomalous highs). The EM surveys (20-foot grid) will be used to initially identify and pinpoint areas with conductivity contrasts; i.e., "hot spots." The EM surveys will measure the electrical response created by buried materials to identify waste locations. For example, a 55-gallon drum can provide a relatively high response of greater than 30 millisiemans per meter at depths of 10-15 feet below ground surface.

The 20-foot grid from the EM survey will be re-surveyed using a magnetometer/gradiometer for confirmation, as well as delineation of the lower extent of the SWMU. The magnetometer/gradiometer can detect variation in the subsurface by measuring the total field or earth's magnetic field vector and the magnetic vertical gradient.

Measured geophysical survey data can be plotted and contoured for analysis. Magnetic highs can indicate buried ferromagnetic materials while magnetic lows can indicate disturbed soils. The extent of the disturbed soils may indicate the boundary of the former landfill. This information will be used to assure that optimal installation of test pits and soil sampling locations are selected. Geophysical investigations will be conducted in accordance with Section 5.3 of the FSP. Resistivity surveys were not selected because they are labor and time intensive because they require physical placement of probes in the ground.

4.0 RISK ASSESSMENT

A brief description of the methods proposed for conducting human health and ecological risk assessment tasks is outlined in this section. Preliminary conceptual models have been developed to identify potential release and transport mechanisms, potential receptors, and exposure pathways associated with past disposal of debris and waste materials at the five landfills. The objective of the risk assessments is to characterize the potential risks associated with exposure to site media, and where the risks are unacceptable, to develop site-specific remediation goals protective of human health and the environment for use in the evaluation of remedial alternatives at the site.

4.1 HUMAN HEALTH RISK ASSESSMENT

The approach that will be used to assess human health risk at the five landfill sites is consistent with the USEPA's Risk Assessment Guidance for Superfund (RAGS) Volume 1: Human Health Evaluation Manual (Part A) and Development of Risk-based Preliminary Remediation Goals (B) (USEPA, 1989 and 1991) and TNRCC's Risk Reduction Program (31 TAC 335, Subchapter S) (TNRCC, 1996b). Additional guidance may include State of Texas guidance for the closure of municipal landfills under RCRA Subtitle D (30 TAC Chapter 33, Subchapter J).

The TNRCC approach consists of three Risk Reduction Standards (RRS). RRS1 is based on background concentration levels and will serve as an initial screen for NFA site closures. RRS2 allows closure and/or remediation to health risk-based standards and criteria which are based on default assumptions concerning potential exposures. RRS2 will be used as a secondary screen for NFA site closures. If detected concentrations at the investigated SWMUs exceed RRS1 and RRS2, site closure will proceed under RRS3.

4.1.1 Technical Approach

If site closure cannot be completed because site concentrations exceed RRS1 and RRS2, baseline risk assessments will be prepared which will consist of the following five steps:

1. Data evaluation and identification of constituents of potential concern
2. Exposure assessment
3. Toxicity assessment
4. Risk characterization
5. Development of site-specific remediation goals(i.e., media cleanup requirements for RRS3).

<u>Step 1: Data Evaluation and Identification of Chemicals of Potential Concern</u>

Data will first be evaluated to assess the achievement of data quality objectives for the project. The chemicals of potential concern (COPCs) will be those constituents detected in environmental media at the site at concentrations greater than background (RRS1)concentrations for metals, practical quantitation limits (PQLs) for organics and risk-based screening levels (RRS2). The COPCs will be identified in accordance with guidance provided by TNRCC and USEPA. The COPCs are expected to be primarily organic and metal compounds.

Step 2: Exposure Assessment

Exposure assessment estimates the magnitude, frequency, duration, and routes of exposure. An assessment may include current and future exposures. Exposure assessment involves three distinct processes: 1) characterizing the exposure setting, 2) identifying exposure pathways, and 3) quantifying exposure.

- **Characterizing the Exposure Setting.** This step characterizes the exposure setting in terms of physical characteristics of the site and populations that might be exposed. Physical characteristics include climate, vegetation, groundwater, and surface water hydrology. Population characteristics include the location of receptors, the presence of sensitive subpopulations, and activity patterns of current and future populations.

- **Identifying Exposure Pathways.** This step identifies potential exposure pathways with respect to nearby populations. Exposure pathways are determined by the locations of sources, types of release mechanisms, types of contaminants, fate and transport mechanisms, and the location and activities of the receptors.

- **Quantifying Exposures.** This process is conducted in two steps: 1) estimation of exposure concentrations, and 2) calculation of intakes. Exposure concentrations are based on analytical data from the site. Chemical intakes are expressed in terms of mass of chemical intake per day per unit body weight. Intakes are calculated using standard equations which represent specific exposure pathways. Parameters include exposure concentration, fraction ingested, contact rate, exposure duration and frequency, body weight, and averaging time.

Step 3: Toxicity Assessment

Toxicity assessment consists of two stages: hazard identification and dose-response assessment. Hazard identification evaluates whether or not a particular chemical can cause a particular health effect (such as cancer or birth defects) and if the adverse health effect occurs in humans. Hazard identification also evaluates the nature and strength of the evidence of causation. Dose-response assessment quantitatively evaluates toxicity information for the chemical to determine the relationship between the administered dose of the chemical to the incidence of a particular adverse effect in the exposed population. Toxicity values for carcinogens are expressed in units of cancer incidence per unit dose of the chemical; for noncarcinogens, the toxicity values are expressed in terms of a threshold value below which adverse effects are not expected to be observed.

The toxicity assessment will include an identification of critical toxicity values for the constituents of potential concern. A database search will be conducted to identify human and ecological toxicity values. The USEPA's Integrated Risk Information System database and Health Effects Assessment Summary Tables will serve as the primary sources of human health toxicity values. Additional toxicity data may be obtained through consultation with the TNRCC and USEPA's National Center for Environmental Assessment. Ecological toxicity and/or benchmark values will be derived from the TNRCC documents and from the available scientific literature.

Step 4: Human Health Risk Characterization and Uncertainty Analysis

The final stage of the BLRA process is risk characterization and uncertainty analysis. Therefore, the risk characterization step integrates information from the toxicity and exposure assessments to express risk quantitatively. Carcinogenic risk is calculated as the product of the chemical-specific slope factor and the chemical intake. The risk is expressed as a dimensionless number. Noncarcinogenic effects are expressed in terms of dimensionless numbers called hazard quotients. A hazard quotient is the ratio of the chemical intake and the chemical-specific reference dose. In the event that the receptor is exposed to multiple contaminants through multiple pathways, the combined risk (for carcinogens) and hazard indices (for noncarcinogens) are presented as the weak sums of individual risks and hazard quotients. An analysis of uncertainties associated with assumptions associated with the risk assessment will be presented.

Step 5: Development of Risk Reduction Standards

Following the risk assessments, constituents that have an associated unacceptable noncarcinogenic and/or carcinogenic risk to humans and ecological receptors will be further addressed. Site-specific risk reduction standards will be developed, based upon cumulative risk, for such constituents detected in accordance with TNRCC and USEPA guidelines.

4.2 ECOLOGICAL RISK ASSESSMENT

The ERAs will be conducted in accordance with the protocols presented in the TNRCC "Draft Guidance for Conducting Ecological Risk Assessments Under the Texas Risk Reduction Program" (TNRCC, 1996a). In particular, the TNRCC guidance suggests using a tiered approach for assessing ecological risks. It should be noted that, given the highly developed nature of the NAS Fort Worth JRB and surrounding areas, ecological impacts are not expected to be a primary issue at the base. The need for ERAs will be determined based on field observations and analytical results. ERAs may be required for closures under RRS2 and for all closures under RRS3.

As a first step, Tier 1 assessments (i.e., completing the ecological assessment checklist) will be conducted. Depending on the results of this first step, Tier II assessments (screening-level assessments) and/or Tier III assessments (quantitative assessments) may be conducted. If these subsequent tiers are undertaken, further information defining the methodologies and approaches to be used will be developed. In general, the overall strategy for conducting Tier II and Tier III ERAs will be consistent with the TNRCC guidance, the USEPA guidance document "Ecological Risk Assessment for Superfund: Process for Designing and Conducting Ecological Risk Assessments" (USEPA, 1996a), and the "Tri-Services Procedural Guidelines for Performing Ecological Risk Assessments" (DoD, 1996).

4.3 EXPOSURE SETTING

Individual SWMUs to be investigated during this RFI, and their associated potential release and transport pathways include the following:

- **SWMU 17** - This former landfill is approximately 3.4 acres in area and is currently vacant. The area is covered by various grasses and weeds that are not maintained. The surface of the site is also littered with small pieces of concrete, asphalt and rocks that have weathered through the soil cover. The area is surrounded to the west and south by a drainage ditch. The northern extent of the SWMU is not defined other than where ground maintenance begins. Potential contaminants that may have been released to the soil and underlying groundwater at this SWMU included metal and organic constituents. Unauthorized wastes that were discarded at this unit may include leftover paint containers and pesticide residues from runway maintenance and spent solvents from cleaning activities. The alluvial terrace groundwater may release contaminants to surface water in Farmers Branch Creek, two unnamed tributaries to Farmers Branch Creek and two ponds on the golf course.

- **SWMU 27** - This site consists of a ditch approximately 8 feet deep by 20 feet wide and 400 feet long. The ditch typically has approximately 4 to 5 feet of water during the winter months and usually dries out during the summer months due to evaporation and infiltration. The site is partially covered with vegetation. At least five drums of unknown content are currently present in the ditch and may have leaked contaminants to the local perched groundwater system, which may eventually percolate to the Paluxy aquifer. Potential contaminants, which may have been released to the soil and underlying groundwater at this SWMU, may include metals and organic constituents.

- **SWMU 29** - This inactive landfill is surrounded by an 8 foot chain link fence that provides security for Building 1055. This building occupies approximately one fourth of the 4.4 acre site. The remaining portion of the site is either occupied by temporary trailers or is grass-covered. Moderate quantities of unspecified hazardous wastes may be present in surface and subsurface soils. Migration pathways of potential site contaminants such as metals and organic compounds may be by way of leaching to a drainage ditch that parallels the southern border of the site or to the underlying groundwater.

- **SWMU 30** - This inactive landfill is approximately 1.7 acres and received construction debris in the form of concrete, asphalt, steel and wood. A ditch has been created by runoff from an upgradient parking area located adjacent to Building 2570. In this ditch, concrete, asphalt, telephone poles, and reinforcing steel are visible in the west bank. Given its proximity to industrial shops, this SWMU may have received limited amounts of hazardous materials such as thinners, solvents, and POLs. This area has not been previously investigated. The site is currently covered by vegetation, and current land use is limited to maintenance of the grass. The site is located near Building 2570 and is north of the West Fork of the Trinity River. A water line was recently installed across the eastern section of the site. Migration of potential contaminants may occur via leaching surface runoff and airborne redistribution of disturbed soils.

- **SWMU 62** - This inactive landfill is located between Roaring Springs Road and Haile Drive and is sparsely covered with vegetation. The site was identified in the PA/SI conducted by the USACE (1993) as a construction and debris landfill. It was documented that three drums of hydraulic fluid were placed in a centrally located pit, which collected groundwater that seeped into the landfill. Several stock piles of fill dirt containing concrete, asphalt, crushed 55 gallon drums, and wood have accumulated adjacent to the site. This appears to be the site's current unofficial purpose. Potential contaminants may have been released to soil and underlying groundwater at this SWMU. An initial site investigation was performed in 1993, which detected lead, BTEX constituents, and TRPH in soil and groundwater.

4.4 RECEPTORS AND EXPOSURE SCENARIOS

This section represents an overview of the receptors and the potential exposure scenarios for the subject sites. To the extent that in many cases current and future receptors are, in fact, likely to be the same, their risks are already being considered under the "current" scenario. The receptor exposure scenarios in the conceptual model include:

- **On-site Maintenance Worker Receptor** - This exposure assumes that a worker conducts activities on an intermittent or short term basis. Exposure routes for this receptor may include:

  - Incidental ingestion of surface soil
  - Inhalation of fugitive dusts and volatile organics from the surface soil
  - Dermal contact with surface soil
  - Dermal contact with surface water and sediments

- **On-site Worker** - This exposure assumes that a long-term employee is located at the site on a regular basis over their working career. Exposures for this receptor may include:

  - Incidental ingestion of surface soil
  - Inhalation of fugitive dusts and volatile organics from surface soil
  - Dermal contact with surface soil
  - Inhalation of volatile emissions in buildings which originated from soil

- **On-site Construction Worker** - This exposure assumes that construction will occur on the site in the future allowing for a short - duration exposure scenario. Exposures for this receptor may include:

  - Incidental ingestion of soil
  - Inhalation of fugitive dusts and volatile organics in soil
  - Dermal contact with soil or surface water

- **On-site Recreational Receptor** - This exposure assumes that the receptor (e.g., an older child or young adult) visits an area intermittently. This receptor would only be exposed to contaminants in surface water/sediments because the remaining units are secured due to military activities. The exposure routes evaluated for this receptor may include:

- Dermal contact and incidental ingestion of chemicals in the surface water and sediments

- **Future Off-site Resident Receptor** - This exposure assumes that the receptor obtains all household water from private wells. Currently, the alluvial terrace groundwater unit does not impact any private wells. Additionally, there is no certainty that any private wells will be impacted in the future. Complete exposure pathways for groundwater will be determined subsequent to the evaluation of groundwater fate and transport to be conducted as part of the RFI. If it is determined that a future exposure pathway is complete for groundwater, then the exposure routes evaluated for this receptor may include:

  - Ingestion of groundwater
  - Inhalation of volatiles from groundwater
  - Dermal contact with chemicals in the groundwater
  - Ingestion of home-produced foodstuffs including fruits and vegetables

- **Current and Future Ecological Receptors** - Exposures for these receptors may include:

  - Dermal contact with sediment and surface water
  - Ingestion of surface water
  - Incidental ingestion of sediments and soil
  - Dermal contact with soil

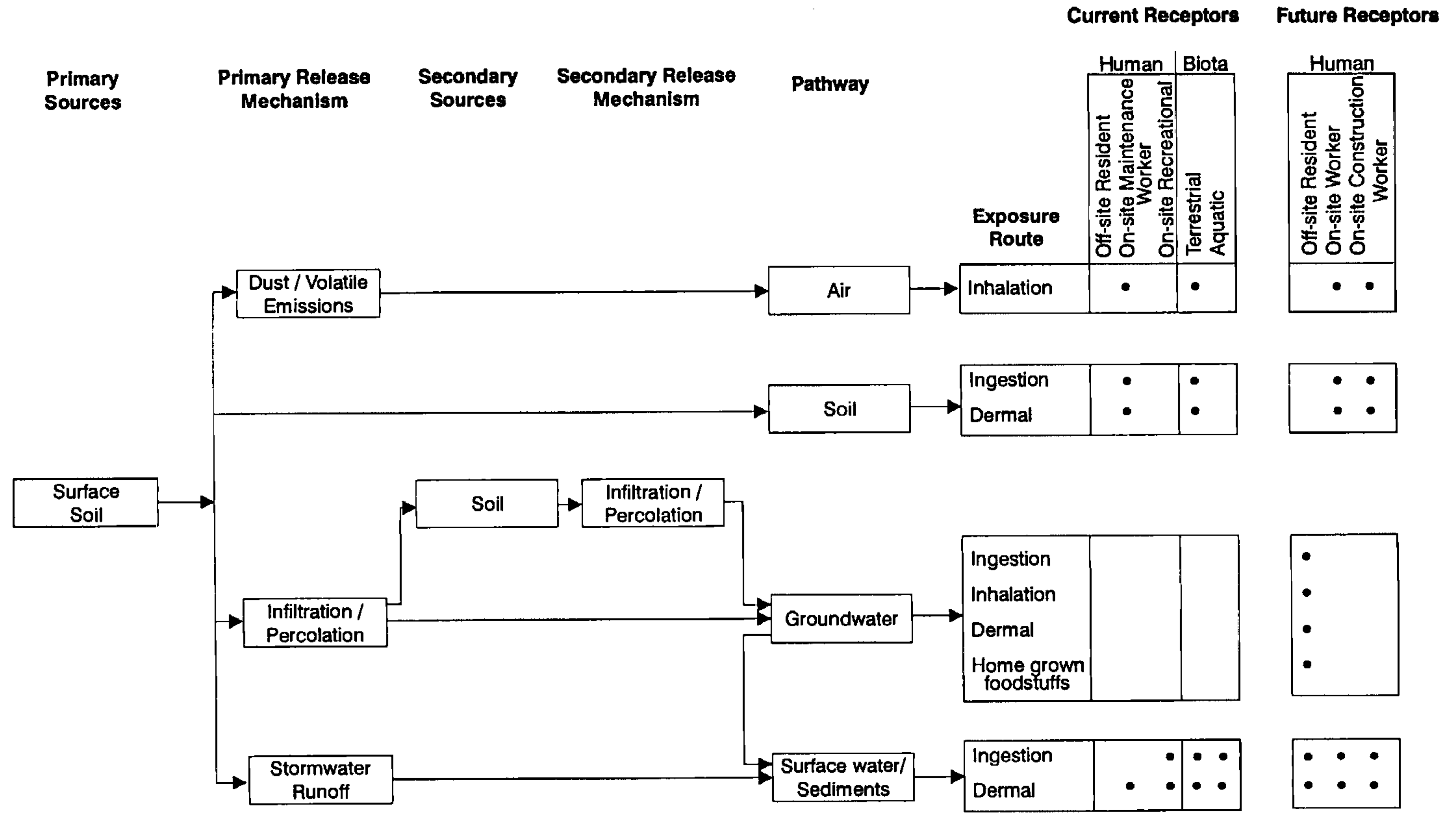
4.5 CONCEPTUAL SITE MODEL

The conceptual model provides a basis for identifying and evaluating the potential risks to human health in the BLRA. The conceptual model facilitates consistent and comprehensive evaluation of risks by creating a framework for identifying the paths by which humans and ecological receptors may be impacted by the subject SWMUs at NAS Fort Worth JRB.

The elements necessary to construct a complete exposure pathway and develop the conceptual model include:

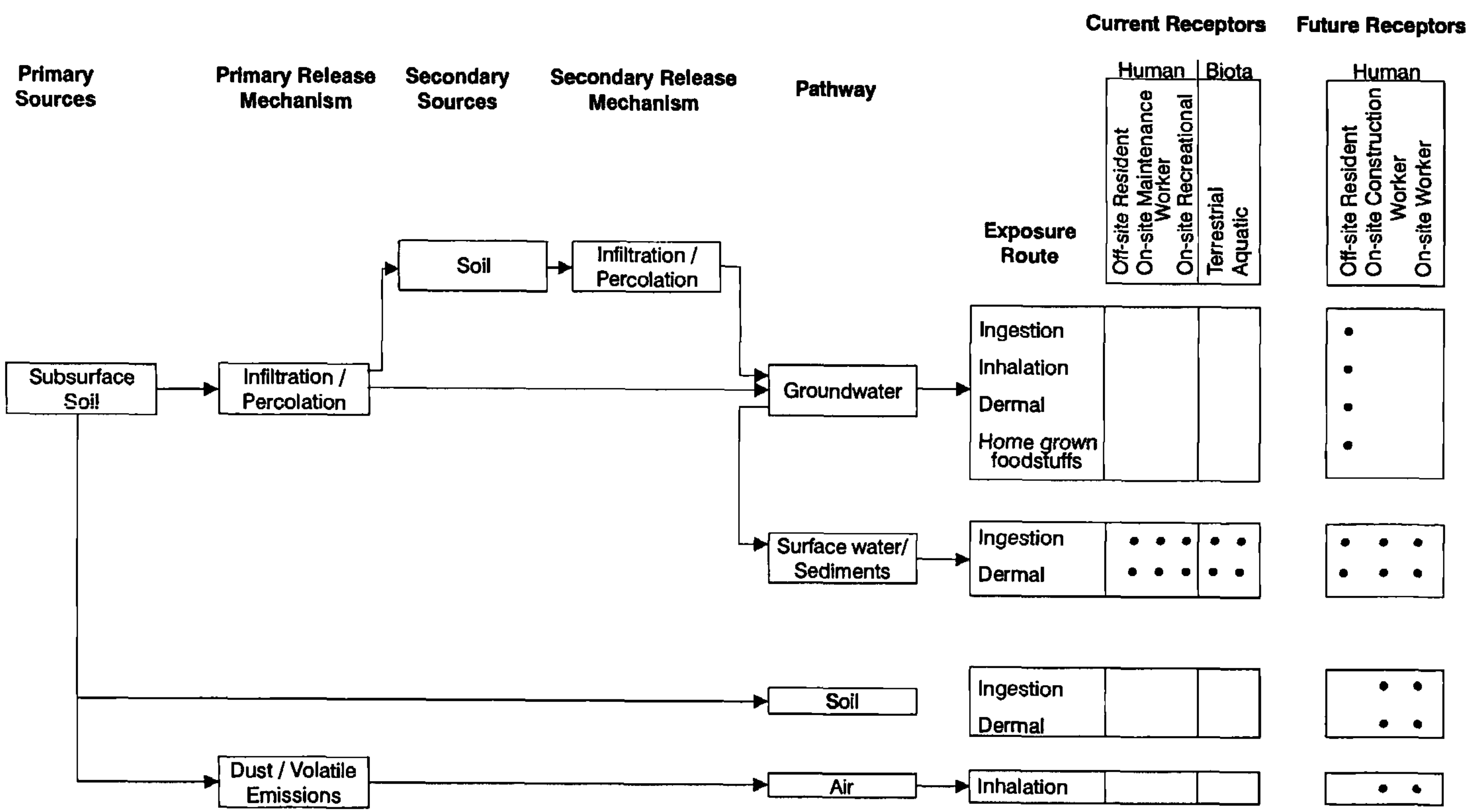
- Sources and COPCs
- Release mechanisms
- Transport pathways
- Exposure pathway scenarios
- Receptors

The conceptual site model for potential human environmental exposures to the soils, sediments, surface waters, and groundwater are summarized in Figures 4.1 and 4.2. Figure 4.1 pertains to exposure and risks to contaminants contained in surface soil, while 4.2 pertains to contaminants in subsurface soils. This separation is significant because certain release mechanisms, and corresponding exposure scenarios, such as exposure to dust and volatile emission from soil, are of concern only if contaminants are, in fact, present in surface soil. If surface soil sampling to be conducted during the RFI does not show the presence of contaminants in surface soil, these exposure pathway scenarios can accordingly be eliminated from the BLRA.



Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FLOWCHRT.CDR		

Figure 4.1
Conceptual Exposure Pathway Model for Surface Soil
NAS Fort Worth JRB, Texas



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Checked By: K. HURLEY	Date: 6/12/97		
Filename: FLOWCHRT.CDR			

Figure 4.2
Conceptual Exposure Pathway Model for Subsurface Soil NAS Fort Worth JRB, Texas

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5.0 REMEDIAL ACTION

If analytical results indicate contaminate levels above RRS1 or RRS2 cleanup levels, a Corrective Measures Study (CMS) will be required in accordance with 30 TAC 335 Subchapter S Risk Reduction Standards. The purpose of the CMS is to develop and evaluate remedial alternatives to reduce risks to human health and the environment to acceptable levels as required for closure under RRS3. A BLRA will be performed as part of the CMS to indicate unacceptable threats to human health or the environment. If the sites are closed under RRS1 or RRS2, then a CMS will not be required.

5.1 REMEDIAL ACTION OBJECTIVES

Specific response objectives will be developed using applicable laws, regulations and guidance, and risk-based methods to define media specific cleanup levels that would reduce risks to public health and the environment to acceptable levels. Potential contaminant migration pathways and exposure pathways will be examined as a basis for estimating acceptable on-site residual contamination levels. Media-specific cleanup levels will be applied at the SWMU source area/boundary. Development of the CMS objectives will also include refinement of the applicable laws, regulations, and guidance specific to NAS Fort Worth JRB.

5.2 REMEDIAL ALTERNATIVES

Based on the objectives detailed in this work plan, potential contaminated media, site contaminants per media, and a list of potential remedial alternatives have been developed and evaluated. Tables 5.1 and 5.2 summarize these alternatives for soil and groundwater, respectively. The alternatives that pass the initial screening process will be further evaluated and compared.

The listed remedial technologies and alternatives will be screened to eliminate from further consideration technologies and alternatives that are undesirable regarding implementability, effectiveness, and cost. The list of alternatives being considered will be narrowed by eliminating the following types of technologies:

- Technologies and alternatives that are not effective because they do not provide for the overall protection of human health and the environment, or do not comply with applicable laws, regulations or guidance.

- Technologies and alternatives that are not implementable or technically inapplicable.

- Technologies/alternatives that are more costly than other technologies/alternatives, but do not provide greater environmental or public health benefits, reliability, or a more permanent solution. Costs alone will not be used to eliminate technologies, but may be used to select representative process options.

For each alternative that warrants further investigation, detailed documentation will be included to evaluate compliance with each of the objectives listed below.

Table 5.1
Technology Types and Process Options for Soil/Sediment
NAS Fort Worth JRB, Texas

General Response Action	Technology Type	Process Options	Description	Comments
No-Action	None	Not Applicable	No-Action	Required to be retained by NCP
Institutional Controls	Access Restrictions	Access Restrictions	Physical limitations to prevent access to land and groundwater	Potentially applicable; retained for further consideration
		Deed Restrictions	Limiting land and groundwater use by subsequent owners	Potentially applicable; retained for further consideration
Containment	Barriers	Grout Curtains	Tubes of grout surround the contaminated area	Not applicable; does not control exposure pathways
		Slurry Walls	Inject clay slurry in continuous trench around contamination	Not applicable; does not control exposure pathways
		Sheet Piling	Driving interlocking steel walls around contamination	Not applicable; does not control exposure pathways
	Capping	Asphalt, clay, concrete, synthetic	Install near-impermeable cover to prevent infiltration to prevent contaminant movement	Potentially applicable
Treatment	Physical	Vapor Extraction	Extracting VOCs from the soil by creating a vacuum	Potentially applicable to VOC contamination
	Chemical	Soil Mixing	Use augers to mix in stabilizing chemicals	Not applicable for organic contaminants
		Soil Washing	Removing contaminants by adding solvents, surfactants to soil	Potentially applicable
		Immobilization	Using cement grout to immobilize contaminated soil	Questionable for organics; requires extensive testing
	Thermal	Incineration	Destroys organic contaminants	Potentially applicable

Table 5.1 (continued)
Technology Types and Process Options for Soil/Sediment
NAS Fort Worth JRB, Texas

General Response Action	Technology Type	Process Options	Description	Comments
Treatment (cont)	Thermal	Low temperature thermal oxidation	Drives off organic contaminants	Potentially applicable
	Biological	Aerobic	Microorganisms metabolize organic contaminants	Not applicable; difficult to implement in heterogeneous sites such as landfills
		Anaerobic	Microorganisms metabolize organic contaminants	Not applicable; difficult to implement in heterogeneous sites such as landfills
Removal/Disposal	Excavation	Excavation	Removing contaminated soil from area	Potentially applicable for both organic and inorganic contamination
	Disposal	On-site Disposal	Creating RCRA landfill and placing contaminated soil in the landfill, or placing non-RCRA soil and sediment at existing landfill	New RCRA landfill not allowed by Air Force regulations; not applicable. Disposal of non-RCRA soil at existing site may be applicable
		Off-site Disposal	Sending waste to RCRA approved landfill if it meets BDAT regulations	Potentially applicable

Table 5.2
Technology Types and Process Options for Groundwater
NAS Fort Worth JRB, Texas

General Response Action	Technology Type	Process Options	Description	Preliminary Screening Comments
No Action	None	Not Applicable	No actions to remove contamination or sever the exposure pathway	Required for consideration by the NCP as a baseline comparison
Institutional Controls	Access Restrictions	Access Restrictions	Physical limitations to prevent access to land and groundwater	Potentially applicable; retained for further consideration
		Deed Restrictions	Limiting land and groundwater use by subsequent owners	Potentially applicable; retained for further consideration
	Monitoring	Monitoring	Water monitoring using existing wells	Potentially applicable; retained for further consideration
Containment	Physical Containment: Barriers	Sheet Piling	Driving interlocking steel walls around contamination	Subject to corrosion; difficult to install with fill; cobbles in soil; not applicable
		Slurry Walls	Inject clay slurry in continuous trench around contamination	Potentially applicable; retained for further consideration
	Capping	Asphalt, Clay, Concrete, Synthetic	Install impermeable cover to prevent infiltration and contaminant movement	Potentially applicable; retained for further consideration
Collection/ Treatment/Disposal	Collection Technologies:	Vertical wells	Pump contaminated groundwater using vertical wells to remove contaminants from the aquifer	Potentially applicable to the uppermost groundwater
		Horizontal wells	Pump contaminated groundwater using horizontal wells to remove contaminants from the aquifer	Potentially applicable to the uppermost groundwater

Table 5.2 (continued)
Technology Types and Process Options for Groundwater
NAS Fort Worth JRB, Texas

General Response Action	Technology Type	Process Options	Description	Preliminary Screening Comments
Collection/ Treatment/Disposal (cont)	Groundwater extraction	Interceptor trench	Intercept dissolved contaminants in the subsurface	Potentially applicable to the uppermost groundwater
	Treatment technologies: Physical treatment	Air stripping	Remove dissolved volatile organics from groundwater with air	Potentially applicable to the uppermost groundwater
		Carbon adsorption	Adsorb dissolved organic compounds onto granulated carbon	Potentially applicable to the uppermost groundwater
		Oil/water separation	Separate emulsified, floating or sinking oils from water	Potentially applicable to the uppermost groundwater
	Chemical Treatment	UV/oxidation	Use ultraviolet light with ozone or hydrogen peroxide to destroy contaminants	Potentially applicable to the uppermost groundwater
		Fenton-like chemistry	Use Fenton-like chemistry to generate hydroxyl radicals to cleave organic bonds	New technology; Potentially applicable to uppermost groundwater
	Biological treatment	Ex-situ bioremediation	Use microorganisms to destroy or alter contaminants	Not reliable for chlorinated compounds; not considered
		In-situ bioremediation	Use microorganisms to destroy or alter contaminants	Not considered because still in the development stage for chlorinated hydrocarbons
		In-situ phytoremediation	Use plants to destroy or alter contaminants	Potentially applicable for Alluvial Terrace Groundwater

Table 5.2 (continued)
Technology Types and Process Options for Groundwater
NAS Fort Worth JRB, Texas

General Response Action	Technology Type	Process Options	Description	Preliminary Screening Comments
Collection/ Treatment/Disposal (cont)	In-situ treatment	Air sparging	Pump air into aquifer, volatilize dissolved organics	Difficult to control in heterogeneous media; could spread contamination; not considered
	Discharge technologies: On-site Discharge	Discharge to surface water	Discharge treated water to local surface water	Potentially applicable for the uppermost groundwater
	Off-site Discharge	POTW	Send water to an off-site treatment facility	Potentially acceptable

- Compliance with other laws and regulations
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Short-term effectiveness
- Implementability
- Cost

To the extent possible, remedial alternatives that use permanent solutions and alternative treatment technologies will be considered. Tables 5.3 and 5.4 summarize the remedial alternatives for each SWMU in this investigation.

5.3 RECOMMENDED FINAL CORRECTIVE MEASURE ALTERNATIVE

For each alternative that warrants further investigation, detailed documentation will be included to evaluate compliance with each of the objectives listed below.

- Overall protection of human health and the environment
- Compliance with media cleanup standards
- Control the source of release
- Compliance with any applicable standards for management of wastes
- Long-term reliability and effectiveness
- Reduction in mobility, toxicity, or volume of wastes
- Short-term effectiveness
- Implementability
- Cost

To the extent possible, remedial alternatives that use permanent solutions and alternative treatment technologies will be considered.

Table 5.3
Soil Remedial Alternatives and Data Needs
NAS Fort Worth JRB, Texas

SWMU	Materials Received/ Current Status	General Response Action	Remedial Alternative	Data Needs
17	Construction waste and rubble; possibly small amounts of hazardous wastes. Inactive; no evidence of releases.	No Action	Not Applicable	• level of and type of contamination • level of groundwater • future level use • extent of contamination
		Containment	Capping	
		Treatment	Vapor Extraction	
			Soil Washing	
			Incineration	
		Removal/Disposal	Excavation	
			Off-site Disposal	
27	Concrete rubble, tree limbs, and street sweeping debris. Active for street debris disposal.	No Action	Not Applicable	• level of and type of contamination • level of groundwater • future level use • extent of contamination
		Containment	Capping	
		Removal/Disposal	Excavation	
			Off-site Disposal	
29	Construction rubble and materials, moderate quantities of unspecified hazardous wastes. Inactive (partially covered by B1055); no evidence of releases.	No Action	Not Applicable	• level of and type of contamination • level of groundwater • future level use • extent of contamination
		Treatment	Vapor Extraction	
			Soil Washing	

Table 5.3 (continued)
Soil Remedial Alternatives and Data Needs
NAS Fort Worth JRB, Texas

SWMU	Materials Received/ Current Status	General Response Action	Remedial Alternative	Data Needs
30	Construction rubble and trees; possibly small amounts of hazardous materials. Inactive; no data found.	No Action	Not Applicable	• level of and type of contamination • level of groundwater • future level use • extent of contamination
		Containment	Capping	
		Treatment	Vapor Extraction	• level of and type of contamination • level of groundwater • future level use • extent of contamination
			Soil Washing	
			Incineration	
		Removal/Disposal	Excavation	
			Off-site Disposal	
62	Construction rubble, drums of hydraulic fluid, and small quantities of hazardous materials. Inactive (Navy uses for soil stockpiles).	No Action	Not Applicable	• level of and type of contamination • level of groundwater • future level use • extent of contamination
		Containment	Capping	
		Treatment	Vapor Extraction	
			Soil Washing	
			Incineration	
		Removal/Disposal	Excavation	
			Off-site Disposal	

Sources: CH2M HILL, 1996b.
Carswell AFB Management Action Plan, October 1993.
RCRA Facility Investigation Statement of Work, January 1997.

Table 5.4
Groundwater Remedial Alternatives and Data Needs
NAS Fort Worth JRB, Texas

SWMU	Materials Received/ Current Status	General Response Action	Remedial Alternative	Data Needs
17	Construction waste and rubble; possibly small amounts of hazardous wastes. Inactive; no evidence of releases.	No Action	Not Applicable	• level of and type of contaminant • level of groundwater • future land use • yield of aquifer • presence of NAPL • location of contaminant • groundwater flow direction • seasonal variation • extent of contamination
		Institutional Controls	Monitoring	
		Collection, Treatment, and Disposal	Air Stripping	
			Carbon Adsorption	
			Oil/water Separation	
			UV/oxidation	
			POTW (on/off site)	
27	Concrete rubble, tree limbs, and street sweeping debris. Active for street debris disposal.	No Action	Not Applicable	• level of and type of contaminant • level of groundwater • future land use • yield of aquifer • presence of NAPL • location of contaminant • groundwater flow direction • seasonal variation • extent of contamination
		Institutional Controls	Monitoring	
		Collection, Treatment, and/or Disposal	Air Stripping	
			Carbon Adsorption	
	Construction rubble and materials, moderate quantities of unspecified hazardous wastes. Inactive (partially covered by B1055); no evidence of releases.		Oil/water Separation	
			UV/oxidation	
			POTW (on/off site)	

Table 5.4 (continued)
Groundwater Remedial Alternatives and Data Needs
NAS Fort Worth JRB, Texas

SWMU	Materials Received/ Current Status	General Response Action	Remedial Alternative	Data Needs
29	Construction rubble and trees; possibly small amounts of hazardous materials. Inactive; no data found.	No Action	Not Applicable	• level of and type of contaminant • level of groundwater • future land use • yield of aquifer • presence of NAPL • location of contaminant • groundwater flow direction • seasonal variation • extent of contamination
		Institutional Controls	Monitoring	
		Collection, Treatment, and Disposal	Air Stripping	
			Carbon Adsorption	
			Oil/water Separation	
			UV/oxidation	
			POTW (on/off site)	• level of and type of contaminant • level of groundwater • future land use • yield of aquifer • presence of NAPL • location of contaminant • groundwater flow direction • seasonal variation • extent of contamination

Table 5.4 (continued)
Groundwater Remedial Alternatives and Data Needs
NAS Fort Worth JRB, Texas

SWMU	Materials Received/ Current Status	General Response Action	Remedial Alternative	Data Needs
30	Construction rubble, drums of hydraulic fluid, and small quantities of hazardous materials. Inactive (Navy uses for soil stockpiles).	No Action	Not Applicable	• level of and type of contaminant • level of groundwater • future land use • yield of aquifer • presence of NAPL • location of contaminant • groundwater flow direction • seasonal variation • extent of contamination
		Institutional Controls	Monitoring	
		Collection, Treatment, and Disposal	Air Stripping	
			Carbon Adsorption	
			Oil/water Separation	
			UV/oxidation	
			POTW (on/off site)	
62	Construction waste and rubble; possibly small amounts of hazardous wastes. Inactive; no evidence of releases.	No Action	Not Applicable	• level of and type of contaminant • level of groundwater • future land use • yield of aquifer • presence of NAPL • location of contaminant • groundwater flow direction • seasonal variation • extent of contamination
		Institutional Controls	Monitoring	
		Collection, Treatment, and Disposal	Air Stripping	
			Carbon Adsorption	
			Oil/water Separation	
			UV/oxidation	
			POTW (on/off site)	

Sources: CH2M HILL, 1996b.
Carswell AFB Management Action Plan, October 1993.
RCRA Facility Investigation Statement of Work, January 1997.

5.3.1 Overall Protection of Human Health and the Environment

Alternatives must adequately protect human health and the environment from unacceptable risks posed by hazardous substances, pollutants, or contaminants present at the site by eliminating, reducing, or controlling exposures to contamination. Overall protection of human health and the environment draws on the assessments of other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with applicable laws, regulations and guidance.

5.3.2 Compliance with Media Cleanup Standards

Alternatives will be assessed to determine whether they will reduce contaminant concentrations to levels below media specific cleanup standards as derived using 30 TAC 335 Risk Reduction Standards. Alternatives will also be assessed as to whether they meet legally applicable or relevant and appropriate requirements, or other federal and state environmental and public health laws and guidance. ARARs for this project were discussed in Section 3.0 of this WP.

5.3.3 Control the Source of Release

The source of the contamination at each of the SWMUs will be confirmed during the RFI process. Remedial alternatives to control future releases from these sources will be evaluated and included in the selected remedial alternative.

5.3.4 Compliance with Applicable Standards for Management of Wastes

A discussion will be included in the CMS pertaining to implementation of waste management activities associated with remedial alternatives. Factors that may affect the waste management activities may include evaluating the effect that closure regulations and land disposal restrictions may have on the selected remedial alternative.

5.3.5 Long-term Reliability and Effectiveness

Alternatives will be assessed for long term effectiveness, permanence, and degree of remedial success. Each technology will be evaluated for the potential deterioration over time and the impact this may have on receptors.

5.3.6 Reduction in Mobility, Toxicity, or Volume of Wastes

The degree to which the corrective measure alternatives employ treatment that reduces toxicity, mobility, or volume will be evaluated. The evaluation will focus on the following specific factors for each potential corrective measures alternative:

- The treatment process and the materials it will treat
- The amount of hazardous material that will be destroyed or treated
- The degree to which the treatment will be irreversible

- The type and quantity of treatment residuals that will remain following treatment
- Whether the alternative would satisfy the statutory preference for treatment as a principal element.

5.3.7 Short-term Effectiveness

The effectiveness of the alternatives will be evaluated to determine their impact on human health and the environment during the period in which the remedial alternative is being constructed and implemented and until the cleanup criteria are met. Factors to be addressed in evaluation of short term effectiveness include:

- Protection of human health and the environment during the remedial action, including such factors as exposure to dust during construction and potential exposure during transportation.
- Protection of workers during the remedial alternative implementation.
- Evaluation of the impact caused to the environment from the implementation of the remedial action.
- Time required to reach the remedial alternative objectives.

5.3.8 Cost

For each alternative, the cost will be estimated within a range of generally -30 percent to + 50 percent. The cost analysis will include separate derivations developed for capital costs, operation and maintenance (O&M) costs, costs of 5 year reviews, net present value of capital and O&M costs, and potential future remedial actions.

6.0 DATA ASSESSMENT, RECORDS, AND REPORTING REQUIREMENTS

The following sections provide an explanation for procedures that are used in the verification and maintenance of data, and how data will be reported throughout the course of the investigation.

6.1 DATA ASSESSMENT

The project chemist will review all data received from the laboratory. This review consists of the following:

- Sample analysis completeness - Were all samples analyzed? Were samples analyzed for the parameters listed in the Work Plans?
- Evaluation of holding times - Were samples analyzed within the specified holding and extraction times?
- Evaluation of quality control - Were standard curves within method control limits? Were preparation and method blanks contaminated? Were continuing calibration standards in control? Were matrix spikes and matrix spike duplicates performed? How did field duplicates compare? Were corrective actions taken?
- Establishment of detection limits - Were detection limits met? If not, why?

The project chemist utilizes Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analysis (EPA, 1988) and National Functional Guidelines for Organic Data Review (EPA, 1991 - Draft) as guidance documents to data validation.

In general, for the Gas Chromatograph (GC), an initial 5-point calibration must exhibit RF of less than 20 percent RSD, or a calibration curve with a correlation coefficient of greater than 0.995, and the continuing calibration check standard should not vary over 15 percent of the initial calibration. Retention time windows must be established for each specific GC column initially, followed by daily retention time windows. Quality control check standards must be analyzed for every analytical batch, method blanks for every analytical batch, and an MS/MSD pair for every 20 samples. Surrogates must be added to all standards, blanks, and samples.

If any data points are qualified, they will receive the data qualifiers described on Table 8.2-1 of the Base-Wide QAPP (HydroGeoLogic, Feb. 1998). The data associated with compounds/analytes which exhibit either poor response, poor percent difference or relative percent difference in the initial calibration or continuing calibration standards, or poor recoveries in the Laboratory Control Sample (LCS) are considered quantitative estimates and are flagged (J, UJ, or R) accordingly. If the Internal Standard (IS) or surrogate fails criteria (after corrective action was taken, compounds associated with the IS or surrogates would be flagged (J, UJ, or R) as estimated. If sample analysis exceeded holding times, the data would be flagged as estimated (J, UJ, or R). If the method blank was contaminated with common laboratory chemicals or field contamination, any result less than or equal to ten times that found in the blank would be flagged as estimated (U) (for common organics, less than or equal to five times for uncommon organics and for any inorganics). When data exhibit several deficiencies resulting in poor QA/QC support, then the data is rejected, considered unusable and flagged with an "R". Any MS/MSD data would be reviewed separately and qualified based on all the data available. Estimated data is not necessarily unusable data. All project-wide precision, accuracy, and completeness goals will be reviewed, and the data will be validated subject to these goals. If these goals are not met, resampling and analysis may be necessary.

The project chemist also reviews the field and office sampling records made during sample collection along with the results from the field QC samples. This review consists of the following:

- Field record completeness: Were all field analysis performed as planned? Were all field samples collected per the Work Plans? Were any problems encountered and how were they resolved? Were all field records complete?

- Sampling and decontamination procedures review: Were all field duplicates collected? How did they compare? Were all rinsates collected? Did these rinsates show contamination? Were the trip blanks contaminated? Did samples arrive intact and in proper shipping protocol?

- Identification of valid samples: Were samples collected using the proper protocol? Were there probable sources of potential contamination during sampling?

- Correlation of field test data and identification of anomalous field test data: Did different methods of measurements for the same test correlate?

Review of the results of the field QC data such as rinsates, trip blanks, and duplicates can help in assessing sample integrity. The field data and laboratory data will be reviewed and evaluated to the established data quality objectives. Data quality evaluations will be performed on all NAS Fort Worth Joint Reserve Base samples (100 percent). However, formal data validation will only be conducted on ten percent of the samples collected from each media of concern during this investigation.

6.2 RECORD KEEPING

Records of field and laboratory activities will be documented on standard forms (Section 8.0 of the FSP) as noted in the accompanying FSP. Project data such as geophysical surveys, groundwater level measurements, boring logs, survey data, well construction forms, chain-of-custody forms, and equipment calibration logs will be reviewed for accuracy and completeness. These documents will be reviewed by the Project Manager daily and retained in the project files.

6.3 REPORTING REQUIREMENTS

6.3.1 RCRA Facility Investigation

The primary report of the project will be the RFI based on the investigation and reporting requirements of the NAS Fort Worth HW-50289 permit. Four copies of the Final Soils and

Groundwater report will be submitted along with the RCRA Facility Investigation report as required by Provision VIII.D of the HW-50289 permit within 60 days of the completion of the RFI.

The report will characterize the environmental conditions at each site, check each sample package for completeness and quality, evaluate data from each site, and recommend a future course of action for each site. Each site potentially has one of three recommended future courses: no action, further investigation, or advancement to a Corrective Measures Study (CMS).

If the SWMU cannot attain closure/remediation under RRS1 or RRS2, then a CMS will be required. Sites continuing to the CMS will be screened for potential remedial alternatives. One alternative will be selected and proposed as the remedial action to be conducted at the site.

6.3.2 Corrective Measures Study (CMS)

The purpose of the CMS is to develop and evaluate potential remedial alternatives and to propose the appropriate corrective measure. An evaluation of the risk to human health and the environment will be evaluated in the CMS based on the results of the RFI. The corrective action which best reduces the risks to human health and the environment to acceptable levels will be proposed.

6.3.3 Corrective Measures Implementation Plan (CMI)

A Corrective Measures Implementation Plan (CMI) will be submitted for sites where the RFI results indicate that remediation is warranted. The CMI work plan details the specific activities that will be undertaken to implement the remedial action. The remedial action alternative selected for an individual site will be based on the alternatives presented in the CMS. The recommendation presented will include preliminary designs, site specific drawings, cost estimates and schedules for the remedial action. The CMI work plan may be submitted paired with a CMS, or the CMS and CMI may be submitted separately.

6.3.4 Decision Documents

If a release of hazardous constituents was not identified at a SWMU, or if the nature and extent of contamination has been defined and the site has attained closure/remediated to RRS No. 1 or RRS No. 2 levels, then the RFI report would serve the purpose of the NFA report (e.g., NFA decision document).

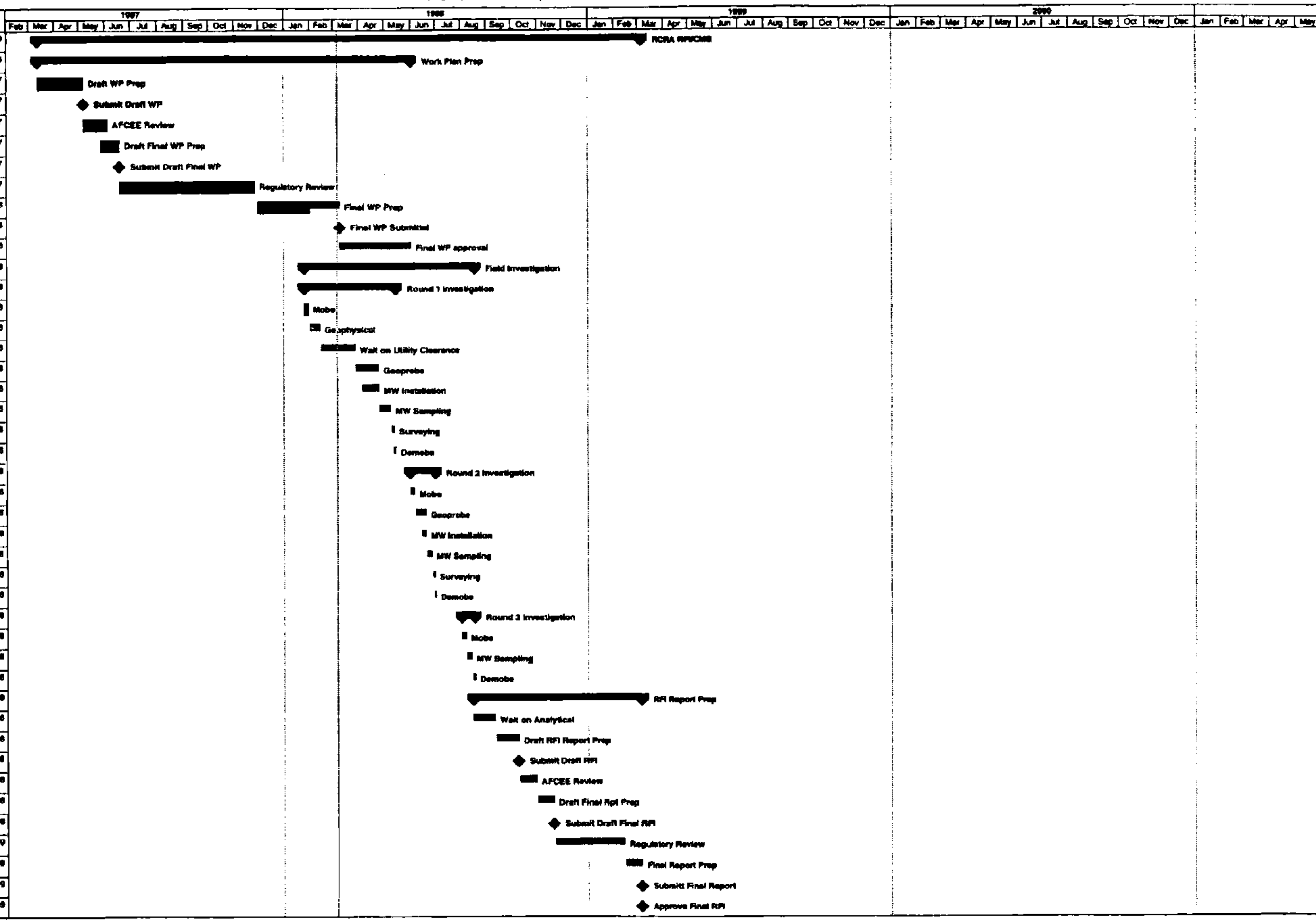
7.0 PROJECT SCHEDULE AND REFERENCES

The activities described in this WP will be implemented in accordance with the schedule provided in Figure 7.1. The starting date for the field effort will be the date of agency concurrence of the relevant portions of the WP. If possible, this schedule will be accelerated with select activities (e.g., procurement of materials and supplies) occurring when resolution of significant technical issues is made between NAS Fort Worth JRB and regulatory agencies.

Schedule as of 3/6/98

Figure 7.1
Project Schedule RFI at Landfills
NAS Fort Worth JRB, Texas

ID	Task Name	Duration	Start	Finish
1	RCRA RFI/CMS	[illegible]	3/12/97	3/5/99
2	Work Plan Prep	310d	3/12/97	6/1/98
3	Draft WP Prep	40d	3/12/97	5/6/97
4	Submit Draft WP	0d	5/6/97	5/6/97
5	AFCEE Review	20d	5/7/97	6/4/97
6	Draft Final WP Prep	15d	5/29/97	6/18/97
7	Submit Draft Final WP	0d	6/18/97	6/18/97
8	Regulatory Review	112d	6/19/97	11/26/97
9	Final WP Prep	69d	12/1/97	3/9/98
10	Final WP Submittal	0d	3/9/98	3/9/98
11	Final WP approval	60d	3/10/98	6/1/98
12	Field Investigation	147d	1/26/98	8/18/98
13	Round 1 Investigation	79d	1/26/98	5/14/98
14	Mobe	5d	1/26/98	1/30/98
15	Geophysical	10d	2/2/98	2/13/98
16	Wait on Utility Clearance	30d	2/13/98	3/27/98
17	Geoprobe	20d	3/30/98	4/24/98
18	MW Installation	15d	4/6/98	4/24/98
19	MW Sampling	10d	4/27/98	5/8/98
20	Surveying	2d	5/11/98	5/12/98
21	Demobe	2d	5/13/98	5/14/98
22	Round 2 Investigation	23d	6/1/98	7/1/98
23	Mobe	5d	6/1/98	6/5/98
24	Geoprobe	10d	6/8/98	6/19/98
25	MW Installation	5d	6/15/98	6/19/98
26	MW Sampling	5d	6/22/98	6/26/98
27	Surveying	2d	6/29/98	6/30/98
28	Demobe	1d	7/1/98	7/1/98
29	Round 3 Investigation	12d	8/3/98	8/18/98
30	Mobe	5d	8/3/98	8/7/98
31	MW Sampling	5d	8/10/98	8/14/98
32	Demobe	2d	8/17/98	8/18/98
33	RFI Report Prep	146d	8/17/98	3/5/99
34	Wait on Analytical	20d	8/17/98	9/11/98
35	Draft RFI Report Prep	20d	9/14/98	10/9/98
36	Submit Draft RFI	0d	10/9/98	10/9/98
37	AFCEE Review	15d	10/12/98	10/30/98
38	Draft Final Rpt Prep	15d	11/2/98	11/20/98
39	Submit Draft Final RFI	0d	11/20/98	11/20/98
40	Regulatory Review	60d	11/23/98	2/12/99
41	Final Report Prep	15d	2/15/99	3/5/99
42	Submit Final Report	0d	3/5/99	3/5/99
43	Approve Final RFI	0d	3/5/99	3/5/99



Project: D.O. 5 Schedule | Task Schedule | Task Summary | Milestone Task ◆ | Task Progress

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TAB

Field Sampling Plan

FINAL
FIELD SAMPLING PLAN

RCRA FACILITY INVESTIGATION OF LANDFILLS
NAS FORTH WORTH JRB, TEXAS

Contract Number F41624-95-D-8005

Prepared for:

U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

Prepared by:

HydroGeoLogic, Inc.
1155 Herndon Parkway, Suite 900
Herndon, VA 20170

March 1998

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PREFACE

This document is part of the Work Plan for a Resource Conservation Recovery Act (RCRA) Facility Investigation (RFI) at five Solid Waste Management Units (SWMUs) at Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), Texas. The investigation is being conducted as part of the United States Air Force Installation Restoration Program (USAF IRP). This work is authorized as Delivery Order 0005 under Air Force Center for Environmental Excellence (AFCEE) Contract No. F41624-95-D-8005. The Work Plans consist of a Work Plan (WP), a Field Sampling Plan (FSP), and a Health and Safety Plan (HSP). The FSP describes in detail the proposed sampling and analysis and the specific procedures, measurements, and record keeping requirements for the field effort.

HydroGeoLogic's Program Manager, Mr. John Robertson, will be responsible for reviewing and approving this FSP. The Project Manager, Mr. James Costello, will be the prime point of contact with NAS Fort Worth JRB and AFCEE and will be responsible for technical, budget, and scheduling associated with this FSP. Quality Assurance, Laboratory, Technical, and Safety and Health Professionals will be responsible for maintaining a high degree of quality control for their associated tasks performed as part of the FSP and HydroGeoLogic's(1998) Base-wide Quality Assurance Project Plan (QAPP).

Mr. Joseph Dunkle, AFCEE/ERD, the Contractor Officer Representative for this scope of work, will be HydroGeoLogic's sole point of contact. The activities described in this FSP will begin after the date of agency concurrence on relevant portions of the FSP to Mr. Dunkle. Field investigative activities are tentatively scheduled to begin in February 1998, and should be completed by July 1998. Laboratory results for soil samples and the first round of groundwater samples collected during the investigation should be available by April 1998.

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FINAL
FIELD SAMPLING PLAN

NAS FORT WORTH JRB
AND
AIR FORCE CENTER
FOR ENVIRONMENTAL EXCELLENCE

Preparer: ______________________________ Date: ________

Approved: ______________________________ Date: ________
Prime Contractor QA/QC Manager

Approved: ______________________________ Date: ________
Prime Contractor Project Manager

Approved: ______________________________ Date: ________
Applicable Subcontractor(s)

Approved: ______________________________ Date: ________
Applicable State and Federal Regulatory Agencies

Approved: ______________________________ Date: ________
Applicable State and Federal Regulatory Agencies

Approved: ______________________________ Date: ________
AFCEE Team Chief

Contract Number F41624-95-D-8005/0005

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LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFBCA	Air Force Base Conversion Agency
AFBRCA	Air Force Base Realignment and Closure Agency
AFCEE	U.S. Air Force Center for Environmental Excellence
AFP-4	Air Force Plant 4
ARARs	Applicable Relevant and Appropriate Regulations
ASTM	American Society for Testing and Materials
bgs	below ground surface
BLRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure
°C	Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMS	Corrective Measures Study
COC	Chain-of-Custody
Cs	Cesium
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Dissolved Oxygen
DoD	Department of Defense
DOT	Department of Transportation
EC	Electrical Conductivity
EM	Electromagnetic Induction
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
Fe	Iron
FID	Flame Ionization Detector
FS	Feasibility Study
FSP	Field Sampling Plan
g	Gammas
GPR	Ground Penetrating Radar
HSC	Health and Safety Coordinator
HSP	Health and Safety Plan
IAW	In Accordance With
IDW	Investigation Derived Waste
IRP	Installation Restoration Program

LIST OF ACRONYMS AND ABBREVIATIONS

IRPIMS	Installation Restoration Program Information Management System
JRB	Joint Reserve Base
KCl	Potassium Chloride
kHz	kiloHertz
L	Liter
LF-02	Landfill No. 2 (a.k.a. SWMU 29)
LF-04	Landfill No. 4 (a.k.a. SWMU 22)
LF-05	Landfill No. 5 (a.k.a. SWMU 23)
LF-06	Landfill No. 6 (a.k.a. SWMU 62)
LF-07	Landfill No. 7 (a.k.a. SWMU 17)
LF-09	Landfill No. 9 (a.k.a. SWMU 30)
LF-10	Landfill No. 10 (a.k.a. SWMU 27)
LNAPL	Light Non-Aqueous Phase Liquid
mL/L	milliliters per Liter
nT	nanoTesla
NAS	Naval Air Station
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
NTU	Nephelometric Turbidity Unit
OD	Outside Diameter
ORP	Oxidation-Reduction Potential
OSHA	Occupational Safety and Health Administration
OVA	Organic Vapor Analyzer
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated biphenol
PID	Photoionization Detector
PM	Project Manager
POLs	Petroleum, Oil and Lubricants
PVC	Polyvinyl Chloride
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation

LIST OF ACRONYMS AND ABBREVIATIONS

RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
RRS	Risk Reduction Standards
SAP	Sampling and Analysis Plan
SARA	1986 Superfund Amendments and Re-authorization Act
SI	Site Investigation
SOW	Statement of Work
SVOCs	Semi Volatile Organic Compounds
SW-846	Solid Waste EPA Test Methods for Evaluating Solid Waste: Physical/Chemical Methods, 3rd edition, 1986
SWMU	Solid Waste Management Unit
SWMU 17	Solid Waste Management Unit No. 17 (a.k.a. LF-07)
SWMU 22	Solid Waste Management Unit No. 22 (a.k.a. LF-04)
SWMU 23	Solid Waste Management Unit No. 23 (a.k.a. LF-05)
SWMU 27	Solid Waste Management Unit No. 27 (a.k.a. LF-10)
SWMU 29	Solid Waste Management Unit No. 29 (a.k.a. LF-02)
SWMU 30	Solid Waste Management Unit No. 30 (a.k.a. LF-09)
SWMU 62	Solid Waste Management Unit No. 62 (a.k.a. LF-06)
TBD	To Be Determined
TCE	Trichloroethene
TNRCC	Texas Natural Resource Conservation Commission
TOC	Total Organic Carbon
US	United States
USACE	United States Army Corps of Engineers
USAF	United States Air Force
USCS	United Soil Classification System
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WP	Work Plan

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1.0 INTRODUCTION

The Field Sampling Plan (FSP) presents, in specific terms, the requirements and procedures for conducting field operations and investigations. This project specific FSP has been prepared to ensure that (1) the data quality objectives specified for this project are met, (2) the field sampling protocols are documented and reviewed in a consistent manner, and (3) the data collected are scientifically valid and defensible. This site specific FSP and the Air Force Center for Environmental Excellence (AFCEE) Quality Assurance Project Plan (QAPP), shall constitute, by definition, an AFCEE Sampling and Analysis Plan (SAP).

Guidelines followed in the preparation of this plan are set out in the NAS Fort Worth Resource Conservation and Recovery Act (RCRA) Permit HW-50289 issued by the TNRCC on February 7, 1991. Additional reference documents followed in the preparation of this FSP include AFCEE's Model Field Sampling Plan (March, 1997) and the AFCEE Handbook for the Installation Restoration Program (IRP) for Remedial Investigations and Feasibility Studies (September, 1993). All laboratory analyses performed as part of this FSP will follow the Base-Wide Quality Assurance Project Plan (HydroGeoLogic, 1998).

This FSP is required reading for all staff participating in the work effort. The FSP shall be in the possession of the field teams during sample collection. HydroGeoLogic, Inc. (HydroGeoLogic) and its subcontractors shall be required to comply with the procedures documented in this FSP in order to maintain comparability and representativeness of the collected and generated data.

Controlled distribution of the FSP shall be implemented by HydroGeoLogic to ensure that the current approved version is being used. A sequential numbering system shall be used to identify controlled copies of the FSP. Controlled copies shall be provided to applicable Air Force (USAF) managers, regulatory agencies, remedial project managers, project managers, and quality assurance (QA) coordinators. Whenever USAF revisions are made or addenda added to the FSP, a document control system shall be put into place to ensure that (1) all parties holding a controlled copy of the FSP shall receive the revisions/addenda, and (2) outdated material is removed from circulation. The document control system does not preclude making and using copies of the FSP; however, the holders of controlled copies are responsible for distributing additional material to update any copies within their organizations. The distribution list for controlled copies shall be maintained by HydroGeoLogic.

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2.0 PROJECT BACKGROUND

The following sections briefly describe the objective of the USAF and the rationale for implementing this RFI workplan.

2.1 SITE HISTORY AND PROJECT OBJECTIVES

Carswell AFB was officially closed on September 30, 1993. A parcel of the former Carswell AFB, Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), is in the process of being transferred from Air Force to Navy management. Before the property transfer can be completed, required environmental investigations of potential contamination related to USAF activities at the NAS Fort Worth property are to be completed and contaminated sites remediated.

On February 7, 1991, the former Carswell AFB (NAS Fort Worth JRB), was issued a RCRA hazardous waste permit (HW-50289) by the TNRCC. This permit requires a RCRA facility investigation of all Solid Waste Management Units (SWMUs) listed in Permit Provision VIII (as well as those SWMUs subsequently added to the list) in order to determine whether hazardous constituents listed in 40 CFR Part 264, Appendix IX have been released into the environment.

SWMU's No. 17,27,29,30, and 62 are the subject of this RCRA Facility Investigation (RFI). SWMU No. 62 was identified on the original list of RFI units in the permit. SWMU's No. 17, 27, 29, and 30 were added to the list of RFI units in the TNRCC letter dated March 2, 1995, to the Air Force Base Conversion Agency (AFBCA).

This investigation is managed by the Air Force under the Environmental Restoration Account. Other portions of the former AFB that are not being transferred to the Navy remain under the Base Realignment and Closure (BRAC) funding and management.

The primary regulatory programs that govern the RFI and potential closure of these sites are RCRA and the TNRCC Risk Reduction Program. The TNRCC is the lead regulatory agency for activities to be conducted at the subject sites.

This RFI has been designed to meet the requirements of Permit Provision VIII of the NAS Fort Worth HW-50289 permit. The RFI work plan (WP) has been prepared using guidance documents from the Air Force Installation Restoration Program (IRP), the Environmental Protection Agency (EPA), TNRCC's RRS, and RCRA.

2.2 PROJECT PURPOSE AND SCOPE

The purpose of this field investigation is to gather sufficient data for closure of five SWMUs located at NAS Fort Worth JRB under the TNRCC Risk Reduction Program. The five SWMUs are SWMU 17 (Landfill No. 7 or LF-07), SWMU 27(Landfill No. 10 or LF-10), SWMU 29 (Landfill No. 2 or LF-02), SWMU 30 (Landfill No. 9 or LF-09), and SWMU 62 (Landfill No. 6 or LF-06).

Field studies that will be used to characterize the landfills include: (1) geophysical surveys using magnetometry and electromagnetic methods will be conducted to determine the physical extent of each landfill and identify possible sources of contamination; (2) soil borings with continuous sampling will be advanced at each SWMU using direct push coring to determine the soil lithology and the nature and extent of soil contamination at each location; (3) direct push soil probes will be used to define the extent of the landfill by visually observing the subsurface waste/native soil interface zones; (4) temporary narrow diameter piezometers will be installed at selected soil boring and soil probe locations to provide an indication of groundwater flow direction prior to the establishment of monitoring wells; (5) one upgradient and three downgradient perimeter monitoring wells will be completed to determine the chemical characteristics of groundwater at each SWMU location; and (6) surface water samples will be collected at one location to determine if contamination is present in the ponded surface water.

The data collected as part of this FSP shall be used to evaluate and determine if additional data will be necessary to proceed to closure under 30 TAC 335 Subchapter S Risk Reduction Standards.

2.3 PROJECT 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. The areas covered by this FSP are five landfills throughout the NAS Fort Worth JRB site. These landfills are identified as SWMU 17 (Landfill No. 7 or LF-07), SWMU 27 (Landfill No. 10 or LF-10), SWMU 29, SWMU 30 (Landfill No. 9 or LF-09), (Landfill No. 2 or LF-02), and SWMU 62 (Landfill No. 6 or LF-06).

2.3.1 SWMU 17

The area designated as SWMU 17 is located within the flightline area near the intersection of Taxiway 197 and White Settlement Road. This landfill reportedly received construction debris in the form of concrete, asphalt, wood, trees, and potentially small amounts of undocumented hazardous materials from 1978 to 1983, but unauthorized dumping may have continued for several years thereafter (AFCEE, 1997). This area consists of approximately 3.5 acres of mostly vacant land covered by grasses and weeds and is littered with small pieces of concrete, asphalt, and rocks.

2.3.2 SWMU 27

This site, located west of the runways and near the southwest corner of the base, consists of a ditch approximately 8 feet deep by 20 feet wide and 400 feet long surrounded by sparse vegetation. The ditch typically has approximately 4- to 5-feet of water during the winter months, and eventually dries out during the summer months. Drums were observed in this ditch during a visual site inspection conducted by HydroGeoLogic. Since there is no documentation as to the source of these drums, they may and/or may have contained material which could act as a source of potential contamination. This area has not been previously investigated.

2.3.3 SWMU 29

This former borrow pit, located in the central section of the base near Haile Drive, was converted to a landfill in 1952, and accepted construction debris and moderate quantities of unspecified hazardous materials. In 1956, the site was covered (AFCEE, 1997). Currently, the site is surrounded by an 8-foot chain-link fence that provides security for Building 1055. This building occupies approximately one fourth of the 4.4-acre site. The remaining portion of the site is either occupied by temporary trailers or covered with asphalt or grass.

2.3.4 SWMU 30

This former landfill, located in the northeast section of the base adjacent to the West Fork of the Trinity River, received construction debris in the form of concrete, asphalt, and wood from 1978 to 1983 (AFCEE, 1997). At the eastern section of the landfill, a ditch has been created by runoff from an upgradient parking area located adjacent to Building 2570. Concrete, asphalt, telephone poles, and reinforcing steel are exposed in the newly formed banks of this ditch. The site is currently covered by vegetation, and current land use is limited to maintenance workers.

2.3.5 SWMU 62

This area is located between Roaring Springs Road and Haile Drive and is sparsely covered with vegetation. The site was a converted borrow pit used for the burial of construction materials and rubble, possibly drums of hydraulic fluid, and small quantities of other hazardous materials. It operated from 1975 to 1978, and was then covered. It has been documented that three drums of hydraulic fluid were placed in a centrally located pit to collect groundwater that seeped into the landfill (CH2M HILL, 1996c). It is unclear from the file reviewed whether this statement implies that the drums contain hydraulic fluid, or that they once contained hydraulic fluid, and the drums were simply used as a sump for water to be pumped from. Several stock piles of fill dirt containing concrete, asphalt, crushed 55-gallon drums, and wood have accumulated adjacent to the site.

2.4 PROJECT SITE CONTAMINATION HISTORY

Section 1.0 of the WP provides the history of environmental investigations conducted at each site and documents subsequent contamination present at each site. Please refer to this section for the contamination history of the sites.

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3.0 PROJECT SCOPE AND OBJECTIVES

The following sections describe the objectives of the RFI and the specific field activities that will be conducted during the investigation.

3.1 OBJECTIVES

The data generated by this project must be of sufficient quality and quantity to support the overall project objective, which is closure of five SWMUs located at NAS Fort Worth JRB under TNRCC RRS. The objectives and focus of this work will be to better define the geological/hydrogeological regime beneath each of the SWMUs, determine the lateral and vertical extent of the former landfills, determine if a source of contamination is present at each unit, and characterize the nature and extent of any contamination detected.

Data from the following categories are required for this study:

Site Characterization - Data will be used to evaluate physical and chemical properties of buried waste, soil, groundwater and surface water. The data will also be used to characterize the nature and extent of any contaminants detected.

Health and Safety - Data will be used to establish the level of protection needed for the work party and other site related personnel. This data will be gathered by the use of organic vapor analyzers, Draeger tubes, and the explosimeter during intrusive activities.

Site characterization data will be a combination of screening data and definitive data. Health and safety data will be collected as screening data. The definitions of screening data and definitive data, as established by the Data Quality Objectives Process for Superfund Interim Final Guidance (EPA/540/G-93/071, 1993) are described below:

- Screening Data with Definitive Confirmation - Screening data are generated by rapid, less precise methods of analysis with less rigorous sample preparation. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data provides analyte identification and quantification. Although the quantification may be determined using analytical methods with QA/QC procedures and criteria associated with definitive data, screening data without associated confirmation data are not considered to be data of known quality.

- Definitive Data - Definitive data will be generated using rigorous analytical methods, such as approved EPA reference methods. Data will be analyte-specific, with confirmation of analyte identity and concentration. These methods produce tangible raw data (e.g., chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files. Data may be generated at the site or at an off-site location, as long as the QA/QC requirements are satisfied. For the data to be definitive, either analytical or total measurement error must be determined.

The data generated by the laboratory analysis of samples must be sufficiently sensitive to allow comparison of the results to the TNRCC RRS. The Base-Wide QAPP (HydroGeoLogic, 1998) describes each method that will be performed as part of the investigation and outlines the quality assurance measures the contract laboratory must follow. The methods of analysis selected for samples collected from NAS Fort Worth JRB will produce screening as well as definitive data.

3.2 SAMPLE ANALYSIS SUMMARY

Samples collected as part of this FSP will be analyzed for the full suite of 40 CFR Appendix IX constituents. In accordance with the AFCEE Base-Wide QAPP (HydroGeoLogic, Feb. 1998), the following EPA Methods will be used to cover the full Appendix IX list:

- SW8260A - Volatile Organics
- SW8270B - Semivolatile Organics
- SW8080A - Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs)
- SW8140 - Organophosphorus Pesticides
- SW8151 - Chlorinated Herbicides
- SW8290 - Dioxins and Furans
- SW9010A/SW9012 - Cyanide
- SW9030 - Sulfide
- SW6010A/7000 - Trace Elements (Metals)
- SW7470A/7471A - Mercury

Table 3.1 presents the list of the number of samples to be collected and the analytical methods to be performed for groundwater, surface water, and soil samples collected during the RFI field investigation.

3.3 FIELD ACTIVITIES

The proposed field tasks described in this FSP will be conducted to achieve the project objectives as presented in the WP. Field investigative activities will be conducted at each of the five subject SWMUs. Table 3.2 contains a summary of the field activities planned during this RFI. Details as to the justification for each sample to be collected are presented in the WP. Table 3.3 is a summary of the data quality levels and intended use for data collected during the RFI.

Table 3.1
Sample Analysis Summary
NAS Fort Worth JRB, Texas

Site	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates	# MS/MSD	Total # Samples
SWMU 17	8260A	GW	4-12[1]	1-3[1]	1-3[1]	1-3[1]	1-3[1]	1-3[1]	9-27[1]
SWMU 17	8270B	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 17	6010A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 17	7470A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 17	8151	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 17	8080A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 17	8290	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 17	9010A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 17	8140	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 17	9030	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 17	8260A	Soil	12[2]	2	1	2	2	1	20[2]
SWMU 17	8270B	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 17	6010A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 17	7471A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 17	8151	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 17	8080A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 17	8290	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 17	9010A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 17	8140	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 17	9030	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 27	8260A	GW	4-12[1]	1-3[1]	0	1-3[1]	1-3[1]	1-3	8-24[1]
SWMU 27	8270B	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]

Table 3.1 (continued)
Sample Analysis Summary
NAS Fort Worth JRB, Texas

Site	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates	# MS/MSD	Total # Samples
SWMU 27	6010A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 27	7470A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 27	8151	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 27	8080A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 27	8290	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 27	9010A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 27	8140	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 27	9030	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 27	8260A	Soil	12[2,3]	1	0	1	2	1	17[2,3]
SWMU 27	8270B	Soil	12[2,3]	1	0	0	2	1	16[2,3]
SWMU 27	6010A	Soil	12[2,3]	1	0	0	2	1	16[2,3]
SWMU 27	7471A	Soil	12[2,3]	1	0	0	2	1	16[2,3]
SWMU 27	8151	Soil	12[2,3]	1	0	0	2	1	16[2,3]
SWMU 27	8080A	Soil	12[2,3]	1	0	0	2	1	16[2,3]
SWMU 27	8290	Soil	12[2,3]	1	0	0	2	1	16[2,3]
SWMU 27	9010A	Soil	12[2,3]	1	0	0	2	1	16[2,3]
SWMU 27	8140	Soil	12[2,3]	1	0	0	2	1	16[2,3]
SWMU 27	9030	Soil	12[2,3]	1	0	0	2	1	16[2,3]
SWMU 27	8260A	SS	3[3]	1	0	1	1	1	7[3]
SWMU 27	8270B	SS	3[3]	1	0	0	1	1	6[3]
SWMU 27	6010A	SS	3[3]	1	0	0	1	1	6[3]

Table 3.1 (continued)
Sample Analysis Summary
NAS Fort Worth JRB, Texas

Site	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates	# MS/MSD	Total # Samples
SWMU 27	7471A	SS	3[3]	1	0	0	1	1	6[3]
SWMU 27	8151	SS	3[3]	1	0	0	1	1	6[3]
SWMU 27	8080A	SS	3[3]	1	0	0	1	1	6[3]
SWMU 27	8290	SS	3[3]	1	0	0	1	1	6[3]
SWMU 27	9010A	SS	3[3]	1	0	0	1	1	6[3]
SWMU 27	8140	SS	3[3]	1	0	0	1	1	6[3]
SWMU 27	9030	SS	3[3]	1	0	0	1	1	6[3]
SWMU 27	8260A	SW	2	1	0	1	1	1	6
SWMU 27	8270B	SW	2	1	0	0	1	1	5
SWMU 27	6010A	SW	2	1	0	0	1	1	5
SWMU 27	7470A	SW	2	1	0	0	1	1	5
SWMU 27	8151	SW	2	1	0	0	1	1	5
SWMU 27	8080A	SW	2	1	0	0	1	1	5
SWMU 27	8290	SW	2	1	0	0	1	1	5
SWMU 27	9010A	SW	2	1	0	0	1	1	5
SWMU 27	8140	SW	2	1	0	0	1	1	5
SWMU 27	9030	SW	2	1	0	0	1	1	5
SWMU 29	8260A	GW	4-12[1]	1-3[1]	0	1-3[1]	1-3[1]	1-3	8-24[1]
SWMU 29	8270B	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 29	6010A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 29	7470A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]

Table 3.1 (continued)
Sample Analysis Summary
NAS Fort Worth JRB, Texas

Site	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates	# MS/MSD	Total # Samples
SWMU 29	8151	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 29	8080A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 29	8290	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 29	9010A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 29	8140	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 29	9030	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 29	8260A	Soil	20[2]	2	0	2	2	1	29[2]
SWMU 29	8270B	Soil	20[2]	2	0	0	2	1	27[2]
SWMU 29	6010A	Soil	20[2]	2	0	0	2	1	27[2]
SWMU 29	7471A	Soil	20[2]	2	0	0	2	1	27[2]
SWMU 29	8151	Soil	20[2]	2	0	0	2	1	27[2]
SWMU 29	8080A	Soil	20[2]	2	0	0	2	1	27[2]
SWMU 29	8290	Soil	20[2]	2	0	0	2	1	27[2]
SWMU 29	9010A	Soil	20[2]	2	0	0	2	1	27[2]
SWMU 29	8140	Soil	20[2]	2	0	0	2	1	27[2]
SWMU 29	9030	Soil	20[2]	2	0	0	2	1	27[2]
SWMU 30	8260A	GW	4-12[1]	1-3[1]	0	1-3[1]	1-3[1]	1-3	8-24[1]
SWMU 30	8270B	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 30	6010A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 30	7470A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 30	8151	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]

Table 3.1 (continued)
Sample Analysis Summary
NAS Fort Worth JRB, Texas

Site	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates	# MS/MSD	Total # Samples
SWMU 30	8080A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 30	8290	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 30	9010A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 30	8140	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 30	9030	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 30	8260A	Soil	12[2]	2	0	2	2	1	19[2]
SWMU 30	8270B	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 30	6010A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 30	7471A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 30	8151	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 30	8080A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 30	8290	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 30	9010A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 30	8140	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 30	9030	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 62	8260A	GW	4-12[1]	1-3[1]	0	1-3[1]	1-3[1]	1-3	8-24[1]
SWMU 62	8270B	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 62	6010A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 62	7470A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 62	8151	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 62	8080A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]

Table 3.1 (continued)
Sample Analysis Summary
NAS Fort Worth JRB, Texas

Site	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates	# MS/MSD	Total # Samples
SWMU 62	8290	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 62	9010A	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 62	8140	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 62	9030	GW	4-12[1]	1-3[1]	0	0	1-3[1]	1-3[1]	7-21[1]
SWMU 62	8260A	Soil	12[2]	2	0	2	2	1	19[2]
SWMU 62	8270B	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 62	6010A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 62	7471A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 62	8151	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 62	8080A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 62	8290	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 62	9010A	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 62	8140	Soil	12[2]	2	0	0	2	1	17[2]
SWMU 62	9030	Soil	12[2]	2	0	0	2	1	17[2]

Notes:
[1] Assume four monitoring wells and 1-3 rounds of sampling for the full suite of Appendix IX constituents pending justification for an abbreviated Appendix IX constituent list based on the analytical results from the first round of sampling.
[2] Soil samples must be collected every 5 feet from the surface to the groundwater. The number of soil samples is based on the estimated average depth to groundwater and 2 days of sampling. The actual number of soil samples collected will vary depending on the actual depth to groundwater.
[3] Two of three surface soil samples are paired with soil boring locations and will share the associated QA/QC samples.

GW = Groundwater
SW = Surface Water
# Equipment Blanks = One equipment blank will be taken per day, per analysis (for example, 3 equipment blanks represents 1 sample/day for 3 days).
# Field Duplicates = Collected on a 10% basis of investigation samples.
# Trip Blanks = One trip blank will be included per cooler when at least one sample is analyzed for VOCs from that cooler.
# Ambient Blanks = One ambient blank will be collected at the beginning of the field investigation for soil and groundwater.

Table 3.2
Field Activities Summary
NAS Fort Worth JRB, Texas

Site	Activity	#
SWMU 17	Soil Borings	4
SWMU 17	Soil Probes	3+
SWMU 17	Install Alluvial Terrace Monitoring Wells	2-4
SWMU 17	Sample Existing Alluvial Terrace Monitoring Wells	2-3
SWMU 17	Piezometers	7
SWMU 17	Geophysical Study (EM-31 and Magnetometer Surveys)	1
SWMU 27	Soil Borings	4
SWMU 27	Soil Probes	3+
SWMU 27	Install Alluvial Terrace Monitoring Wells	4
SWMU 27	Piezometers	5
SWMU 27	Surface Soil Sample Locations	3
SWMU 27	Surface Water Sample Locations	2
SWMU 27	Geophysical Study (EM-31 and Magnetometer Surveys)	1
SWMU 29	Install Alluvial Terrace Monitoring Wells	4
SWMU 29	Soil Borings	4
SWMU 29	Soil Probes	3+
SWMU 29	Piezometers	4
SWMU 29	Geophysical Study (EM-31 and Magnetometer Surveys)	1
SWMU 30	Soil Borings	3
SWMU 30	Soil Probes	2+
SWMU 30	Piezometers	5
SWMU 30	Install Alluvial Terrace Monitoring Wells	4
SWMU 30	Geophysical Study (EM-31 and Magnetometer Surveys)	1
SWMU 62	Soil Boring	3
SWMU 62	Soil Probes	4+
SWMU 62	Install Alluvial Terrace Monitoring Wells	4
SWMU 62	Piezometers	5
SWMU 62	Geophysical Study (EM-31 and Magnetometer Surveys)	1

Table 3.3
Data Quality Levels and Intended Use for Field and Laboratory Data
NAS Fort Worth
JRB, Texas

Sampling Matrix/ Location	Parameters[a]	Analytical Method	Field/Lab Analysis	Data Quality Level	Intended Use
Soil, all locations	VOCs	PID	Field	Screening	Field screening for selecting samples for lab analysis
	EM inductance Gravity response	Geophysical Survey	Field		Delineating the extent of the landfill, identification of "hot spots"
		Boring Logs	Field		To differentiate the stratigraphy, to identify buried waste
Groundwater all locations	Temperature pH EC Turbidity	170.1 150.1 120.1 180.1	Field Field Field Field	Screening Screening Screening Screening	Field screening to determine sufficient purging/development of monitoring well
Groundwater	ICP Priority Pollutant metals Mercury VOCs SVOCs Pesticides/PCBs Herbicides OP Pesticides Dioxins/Furans Cyanide Sulfide	6010A/7000 7470A/7471A 8260A 8270B 8080A 8151 8140 8290 9010A/9012 9030	Lab Lab Lab Lab Lab Lab Lab Lab Lab Lab	Definitive Definitive Definitive Definitive Definitive Definitive Definitive Definitive Definitive Definitive	Nature/extent of contaminants, risk assessment, corrective measures study
Soil	ICP Priority Pollutant metals Mercury VOCs SVOCs Pesticides/PCBs Herbicides OP Pesticides Dioxins/Furans Cyanide Sulfide	6010A/7000 7470A/7471A 8260A 8270B 8080A 8151 8140 8290 9010A/9012 9030	Lab Lab Lab Lab Lab Lab Lab Lab Lab Lab	Definitive Definitive Definitive Definitive Definitive Definitive Definitive Definitive Definitive Definitive	Nature/extent of contaminants, risk assessment, corrective measures study

Notes: [a] VOCs - Volatile Organic Compounds
EC - Electrical Conductivity
SVOCs - Semivolatile Organic Compounds
NA - Not Applicable

The following sections describe the proposed field investigation activities for each site to be investigated during this study. More detailed descriptions of the rationale and justification for each of the proposed activities are presented in the WP.

3.3.1 SWMU 17

Proposed field activities to be conducted at SWMU 17 include geophysical surveys to characterize the extent of the landfill and determine the presence of drums or other potentially hazardous materials; collection of direct push continuous soil cores for visual observation and chemical analysis; establishment of temporary piezometers; installation, development and sampling of alluvial terrace monitoring wells; and advancement of soil probes.

The survey procedure for SWMU 17 will begin by creating a grid over an approximate 8.2-acre area (660 feet [N-S] by 560 feet [E-W]) that will overlay the area expected to have been used as a landfill. The grid of the proposed geophysical survey is presented on Figure 3.1. Although the lateral extent of the landfill is not expected to be this large, a fringe around the landfill is desired and will serve as a background data set for comparison. Station locations will be placed on 20 foot centers using a tape measure for distance and a transit for trueness. The base station for this grid will be from a temporary stake near the road located to the east of the landfill. All distances on the geophysical survey will be measured in feet from this location.

Proposed locations for soil borings, temporary piezometers, existing, and potential monitoring wells are presented in Figure 3.2. Based on the results of the geophysical survey and specific site conditions, soil boring/piezometer locations may be shifted slightly to accommodate "hot spots", utilities, or other obstructions.

Four direct push soil borings are planned within the SWMU boundaries. Continuous soil cores will be obtained to visually characterize the soil and waste in the SWMU. Soil samples for chemical analysis will be collected every five feet from the ground surface to the water table. Surface soil samples at each boring location will be collected using a stainless steel scoop or trowel. Each boring will be advanced into the water table, and a temporary narrow diameter piezometer (0.75"- 1.0") will be placed in the borehole to allow gauging of groundwater. Depth to groundwater at this SWMU is estimated to range from 6'-18' below the ground surface (bgs).

Three soil probes will also be advanced outside the SWMU boundaries to install temporary piezometers. Information on groundwater elevation from these piezometers will be used to fill in data gaps in the west, north, and northeast. Continuous cores will be collected from these soil probes, and visual observations will be made to confirm the outer boundaries of the SWMU. The actual location and number of soil probes may be modified pending results from the geophysical study.

At each narrow diameter piezometer location, an inert substance will be placed at least 0.5 feet into the borehole to plug the annulus between the casing and the borehole. A layer of hydrated bentonite will be completed to the surface to keep any potential runoff from entering the borehole. Groundwater will be allowed to reach equilibrium over a period of 12 to 24 hours before gauging depth to water. Piezometers and existing monitoring wells in the vicinity of the SWMU will then be surveyed and gauged to determine groundwater elevations and flow directions.

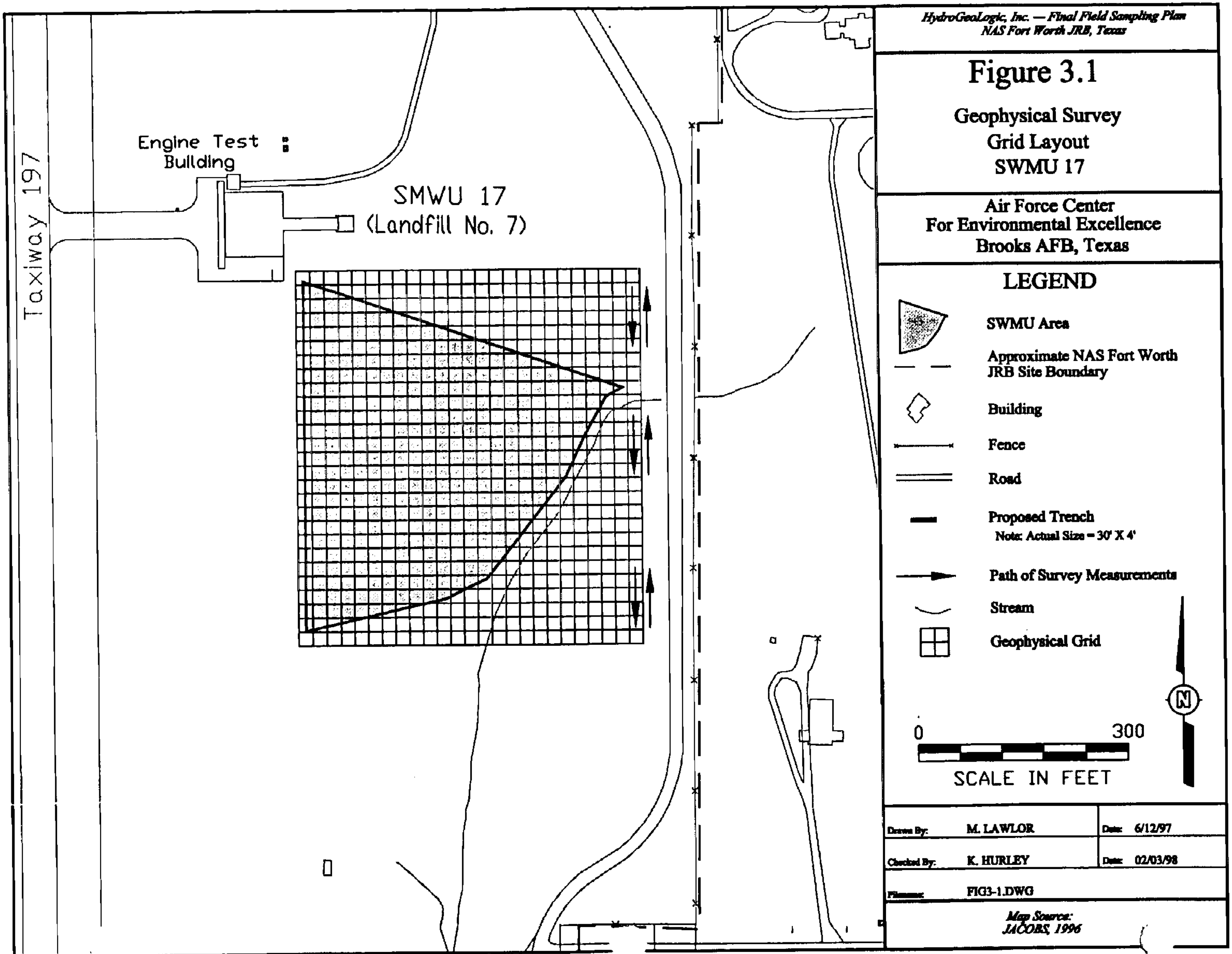
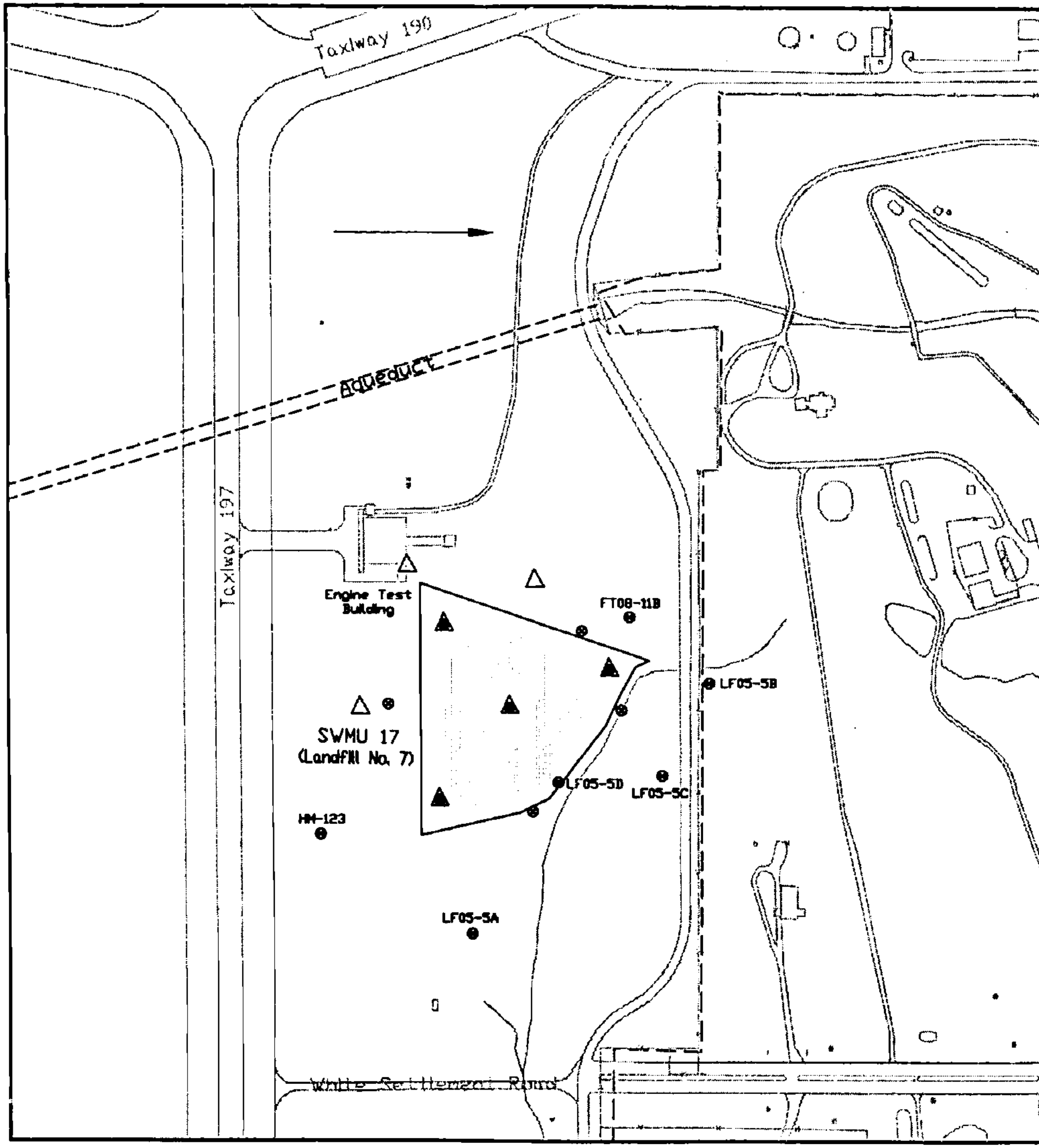


Figure 3.1
Geophysical Survey
Grid Layout
SWMU 17

Figure 3.2

Proposed Investigation Activities SWMU 17

Air Force Center For Environmental Excellence Brooks AFB, Texas



LEGEND

- SWMU Area
- Approximate NAS Fort Worth JRB Site Boundary
- Proposed Monitoring Well
- Proposed Soil Boring
- Temporary Piezometer
- Fence
- Road
- LF05-5A Existing Monitoring Well
- Groundwater Flow Direction
- Stream

0 — 500

SCALE IN FEET

N

Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU17-PIA.dwg
Revised: 12/30/97
Map Source: Jacobs, 1996

Groundwater flow at NAS Fort Worth JRB is generally west to east. However, as depicted in Figure 3.3, a hydrogeologic ridge appears to cross through SWMU 17 along a west to east axis. Groundwater flow around this ridge is to the east, southeast, and northeast. Water table elevations obtained from temporary piezometers, as well as existing monitoring wells near SWMU 17, will be used do determine local groundwater flow. The resulting groundwater flow data will then be utilized to evaluate the position and potential use of existing wells and to site any additional wells needed to monitor water quality in the vicinity of SWMU 17.

Monitoring wells will be installed using a hollow stem auger. A minimum of one upgradient and three downgradient perimeter monitoring wells are needed at this site. Soil borings used to establish monitoring wells will be drilled 1-foot into the bedrock and completed with 2-inch diameter casing and screen. Depth to bedrock is estimated at 30 feet bgs. No soil samples will be collected for chemical analysis during monitoring well installation activities.

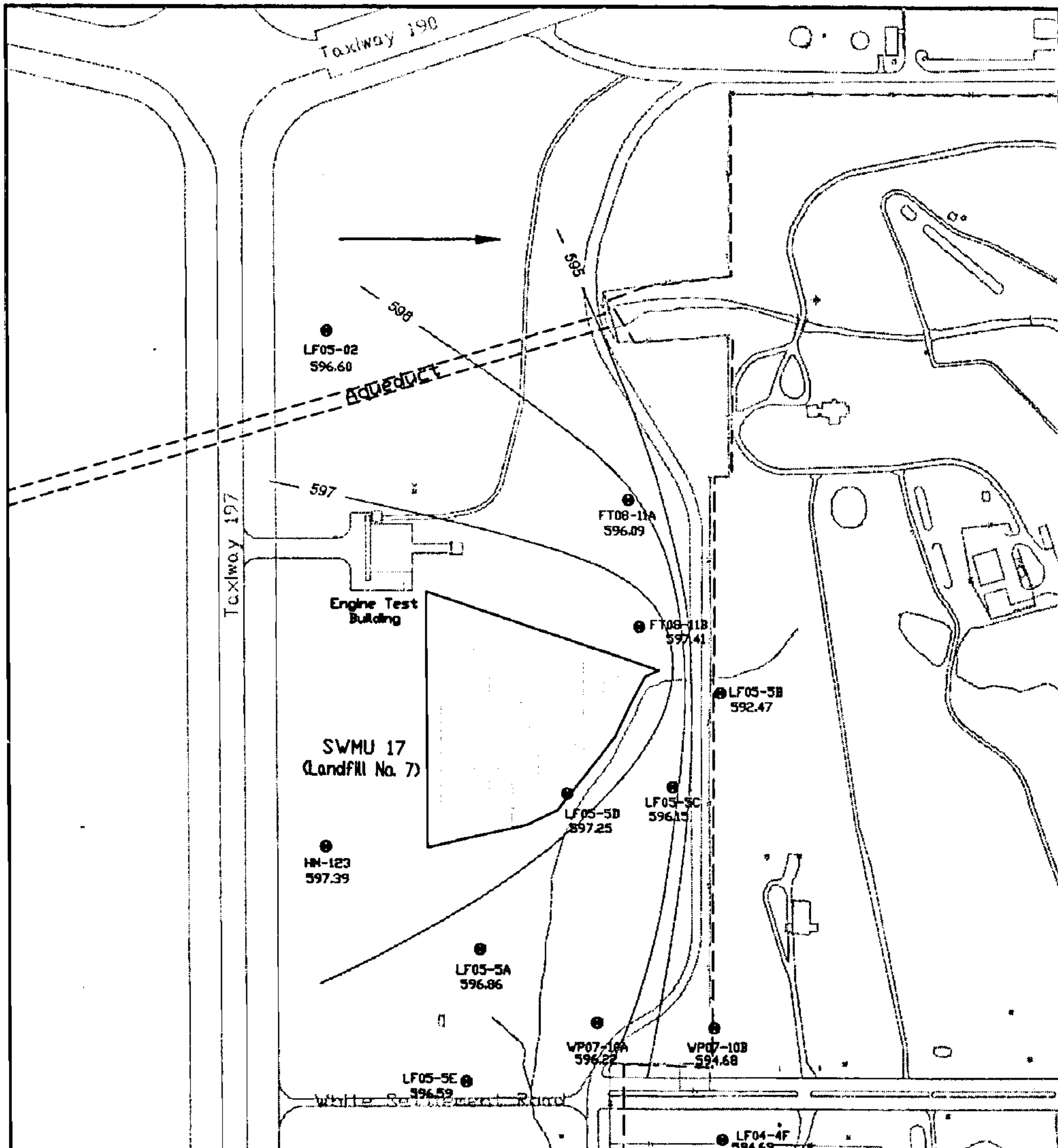
The installation and sampling of new and existing monitoring wells is designed to evaluate the relative quality of the groundwater upgradient of SWMU 17 versus the quality downgradient of the unit (Figure 3.2). The existing wells located west of the unit, HM-123 and LF05-5A, may be used to evaluate the groundwater quality as it enters the unit. Monitoring wells LF05-5D, FT08-11B, and LF05-5B will be evaluated as potential downgradient wells. Additional monitoring wells may be sited to the west and north based on groundwater elevation and flow patterns. The difference between the physical and chemical characteristics of the groundwater upgradient versus downgradient of the unit will be used to determine if the waste buried within the unit has impacted groundwater quality.

The samples collected from the soil borings and monitoring wells will provide additional information to determine whether the SWMU is contributing to the existing trichloroethene (TCE) plume that originates from Air Force Plant 4 (AFP-4). Additionally, the samples will be used to evaluate if the waste buried in this SWMU has resulted in contamination originating from other organic or inorganic chemicals. Based on the lack of historical records of wastes buried within the SWMU, all soil and groundwater samples will be analyzed for a full suite of Appendix IX constituents. Classes of compounds contained in Appendix IX include volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs), herbicides, pesticides/PCBs, OP Pesticides, dioxins/furans, cyanide, sulfide, mercury, and priority pollutant metals.

Three rounds of groundwater sampling spaced at approximately two month intervals are planned. If analytical results from the first round of sampling does not reveal contamination across the full suite of Appendix IX constituents, then a shorter list of analytes will be proposed for subsequent rounds of sampling.

3.3.2 SWMU 27

Proposed field activities to be conducted at this SWMU include geophysical surveys to characterize the extent of the landfill; direct push continuous soil cores for visual observation and chemical analysis; temporary piezometers; soil probes; collection of surface water and soil samples; and the installation and sampling of new alluvial terrace monitoring wells.



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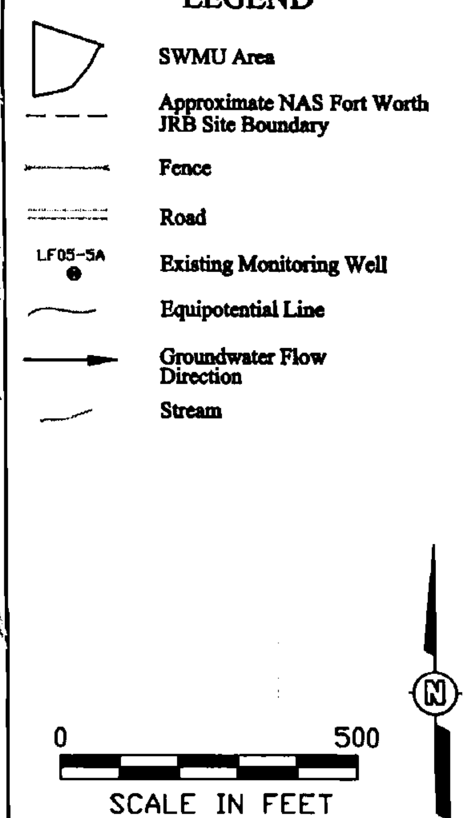
NAS Fort Worth JRB, Texas

Figure 3.3

Potentiometric Surface Map
in the Vicinity of SWMU 17
January, 1997

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND



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Revised: 12/30/97
Map Source: Jacobs, 1996

Two geophysical surveys will be conducted around the perimeter of the open trench to identify the extent of the landfill and potential "hot spots." The survey procedure for SWMU 27 will begin by creating a grid over an approximate 7.3-acre area (1,140 feet [N-S] by 280 feet [E-W]) that will overlay the area suspected as having been used as a landfill (Figure 3.4). Although the lateral extent of the landfill is not expected to be this large, a fringe around the landfill is desired and will serve as a background data set for comparison. Station locations will be placed on 20 foot centers using a tape measure for distance and a transit for trueness. The base station for this grid will be at the northwest corner of the landfill. All distances on the geophysical survey will be measured in feet from this location.

As described in Section 2.2.3.2 of the WP, the southern portion of SWMU 27 is occupied by a trench approximately 8 feet deep by 20 feet wide and 400 feet long. Seasonally, the trench may contain standing water. Three surface soil samples will be collected from the bottom of the trench to determine whether debris placed in the trench has impacted the underlying soils. Surface soil samples at each location will be collected using stainless steel scoops or trowels. Two surface water samples will also be collected from the north and south ends of the trench to ascertain whether contamination is present in the surface water as a result of the buried debris. As shown on Figure 3.5, two of the three surface soil samples are paired with soil boring and surface water locations. All surface soils and water samples will be analyzed for the full suite of Appendix IX constituents.

Although groundwater flow at NAS Fort Worth JRB is generally from west to east across the base, localized variations in groundwater flow directions exist. No monitoring wells are located near SWMU 27, and there is little information on groundwater flow in this area of the base. As shown on Figure 3.5, SWMU 27 is located directly west of the south end of the main runway. Careful study of Figure 2.13 (Lake Worth Topographic Map) shows that a small branch of Farmers Branch Creek, with seasonal intermittent flow, is located approximately 500 to 600 feet to the north and northwest of SWMU 27. Local groundwater flow in this area may be in the direction of this tributary. Temporary piezometers will be used to evaluate groundwater flow directions prior to the installation of monitoring wells.

Four soil borings will be driven into the subsurface around the perimeter of the trench. Soil cores will be collected continuously to the top of the water table for visual classification of soils and waste. Soil samples from these cores will be taken for chemical analysis at five foot intervals from the ground surface to the water table. These samples will be analyzed for the full suite of Appendix IX constituents to evaluate the presence of potential soil contamination in the alluvium. The soil borings located on the north and south sides of the trench will be advanced into the water table and converted to temporary piezometers.

Three additional piezometers will be installed near the estimated SWMU boundaries to provide the aerial coverage needed to determine groundwater flow directions. The soil probes used to install these piezometers will be sampled continuously for lithologic characterization.

After local groundwater flow patterns have been established, four perimeter 2-inch monitoring wells will be installed using a hollow stem auger. Each of these augered soil borings will be completed 1-foot into the bedrock. The monitoring well pattern will consist of one upgradient well and three downgadient wells to assess whether waste buried at this SWMU has impacted the

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Figure 3.4

Geophysical Survey Grid Layout SWMU 27

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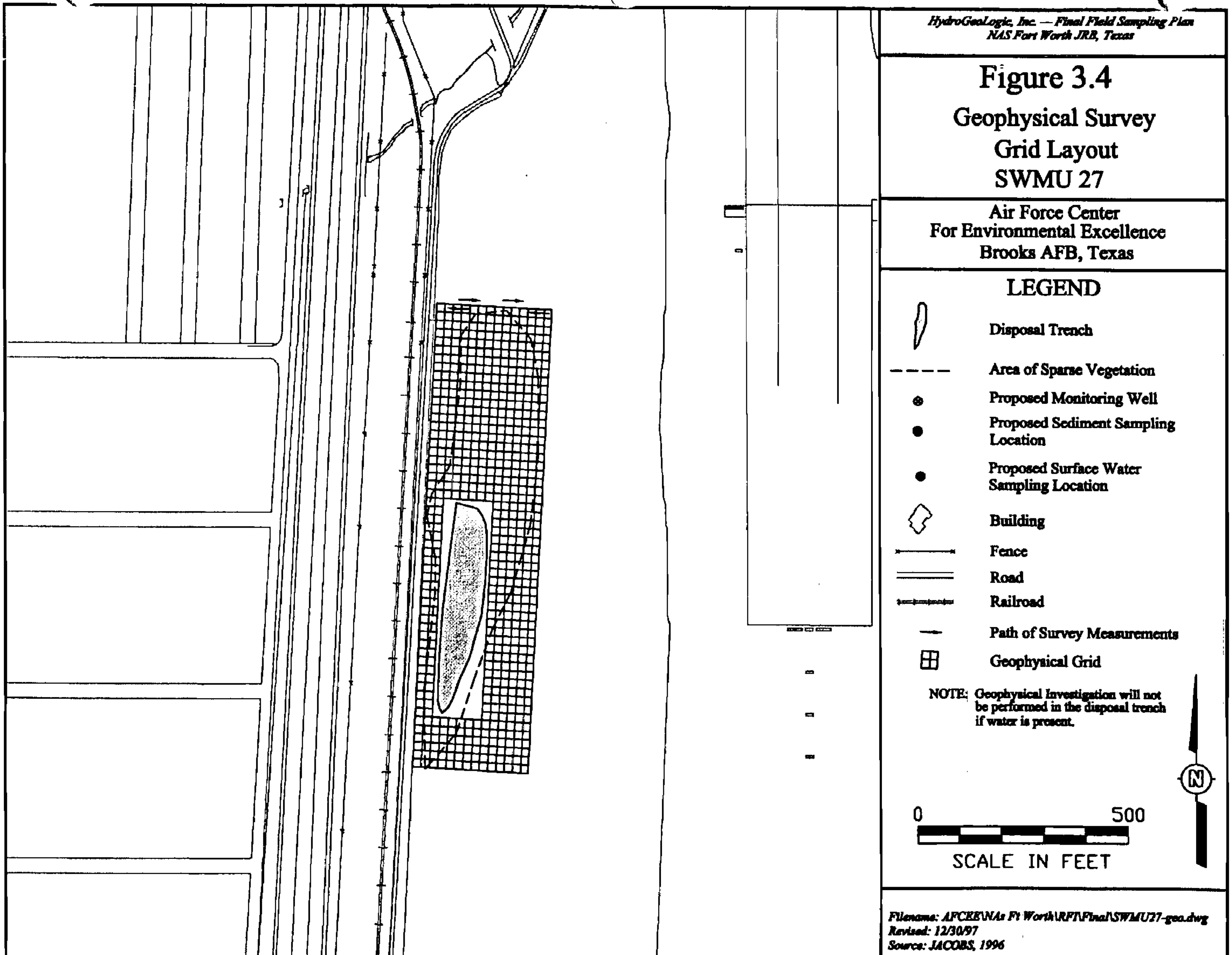

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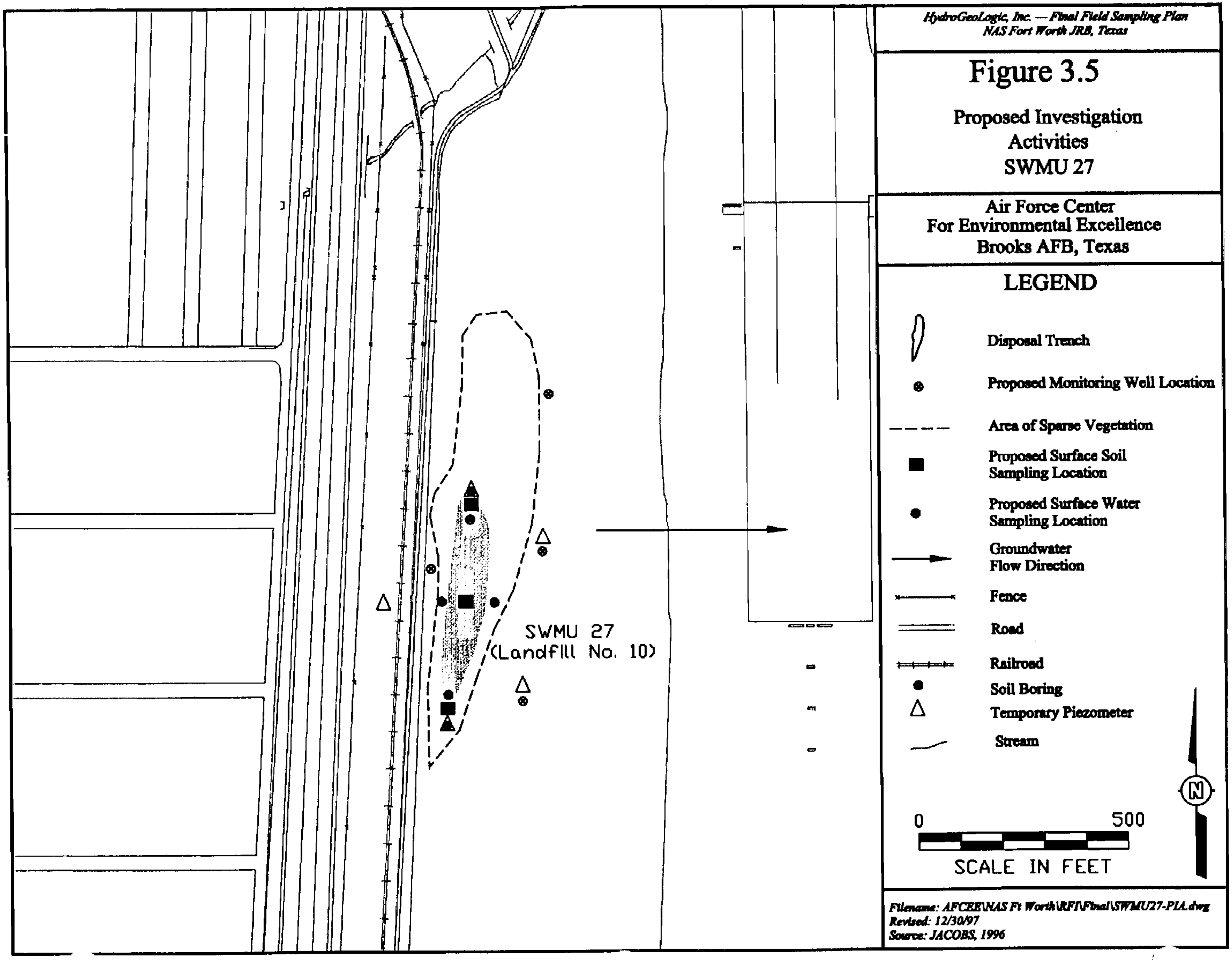
Revised: 12/30/97
Source: JACOBS, 1996



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NAS Fort Worth JRB, Texas

Figure 3.5

Proposed Investigation Activities SWMU 27

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Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU27-PIA.dwg
Revised: 12/30/97
Source: JACOBS, 1996

alluvial terrace groundwater. As there is no historical chemical data at this site, groundwater samples will be analyzed for the full suite of Appendix IX constituents. Proposed locations for soil borings and monitoring wells are presented in Figure 3.5.

Three rounds of groundwater sampling spaced at approximately two month intervals are planned. If analytical results from the first round of sampling does not reveal contamination across the full suite of Appendix IX constituents, then a shorter list of analytes will be proposed for subsequent rounds of sampling.

3.3.3 SWMU 29

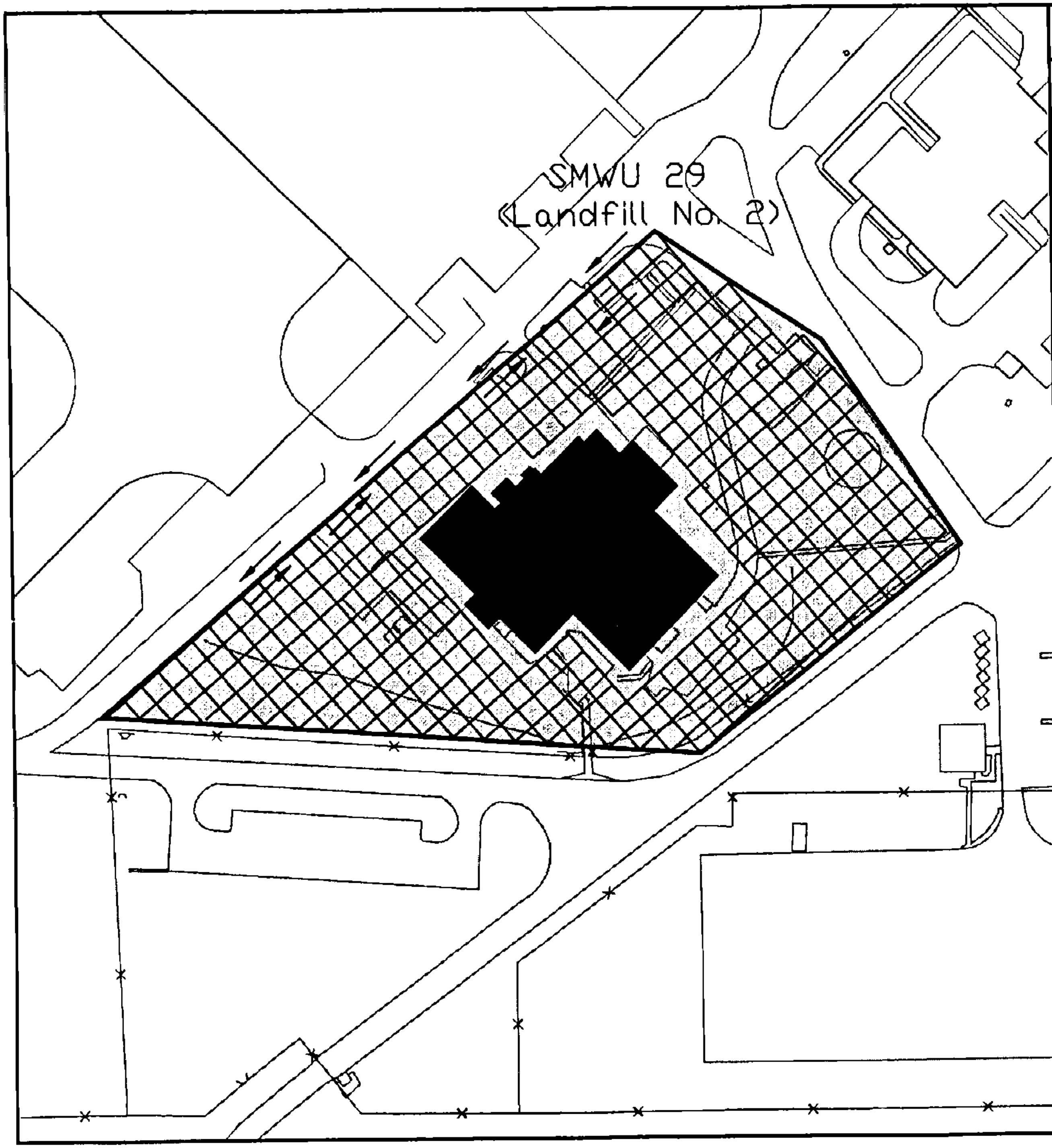
Field activities to be conducted at SWMU 29 during this study include a geophysical study using electromagnetic induction and magnetometry, four direct push soil borings to the top of the water table, four temporary narrow diameter piezometers, and drilling four 2-inch diameter monitoring wells. Surface soil, subsurface soil and groundwater samples will be collected and sent to the laboratory for analysis.

The geophysical survey procedure for SWMU 29 will begin by creating a grid over an approximate 6.0-acre area (660 feet [N-S] by 400 feet [E-W]) that will overlay the area suspected as having been used as a landfill (Figure 3.6). Due to roads and fences that surround the SWMU, no fringe area around the SWMU will be surveyed during the geophysical surveys. Station locations will be placed on 20 foot centers using a tape measure for distance and a transit for trueness. The base station for this grid will be at the northwest corner of the landfill. All distances on the geophysical survey will be measured in feet from this location.

The success of the geophysical survey may be limited by the presence of numerous buildings, trailers, roads and associated utilities within the SWMU boundary. Should results from the geophysical survey prove to be inadequate or limited in success, then direct push soil probes will be driven around the perimeter of the SWMU in an effort to define the aerial extent of the SWMU. This method may be used to confirm the results of the geophysical survey, or it will be used as a stand alone method. If necessary, some of these soil probes will be converted to temporary piezometers.

Four soil borings will be installed inside the perimeter of the SWMU. Continuous soil cores will be collected to evaluate the physical characteristics of the soil and waste. Soil samples from these continuous cores will be collected for chemical analysis every five feet from the ground surface to the water table. Analytical results from these samples will be used to assess the nature of potential chemical contamination of the soil beneath the unit. All four of the soil borings will be advanced into the water table and converted to temporary piezometers. Local groundwater flow patterns determined from these piezometers will help to pinpoint the locations of monitoring wells.

Four additional augered soil borings will be drilled 1 foot into the bedrock to install 2-inch monitoring wells. Some of the temporary piezometer locations may be over-drilled by hollow stem auger and converted to monitoring wells. Groundwater flow at the Base is generally west to east. Three of the monitoring wells are proposed in what appears to be the downgradient direction. These wells are designed to evaluate quality of the groundwater as it leaves the unit.



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NAS Fort Worth JRB, Texas

Figure 3.6

Geophysical Survey Grid Layout SWMU 29

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LEGEND

- SWMU Area
- Building
- Fence
- Road
- Path of Survey Measurements
- Geophysical Grid

0 200
SCALE IN FEET

N

Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU29-geo
Revised: 12/30/97
Source: JACOBS, 1996

The other monitoring well is proposed to evaluate the groundwater quality as it enters the unit. The relative difference in the groundwater quality upgradient versus downgradient of the unit will be used to evaluate the waste buried in the unit and how it is impacting groundwater quality.

The monitoring wells will also provide valuable information as depth to bedrock, the lithologic unit represented as bedrock, and the depth to groundwater. The proposed locations of direct push soil borings, temporary piezometers, soil probes, and monitoring wells are presented in Figure 3.7. Some of the locations may need to be shifted based on accessibility and utility clearance.

Based on the lack of available historical records of buried debris and suspected contaminants associated with the SWMU, all soil and groundwater samples will be analyzed for a full suite of Appendix IX constituents. Three rounds of groundwater sampling are planned for the new wells. Analytical results of the first round of sampling may be used to justify a shorter Appendix IX analyte list in subsequent rounds of sampling.

Additional soil borings and monitoring wells may be installed at a later date to delineate the extent of contamination originating from the SWMU if the proposed monitoring wells identify contamination above RRS.

3.3.4 SWMU 30

A geophysical survey, three soil borings, five temporary piezometers, four monitoring wells, and at least 2 soil probes will be used to evaluate this site. The objectives of this investigation will be to characterize the waste buried at this unit, determine the physical and chemical characteristics of the soil and groundwater beneath the site, and evaluate if the waste buried in the unit poses an unacceptable risk to human health and the environment.

The geophysical survey procedure for SWMU 30 will begin by creating a grid over an approximate 4.4-acre area (500 feet by 380 feet) that will overlay the area suspected as the former landfill location (Figure 3.8). Although the lateral extent of the landfill is not expected to be this large, a fringe around the landfill is desired and will serve as a background data set for comparison. Station locations will be placed on 20 foot centers, using a tape measure for distance and a transit for trueness. The base station for this grid will be along the fence to the south of the landfill. All distances on the geophysical survey will be measured in feet from this location.

Three soil borings will be driven to the top of the water table within the SWMU boundaries. Soil samples will be collected continuously for lithologic characterization. Observations made from these cores will be used to characterize the waste/soil buried in the landfill. Soil samples for chemical analysis will be collected every five feet from the ground surface to the water table to define soil quality in the landfill. Surface soil samples at each boring location will be collected using stainless steel scoops or trowels. Depth to groundwater is estimated to range from 10 to 15 feet bgs. All of these soil borings will be continued into the water table to allow for installation of temporary piezometers.

HydroGeoLogic, Inc. — Final Field Sampling Plan
NAS Fort Worth JRB, Texas

Figure 3.7

Proposed Investigation Activities
SWMU 29

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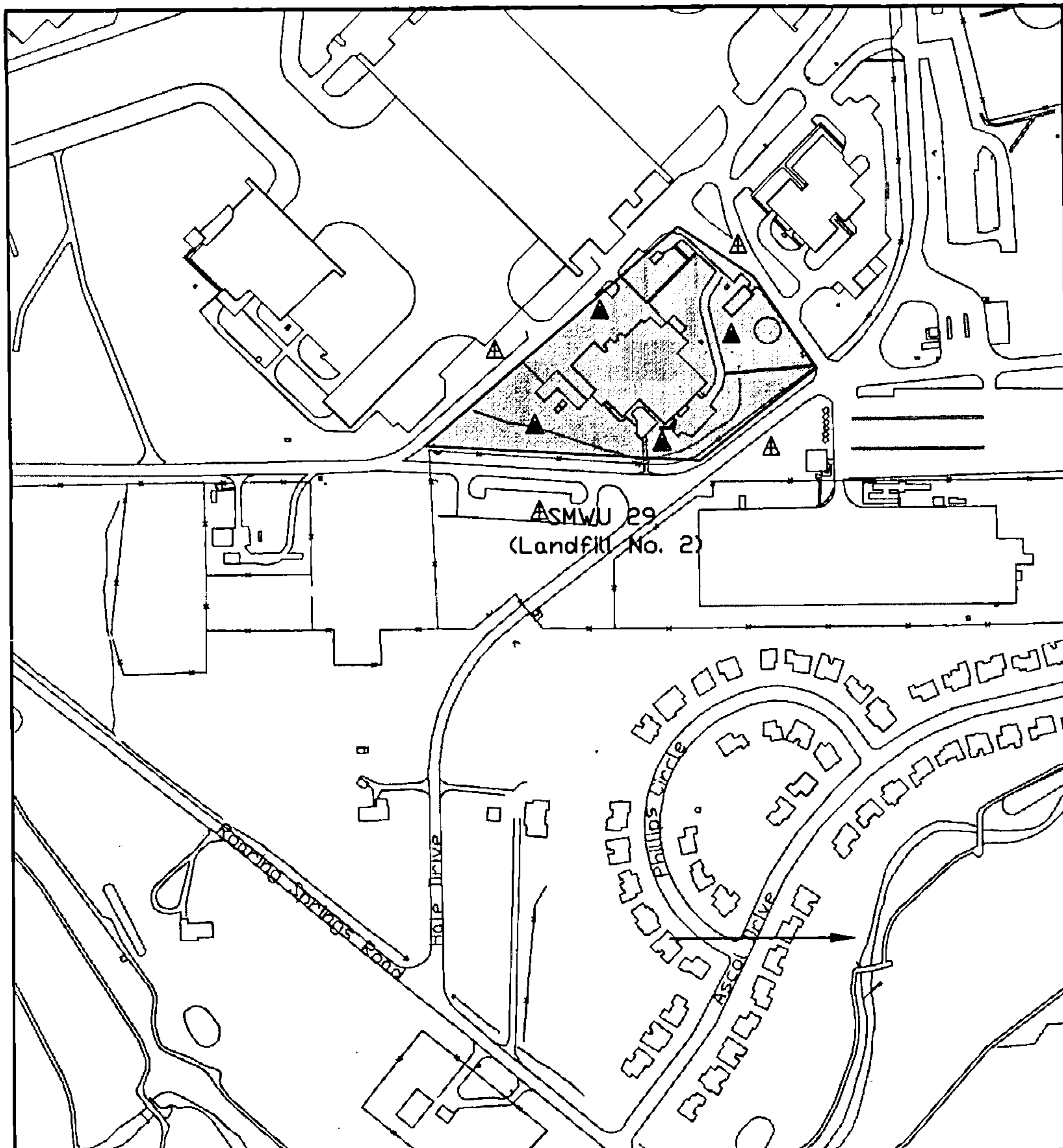

LEGEND

- SWMU Area
- Proposed Monitoring Well
- Proposed Soil Boring
- Building
- Fence
- Road
- Groundwater Flow Direction
- Temporary Piezometer
- Potential Soil Probes & Piezometer

0 500
SCALE IN FEET

N

Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU29-PIA
Revised: 12/30/97
Source: JACOBS, 1996

Figure 3.8

Geophysical Survey
Grid Layout
SWMU 30

Air Force Center
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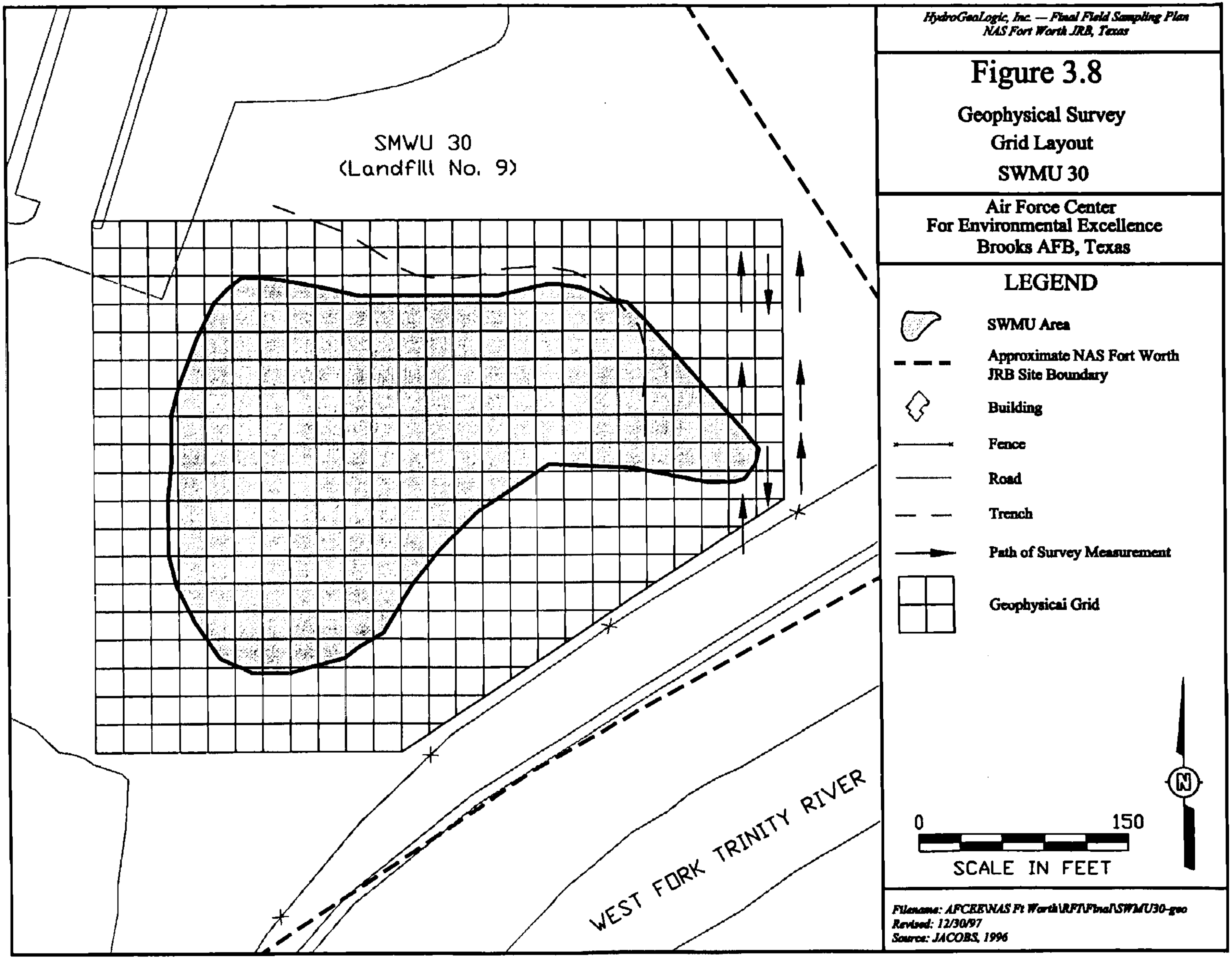
Brooks AFB, Texas



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Revised: 12/30/97
Source: JACOBS, 1996

As shown in Figure 3.9, SWMU 30 is located near a bend in the West Fork of the Trinity River. A close examination of Figure 2.13 (Lake Worth topographic Map) shows the SWMU on a relatively flat terrace located within the current flood plain of the River. A former meander bend of the West Fork of the Trinity River near SWMU 30 is also depicted in Figure 2.13. Based on this information, local groundwater flow in the vicinity of the SWMU may have a southwestern component parallel to the river flow direction, or it may flow directly to the river. Temporary piezometers will be used to evaluate local groundwater flow directions prior to the installation of monitoring wells.

A minimum of four perimeter monitoring wells will be installed as soon as local groundwater flow directions have been established. Four augered soil borings, one upgradient and three downgradient, will be drilled 1-foot into bedrock and converted to 2-inch monitoring wells. Proposed locations for soil borings, piezometers and monitoring wells are presented in Figure 3.8.

Since there is little information concerning the nature of contaminants associated with the SWMU, all soil and groundwater samples will be analyzed for a full suite of Appendix IX constituents. Three rounds of groundwater sampling are planned for the new wells. Analytical results of the first round of sampling may be used to justify a shorter Appendix IX analyte list in subsequent rounds of sampling. Additional soil borings and monitoring wells may be installed at a later date to delineate the extent of contamination originating from the SWMU if the proposed monitoring wells identify contamination above RRS.

3.3.5 SWMU 62

A geophysical survey, three direct push soil borings, five temporary piezometers, four soil probes, and four monitoring wells will be used to evaluate potential contamination resulting from waste buried at SWMU 62.

Two geophysical tools will be used to conduct surveys at SWMU 62 to delineate the extent of the landfill and identify "hot spots" that may be contributing to subsurface contamination. The survey procedure for SWMU 62 will begin by creating a grid over an approximate 2.5-acre area (460 feet [N-S] by 240 feet [E-W]) that will overlay the area expected to have been used as a landfill (Figure 3.10). Although the lateral extent of the landfill is not expected to be this large, a fringe around the landfill is desired and will serve as a background data set for comparison. Station locations will be placed on 20 foot centers, using a tape measure for distance and a transit for trueness. The base station for this grid will be along the fence to the north of the landfill. Measurements will be taken at each of the grid nodes and recorded. All distances on the geophysical survey will be measured in feet from this location.

Three soil borings will be installed inside the perimeter of the unit. Soil boring locations are depicted in Figure 3.11. Continuous cores will be used to evaluate the physical characteristics of the soil and waste. Soil samples from these continuous cores will be collected for chemical analysis every 5 feet from the ground surface to the water table. Surface soil samples at each boring location will be collected using stainless steel scoops or trowels. The central soil boring will be advanced into the water table and converted into a temporary piezometer.

Figure 3.9

Proposed Investigation Activities SWMU 30

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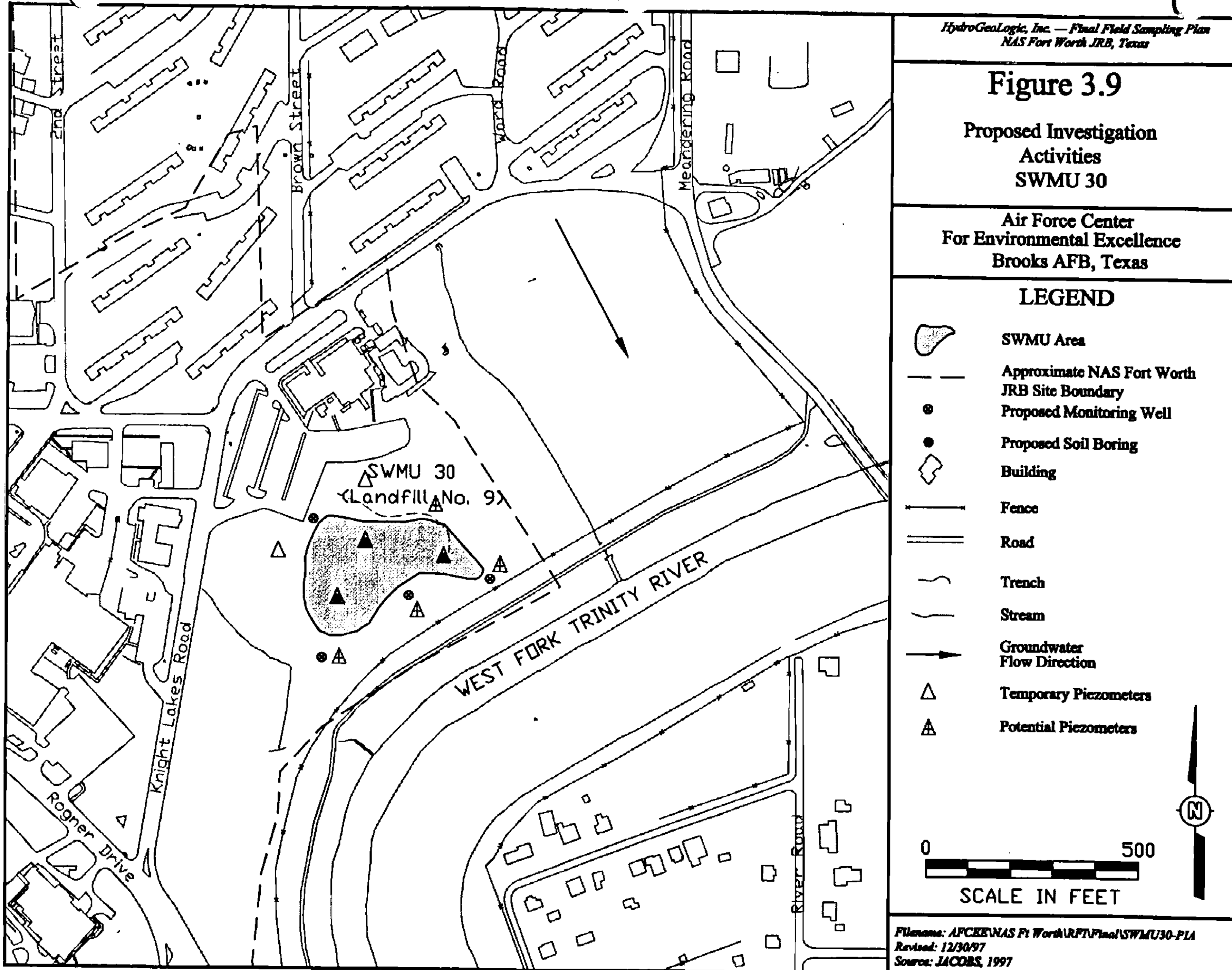

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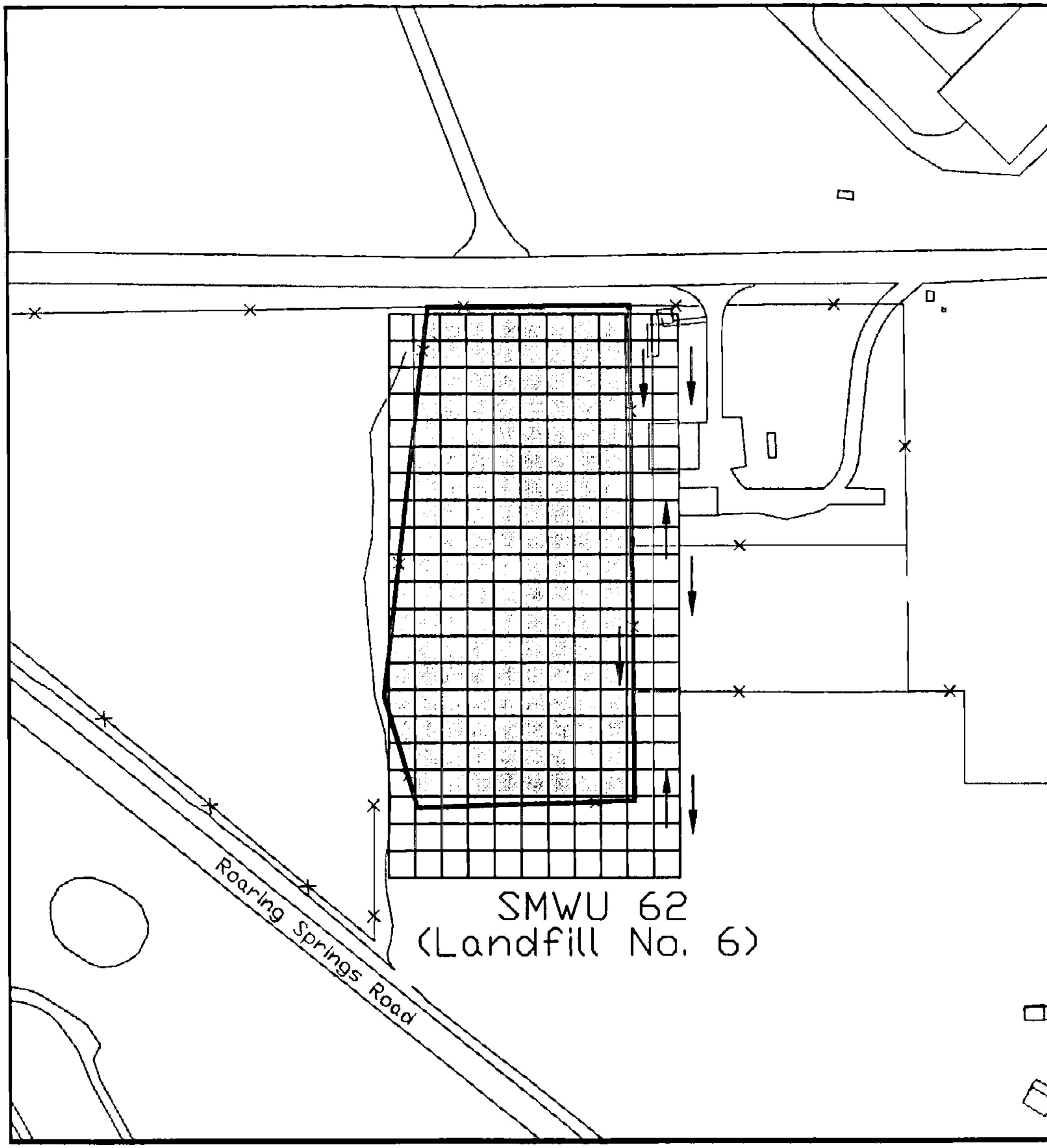
Revised: 12/30/97
Source: JACOBS, 1997



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NAS Fort Worth JRB, Texas

Figure 3.10

**Geophysical Survey
Grid Layout
SWMU 62**

**Air Force Center
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Brooks AFB, Texas**

LEGEND

SWMU Area

Proposed Monitoring Well

Building

Fence

Road

Path of Survey Measurements

Geophysical Grid

0 150
SCALE IN FEET

N

Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU62-geo.dwg
Revised: 12/30/97
Source: JACOBS, 1996

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NAS Fort Worth JRB, Texas

Figure 3.11

Proposed Investigation Activities SWMU 62

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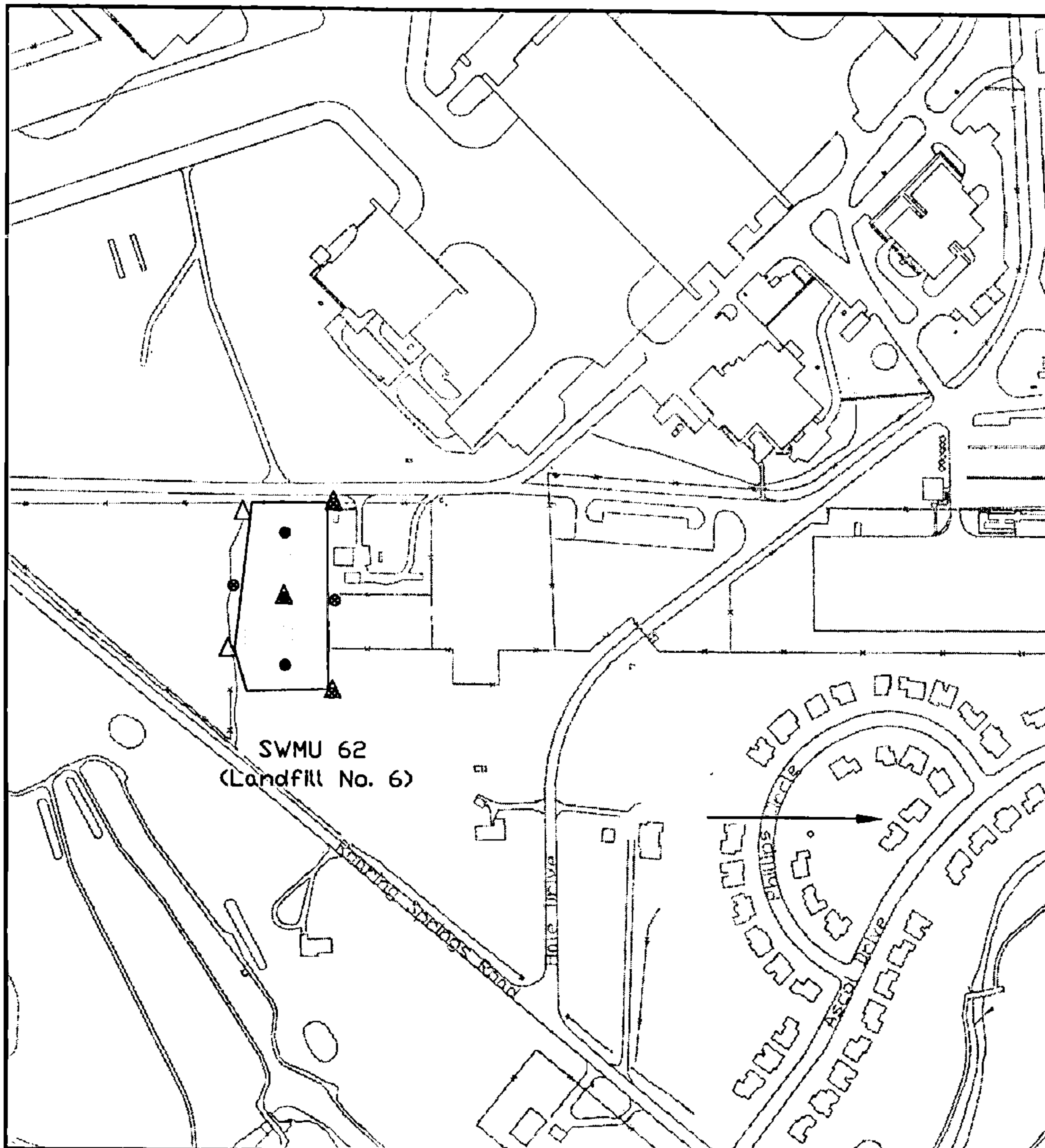

LEGEND

- SWMU Area
- Proposed Soil Boring
- Building
- Fence
- Road
- Proposed Monitoring Well Location
- Groundwater Flow Direction
- Temporary Piezometer

0 500
SCALE IN FEET

N

Filename: AFCEE\NAS Ft Worth\RFI\Final\SWMU62-PIA.dwg
Revised: 12/30/97
Source: JACOBS, 1996

Four soil probes will also be driven into the subsurface to install additional temporary piezometers outside the SWMU. Groundwater flow is generally from the west to the east in the alluvium beneath NAS Fort Worth JRB; however, information on local groundwater flow patterns near SWMU is limited. The temporary piezometers are proposed to determine local groundwater flow directions prior to the installation of monitoring wells.

Four monitoring wells will then be installed around the perimeter of the SWMU. Each of the augered soil borings used to establish the monitoring wells will be drilled 1-foot into bedrock and completed with 2-inch diameter PVC casing and screen. These wells will be used to determine depth to bedrock, evaluate the unit represented as bedrock, and characterize the physical/chemical characteristics of groundwater beneath the unit. By comparing the groundwater quality upgradient of the unit with the quality of the groundwater downgradient of the unit, it can be determined whether the waste buried in the unit has impacted groundwater quality beneath the site.

Based on the lack of historical records of buried debris and suspected contaminants associated with the SWMU, all soil and groundwater samples will be analyzed for a full suite of Appendix IX constituents. Three rounds of groundwater sampling are planned for the new wells. Analytical results of the first round of sampling may be used to justify a shorter Appendix IX analyte list in subsequent rounds of sampling. Additional soil borings and monitoring wells may be installed at a later date to delineate the extent of contamination originating from the SWMU, if the original suite of monitoring wells identify contamination above RRS.

4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Figure 4.1 shows the project organization, reporting relationships, and line authority. Table 4.1 lists key project personnel and their respective telephone numbers. Other personnel will be assigned as necessary. The specific responsibilities are described in the following subsections.

Table 4.1
Key Project Personnel
RCRA Facility Investigation - SWMUs 17,27,29,30, and 62
NAS Fort Worth JRB, Texas

Name	Title	Organization	Telephone
Joseph Dunkle	Team Chief	AFCEE/ERD	(210) 536-5290
John B. Robertson	Program Manager	HydroGeoLogic	(703) 478-5186
James Costello	Project Manager	HydroGeoLogic	(703) 478-5186
Gary Mayer	QA Manager	HydroGeoLogic	(703) 478-5186
Christopher Spill	Health & Safety Officer	HydroGeoLogic	(703) 478-5186
TBD	Lab Project Manager	TBD	TBD
TBD	Lab Operations Manager	TBD	TBD
TBD	Lab QA Officer	TBD	TBD
TBD	Lab Sample Custodian	TBD	TBD
Michael Rodtang	Project Geologist	HydroGeoLogic	(703) 478-5186
Robert Wallace	Project Geologist	HydroGeoLogic	(703) 478-5186
Omar Abdi	Data Mgmt. Supervisor	HydroGeoLogic	(703) 478-5186
Bruce Rappaport	Senior Reviewer	HydroGeoLogic	(703) 478-5186
Miquette Gerber	Senior Reviewer	HydroGeoLogic	(703) 478-5186

TBD - To Be Determined

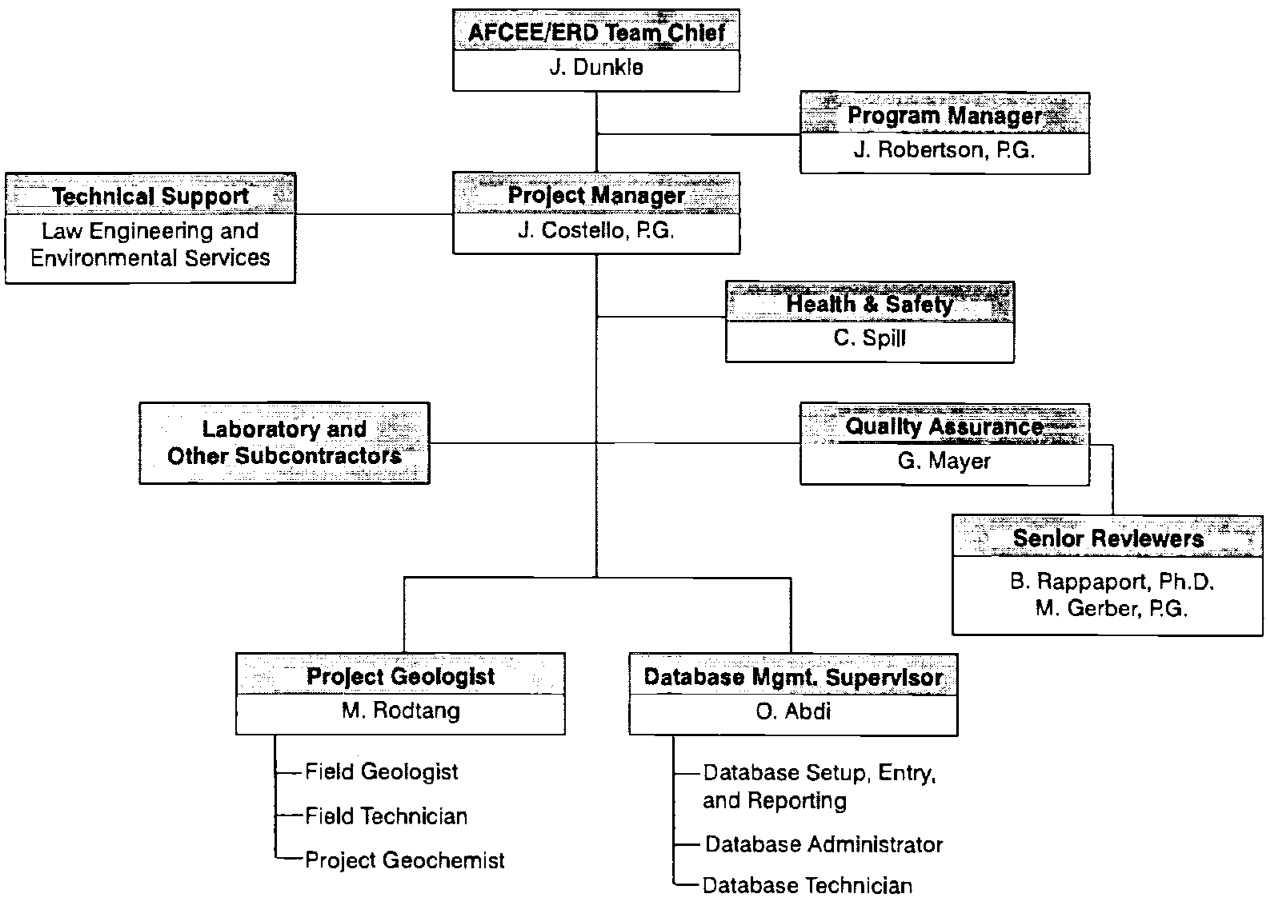

Figure 4.1 Project Organization Chart, NAS Fort Worth JRB

4.1 MANAGEMENT RESPONSIBILITIES

4.1.1 Program Manager

The Program Manager's responsibilities will include:

- Reviewing and approving the WP, QAPP, FSP, and HSP
- Providing sufficient resources to the project team so that it can respond fully to the requirements of the investigation
- Providing direction and guidance to the Project Manager
- Reviewing the final project report
- Providing other responsibilities as requested by the Project Manager

4.1.2 Project Manager

The Project Manager will be the prime point of contact with AFCEE and will have primary responsibility for technical, budget, and scheduling matters. His duties will include:

- Reviewing and approving project plans and reports
- Assigning duties to the project staff and orienting the staff to the needs and requirements of the project
- Obtaining the approval of the QA Manager for proposed variances to the WP and FSP
- Supervising the performance of project team members
- Providing budget and schedule control
- Reviewing subcontractor work and approving subcontract invoices
- Ensuring that major project deliverables are reviewed for technical accuracy and completeness, including data validity, before their release
- Ensuring that all resources of the laboratory are available on an as-required basis
- Overseeing final analytical reports

4.2 QA AND HEALTH AND SAFETY RESPONSIBILITIES

4.2.1 QA Manager

Responsibilities of the QA Manager will include:

- Serving as official contact for QA matters for the project
- Identifying and responding to QA/QC needs and problem resolution needs, and answering requests for guidance or assistance
- Reviewing, evaluating, and approving the FSP and QAPP and all changes to these documents
- Verifying that appropriate corrective actions are taken for all nonconformances
- Verifying that appropriate methods are specified in the FSP and QAPP for obtaining data of known quality and integrity
- Fulfilling other responsibilities as requested by the Project Manager
- Evaluating subcontractor quality program
- Training Staff on QA subjects
- Supervising staff in QA Program related tasks
- Recommending changes in the QA Program

4.2.2 Health and Safety Coordinator

Responsibilities of the Health and Safety Coordinator (HSC) will include:

- Developing the HSP
- Ensuring that the requirements of the QAPP are satisfied
- Providing other responsibilities as identified in the HSP

4.3 LABORATORY RESPONSIBILITIES

4.3.1 Laboratory Project Manager

The laboratory's Project Manager will report directly to HydroGeoLogic's Project Manager and will be responsible for the following:

- Ensuring that all resources of the laboratory are available on an as-required basis
- Overseeing final analytical reports

4.3.2 Laboratory Operations Manager

The laboratory's Operation Manager will report to the laboratory's Project Manager and will be responsible for the following:

- Coordinating laboratory analyses
- Supervising in-house chain-of-custody
- Scheduling sample analyses
- Overseeing data review
- Overseeing preparation of analytical reports
- Approving final analytical reports prior to submission to HydroGeoLogic

4.3.3 Laboratory QA Officer

The laboratory's QA officer has the overall responsibility for data after it leaves the laboratory. The QA officer will be independent of the laboratory but will communicate data issues through the laboratory's Project Manager. In addition, the QA officer will:

- Conduct audits of laboratory analyses
- Provide oversight of laboratory QA
- Provide oversight of QA/QC documentation
- Conduct detailed data review
- Determine whether to implement laboratory corrective actions, if required
- Define appropriate laboratory QA procedures
- Prepare laboratory Standard Operation Procedures

4.3.4 Laboratory Sample Custodian

The laboratory's Sample Custodian will report to the Operations Manager. Responsibilities of the Sample Custodian will include:

- Receiving and inspecting the incoming sample containers

- Recording the condition of the incoming sample containers
- Signing appropriate documents
- Verifying chain-of-custody and its correctness
- Notifying laboratory manager and laboratory supervisor of sample receipt and inspection
- Assigning a unique identification number and customer number, and entering each into the sample receiving log
- Initiating transfer of the samples to appropriate lab sections with the help of the laboratory operations manager
- Controlling and monitoring access/storage of samples and extracts

4.4 FIELD RESPONSIBILITIES

4.4.1 Project Geologist

The Project Geologist will be responsible for geologic interpretations as well as acting as lead coordinator for field activities. The Project Geologist's duties and responsibilities will include:

- Providing orientation and any necessary training to field personnel (including subcontractors) on the requirements of the FSP, HSP, and QAPP before the start of work
- Providing direction and supervision to the sampling crews
- Monitoring sampling operations to ensure that the sampling team members adhere to the QAPP and FSP
- Ensuring the use of calibrated measurement and test equipment
- Maintaining a field records management system
- Coordinating activities with the Project Manager
- Supervising geological data interpretation activities
- Overseeing field data documentation and conducting quality checks on interpretive geologic work products
- Reviewing reports for compliance with State of Texas and EPA requirements
- Assuming the duties of the HSC at the direction of the HSC

4.5 SUBCONTRACTORS

Subcontractors will be used for the drilling of soil borings; installation of monitoring wells; and excavation of test pits during the field investigation. In addition, laboratory analyses of all samples collected during the investigation will also be subcontracted to an AFCEE approved laboratory.

Qualified subcontractors will be selected in accordance with AFCEE requirements and HydroGeoLogic Procurement and QA procedures. Subcontractors will meet predetermined qualifications developed by the Project Manager and defined in the procurement bid packages. Each bid submitted will be reviewed for technical, QA, and purchasing requirements. All subcontractors will be required to follow the procedures of the WP, FSP, QAPP, and HSP. Periodic QC inspections of each subcontractor may be performed as specified in the FSP (Section 7.5), QAPP (Section 9.1), and HSP (Section 1.3.2). These inspections will be performed by the QA Manager, or his designate, as unannounced audits to confirm adherence to the procedures and guidance outlined in the aforementioned documents. Such inspections may relate to health and safety, QAPP requirements, and field standard operating procedures.

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5.0 FIELD OPERATIONS

The overall project field logistics and activities necessary to complete the project sampling objectives described in the work plan are presented in this section. All field work will be conducted in accordance with the site HSP. HydroGeoLogic is the prime contractor for the field investigation. The point-of-contact (POC) at the Base will be Mr. Joseph Dunkle. HydroGeoLogic's Project Geologist/Field Coordinator will be Mr. Michael Rodtang.

5.1 GEOLOGIC STANDARDS

The lithologic descriptions for consolidated materials (igneous, metamorphic, and sedimentary rocks) shall follow the standard professional nomenclature (cf. Tennissen, A.C., 1983, Nature of Earth Materials, 2nd Edition, p. 204-348), with special attention given to describing fractures, vugs, solution cavities and their fillings or coatings, and any other characteristics affecting permeability. Colors shall be designated by the Munsell Color System.

The lithologic descriptions for unconsolidated materials (soils [engineering usage] or deposits) shall use the name of the predominant particle size (e.g., silt, fine sand, etc.). The dimensions of the predominant and secondary sizes shall be recorded using the metric system. The grain size and name of the deposit shall be accompanied by the predominant mineral content, accessory minerals, color, particle angularity, and any other characteristics. The classic deposit descriptions shall include, as a supplement, symbols of the Unified Soil Classification System (USCS). The color descriptions shall be designated by the Munsell Color System.

The sedimentary, igneous, and metamorphic rocks and deposits shall be represented graphically by the patterns shown in Figure 5.1. Columnar sections, well and boring logs, well construction diagrams, cross sections, and three-dimensional (3-D) diagrams shall use these patterns. Supplementary patterns shall follow Swanson, R. G., 1981, Sample Examination Manual, American Association of Petroleum Geologists, p IV-41 and 43. Geologic structure symbols shall follow American Geological Institute Data Sheets, 3d Edition, 1989, sheets 3.1 through 3.8.

The scales for maps, cross sections, or 3-D diagrams shall be selected in accordance with the geologic and hydrologic complexity of the area and the purposes of the illustrations. Geophysical logs shall be run at a constant vertical scale of 1 inch equals 20 feet. When geophysical logs are superimposed on geologic logs, cross sections, or 3-D diagrams, the scales shall be the same. If defining geological conditions requires other scales, additional logs at those scales shall be provided.

For orientation, the cross sections shall show the Northern end on the viewer's right. If the line of cross section is predominantly East-West, the Eastern end is on the right. Maps shall be oriented with North toward the top, unless the shape of the area dictates otherwise. Indicate orientation with a North arrow.

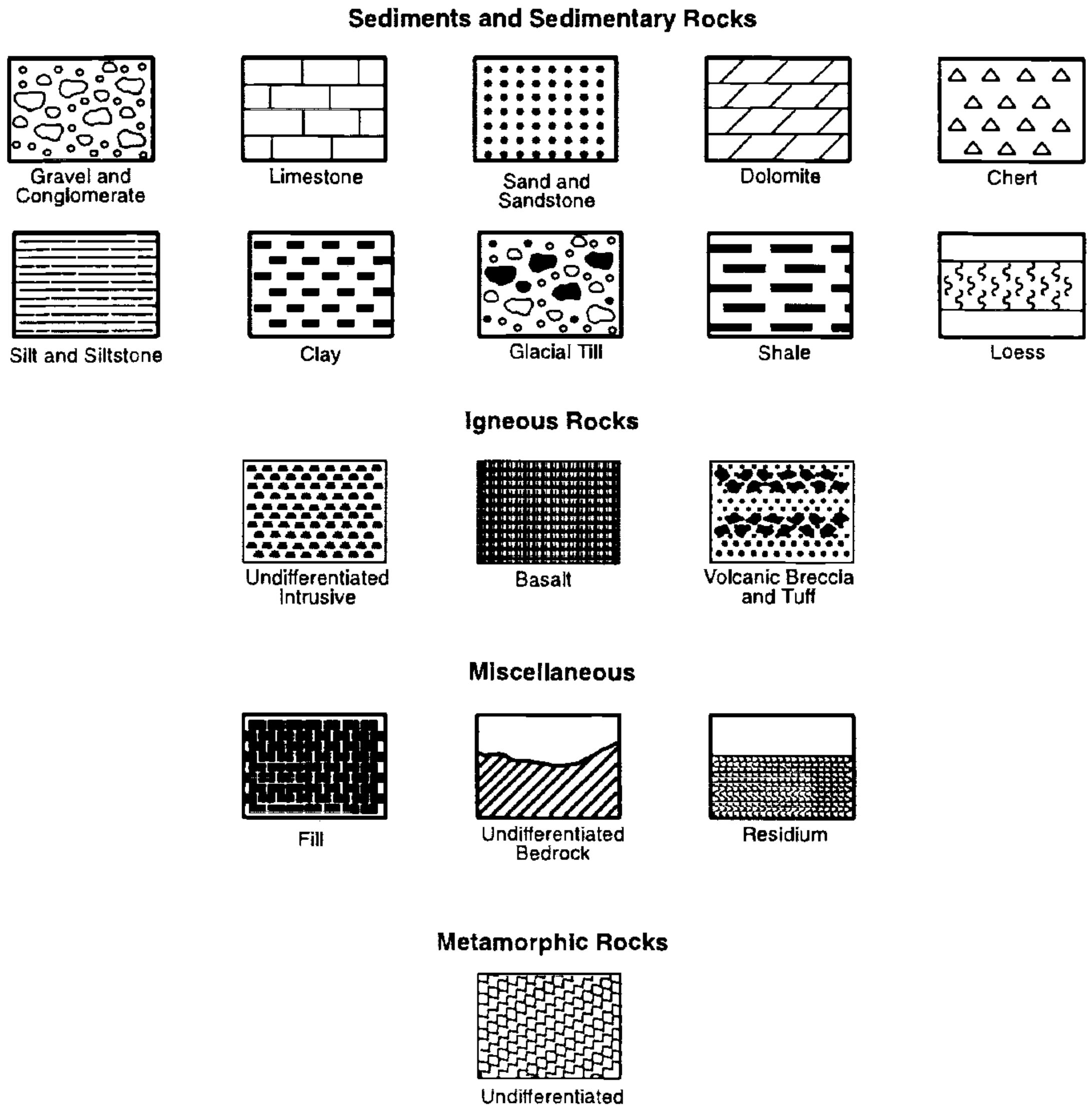

Figure 5.1 Lithologic Patterns for Illustration

5.2 SITE RECONNAISSANCE, PREPARATION, AND RESTORATION PROCEDURES

Areas designated for intrusive sampling shall be surveyed for the presence of underground utilities. Utility locations are determined using existing utility maps; in the field, they are verified by using a hand-held magnetometer or utility probe. Prior to commencement of drilling activities, digging permits will be obtained from the Air Force Base Realignment and Closure Agency (AFBRCA) office, located on White Settlement Road. The Base civil engineer will be contacted to verify that selected locations are free of underground utilities. Those locations not clear of underground utilities will be relocated to achieve clearance, and then verified for clearance a second time. Vehicle access routes to sampling locations shall be determined prior to any field activity.

A centralized decontamination area shall be provided for drilling rigs and equipment. The decontamination area shall be large enough to allow storage of cleaned equipment and materials prior to use, as well as to stage drums of decontamination waste. The decontamination area shall be lined with a heavy gauge plastic sheeting, and designed with a collection system to capture decontamination waters. Solid wastes shall be accumulated in 55-gallon drums and subsequently transported to a waste storage area designated by the USAF. Smaller decontamination areas for personnel and portable equipment shall be provided as necessary. These locations shall include basins or tubs to capture decontamination fluids, which shall be transferred to a large accumulation tank as necessary. These designated areas of decontamination shall be determined during the pre-construction meeting.

The field office and the primary staging area for field equipment and supplies will be located in the building adjacent to the west side of the AFBCA office at 6550 White Settlement Road. This location is in close proximity to SWMU 17 which is under investigation.

Each work site or sampling location shall be returned to its original condition when possible. Efforts shall be made to minimize impacts to work sites and sampling locations, particularly those in or near sensitive environments such as wetlands. Following the completion of work at a site, all drums, trash, and other waste shall be removed. Decontamination and/or purge water and soil cuttings shall be transported to the designated locations as described in Section 5.10. At the completion of field activities, all capital equipment and consumable materials will be removed or turned over to base personnel in accordance with AFCEE procedures. A final site walk will be conducted with the Base representative, at his/her discretion, to ensure that all sampling locations have been restored satisfactorily before final demobilization from the site.

5.3 GEOPHYSICAL SURVEYS

Two geophysical tools, an Electromagnetic Induction (EM) tool and a magnetometer will be used to evaluate the extent of the landfills and any "hot spots" that may be present at SWMU's 17, 27, 29, 30 and 62. For each SWMU location, the EM survey will be used to initially identify and pin point areas with conductivity contrasts; i.e., "hot spots." The grid will then be resurveyed, including the "hot spots" using the cesium (Cs) magnetic gradiometer as a confirmatory tool. The data gathered from these surveys will help identify areas of buried wastes and provide indications on the depths of groundwater, bedrock, and stratigraphy. This information will be used to assure that optimal trenching and soil sampling locations are selected.

5.3.1 General Requirements For Geophysical Surveys

General requirements for all geophysical surveys are as follows: (1) HydroGeoLogic shall provide a professional geologist or engineer to supervise the project, (2) the locations of surface geophysical grid system layouts shall be shown on a site map, (3) final results shall be presented in plain views and cross sections; contours shall be used where appropriate, (4) the interpretation of results shall discuss positive and negative results, as well as limitations of the method and data, and (5) the interpretation of the data shall be incorporated into the conceptual site model.

5.3.2 Surface Geophysical Surveys

Surface geophysical techniques include, but are not limited to, ground penetrating radar (GPR), magnetometry, and electromagnetic techniques. Use of any of these techniques is dictated by the project data quality objectives (Section 3.0), and the objectives of these techniques is to locate the boundaries of suspected or known underground metallic objects or volumes of disturbed soil. The areas to be surveyed are described in Section 3.0 and shown on site maps presented in the WP.

Surface geophysical surveys are conducted within predetermined grids defined by transect lines crossing each site or area of interest. The spacing of the grids is determined from the approximate dimensions of the features to be located. Qualified individuals will conduct the surveys and will be supervised by a professional geologist or engineer.

Location and elevation information sufficient to map and assess the survey results shall be recorded. Depending on the level of accuracy and detail required, northing and easting from a surveyed reference point, measurements in a third order survey, depth below ground surface (bgs), and/or professionally surveyed points and transects may be included. Location data, instrument numbers, calibration information, geophysical interpretation, and maps for all geophysical surveys shall be stored in project files.

General requirements for surface geophysical surveys are as follows: (1) HydroGeoLogic will correlate surface survey data (profiles and soundings) with at least one soil boring, well bore, or outcrop at the same site as the survey, and (2) the location and elevation of at least two points of the geophysical survey grid will be surveyed according to the specifications of Section 5.8.

5.3.2.1 <u>Electromagnetic Methods</u>

An electromagnetic survey measures the electrical conductivity of a subsurface volume, which is a function of the soil or rock type, porosity/permeability, and fluid content. The measured values, referred to as terrain conductivity, are obtained without direct ground contact through electromagnetic induction. Data collected during an electromagnetic survey can be used to map the location of buried metallic objects; depth or thickness determinations cannot be made solely by this method. The electromagnetic technique can also detect chemicals or contaminant plumes (e.g., hydrocarbons in high concentrations, or other conductive or resistive chemicals). A Geonics' model EM-31 will be used to measure the apparent conductivity of the soil at various depths. The instrument consists of a transmitter coil energized with an alternating current at a 9.9 kiloHertz (kHz) frequency, and a receiver coil, separated by a rigid boom. The time-varying magnetic field arising from the alternating current in the transmitter coil induces very small currents into the earth. These currents generate a secondary magnetic field, which is received, together with the primary field, by the receiver coil. The instrument then measures the terrain conductivity by comparing the strength of the two signals.

The EM-31 has an intercoil spacing of 3.7 meters, which yields an effective depth of exploration of about 20 feet. Based on existing site conditions, cultural interference (i.e. utilities, fences, etc.) will be documented during each survey and evaluated as part of the data interpretation. Both quadrature and in-phase channels will be utilized. The quadrature phase channel reads the apparent terrain conductivity of the soil, while the in-phase provides a measure of the terrain magnetic susceptibility. The instrument is calibrated to read terrain conductivity in millimhos per meter. The subsequent readings along the line and station location can be digitally recorded in the field using a portable data logger. This device provides an efficient data interface for computer enhancement and mapping.

The EM-31 survey looks for changes in the terrain conductivity and magnetic susceptibility values as compared with the natural undisturbed soils. This technique has been proven successful in locating buried metallic objects such as pipes, drums, and tanks. Values for buried metallic objects depend upon size and depth of, and distance from the object to the instrument. The presence of subsurface metallic objects near the EM-31 will cause a dramatic change in the instrument readings. Non-metallic objects, such as plumes from petroleum, oils and lubricants (POLs), and chlorinated solvents, can also be detected since they will yield an anomalous low because of their relatively low conductivity.

The EM-31 survey will be utilized to quickly investigate and pin point areas with conductivity contrasts. The EM-31 instrument will be initially calibrated and corrected to zero reading. The DL55/31 Data Logger will be initialized and programmed for the aforementioned survey lines, direction, increment, and reading type. The survey procedure for the EM-31 will be to hand carry the instrument along grid lines with station readings every 20 feet except where surface obstructions may prevent continuous profiling. Section 3.3 further describes the established grid patterns of the survey.

5.3.2.2 Magnetometry

Magnetometer surveys measure variations in the earth's magnetic field. Measurements of the magnetic gradient can be used to locate buried ferrous objects such as tanks, pipelines, and metallic debris.

Magnetometer surveys are conducted using a magnetometer/gradiometer or equivalent equipment. The magnetometer has two sensors and an electronics package and can collect both total field data and vertical gradient data and can discriminate to 0.2 gammas (g) in a total field of 40,000 to 60,000g. Magnetic readings are stored in memory with the time of day, station numbers, and line numbers of the readings. A base station for magnetic readings is established at the start of each day's measurements. Magnetic readings will be collected and recorded in the morning, at noon, and at the end of day to evaluate instrument drift.

The GeoMetrics 858G magnetic gradiometer uses the earth's magnetic field and local variations in the field. The magnetic survey involves the measurement of the earth's magnetic field at various points on the ground surface. Variations in the magnetic susceptibility of the subsurface materials produce anomalies within the earth's magnetic field that can be resolved using a magnetic gradiometer. For the purpose of this project, the magnetic gradiometer will be used to detect ferromagnetic objects, such as drums or tanks, to depths of 10 to 15 feet below the ground surface. For larger objects, or groups of objects, the survey can penetrate to a depth of 25 feet. An added benefit of using the magnetometer is that ferromagnetic objects on the land surface, such as fences and manhole covers, will not create interference; i.e., false anomalies with the survey.

Two types of magnetic measurements that can be obtained include a magnetic total field and magnetic vertical gradient. The total field intensity is simply the magnitude of the earth's magnetic field vector. The magnetic vertical gradient is a measure of the difference in the total magnetic field between two sensors set at different fixed heights above the ground. In general, the total field measurements are most suitable for reconnaissance surveys, while gradient measurements allow resolution of more complex anomalies.

Magnetic measurements are affected by several sources that interfere with the desired magnetic signal. By using standard surveying techniques, however, the effects of these sources of interference can be removed or corrected from the magnetic data.

The magnetometer will utilize its gradiometer capabilities for geologic reconnaissance to discern between native materials and those that are relict. This will be accomplished by the gradiometer receiving anomalous low readings that will be in response to disturbed soils; i.e., landfill materials. Areas that have not been disturbed will be received and recorded equal to those of normal background levels. These anomalous lows from the gradiometer, and data collected from the EM-31, will help to determine the aerial and vertical extent of the landfill.

The magnetometer survey will be conducted to confirm any anomalous areas detected by the EM-31 survey. The magnetometer will be initially calibrated and corrected to a zero reading. As the magnetic survey proceeds, a built-in data logger will record any magnetic variation in the earth's magnetic field; i.e., "hot spots." The surveyor will also have the capability of viewing these variations, on the screen, as they are recorded. The survey procedure for the magnetometer will be the same as for the EM-31, which will be to hand carry the instrument along established grid lines with station readings every 20 feet except where surface obstructions may prevent continuous profiling. Section 3.3 further describes the established grid patterns of the survey.

5.4 BOREHOLE DRILLING, LITHOLOGIC SAMPLING, LOGGING, AND ABANDONMENT

5.4.1 General Drilling Procedures

All drilling activities shall conform with state and local regulations and will be supervised by a professional geologist or engineer. HydroGeoLogic will obtain and pay for all permits, applications, and other documents required by state and local authorities.

The location of all borings will be coordinated, in writing, with the base civil engineer, or equivalent, before drilling commences. When drilling boreholes through more than one water bearing zone or aquifer, HydroGeoLogic and its subcontractors will take measures to prevent cross-connection or cross-contamination of the zones or aquifers.

The drill rig will be cleaned and decontaminated in accordance with (IAW) the procedure in Section 5.9. The drill rig shall not leak any fluids that may enter the borehole or contaminate equipment placed in the hole. The use of rags or absorbent materials to absorb leaking fluids is unacceptable, and will not be permitted.

As hollow-stem auger drilling is to be used for this project; drilling fluids shall not be used. A log of drilling activities will be kept in a bound field notebook. Information in the log book will include location, time on site, personnel and equipment present, down time, materials used, samples collected, measurements taken, and any observations or information that would be necessary to reconstruct field activities at a later date. At the end of each day of drilling, the drilling supervisor will complete a Log of Daily Time and Materials Form. An example of this form is provided in Appendix D.

HydroGeoLogic will dispose of all trash, waste grout, cuttings, and drilling fluids as coordinated with the base civil engineer or NAS Fort Worth JRB representative.

5.4.2 Sampling and Logging

The lithology in all boreholes will be logged. The boring log form (Appendix D) will be used for recording the lithologic logging information. Information on the boring log sheet includes the borehole location, drilling information, sampling information (such as sample intervals), recovery, blow counts, and sample description information.

Unconsolidated samples for lithologic description will be obtained continuously at 2-foot intervals using split spoon samplers and standard penetration tests. Lithologic descriptions of unconsolidated materials encountered in the boreholes will generally be described in accordance with American Society for Testing and Materials (ASTM) D-2488-90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 1990). Descriptive information to be recorded in the field will include: (1) identification of the predominant particles: size and range of particle sizes, (2) percent of gravel, sand, fines, or all three, (3) description of grading and sorting of coarse particles, (4) particle angularity and shape, and (5) maximum particle size or dimension.

Plasticity of fines description include (1) color using Munsell Color System, (2) moisture (dry, wet, or moist), (3) consistency of fine grained soils, (4) structure of consolidated materials, and (4) cementation (weak, moderate, or strong).

Identification of the USCS group symbol will be used. Additional information to be recorded includes the depth to the water table, caving or sloughing of the borehole, changes in drilling rate, depths of laboratory samples, presence of organic materials, presence of fractures or voids in consolidated materials, and other noteworthy observations or conditions, such as the locations of geologic boundaries.

Lithologic descriptions of consolidated materials encountered in the boreholes will generally be described in accordance with Section 5.1. Consolidated samples for lithologic description will be obtained continuously at 2-foot intervals using split spoon samplers and standard penetration tests All samples will be monitored with an organic vapor monitor (e.g., PID, OVA). The samples shall be handled in such a way as to minimize the loss of volatiles; these procedures are described in Section 6.0. Cuttings will be examined for their hazardous characteristics. Materials suspected to be hazardous because of abnormal color, odor, or organic vapor monitor readings will be containerized in conformance with RCRA, state, and local requirements.

5.4.3 Abandonment

Boreholes that are not converted to monitor wells will be abandoned in accordance with 30 TAC Chapter 238, Water Well Driller Rules (TNRCC, 1997). Since the borings will not exceed 100 feet, the boring will be plugged to a depth not exceeding two feet below ground surface with a solid column of either cement, or 3/8 inch or larger granular sodium bentonite. The granular bentonite shall be hydrated at frequent intervals while strictly adhering to the manufacturer's specifications. The top two feet of each boring will be filled with cement as an atmospheric barrier (TNRCC, 1997).

All abandoned boreholes will be checked 24 to 48 hours after mud/solid bentonite emplacement to determine whether curing is occurring properly. More specific curing specifications may be recommended by the manufacturer and will be followed. If settling has occurred, a sufficient amount of cement will be added to fill the hole to the ground surface. These curing checks and any addition of cement will be recorded in the field log.

5.5 MONITOR WELL CONSTRUCTION

The on-site Project Geologist will supervise the drilling, soil boring, geophysical surveys, lithologic sampling, and monitor well construction and will be a professional geologist or engineer. A Professional Geologist will affix his/her signature and registration/ certification seal to all drilling logs, as-built well construction diagrams, lithologic logs, sampling records, and similar documents. Although floating petroleum products (i.e., light non-aqueous phase liquids, LNAPLs) are not anticipated, shallow monitor wells shall be screened across the water table if they are encountered. The length of the screen will be such that tidal and seasonal water table fluctuations shall not cause water levels to rise above or fall below the screened interval. If dense petroleum products (i.e., dense non-aqueous phase liquids [DNAPLs]) are encountered, monitor wells will be screened at the bottom of the aquifer to capture the DNAPL.

5.5.1 Drilling Requirements

All drilling and well installations will conform to state and local regulations, and HydroGeoLogic will obtain and pay for all permits, applications, and other documents required by state and local authorities. The location of all borings will be coordinated in writing with the base civil engineer or equivalent before drilling commences.

The rig will be cleaned and decontaminated according to the guidelines described in Section 5.9. The rig will not leak any fluids that may enter the borehole or contaminate equipment that is placed in the hole. Rags or absorbent materials will not be used to absorb leaking fluids.

HydroGeoLogic and its drilling subcontractors will dispose of all trash, waste grout, cuttings, and drilling fluids as coordinated with the base civil engineer or representative. Monitoring wells will be completed in the alluvial terrace groundwater only, thereby preventing cross-connection or cross-contamination of other water bearing zones or aquifers.

5.5.2 Monitoring Well Borehole Requirements

As hollow-stem auger drilling is to be used for this project, the inside diameter of the auger will be at least 4-inches larger than the outside diameter of the casing and well screen.

The completed monitor wells will be sufficiently straight to allow passage of pumps or sampling devices and will be plumb within 1 degree of vertical where the water level is greater than 30 feet below land surface unless otherwise approved by AFCEE. AFCEE may waive a plumbness requirement. Any request for a waiver from straightness or plumbness specifications will be made, in writing, to AFCEE in advance of mobilization for drilling. HydroGeoLogic, or its drilling subcontractor, will use a single-shot declination tool to demonstrate plumbness. Monitor wells not meeting straightness or plumbness specifications will be redrilled and/or reconstructed.

Formation samples for lithologic description will be obtained continuously at 2-foot sampling intervals. All samples will be monitored with an organic vapor monitor (e.g., PID, OVA). The samples will be handled in such a way as to minimize the loss of volatiles. These procedures are described in Section 6.0. Cuttings will be examined for their hazardous characteristics. Materials that are suspected of being hazardous because of abnormal color, odor, or organic vapor monitor readings shall be containerized in conformance with RCRA and the state and local requirements.

The documentation record and forms (Appendix D) will document the following information for each boring: (1) boring or well identification (this identification shall be unique, and HydroGeoLogic will ensure it has not been used previously at the installation.), (2) purpose of the boring (e.g., soil sampling, monitor well), (3) location in relation to an easily identifiable landmark, (4) names of drilling contractor and logger, (5) start and finish dates and times, (6) drilling method, (7) types of drilling fluids and depths at which they were used (not applicable to the drilling method used for this project), (8) diameters of surface casing, casing type, and methods of installation, (9) depth at which saturated conditions were first encountered, (10) lithologic descriptions and depths of lithologic boundaries, (11) sampling-interval depths, (12) zones of caving or heaving, (14) drilling rate, and (15) drilling rig reactions, such as chatter, rod drops, and bouncing.

In addition to the above, the following information shall be recorded when rock core samples are collected: (1) the depth interval and top and bottom of each core shall be marked on the core box, (2) percentage of core recovered, (3) number of fractures per foot, (4) angle of fractures relative to the core axis, and (5) breaks due to coring and core handling shall be distinguished from naturally occurring fractures.

A standard penetration test shall be performed each time a split spoon sample is taken. The test shall be performed in accordance with ASTM D-1586.

5.5.3 Casing Requirements

The casing requirements that will be followed are (1) all casing will be new, unused, and decontaminated according to the specifications of Section 5.9, (2) glue will not be used to join casing, and casings will be joined only with compatible welds or couplings that shall not interfere with the planned use of the well, (3) all polyvinyl chloride (PVC) will conform to the ASTM Standard F-480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System), (4) all metal casing will be seamless stainless steel casing, and the casing "mill" papers will be included in the appendix of the technical report, (5) the casing will be straight and plumb within the tolerance stated for the borehole, and (6) the driller shall cut a notch in the top of the casing to be used as a measuring point for water levels.

All monitoring wells for this project will be constructed using flush threaded two-inch diameter Schedule 40 PVC casing. The notches cut in the top of the monitoring well casings for water level measuring points will be oriented on the north side of each casing for uniformity.

5.5.4 Well Screen Requirements

AFCEE well screen requirements are as follows: (1) all requirements that apply to casing will also apply to well screen, except for strength requirements, (2) monitor wells will not be screened across more than one water-bearing unit, (3) screens will be factory slotted or wrapped, (4) screen slots will be sized to prevent 90 percent of the filter pack from entering the well, and for wells where no filter pack is used, the screen slot size will be selected to retain 60 to 70 percent of the formation materials opposite the screen, and (5) the bottom of the screen is to be capped, and the cap will be joined to the screen by threads.

The monitoring wells will be constructed using flush-threaded two-inch diameter Schedule 40 PVC casing and screen. The length of the well screen will be up to 20 feet long so that the upper 20 feet of the uppermost flow zone of the uppermost aquifer is screened with 0.010 inch continuous slotted PVC screen. The bottom of the screen will be capped using a flush threaded PVC cap.

5.5.5 Annular Space Reqnirements

The annular apace requirements are the following: (1) the annular space will be filled with a filter pack, a bentonite seal, and casing grout between the well string and the borehole wall, and (2) as the annular space is being filled, the well string will be centered and suspended such that it does not rest on the bottom of the hole, and for wells greater than 50 feet deep, at least two stainless steel centralizers will be used, one at the bottom and one at the top of the screen. Additional centralizers will be used as needed.

5.5.6 Filter Pack Reqnirements

The filter pack will consist of silica sand or gravel and will extend from the bottom of the hole to at least 2 feet above the top of the well screen. After the filter pack is emplaced, the well will be surged with a surge block for ten minutes. The top of the sand pack will be sounded to verify its depth during placement. Additional filter pack will be emplaced as required to return the level of the pack to 2 feet above the screen. The well will then be surged again for five minutes, and additional filter pack will be emplaced as required to bring its level to 2 feet above the screen.

The filter pack material will be clean, inert, and well-rounded, and will contain less than 2 percent flat particles. The sand will be certified free of contaminants by vendor or contractor. If decontamination is necessary, the methods shall be approved in writing by AFCEE.

The filter pack will have a grain size distribution and uniformity coefficient compatible with the formation materials and the screen. This will be calculated as described in Chapter 12, Ground Water and Wells, 2nd Edition (Driscoll, 1986). The grain size of the filter pack material will be determined based on existing grain size analysis prior to mobilization to the field. The filter pack will not extend across more than one water-bearing unit. The filter pack will be emplaced with a bottom discharge tremie pipe of at least 1 ½ inches in diameter. The tremic pipe will be lifted from the bottom of the hoel at the same rate the filter pack is set. HydroGeoLogic will record the volume of the filter pack emplaced in the well. If potable water is necessary to place the filter pack, HydroGeoLogic will obtain prior approval from the regulatory agency providing oversight, and will ensure that no contaminants are introduced into the well.

5.5.7 Bentonite Seal Requirements

The bentonite seal requirements that will be followed are (1) the bentonite seal will consist of at least 2 feet of bentonite between the filter pack and the casing grout, (2) the bentonite will be hydrated before placement and shall be installed by pump tremie methods, and (3) only 100 percent sodium bentonite shall be used.

5.5.8 Casing Grout Requirements

The casing grout requirements are as follows: (1) the casing grout will extend from the top of the bentonite seal to ground surface, (2) the grout will be mixed in the following proportions: 94 pounds of neat Type I Portland or American Petroleum Institute Class A cement, not more than 4 pounds of 100 percent sodium bentonite powder, and not more than 8 gallons of potable water, (3) all grout will be pump tremied using a side-discharge tremie pipe, and pumping will continue until 20 percent of the grout has been returned to the surface, and (4) in wells where the bentonite seal is visible and within 30 feet of the land surface, the 20 percent return is not necessary so long as the tremie pipe is pulled back as the grout is emplaced.

5.5.9 Surface Completion Requirements

For flush-mounted completions, the casing will be cut about three inches below the land surface and provided a water-tight casing cap to prevent surface water from entering the well. To allow for escape of gas, a small diameter (e.g., ¼-inch) vent hole will be placed in the upper portion of the casing, or a ventilated well cap will be used. A freely draining valve box with a locking cover will be placed over the casing. The top of the casing will be at least one foot above the bottom of the box. The valve box lid will be centered in a three-foot diameter, four-inch thick concrete pad that slopes away from the box at ¼ inch per foot. The identity of the well will be permanently marked on the valve box lid and the casing cap. Where heavy traffic may pass over the well or for other reasons, the concrete pad and valve box/lid assembly will be constructed to meet the strength requirements of surrounding surfaces.

When above-ground surface completion is used, the well casing will be extended 2 or 3 feet above land surface. A casing cap will be provided for each well, and the extended casing will be shielded with a steel sleeve that is placed over the casing and cap and seated in a 3-foot by 3-foot by 4-inch concrete surface pad. To allow for escape of gas, a small diameter (e.g., ¼-inch) vent hole will be placed in the well casing, or a ventilated well cap will be used. The concrete surface pad will be reinforced with steel reinforcing bars at least 1/4 inch in diameter. The ground surface will be freed of grass and scoured to a depth of 2 inches before setting the concrete pad. The diameter of the sleeve will be at least 6 inches greater than the diameter of the casing. The pad will be sloped away from the well sleeve. A lockable cap or lid will be installed on the guard pipe. The identity of the well will be permanently marked on the casing cap and the protective sleeve. Three 3-inch diameter concrete-filled steel guard posts, each 5 feet in total length, will be installed radially from each well head. The guard posts will be recessed approximately 2 feet into the ground and set in concrete. The guard posts will not be installed in the concrete pad placed at the well base. The protective sleeve and guard posts will be painted with a color specified by the installation civil engineer.

All wells will be secured as soon as possible after drilling with corrosion-resistant locks for both flush and above-ground surface completions. The locks will either have identical keys or be keyed for opening with one master key. The lock keys will be delivered to the appropriate USAF personnel following completion of the field effort. A Monitoring Well Construction Form will be completed for each well (Appendix D).

5.6 MONITOR WELL DEVELOPMENT

The monitor well development requirements are as follows: (1) all newly installed monitor wells will be developed no sooner than 24 hours after installation to allow for grout curing, (2) all drilling fluids used during well construction will be removed during development, (3) wells will be developed using surge blocks and bailers or pumps (prior approval for any alternate method will be obtained, in writing, from AFCEE before well construction begins), and wells will be developed until the turbidity of the well is less than or equal to 10 nephelometric turbidity units (NTU) and remains within a 5 NTU range for at least 30 minutes and the stabilization criteria in Section 6.0 are met, (4) discharge water color and volume will be documented, (5) no sediment will remain in the bottom of the well, (6) no detergents, soaps, acids, bleaches, or other additives will be used to develop a well, and (7) all development equipment will be decontaminated according to the specifications in Section 5.9.

5.7 ABANDONING MONITOR WELLS

All abandonment of monitor wells, when necessary, shall be performed in accordance with state and local laws and regulations. If slurry is used, a mud balance and/or Marsh Funnel will be used to ensure that the density (lbs/gal) of the abandonment mud mixture conforms with the manufacturer's specification. All abandoned monitor wells will be checked 24 to 48 hours after mud/solid bentonite emplacement to determine whether curing is occurring properly. More specific curing specifications or quality assurance checks may be recommended by the manufacturer and will be followed. Additionally, if significant settling has occurred, a sufficient amount of mud/solid bentonite will be added to attain its initial level. These slurry/solid bentonite curing checks, and any addition of mud/solid bentonite, will be recorded in the field logs.

5.8 SURVEYING

All surveying locations of field activities will be measured by a state of Texas certified land surveyor as the distance in feet from a reference location that is tied to the state plane system. The surveys will be third order (cf. Urquhart, L.C., 1962 Civil Engineering Handbook, 4th Edition, p. 96 and 97). An XY-coordinate system will be used to identify locations. The X-coordinate will be the East-West axis; the Y-coordinate will be the North-South axis. The reference location is the origin. All surveyed locations will be reported using the state plane coordinate system. The surveyed control information for all data collection points will be recorded and displayed in a table. The table will give the X and Y coordinates in state plane coordinate values, the ground elevation, and the measuring point elevation if the location is a ground-water monitor well. The elevation of all newly installed wells and piezometers will be surveyed at the water level measuring point (notch) on the riser pipe. The elevation of the ground surface at each water level measuring point will be included in the survey.

The X-Y coordinates for each sample location will be determined to within 0.1 feet and referenced to the State Plane Coordinate System. Vertical control will be to the National Geodetic Vertical Datum (NGVD) and will be within 0.01 feet for all sampling locations.

5.9 EQUIPMENT DECONTAMINATION

All equipment that may directly or indirectly contact samples will be decontaminated in a designated decontamination area. This includes casing, drill bits, auger flights, the portions of drill rigs that stand above boreholes, sampling devices, and instruments, such as slugs and sounders. In addition, HydroGeoLogic and its subcontractors will take care to prevent the sample from coming into contact with potentially contaminating substances such as tape, oil, engine exhaust, corroded surfaces, and dirt.

The following procedure will be used to decontaminate large pieces of equipment such as casings, auger flights, pipe and rods, and those portions of the drill rig that may stand directly over a boring or well location or that come into contact with casing, auger flights, pipe, or rods. The external surfaces of equipment will be washed with high-pressure hot water and Alconox, or equivalent laboratory-grade detergent, and if necessary, scrubbed until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been removed. The equipment will then be rinsed with potable water. The inside surfaces of casing, drill rod, and auger flights will also be washed as described.

The following procedure will be used to decontaminate sampling and drilling devices such as split spoons, bailers, and augers that can be hand-manipulated. For sampling and smaller drilling devices, the equipment will be scrubbed with a solution of potable water and Alconox, or equivalent laboratory-grade detergent. The equipment will then be rinsed with copious quantities of potable water followed by a rinse with ASTM Type II Reagent Water. High pressure liquid chromatograph-grade water and distilled water purchased in stores are not acceptable substitutes for ASTM Type II Reagent-Grade Water. The equipment will then be rinsed with pesticide-grade methanol followed by a rinse with pesticide-grade hexane. The equipment will then be allowed to air dry on a clean surface or rack, such as Teflon®, stainless steel, or oil-free aluminum, elevated at least 2 feet above ground. If the sampling device will not be used immediately after being decontaminated, it will be wrapped in oil-free aluminum foil, or placed in a closed stainless steel, glass, or Teflon® container.

Reagent-Grade II Water, methanol, and hexane will be purchased, stored, and dispensed only in glass, stainless steel, or Teflon® containers. These containers will have Teflon® caps or cap liners. HydroGeoLogic and its subcontractors will assure that these materials remain free of contaminants. If any question of purity exists, new materials will be used.

All fluids generated during decontamination activities will be placed in 55-gallon drums. All drums will be properly labeled as to content and shall be staged in a central location designated by the Base representative for temporary storage pending removal and disposal.

5.10 WASTE HANDLING

Waste handling will be dealt with on a site-by-site basis. Waste will be classified as either noninvestigative waste or investigative waste per the requirements of 30 TAC §335 Subchapter R and 40 CFR Part 261, Subpart C.

Non-investigative waste, such as litter and household garbage, will be collected on an as-needed basis to maintain each site in a clean and orderly manner. This waste will be containerized and transported to the designated sanitary landfill or collection bin. Acceptable containers will be sealed boxes or plastic garbage bags.

Waste containers will be labeled with the following information: type of matrix being contained, depth from which matrix was obtained, date matrix was contained, company name and phone number, and whether matrix is considered hazardous or not.

Characterization of Investigation Derived Waste (IDW) will be based on sample analysis obtained during the field investigation following EPA approved methods. Hazardous waste classification will first be determined as per 40 Code of Federal Regulations §261.2, §261.3, or §261.4. Waste that is nonhazardous, is then classified as Class 1, Class 2, or Class 3 according to 30 TAC §335.505 - 335.507. Once the IDW has been characterized, an eight digit waste code number will be provided as required in §335.501. The disposal of IDW will be conducted in a timely and cost effective manner, and in accordance with all state and federal regulations.

IDW will be properly containerized and temporarily stored at each site, prior to transportation. Depending on the constituents of concern, fencing or other special marking may be required. The number of containers will be estimated on an as-needed basis. Acceptable containers will be sealed in either U.S. Department of Transportation (DOT)-approved steel 55-gallon drums or small dumping bins with lids. The containers will be transported in such a manner to prevent spillage or particulate loss to the atmosphere.

The IDW will be segregated at the site according to matrix (solid or liquid) and as to how it was derived (drill cuttings, drilling fluid, decontamination fluids, and purged groundwater). Each container will be properly labeled with site identification, sampling point, date, depth, matrix, constituents of concern, and other pertinent information for handling.

Waste generated during the field activities will be handled and disposed of in accordance with applicable federal, state, and local regulations. Disposable materials such as latex gloves, aluminum foil, paper towels, etc., shall be placed and sealed in plastic garbage bags for disposal with sanitary waste from the site. Soil cuttings will be placed in 55-gallon steel open top drums with lids. Development and purge waters evacuated from groundwater monitoring wells, and all fluids generated during decontamination activities, will be placed in 55-gallon steel drums. Drums will be properly labeled with the appropriate boring or well number, and content, and will be staged in a central location designated by the Base representative for temporary storage pending removal and disposal.

5.11 HYDROGEOLOGICAL CONCEPTUAL MODEL

The project geologist or engineer will develop a base and site geological and hydrological conceptual model from pre-existing U.S. Geological Survey (USGS), regional, state, and local studies and information developed during the project. Maps and cross sections will be used to depict the conceptual model. The model will be the basis for evaluating monitoring well and piezometer locations, contaminant distribution (plume delineation), and the closeness of fit to natural conditions of analytical or computer-based numerical models.

The Project Geologist will be responsible for evaluating the fit of analytical or numerical groundwater flow and contaminant transport models to natural site conditions and the model's ability to predict the spatial and temporal distribution of contaminants. The model will consider stratigraphy, geological structure, aquifer homogeneity or heterogeneity, hydraulic conductivity, transmissivity, storativity, and effective porosity. As applicable, the model will consider leakage, dispersivity, and attenuation.

The Project Geologist will evaluate the reliability of predictions resulting from use of the model. Reliability will be based on sufficiency and representativeness of field data, model calibration, degree of change of field data during calibration, and model sensitivity to changes in selected variables. The values assigned to nodes of numerical models and the amount of change of field values will be displayed on maps or cross sections.

5.12 CORRECTIVE ACTION

Table 5.1 contains a summary of field quality control procedures and corrective actions.

Table 5.1
Field Corrective Action Procedures
NAS Fort Worth JRB, Texas

Situation	Calibration	Frequency	Field Objective Affected	Corrective Action Procedure
Equipment malfunction			Equipment is calibrated and operating properly	- Notification of site supervisory personnel
PID/OVA	- Calibrated to ±20% of known calibration gas	- Daily		- Correct problem, recalibrate
pH	- Calibrated with two buffer solutions that bracket expected sample pH	- Daily		- Repair or replace malfunctioning parts
SC	- Calibrated with two standards in expected range of sample SC	- Daily		- Recalibrate and/or replace standards
Temperature	- Calibrate within expected temperature range of samples	- Monthly		
Turbidity	- Calibrate within expected range of sample turbidity	- Daily		- Document to Project Geologist, Project Manager, and Quality Assurance Manager
Incorrect sample collection procedures	NA	NA	Samples are taken according to standard operating procedures	- Notification of site supervisory personnel - Review of situation and correct procedures - Document to Project Geologist, Project Manager, and Quality Assurance Manager
Insufficient sample volume collection	NA	NA	Sufficient sample volume is provided to maintain sample integrity so that all required analyses can be conducted	- Notification of site supervisory personnel by laboratory manager - Review site affected and impact of samples on site characterization - correct procedures - Document to Project Geologist, Project Manager, and Quality Assurance Manager
Incorrect measurement data collection	NA	NA	Measurements are conducted according to standard operating procedures	- Notification of site supervisory personnel - Review of situation and correct procedures - Document to Project Geologist, Project Manager, and Quality Assurance Manager

NA = Not Applicable

6.0 ENVIRONMENTAL SAMPLING

6.1 SAMPLING PROCEDURES

All purging and sampling equipment will be decontaminated according to the specifications in Section 5.9 prior to any sampling activities and will be protected from contamination until ready for use. The construction material of the sampling devices (e.g.,plastic, PVC, metal) discussed below will be appropriate for the contaminant of concern and shall not interfere with the chemical analyses being performed.

6.1.1 Groundwater Sampling

6.1.1.1 Monitor Well Sampling

When numerous monitor wells are to be sampled in succession, those wells expected to have low levels of contamination or no contamination will be sampled prior to those wells expected to have higher levels of contamination. This practice will help reduce the potential for cross contamination between wells. All sampling activities will be recorded in the field log book. Additionally, all sampling data will be recorded on a Field Sampling Report form. An example Field Sampling Report form is shown in Appendix D.

Before ground-water sampling begins, wells will be inspected for signs of tampering or other damage. If tampering is suspected, (i.e., casing is damaged, lock or cap is missing) this shall be recorded in the field log book and on the well sampling form, and reported to the Project Geologist/Field Coordinator. Wells that are suspected of having been tampered with will not be sampled until the Project Geologist/Field Coordinator has discussed the matter with the Project Manager.

Before the start of sampling activities, plastic sheeting will be placed around the well. The plastic sheeting will be used to provide a clean working area around the well head and prevent any soil contaminants from contacting sampling equipment. Water will be removed from the protective casing, or in the vaults around the well casing, prior to venting and purging. Every time a casing cap is removed to measure water level or collect a sample, the air in the breathing zone will be checked with an organic vapor meter, and the air in the well bore shall be checked with an explosimeter. Procedures in the HSP will be followed when high concentrations of organic vapors or explosive gases are detected. Air monitoring data will be recorded on the well sampling form.

Purge pump intakes will be equipped with a positive foot check valve to prevent purged water from flowing back into the well. Purging and sampling will be performed in a manner that minimizes aeration in the well bore and the agitation of sediments in the well and formation. Equipment will not be allowed to free-fall into a well.

In addition to the information required in Section 8.0, the following information will be recorded each time a well is purged and sampled: (1) depth to water before and after purging, (2) well bore volume calculation, (3) sounded total depth of the monitor well, (4) the condition of each well, including visual (mirror) survey, (5) the thickness of any light or dense non-aqueous phase liquid

(LNAPL or DNAPL) layer, and (6) field parameters, such as pH, temperature, specific conductance, and turbidity. This information will be encoded in IRP Information Management System (IRPIMS) files when required. In order to ensure that the most current techniques are employed for low flow purging and sampling, recommendations as outlined in USEPA research paper entitled *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures (April 1996)* have been adapted where practical to augment current AFCEE procedures.

6.1.1.1.1 Water Level and NAPL Thickness Measurement

An interface probe will be used if a nonconductive floating LNAPL layer is suspected in the well. It will be slowly lowered to the groundwater in order to produce the least disturbance to the water surface in the casing. The probe will be used to determine the presence of floating product, if any, prior to measurement of the ground-water level. The ground-water level will then be measured to the nearest 0.01 foot using an electric water level indicator. For wells which are suspected of containing separate phase DNAPLs, the interface probe shall be lowered to the bottom of the well before purging to gauge the elevation and thickness of potential DNAPL layers.

Water levels will be measured from the notch located at the top of the well casing and recorded on the well sampling form. If well casings are not notched, measurements will be taken from the north edge of the top of the well casing, and a notch will be made using a decontaminated metal file.

Well depths obtained from well logs will be used to estimate the length of the screened water column. Following water sample collection, the total depth of the well from the top of the casing will be determined using a weighted tape or electric sounder, and then recorded on the well sampling form. The water level depth will be subtracted from the total depth of the well to determine the actual height of the water column present in the well casing. All water level and total depth measuring devices will be routinely checked with a tape measure to ensure measurements are accurate.

6.1.1.1.2 Purging Prior to Sampling

Purging of monitor wells is performed to evacuate water that has been stagnant in the well and may not be representative of the aquifer. Purging will be accomplished using the micropurge technique. Micropurge is a low flow-rate monitor well purging and sampling method that induces laminar (non turbulent) flow in the immediate vicinity of the sampling pump intake, thus drawing groundwater directly from the sampled aquifer, horizontally through the well screen, and into the sampling device.

Pumps capable of achieving low-flow rates in the range of 0.1-0.5 L/min will be used for purging and sampling. These low flow rates minimize disturbance in the screened aquifer, resulting in (1) minimal production of artificial turbidity and oxidation, (2) minimal mixing of chemically distinct zones, (3) minimal loss of volatile organic compounds, and (4) collection of representative samples while minimizing purge volume.

Pumps will be lowered to the middle of the screened interval or slightly above the interval (i.e., a measured depth of 43% of the saturated screened interval below the top of the water table) to minimize the resuspension of solids which have collected at the bottom of the well and to minimize the potential mixing of stagnant water trapped in the casing above the screen. The key is to minimize the disturbance of water and solids in the well casing.

As a guide to flow rate adjustment during purging, water levels will be checked and recorded to monitor drawdown in the well. Groundwater will be pumped in a manner which minimizes stress to the system, taking into account established site sampling objectives. The goal is to purge the well at a rate that does not draw down the static water level more than 0.33 feet.

Temperature, pH, electrical conductivity (EC), Dissolved Oxygen (DO), Oxidation-Reduction Potential (ORP), and turbidity will also be measured during purging and recorded on the well sampling form. Measurements will be taken every three to five minutes when flow rates are in the 0.1-0.5 L/min range. Stabilization is achieved after all parameters have stabilized for three consecutive readings. Successive readings should be approximately within ± 1.0° C for temperature, ± 0.1 units for pH, ± 5 percent for EC, ± 0.1 mg/L or 10 percent (whichever is greater) for DO, ± 10 percent for ORP, and ± 10 percent for turbidity. In general, the order of stabilization is pH, temperature, and EC, followed by ORP, DO, and turbidity. Water samples will be collected immediately after parameter stabilization using the same pump that was used in purging. Field equipment will be calibrated IAW the Draft Base-Wide QAPP (HydroGeoLogic, Feb. 1998), Section 6.0, and in Section 7.2 of this FSP.

In lieu of measuring all five parameters (pH, EC, Turbidity, DO, and ORP), a minimum subset would include pH, EC, and Turbidity or DO as critical stabilization parameters. If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. Turbidity is a very conservative parameter in terms of stabilization and is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in groundwater may exceed 10 NTUs. (reference: EPA Apr. 1996)

For wells known to have a less than 0.1 L/min flow rate then a low-flow (<0.1L/min) pump will be lowered into the well to mid-screen as described above and set in place a minimum of 48 hours prior to the initiation of purging procedures. This procedure will reduce the purge volume requirements. Water samples will be collected as soon as parameters have stabilized. (reference: EPA Apr. 1996)

Alternately, if a well is known to have less than a 0.1 L/min flow rate then a passive sampling device could be lowered to mid-screen and set in place a minimum of 48 hour prior to retrieval. Regulatory approval for sample volumes, which are lower than required by individual EPA analytical methods, would have to be obtained prior to using this procedure. (reference: EPA Apr. 1996)

If, during low-flow purging, the drawdown is greater than 0.33 feet, then the micropurge technique is assumed to be invalid and will be discontinued; the reason is that groundwater flow to the pump is no longer considered to be laminar across the screen from the aquifer. The flow in the vicinity of the pump would then contain a vertical component from the stagnant water column in the filter pack and casing.

In this situation (i.e., drawdown >0.33 feet at low-flow rates), the pumping rate will be increased, and a minimum of three borehole volumes will be removed to ensure that all of the stagnant water has been removed from the borehole. The drawdown will continue to be monitored, and the pumping rate will be adjusted to avoid pumping the well dry. Measurements for water quality parameters will be taken every three to five minutes. After three well volumes have been removed and water quality parameters have stabilized for three consecutive readings, water samples will be collected. Water samples will be collected using a low-flow pump.

If the parameters do not stabilize, then five well volumes will be removed and water samples will be collected using a low-flow pump.

If a well is purged dry, then the well will be sampled as soon as a sufficient volume of groundwater has entered the well to enable the collection of necessary groundwater samples. (reference: EPA Nov. 1992) Water samples will be collected using either a low-flow pump or a Teflon bailer.

Water removed from the well during purging will be containerized. Detailed information concerning IDW is presented in Section 5.10. A maximum of five (5) well volumes may be removed from any well before it is sampled. *The well bore volume is defined as the volume of submerged casing, screen, and filter pack.* One well volume can be calculated using the following equation (reference: Ohio EPA, 1993):

$$V = H \times F$$

where V = one well volume
H = the difference between the depth of well and depth to water (ft)
F = factor for volume of one foot section of casing (gallons) from Table 6.1

Table 6.1
Volume of Water in One-Foot Section of Well Casing

Diameter of Borehole (inches)	F Factor (gallons)
1.5	0.09
2	0.16
3	0.37
4	0.65
6	1.47
8	2.60
10	*4.04*
12	*5.81*

F can also be calculated from the formula:

$$F = \Pi \, (D/2)^2 \times 7.48 \text{ gal/ft}$$

where D = the inside diameter of the well casing (feet) and Π = 3.141593.

6.1.1.1.3 Sample Collection

At newly developed wells, water samples may only be collected after a 24 hour period has elapsed from the conclusion of monitoring well development activities.

Following the micropurge techniques outlined above, a small positive-displacement pump (e.g., bladder pump) may be used collect water samples. Samples to be analyzed for volatile or gaseous constituents will not be withdrawn with pumps or at flows that degas the samples. Water-quality indicators will be monitored during micropurge (turbidity, DO, specific conductance, temperature, etc.).

Groundwater samples will be collected after the critical water quality indicators have stabilized for three consecutive readings. Stabilization shall be defined as follows: temperature ± 1.0° C, pH ±0.1 units, EC ±5 percent, DO ± 0.1 mg/L or 10 percent (whichever is greater), ORP ±10 percent, and turbidity ± 10 percent change between three consecutive readings. Where possible, groundwater samples will be collected using the same pump employed in the purging procedure. If the parameters do not stabilize, a subset (pH, EC, and turbidity or DO) will be used as the stabilization parameters. If subset parameters do not stabilize, then the sample shall be collected as described above in Section 6.1.1.1.2, and the anomalous parameters shall be brought to the Field Coordinator's attention (per HydroGeoLogic, 1998). Field equipment will be calibrated IAW the Draft Base-Wide QAPP (HydroGeoLogic, 1998), and Section 7.2 of this document.

The preservative hydrochloric acid shall be added to the VOC sample bottle before introducing the sample water. The sample shall be collected from the pump discharge line using a slow, controlled pour down the side of a tilted sample vial to minimize volatilization. The sample vial shall be filled until a meniscus is visible and immediately sealed. When the bottle is capped, it shall be inverted and gently tapped to ensure no air bubbles are present in the vial. If, after the initial filling bubbles are present, the vials shall be discarded and the VOC sampling effort shall be repeated. Refilling of vials will result in loss of preservatives. After the containers are sealed, sample degassing may cause bubbles to form. These bubbles shall be left in the container. These samples shall never be composited, homogenized, or filtered.

Following collection of VOC samples, remaining water samples shall be collected in the following order: SVOCs including polynuclear aromatic hydrocarbons (PAHs); pesticides/PCBs; herbicides; organophosphorus pesticides, dioxins/furans; metals; mercury; cyanide; sulfide, Total Organic Carbon (TOC); methane; Fe (II); alkalinity; and common anions.

The pH of preserved samples will be checked in the field by pouring a small amount of the water sample onto pH paper. The paper will not touch the sample inside the container. The pH of acidified VOC samples will not be checked. The preservation checks will be documented in the chain-of-custody (COC) forms. One preserved VOC sample per day per sampling crew shall be checked with pH paper. The sole purpose of this sample is to check the pH of VOC samples, it will not be submitted for analysis.

Field filtering of metals will not occur.

Required sample containers, preservation methods, volumes and holding times are given in Section 6.2 and Table 6.1. Sampling equipment shall be decontaminated in accordance with Section 5.9 upon completion of sampling activities.

6.1.1.2 Direct Push Sampling

Direct push sampling involves advancing a sampling probe to the point below the water table from which the sample is desired. The probe can be advanced by direct hydraulic pressure, or by using a slide or rotary hammer. When the probe is at the proper depth, sampling ports on the probe are opened, and the sample is collected using a bailer, by vacuum pressure, or by using the natural pressure of the formation. Samples collected for VOC analysis shall not be drawn by vacuum pressure. The advantage of this method is that no drill cuttings are produced.

HydroPunch®, cone penetrometer (e.g., SCAPS) or Geoprobe® samples are generally collected for on-site or quick-turnaround analysis to determine if the boring should be converted to a monitor well or to fill data gaps. These samples are not directly comparable to monitor well samples because they are collected from disturbed conditions. HydroPunch® sampling is performed during drilling when the boring extends below the water table. With this method, a 2-inch diameter core is obtained by advancing a core sampler into the unconsolidated formation 3-5 feet below the water table using direct hydraulic pressure or a hydraulic hammer. The core is then retrieved, leaving a small borehole. The borehole is then completed as a temporary monitor well that can be sampled with a 1-inch diameter bailer or peristaltic pump, depending on depth. The temporary monitor well shall be sampled with a 1-inch diameter bailer.

6.1.2 Subsurface Soil Sampling

Soil samples will be collected based on odors, discoloration, organic vapor meter readings, and any other field screening method. If no odors, discoloration or organic vapor readings are observed, subsurface samples will be collected directly above the water table surface.

6.1.2.1 Split-Spoon Samples

During monitoring well installation using hollow-stem auger methods, soil samples will be collected using stainless steel, continuous drive, California modified split-spoon samplers, or equivalent. These samplers are 24 inches in length and have an outside diameter (OD) of 3 inches to accommodate four stainless steel/Teflon® sleeves, each of which is 6 inches in length. Soil samples during monitoring well installation will be field screened for VOCs. Soil samples from borings located inside SWMU boundaries will be collected for chemical analysis every five (5) feet from the ground surface to the water table.

For split-spoon samples collected using hollow stem augers, a standard penetration test will be performed in accordance with ASTM D-1586 "Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils." The sample is obtained by driving the sampler a distance of 1 foot into undisturbed soil with a 140-pound hammer free falling a distance of 30 inches. The sampler is first driven 6 inches to seat it in undisturbed soil; then the test is performed. The number of hammer blows for seating the spoon and making the test are then recorded for each 6 inches of penetration on the drill log (i.e., 5/7/8). The standard penetration test result (N) is obtained by adding the last two figures (i.e., 7+8=15 blows per foot). The sampler is then driven an additional 6 inches to fill the remainder of the split-spoon prior to retrieval.

As soon as the split-spoon is opened, the open ends of the stainless/Teflon® steel sleeves will be monitored for organic vapors using the PID or FID. Air monitoring results will be recorded on the boring log and in the field log book.

Samples for VOC analysis will be collected as an entire stainless steel/Teflon® sleeve sample. Stainless steel/Teflon® rings selected for VOC analysis will be completely filled, if possible, to minimize headspace. Sleeves with large gravel or debris will not be used. Following monitoring for organic vapors, the sleeves will be capped on both ends with Teflon® sheeting and plastic end caps to prevent volatilization. The stainless steel/Teflon® rings will then be affixed with a completed sample label, placed in a zip lock plastic bag and placed in an iced cooler held at a temperature below 4°C.

Samples collected concurrently with VOC samples to be tested for other analytical parameters will be collected by extruding the soil out of the stainless steel/Teflon® sleeves immediately adjacent to (above and below) the VOC sample interval. Soil chemistry samples not being analyzed for VOCs will be placed in 8 or 16-ounce, laboratory cleaned, EPA-approved glass containers with Teflon® lined lids. This will be done using clean stainless steel sampling tools. If soil from several stainless steel/Teflon® rings must be composited to provide sufficient sample volume for a particular analysis (other than VOC's), the sample will be composited and homogenized in a stainless steel bowl using a stainless steel trowel or scoop. The sample will then be transferred into the appropriate sample container, sealed, labeled, and placed in an iced cooler held at a temperature below 4°C.

If initial screening results indicate the presence of organic vapors, a headspace analysis will be conducted on remaining portions of the sample.

6.1.2.2 Direct Push Sampling

Direct push sampling involves advancing a sampling probe from by direct hydraulic pressure or by using a slide or rotary hammer. Samples may be collected continuously or at specific depths. The samples are collected in brass/stainless steel sleeves. The sleeve shall be capped with Teflon® tape and end caps. The ends of the capped sleeve shall then also be wrapped with Teflon® tape. Care shall be taken not to touch the ends of the sleeves prior to capping. Custody seals shall be placed across the capped ends of the sleeve. Once the container has been filled, the appropriate information shall be recorded in the field log book.

6.1.3 Surface Soil Sampling

Surface soil samples shall be collected from the land surface to 6 inches below the surface. The sample shall be homogenized and quartered before being containerized. Sample collected for VOC analysis shall be containerized prior to sample homogenization. Stainless steel scoops or trowels, glass jars with Teflon® lids or equivalent equipment compatible with the chemical analyses proposed shall be used to collect and store samples. Above ground plant parts and debris will be excluded from the sample.

In addition to records outlined in Section 8.0, record unusual surface conditions that may affect the chemical analyses, such as (1) asphalt chunks that may have been shattered by mowers, thus spreading small fragments of asphalt over the sampling area, (2) distance to roadways, aircraft runways, or taxiways, (3) obvious, deposition of contaminated or clean soil at the site, (4) evidence of dumping or spillage of chemicals, (5) soil discoloration, and/or (6) unusual condition of growing plants, etc.

6.1.4 Surface Water Sampling

Surface water samples will be collected so as to not to cause cross-contamination. At locations where both surface water and sediment samples are collected, the surface water sample will be obtained first. The pH, temperature, and specific conductance, will be measured and recorded at each surface water sampling point. Each sampling location where surface water or sediment samples are collected will be permanently marked (e.g., flagged stake in trench bank) and will be recorded on a project map.

Surface water samples will be taken from each end of the ponded trench at SWMU 27. Water samples will be collected using a beaker when grab samples are required, or using an autosampler (discrete or composite samples) with the inlet line located at the desired sampling depth.

The following records will be maintained in addition to those in Section 8.0: (1) the width and depth of the trench, (2) surface water conditions (e.g., floating oil or debris, gassing), (3) the location of any discharge pipes, sewers and tributaries, and (4) instrument calibration.

6.2 SAMPLE HANDLING

6.2.1 Sample Containers

Sample containers will be provided to field personnel, precleaned and treated according to EPA specifications for the methods. No sampling containers will be reused for the sampling events of this RFI. Containers will be stored in clean areas to prevent exposure to fuels, solvents, and other contaminants. Amber glass bottles are used routinely where glass containers are specified in the sampling protocol.

6.2.2 Sample Volumes, Container Types, and Preservation Requirements

Sample volumes, container types, and preservation requirements for the analytical methods performed on AFCEE samples are listed in Table 6.2. Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. Holding times for methods used in this FSP are specified in Table 6.2.

6.2.3 Sample Identification

The following information will be written in the log book and on the sample label when samples are collected for laboratory analysis:

- Project identification (name and number)
- Sample identification number
- Sample location
- Preservatives added
- Date and time of collection
- Requested analytical methods
- Sampler's name

Each sample will be assigned a unique identification number that describes where the sample was collected. The number will consist of a maximum 12 digit alphanumeric code as follows:

xxxxyyyyzzaa

where:

xxxx represents the site identification (e.g., LF02, LF06, LF07, LF09, LF10)

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

zz represents the medium (e.g., GW=ground water, SO=soil, SW=surface water, SD=sediment)

Table 6.2
Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times

Name	Analytical Methods	Container[a]	Preservation[b,c]	Minimum Sample Volume or Weight	Maximum Holding Time
Metals (except mercury)	SW6010A SW6020 and SW-846 AA methods	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	180 days (water and soil)
Mercury	SW7470 SW7471	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	28 days (water and soil)
Chlorinated herbicides	SW8150B SW8151	G, Teflon-lined cap, T	4°C, pH 5-9	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Cyanide, total and amenable to chlorination	SW9010A SW9012	P, G, T	4°C; NaOH to pH > 12; 0.6g ascorbic acid	500 mL or 4 ounces	14 days (water and soil)
Dioxins and furans	SW8290	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$ (Kept Dark)	1 liter or 8 ounces	30 days to extraction and 45 days after extraction (water and soil)
Organochlorine pesticides and polychlorinated biphenyls (PCBs)	SW8080A, SW8081,	G, Teflon-lined cap, T	4°C, pH 5-9	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Organo-phosphorus Pesticides	SW8140	G, Teflon-lined cap, T	4°C, pH 5-9	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Sulfide	SW9030	P, G, T	4°C; NaOH to pH >9, 2ml zinc acetate	500ml or 4 ounces	7 days
Total Organic Carbon	SW9060	one 250 m/L polyethylene	4°C; H_2SO_4 to pH < 2	250 m/L	28 days

Table 6.2 (continued)
Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times

Name	Analytical Methods	Container[a]	Preservation[b,c]	Minimum Sample Volume or Weight	Maximum Holding Time
Methane	SW3810 Mod.	3 40 mL clear glass vials with rubber septa & Teflon lined caps	4°C	120mL	14 days
Ferrous Iron	HACH method #8146	100-ml glass vials	NA	NA	Field method- analyze immediately
Alkalinity	E310.1	One 500-mL polyethylene	4°C	250mL	14 days
Common Anions	SW9056	one 1-L polyethylene	4°C	100mL	28 days for Br^-, F^-, Cl^- and SO_4^{-2}: 48 hours for NO_3^-, NO_2^-, and PO_4^{-3}
Semivolatile organics	SW8270B SW8310	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Volatile organics	SW8010, SW8020, SW8260A	G, Teflon-lined septum, T	4°C, 0.008% $Na_2S_2O_3$ (HCl to pH < 2 for volatile aromatics by SW8260)[b]	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid

[a] Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
[b] No pH adjustment for soil.
[c] Preservation with 0.008 percent $Na_2S_2O_3$ or by ascorbic acid is only required when residual chlorine is present.

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

For example, the second soil sample of soil boring 02 collected from LF02 will be identified as "LF02-SB02-SO-02." A duplicate groundwater sample collected from MW04 at LF07 would be identified as "LF07-MW04-GW-52," and sent to the laboratory as a blind sample. Proper notes will, however, be entered into the field sampling log book to track this sample as a field duplicate.

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

xxyyyyyyzz

where:

xx represents medium (e.g. ER=equipment rinsate, TB=trip blank, AB=ambient blank)

yyyyyy represents date (day, month, year)

zz represents sample number from 01 to 99

The field coordinator will maintain a list that describes how each QC sample corresponds with specific environmental samples. For instance, each trip blank will be correlated with a particular set of samples shipped to the laboratory, and each rinsate will be correlated to those samples collected by a particular set of decontaminated sampling tools.

6.3 SAMPLE CUSTODY

Procedures to ensure the custody and integrity of the samples begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field and laboratory records.

COC records will be maintained for all field and field QC samples. A sample is defined as being under a person's custody if any of the following conditions exist: (1) it is in their possession, (2) it is in their view, after being in their possession, (3) it was in their possession, and they locked it up, or (4) it is in a designated secure area. All sample containers will be sealed in a manner that will prevent or detect tampering if it occurs. In no instance will tape be used to seal sample containers. Samples will not be packaged with activated carbon. Appendix D contains a sample COC form.

The following minimum information concerning the sample will be documented on the COC form (as illustrated in Appendix D):

- Unique sample identification
- Date and time of sample collection

- Source of sample (including name, location, and sample type)
- Designation of MS/MSD
- Preservative used
- Analyses required
- Name of collector(s)
- Pertinent field data (pH, temperature, etc.)
- Serial numbers of custody seals and transportation cases (if used)
- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
- Bill of lading or transporter tracking number (if applicable)

All samples will be uniquely identified, labeled, and documented in the field at the time of collection IAW Section 6.2.3 of the FSP. Samples collected in the field will be transported to the laboratory or field testing site as expeditiously as possible. When a 4°C requirement for preserving the sample is indicated, the samples will be packed in ice or chemical refrigerant to keep them cool during collection and transportation. During transit, it is not always possible to rigorously control the temperature of the samples. As a general rule, storage at low temperature is the best way to preserve most samples. A temperature blank (a VOC sampling vial filled with water) will be included in every cooler and used to determine the internal temperature of the cooler upon receipt of the cooler at the laboratory.

6.4 FIELD QUALITY CONTROL SAMPLES

Field quality control samples such as blanks and duplicates will be collected as described in the following sections.

6.4.1 Ambient Blank

The ambient blank consists of ASTM Type II reagent grade water poured into a VOC sample vial at the sampling site. It is handled like an environmental sample and transported to the laboratory for analysis. Ambient blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes.

Ambient blanks are used to assess the potential introduction of contaminants from ambient sources (e.g., active runways, engine test cells, gasoline motors in operation, etc.) to the samples during sample collection. Ambient blanks will be collected downwind of possible VOC sources. One ambient blank will be collected at the beginning of the field investigation. Additional ambient blanks will be collected if site conditions warrant.

6.4.2 Equipment Blank

An equipment blank is a sample of ASTM Type II reagent grade water poured into or over or pumped through the sampling device, collected in a sample container, and transported to the laboratory for analysis. Equipment blanks are used to assess the effectiveness of equipment decontamination procedures. Equipment blanks will be collected immediately after the equipment has been decontaminated. The blank will be analyzed for all laboratory analyses requested for the environmental samples collected at the site. One equipment blank will be collected per day for each type of sampling equipment used.

6.4.3 Trip Blank

The trip blank consists of a VOC sample vial filled in the laboratory with ASTM Type II reagent grade water, transported to the sampling site, handled like an environmental sample, and returned to the laboratory for analysis. Trip blanks are not opened in the field. Trip blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes. Trip blanks are used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures. One trip blank will accompany each cooler of samples sent to the laboratory for analysis of VOCs.

6.4.4 Field Duplicates

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously, or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field so that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection.

Duplicate sample results are used to assess precision of the sample collection process. Precision of soil samples to be analyzed for VOCs is assessed from collocated samples because the compositing process required to obtain uniform samples could result in loss of the compounds of interest. One duplicate sample will be collected for every ten groundwater and surface water samples collected.

6.4.5 Field Replicates

A field replicate sample, also called a split, is a single sample divided into two equal parts for analysis. The sample containers are assigned an identification number in the field such that they cannot be identified as replicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field replicate samples prior to the beginning of sample collection. Replicate sample results are used to assess precision. One replicate sample will be collected for every ten soil and sediment samples collected.

7.0 FIELD MEASUREMENTS

7.1 PARAMETERS

7.1.1 Field Screening of Soils

RFI field activities will utilize field screening of soil samples for VOCs to determine the depth from which the laboratory analytical samples will be collected. During hand auguring, hollow-stem auger drilling, and sediment sampling activities, head space readings will be recorded from collected soils. Headspace analysis will be performed on each lithologic and analytical soil sample collected. A portion of the recovered soil sample will be placed into a quart-size, resealable plastic bag, and the bag will be labeled, sealed, and shaken to mix the sample. The sample will be allowed to volatilize in a shaded area for approximately 15 minutes after which a headspace reading will be taken by punching through the bag with an OVA or PID sampling tip. The OVA or PID shall be calibrated using a standard of known concentration (e.g., isobutylene at 104 parts per million) in accordance with the requirements of the Draft Base-Wide QAPP (HydroGeoLogic, 1998). The sampling tip will not be placed in the soil, but in the headspace of the bag. A background headspace value will be obtained from empty resealable plastic bags handled in a manner identical to the plastic bag containing the headspace sample. The headspace reading and the background reading will be recorded on the Soil Boring Log (Appendix D).

7.1.2 Field Parameters for Water Samples

Temperature, pH, EC, and turbidity will be measured during monitoring well development and purging. The temperature of each water sample will be measured by either a pH meter/temperature probe, conductivity meter/temperature probe, or a mercury thermometer. This measurement will also be used to calibrate the pH meter.

The pH of each water aliquot will be measured by a portable pH meter. The pH meter will be calibrated with two buffer solutions of the appropriate range for the expected values of pH. The meter will be recalibrated daily. The stability of the calibration will be verified through the analysis of one standard periodically throughout the day as deemed necessary by the Field Coordinator, but at least once every five hours.

The EC of each water sample will be measured with a factory calibrated, portable, field conductivity meter. The instrument will be rinsed with reagent water between each use and the calibration of the probe shall be checked at the beginning and middle of each day using two potassium chloride (KCl) solutions of known conductance values. Calibration records will be maintained on the Calibration Log (Appendix D).

The turbidity of each water aliquot will be measured using a portable nephelometer. Calibration of the instrument is periodically performed at the factory as part of routine maintenance. A standard 0.2 NTU solution will be used to verify the stability of the calibration on a daily basis. All measurements will be recorded on the Well Development Record/Monitor Well Purging Form (Appendix D).

7.2 EQUIPMENT CALIBRATION AND QUALITY CONTROL

Field equipment will be maintained and calibrated to the standards in their respective operations manuals. Equipment failures will be repaired in the field if possible; if not, the instrument will be tagged, removed from use, and returned for repair or replacement. Field equipment will be calibrated daily before the start of sampling activities. Calibration records will be maintained on the Calibration Log (Appendix D). The calibration record will include a unique instrument number (e.g., serial number), standards used, concentrations, and meter readings.

7.3 EQUIPMENT MAINTENANCE AND DECONTAMINATION

7.3.1 Equipment Maintenance

Field equipment will be kept in a controlled storage room and will be decontaminated prior to return to storage; any malfunctions will be reported to the Field Coordinator. The Field Coordinator will initiate actions necessary for the repair or replacement of defective equipment. Equipment maintenance logs are kept updated and on file. Power supplies of battery-powered instruments will be checked daily. Rechargeable instruments will be recharged daily.

7.3.2 Decontamination of Field Instruments

Decontamination of field instruments will be instrument-specific. The probes of the pH, temperature, DO, and specific conductivity meters will be rinsed with reagent grade water before and after each use, and at the end of each day. The measurement vial for the turbidity meter will be rinsed with deionized water before and after each use. No decontamination is required for the organic vapor analyzer.

7.4 FIELD MONITORING MEASUREMENTS

7.4.1 Groundwater Level Measurements

Water-level measurements will be taken in all wells and piezometers to determine the elevation of the water table or piezometric surface at least once within a single 24-hour period. These measurements will be taken after all wells and piezometers have been installed and developed and their water levels have recovered completely. Any conditions that may affect water levels will be recorded in the field log.

Water-level measurements will be taken with electric sounders, air lines, pressure transducers, or water-level recorders (e.g., Stevens recorder). Devices that may alter sample composition will not be used. Pressure gauges, manometers, or equivalent devices will be used for flowing wells to measure the elevation of the piezometric surface. All measuring equipment will be decontaminated according to the specifications in Section 7.3 and 5.9. Groundwater level will be measured to the nearest 0.01 foot.

Static water levels will be measured each time a well is sampled, and before any equipment enters the well. If the casing cap is airtight, time will be allowed prior to measurement for equilibration of pressures after the cap is removed. Measurements will be repeated until water level is stabilized.

7.4.2 Floating Hydrocarbon Measurements

HydroGeoLogic does not anticipate encountering floating hydrocarbons based on the results from previous sampling events that have occurred at NAS Fort Worth JRB. However, if encountered, the thickness of hydrocarbons floating in monitor wells will be measured with an electronic interface probe. Hydrocarbon detection paste, or any other method that may affect water chemistry, will not be used. When detected, the presence of floating hydrocarbons will be confirmed by withdrawing a sample with a clear, bottom-fill Teflon® bailer.

7.4.3 Groundwater Discharge Measurements

Groundwater discharge measurements will be obtained during monitor well purging. Groundwater discharges may be measured with orifice meters, containers of known volume, in-line meters, flumes, or weirs, following guidelines specified in the Water Measurement Manual, Bureau of Reclamation, 1967. Any measurement device will be calibrated using containers of known volume.

7.5 FIELD PERFORMANCE AND SYSTEM AUDITS

The Project Geologist or a designated representative will conduct weekly informal audits of the field activities. The weekly audit for completeness will include the following items:

- Sample labels
- Chain of custody records
- Field notebooks
- Sampling operations
- Document control

The first three items above will be checked for completeness. Sampling operations will be reviewed to determine if they are performed as stated in the WP or as directed by the Project Geologist. The informal document control audit will consist of checking each document for completeness, including items such as signatures, dates, and project numbers.

An unscheduled systems audit of field operations will be conducted using the project-specific work plan and will be used to review the total data generation. The audit will include on-site review of the field operational system, physical facilities for sampling, and equipment calibrations. A performance audit may be conducted by the Project Manager (PM) and Project Geologist if deemed necessary by the PM, Project Geologist, Lab Coordinator, or Client. The audit may focus on verifying that proper procedures are being followed so that subsequent sample data will be valid. Prior to the audit, a checklist will be prepared by the PM and Project Geologist that will serve as a guide for the performance audit.

The audit will verify whether or not (1) collection of samples follows the available written procedures, (2) chain of custody procedures are followed for traceability of samples origin,

(3) appropriate QC checks are being made in the field and documented in the field log book, (4) specified equipment is available, calibrated, and working properly, (5) sampling crews are adequately trained, (6) record-keeping procedures are being followed and appropriate documentation is maintained, and corrective action procedures are followed. An audit report summarizing the results and corrections will be prepared and filed in the project files.

8.0 RECORD KEEPING

HydroGeoLogic will maintain field records sufficient to recreate all sampling and measurement activities and to meet all IRPIMS data loading requirements. The information shall be recorded with indelible ink in a permanently bound notebook with sequentially numbered pages. These records shall be archived in an easily accessible form and made available to the USAF upon request.

The following information will be recorded for all field activities: (1) location, (2) date and time, (3) identity of people performing activity, and (4) weather conditions; for field measurements: (1) the numerical value and units of each measurement, and (2) the identity of and calibration results for each field instrument will also be recorded.

The following additional information will be recorded for all sampling activities: (1) sample type and sampling method, (2) the identity of each sample and depth(s), where applicable, from which it was collected, (3) the amount of each sample, (4) sample description (e.g., color, odor, clarity), (5) identification of sampling devices, and (6) identification of conditions that might affect the representativeness of a sample (e.g., refueling operations, damaged casing).

The following section describes the field documentation procedures, which will be followed as a means of recording observations and findings during the RFI field investigation. Documentation will include the form of field log books, various sample and calibration forms, site photographs, and drawings/sketches. All documentation will be completed in indelible ink and corrections will be stricken out with a single line and initialed. Examples of field forms are included in Appendix D.

8.1 FIELD LOG BOOK

Log books with sequentially numbered pages will be kept at the site during all field activities and will be assigned to each sample team. These logs will be updated, continually, and will constitute master field investigation documents. Information to be recorded in the logs includes, but is not limited to, the following:

- Project identification
- Field activity subject
- General work activity, work dates, and general time of occurrence
- Unusual events
- Subcontractor progress or problems
- Communication with the client or others
- Weather conditions
- HydroGeoLogic personnel, subcontractors, and visitors on site
- Sample number and time of day for each sample collected for analysis
- Listing by sample number of samples collected during the day, sorted by chain-of-custody record number (compiled at the end of the day)
- Record of telephone call to laboratory informing it of sample shipment

- Accomplishment of decontamination of drilling rig, construction materials, and sampling equipment
- Accomplishment of required calibration checks
- Accomplishment of well point purging, with time and/or volume
- Disposition of purge water, decontamination fluids, and soil cuttings
- Well water levels and field measurements
- Variances from project plans and procedures (details will be recorded in the log book and presented in the RFI)
- Accomplishment of tailgate safety meetings
- Review of project procedures with site personnel
- Head space screening and breathing zone readings
- Accomplishment of decontamination of water sampling equipment
- Photographs taken and identification numbers
- Name and signature of person making log book entries
- Inspections and results of inspections.

8.2 FIELD EQUIPMENT LOG BOOK

A field equipment log book will be kept on site to document the proper use, maintenance, and calibration of field testing equipment. Accompanying the field equipment log book will be a three-ring binder containing operator manuals, specifications, and calibration requirements and procedures for all field testing equipment. Information to be recorded in the field equipment log book includes:

- Equipment calibration status
- Equipment decontamination status
- Equipment nonconformance
- Equipment inspection and repair records
- Name and signature of person making entry
- Date of entry
- Name of equipment and its identifying number
- Nature of work conducted
- List or reference of procedures used for calibration or maintenance
- Manufacturer, lot number, and expiration date of calibration standards
- Measurement results.

8.2.1 Sample Collection Log

A sample collection log form (i.e., Field Sampling Report) will be completed for each sample collected during the investigation. An example of the Field Sampling Report Form is included in Appendix D. Information to be included on the form includes:

- Date and time of sample collection
- Sample location
- Sample type (i.e., surface soil, sediment, groundwater, etc.)
- Name of person collecting samples
- Sample volumes and container types.

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TAB

Health and Saftey Plan

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FINAL
HEALTH AND SAFETY PLAN

RCRA FACILITY INVESTIGATION OF LANDFILLS
NAS FORT WORTH JRB, TEXAS

Contract Number F41624-95-D-8005

Prepared for:

U.S. Air Force Center for Environmental Excellence
Brooks AFB, Texas

Prepared by:

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March 1998

FINAL
HEALTH AND SAFETY PLAN
RCRA FACILITY INVESTIGATION OF LANDFILLS
AT NAS FORT WORTH JRB, TEXAS

PROJECT:	U.S. Air Force Center for Environmental Excellence
PROJECT NUMBER:	Contract No. F41624-95-D-8005 HydroGeoLogic Project No. AFC001
PROJECT SITE LOCATION:	NAS Fort Worth JRB, Texas
PROJECT MANAGER:	James Costello, P.G.
HEALTH AND SAFETY OFFICER:	Christopher Spill
SITE SAFETY OFFICER:	TBA
PLAN PREPARERS:	Christopher Spill, Kenneth Hurley
PLAN REVIEWER:	Claire Black, G.I.O.H., C.H.M.M.
PREPARATION DATE:	June 1997

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HydroGeoLogic, Inc.
Project Manager

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LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	U.S. Air Force Center for Environmental Excellence
ANSI	American National Standards Institute
°C	Celsius
CAFB	Carswell Air Force Base
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CMS	Corrective Measures Study
COR	Contracting Officer's Representative
CPC	Chemical Protective Clothing
CPR	Cardiopulmonary Resuscitation
dB(A)	decibel A-weighted scale
DOT	Department of Transportation
EPA	U.S. Environmental Protection Agency
FAR	Federal Acquisition Regulation
FSP	Field Sampling Plan
HAZWOPER	Hazardous Waste Site Operations
HCS	Hazard Communication Standard
HEPA	High Efficiency Particulate Matter
HSO	Health and Safety Officer
HSP	Health and Safety Plan
JRB	Joint Reserve Base
KCl	Potassium Chloride
LEL	Lower Explosive Limit
LF	Landfill
mg/m^3	milligrams per cubic meter
MSDS	Material Safety Data Sheet
NAS	Naval Air Station
NIOSH	National Institute for Occupational Safety and Health
O_2	Oxygen
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PID	Photoionization Detector
PM	Project Manager

LIST OF ACRONYMS AND ABBREVIATIONS

POC	Point of Contact
PPE	Personal Protective Equipment
PVC	Polyvinyl Chloride
RCO	Responsible Corporate Officer
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
SAP	Sampling and Analysis Plan
SOW	Statement of Work
SSO	Site Safety Officer
SWMU	Solid Waste Management Unit
T	Air Temperature
T_{aj}	Adjusted Air Temperature
TLV	Threshold Limit Value
UEL	Upper Explosive Limit
US	United States
USCG	United States Coast Guard
VOC	Volatile Organic Compound
WP	Work Plan

1.0 INTRODUCTION

1.1 PURPOSE

This Health and Safety Plan (HSP) is designed to assign responsibilities, establish personnel protection standards, specify mandatory operating procedures, and provide for emergency contingencies with respect to health and safety issues that may arise while HydroGeoLogic, Inc. (HydroGeoLogic) personnel and subcontractor personnel are engaged in Resource Conversation and Recovery Act (RCRA) Facility Investigation (RFI) activities at Solid Waste Management Unit (SWMU) 29 (Landfill No. 2 or LF-02), SWMU 62 (Landfill No. 6 or LF-06), SWMU 17 (Landfill No. 7 or LF-07), SWMU 30 (Landfill No. 9 or LF-09), and SWMU 27 (Landfill No. 10 or LF-10) of the Former Carswell Air Force Base (CAFB) now referred to as the Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB) located in Fort Worth, Texas. The request for RFI activities was identified in the statement of work (SOW) dated January 21, 1997 under the authorization of the U.S. Air Force Center for Environmental Excellence (AFCEE) Contract Number F41624-95-D-8005, Delivery Order Number 0005. This HSP conforms to the requirements of the Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1910 and 1926. Detailed OSHA requirements for hazardous waste operations are contained in OSHA Standard 29 CFR 1910.120 and OSHA Standard 29 CFR 1926.65, "Hazardous Waste Operations and Emergency Response." Additional guidance for hazardous waste operations may be found in the Environmental Protection Agency (EPA) publication, "Standard Operating Safety Guides" (November 1987), the National Institute of Occupational Safety and Health (NIOSH)/OSHA/U.S. Coast Guard (USCG)/EPA publication, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" (October 1985), and the Federal Acquisition Regulation (FAR) clause 52.236-13: Accident Prevention.

This HSP is based on available background information regarding possible chemical, physical, and biological hazards that may exist at the site. If more information concerning the nature and/or concentrations of contaminants becomes available, this HSP will be amended accordingly.

1.2 APPLICABILITY

The provisions of the HSP are mandatory for all official visitors, HydroGeoLogic employees, and subcontractors while investigations are being conducted at NAS Fort Worth JRB. These investigations will include: the installation of 6 test pits at SWMUs 17 and 62 with associated surface and subsurface soil sampling; geophysical surveys at SWMUs 17, 27, 29, 30, and 62; completion and sampling of 26 soil borings; the installation of 21 groundwater monitoring wells; and groundwater sampling of newly installed and existing monitoring wells to evaluate the nature and extent of potential contamination associated with each of the SWMUs. Inadequate health and safety precautions on the part of visitors or subcontractors, or the belief that personnel on the site are or may be exposed to an immediate health hazard, can be cause for HydroGeoLogic to suspend on-site activities and require all personnel to evacuate the area of concern.

1.3 PROJECT ORGANIZATION, PERSONNEL, AND RESPONSIBILITIES

This section provides HydroGeoLogic's personnel organization for this project as presented in Figure 4.1 of the Field Sampling Plan (FSP) and establishes the roles and responsibilities of various project personnel in regard to site health and safety. The authority and responsibilities of each HydroGeoLogic individual utilized for this project are presented in the following sections.

1.3.1 Responsible Corporate Officer (RCO)

The RCO for this project will be John Robertson, P.G. (Executive Vice-President). The RCO has authority to direct changes to the Corporate Health and Safety Program and determines and implements personnel disciplinary actions, as required. The RCO's responsibilities for this project include:

- Direct and monitor the implementation of the Corporate Health and Safety Program.
- Advise on health and safety matters.
- Issue directives, advisories, and information to the Health and Safety Officer (HSO).

1.3.2 Health and Safety Officer (HSO)

The HSO for this project will be Christopher Spill. He will be assisted by Claire Black, an industrial hygienist at Law Engineering. The HSO has the authority to:

- Suspend work or otherwise limit exposure to personnel if health and safety plans appear to be unsuitable or inadequate.
- Direct personnel to change work practices if existing practices are deemed to be hazardous to their health and safety.
- Remove personnel from projects if their actions or conditions endanger their health and safety or the health and safety of co-workers.
- Approve the qualifications of employees to work at hazardous waste sites.
- Approve health and safety plans.

The HSO responsibilities for this project will include:

- Interface with Project Manager (PM) in matters of health and safety.
- Keep the RCO and PM informed on the status of the site health and safety plan.
- Develop or review and approve project health and safety plans prior to submittal.

- Conduct staff training and orientation on health and safety related activities.
- Appoint or approve Site Safety Officer (SSO).
- Monitor compliance with health and safety plans and conducts site audits.
- Assist in obtaining required health and safety equipment.
- Approve personnel to work on hazardous waste management projects with regard to medical examinations and health and safety training.
- Maintain records pertaining to medical surveillance, training, fit testing, chemical exposure, and accidents/incidents.
- Provide industrial hygiene/chemical safety guidance.

1.3.3 Project Manager (PM)

The PM for this project will be James Costello, P.G. The PM has the authority to:

- Coordinate with the HSO on health and safety matters.
- Assign HSO-approved SSO to project and, if necessary, assign a suitably qualified replacement.
- Temporarily suspend field activities if health and safety of personnel are endangered, pending an evaluation by the HSO.
- Temporarily suspend an individual from field activities for infractions of the health and safety plan, pending an evaluation by the HSO.

The PM responsibilities for this project will include:

- Assure that the project is performed in a manner consistent with the health and safety program.
- Assure that the project health and safety plan is prepared, approved, and properly implemented.
- Provide the HSO with the information needed to develop health and safety plans.
- Assure that adequate funds are allocated to fully implement project health and safety plans.

1.3.4 Site Safety Officer (SSO)

The Site Safety Officer (SSO) will direct all on-site health and safety training and daily safety inspections. A qualified HydroGeoLogic employee who has performed these functions before will be the designated SSO. The SSO has the authority to temporarily suspend field activities if health and safety of personnel are endangered, pending further consideration by the HSO, and to temporarily suspend an individual from field activities for infractions of the health and safety plan, pending an evaluation by the HSO.

The SSO will report any problems or concern to the HydroGeoLogic HSO and PM. The HSO will also review accident reports and air monitoring data sheets; however, because these reviews are necessarily conducted after the fact, the SSO remains the principal person responsible for on-site safety. At the facilities, the SSO has primary responsibility for:

- Directing health and safety activities on a site.
- Assuring that appropriate personal protective equipment (PPE) is available and properly utilized by HydroGeoLogic personnel, visitors, and subcontractor personnel.
- Assuring that personnel are aware of the provisions of this plan, are instructed in the work practices necessary to ensure safety, and are aware of planned procedures for dealing with emergencies.
- Assuring that personnel are aware of the potential hazards associated with investigation activities.
- Monitoring the safety performance of all personnel to ensure that required work practices are followed.
- Monitoring the physical condition of site workers for heat and cold stress.
- Correcting any work practices or conditions that may result in injury or exposure to hazardous substances.
- Assuring the completion of the site-specific HSP forms presented in Section 14.1 (i.e., Compliance Agreement, Accident/Incident Reports, Site Safety Briefing Form, etc.).
- Assuring that a copy of the HSP is maintained on the site during all investigation activities.
- Assuring that all air monitoring and equipment calibrations required by the HSP are preformed and recorded, and that logs/forms that include these activities are maintained (Section 14.1).
- Assuring that the subcontractor's medical monitoring program is adequate per OSHA Standard 29 CFR 1910.120 and this document.

- Verify OSHA 40-Hour Health and Safety training before admitting official site visitors (Air Force and regulatory representatives) into the exclusion zone and verify medical certification and fit-testing for respirator use when visitors request admittance into a Level C PPE exclusion zone (per OSHA Standard 29 CFR 1910.120).

1.3.5 Project Field Personnel

Personnel working on this project will be approved by the PM and the HSO and will meet the qualifications outlined in OSHA Standard 29 CFR 1910.120 and this HSP. The project personnel involved in on-site investigations and operations are responsible for:

- Taking all reasonable precautions to prevent injury to themselves and to their fellow employees.

- Implementing the HSP and reporting any deviations from the anticipated conditions described in the plans to the SSO.

- Performing only those tasks that they believe they can do safely, and immediately reporting any accidents and/or unsafe conditions to the SSO.

1.3.6 Subcontractor Responsibilities

It is the responsibility of each HydroGeoLogic subcontractor to ensure compliance with all applicable Federal, state, and OSHA regulations including OSHA Standard 29 CFR, Parts 1900 through 1910, Part 1926, and the contents of this HSP. Specifically contained within these OSHA regulations is OSHA Standard 29 CFR 1910.120, which includes requirements for training and medical surveillance for employees engaged in certain hazardous waste operations.

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2.0 SITE DESCRIPTION INFORMATION

A detailed description of the NAS Fort Worth JRB sites under investigation is presented in Section 1.0 of the Work Plan. Please refer to this section for detailed site description information.

The areas of interest for this investigation are five landfills. A brief description of the materials believed to have been deposited at each site is presented as follows: SWMU 17 reportedly historically received construction debris in the form of concrete, asphalt, wood, trees, and potentially small amounts of undocumented hazardous materials. SWMU 27, still in operation, receives concrete rubble, tree limbs, and street sweepings. SWMU 29 reportedly historically accepted construction debris and moderate quantities of unspecified hazardous wastes. SWMU 30 reportedly historically received construction debris such as concrete, asphalt, and wood. Finally, SWMU 62 reportedly historically accepted construction debris, moderate quantities of unspecified hazardous wastes, and three drums of hydraulic fluid.

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3.0 RCRA FACILITY INVESTIGATION ACTIVITIES

The RFI activities to be conducted at the NAS Fort Worth JRB over a one month period will include:

- Installation of approximately 6 test pits at SWMUs 17 and 62 requiring a field geologist, field technician, and backhoe subcontractor to characterize surface and subsurface soil and types of waste associated with the SWMUs.
- Installation of 26 soil borings (21 of the soil borings will be converted to monitoring wells) site-wide requiring a field geologist, field technician, and drilling subcontractor to characterize the soil and groundwater associated with the SWMUs.
- Groundwater sampling at the new well locations and three pre-existing well sites using a submersible pump.
- Geophysical surveys at SWMUs 17, 27, 29, 30, and 62 utilizing a electromagnetic conductivity meter and a magnetometer/gradiometer.
- Surface water and surface soil sampling at SWMU 27.

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4.0 HAZARD ASSESSMENT

This section identifies and evaluates potential site hazards which may be encountered during RFI activities. Control measures, to protect site personnel from these potential hazards, are incorporated throughout this HSP, but are mainly contained in the following sections:

- Section 6.0, Air Monitoring
- Section 7.0, Personal Protective Equipment
- Section 11.0, Standard Work Practices

4.1 CHEMICAL HAZARDS

Based upon the information obtained from previous site investigations (groundwater and soil), the primary chemicals of concern at NAS Fort Worth JRB have been listed in Table 4.1.

The primary concerns from a chemical exposure standpoint are inhalation, ingestion, and absorption by direct skin contact with contaminants in locations expected to be source areas. The specific contaminants, their exposure limits, and recognition qualities are presented in Table 4.1. The acute and chronic symptoms of overexposure to these chemical contaminants and first aid procedures are presented in Table 4.2. If additional contaminants are identified as being present at the NAS Fort Worth JRB, this HSP will be amended accordingly.

4.2 DECONTAMINATION SOLUTIONS AND PRESERVATIVES

Chemicals used to decontaminate sampling equipment and to preserve environmental sampling also present hazards to the project personnel who use them. The chemicals likely to be brought to the site for use in this manner include:

- Nitric Acid
- Hydrochloric Acid
- Methanol
- Hexane
- Alconox ™
- Liquid Tide ™

Although overexposure to these chemicals is unlikely, the acute and chronic symptoms and first aid procedures are also presented in Table 4.2.

Table 4.1
Exposure Limits and Recognition Qualities

Compound	Permissible Exposure Limit (PEL)[a]	IDLH Level[b]	Recognition Qualities			Odor Warning Concentration (ppm)	LEL[c] (%)	UEL[d] (%)	Ionization Potential (eV)
			Color	Odor	State				
Arsenic Compounds	0.010 mg/m^3	5 mg/m^3[e]	silver gray to tin-white	odorless	solid	NA	NA	NA	NA
Lead	0.050 mg/m^3	100 mg/m^3	gray	odorless	solid	NA	NA	NA	NA
Mercury	0.100 mg/m^3	10 mg/m^3	silver-white	odorless	liquid	NA	NA	NA	NA
Nitric Acid	2 ppm	25 ppm	colorless, red or yellow	acrid, suffocating	liquid	NA	NA	NA	11.95
Hydrochloric Acid	C 5 ppm	50 ppm	colorless to light yellow	irritating	gas	NA	NA	NA	12.74
Methanol	200 ppm	6000 ppm	colorless	pungent	liquid	100	6.0	36.0	10.84
Hexane	500 ppm	1100 ppm	colorless	gasoline-like	liquid	NA	1.1	7.5	10.18
Benzene	1.0 ppm[f]	500 ppm[e]	colorless to light yellow	aromatic	liquid	1.5 - 5.0	1.2	7.8	9.24
Toluene	200 ppm	500 ppm	colorless	aromatic	liquid	0.17 - 40	1.1	7.1	8.82
Ethylbenzene	100 ppm	800 ppm	colorless	aromatic	liquid	4.7 - 5.0	0.8	6.7	8.76
Total Xylene	100 ppm	900 ppm	colorless	aromatic	liquid	1.0 - 1.5	1.1	7.0	8.56
Trichloroethylene	100 ppm[f]	1000 ppm[e]	colorless	chloroform-like	liquid	28.0	8.0	10.5	9.45
Tetrachloroethylene	100 ppm[f]	150 ppm[e]	colorless	chloroform-like	liquid	27.0	NA	NA	9.32
Vinyl Chloride	1 ppm	Unknown [e]	colorless	pleasant	liquid or gas	3,000	3.6	33	9.99
Chloroethane	1000 ppm	3800 ppm	colorless	ether-like	liquid or gas	NA	3.8	15.4	10.97
1,1-Dichloroethane	100 ppm	3000 ppm	colorless	chloroform-like	liquid	NA	5.4	11.4	11.06

Table 4.1 (Cont.)
Exposure Limits and Recognition Qualities

Compound	Permissible Exposure Limit (PEL)[a]	IDLH Level[b]	Recognition Qualities			Odor Warning Concentration (ppm)	LEL[c] (%)	UEL[d] (%)	Ionization Potential (eV)
			Color	Odor	State				
bis-(2-ethylhexyl)phthalate	5 mg/m^3	5000 mg/m^3	colorless	slight	liquid	NA	0.3	NA	NA
1,2-Dichloroethene	200 ppm	1000 ppm	colorless	slightly acrid, chloroform-like	liquid	17.0	5.6	12.8	9.65

[a] OSHA Permissible Exposure Limit or the American Conference of Governmental Industrial Hygienists' Threshold Limit Value (both 8-hour time weighted averages)
[b] Immediately Dangerous to Life or Health
[c] Lower explosive limit
[d] Upper explosive limit
[e] To be treated as a carcinogen
[f] The value presented is the OSHA PEL, which is not necessarily the more conservative of the available exposure limits. The air monitoring screening levels in Table 6.1 are based upon the more conservative values

C Ceiling value, a 15-minute Time Weighted Average that shall not be exceeded at any time during the work day
NA Not Applicable

Table 4.2
Acute And Chronic Effects
Symptoms of Overexposure And First Aid Treatment

Compound	Symptoms of Overexposure	First Aid Treatment
Arsenic	Ulceration of nasal septum; dermatitis; gastrointestinal disturbances; peripheral neuropathy; respiratory irritation; hyperpigmentation of skin; carcinogen	Eye: Irrigate immediately (15 min) Skin: Soap wash immediately Inhalation: Not a inhalation hazard Ingestion: Medial attention immediately
Lead	Weak, lassitude, insomnia; facial pallor; pal eye, anorexia, weight loss, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremors; paralysis of wrist and ankles; encephalaopathy; nephropathy; irritation to eyes; hypotension	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Mercury	Cough, chest pain, dyspnea, bronchitis pneumonitis; tremors, insomnia; irritability, indecision; headache, fatigue, weak; stomatitis, salivation; gastrointestinal disturbance, anorexia, weight loss; proteinuria; irritation of the eyes, skin	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Benzene	Irritation to eyes, nose, respiratory systems; giddiness; headache, nausea, staggered gait; fatigue, anorexia, lassitude; dermatitis; bone marrow depressant/depression; carcinogenic	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Artificial respiration Ingestion: Medical attention immediately: DO NOT INDUCE VOMITING
Toluene	Fatigue, weakness; confusion, euphoria, dizziness, headache; dilated pupils, lacrimation; nervousness, muscle fatigue, insomnia; paresis; dermatitis	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air Ingestion: Medical attention immediately; DO NOT INDUCE VOMITING
Ethylbenzene	Irritation to eyes, mucous membranes; headache; dermatitis; narcosis; coma	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Artificial respiration Ingestion: Medical attention immediately
Xylene	Dizziness, excitement, drowsiness, incoordination, staggering gait; irritation of eyes, nose, throat; corneal vacuolization; anorexia, nausea, vomiting, abdominal pain; dermatitis	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air Ingestion: Medical attention immediately; DO NOT INDUCE VOMITING
Trichloroethylene	Headache, vertigo; visual disturbance, tremors, somnolence, nausea, vomiting; irritation of the eyes; dermatitis; cardia arrhythmias, paresthesia; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately

Table 4.2 (continued)
Acute and Chronic Effects
Symptoms of Overexposure and First Aid Treatment

Compound	Symptoms of Overexposure	First Aid Treatment
Tetrachloroethylene	Irritation of the eyes, nose, throat; nausea; flush face, neck; vertigo, dizziness, incoordination; headache, somnolence; skin erythema; liver damage; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
Vinyl Chloride	Weakness; abdominal pain, gastrointestinal bleeding; hepatomegaly; pallor or cyan of extremities; carcinogen	Inhalation: Respiratory support
Chloroethane	Incoordination, inebriate; abdominal cramps; cardiac arrhythmias, cardiac arrest; liver and kidney damage	Eye: Irrigate immediately Skin: Water flush promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
1,1-Dichloroethane	Central nervous system depressant; skin irritant; liver and kidney damage	Eye: Irrigate immediately Skin: Soap flush promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
1,2-Dichloroethene	Irritation of eyes and respiratory system; central nervous system depressant/depression	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Respiratory support Ingestion: Medical attention immediately
bis-(2-ethylhexyl)phthalate	Irritation of eyes, mucous membranes; carcinogen	Eye: Irrigate immediately Skin: Not a dermal hazard Inhalation: Respiratory support Ingestion: Medical attention immediately
Nitric Acid	Irritation of eyes, mucous membranes, and skin; delayed pulmonary edema, pneuitis, bronchitis; dental erosion	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Respiratory support Ingestion: Medical attention immediately
Hydrochloric Acid	Inflammation of the nose, throat, laryngeal; cough, burns throat, choking; burns eyes, skin; dermatitis	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Respiratory support Ingestion: Medical attention immediately
Methanol	Eye irritant, headache, drowsiness; lightheadedness, nausea, vomiting; visual disturbances, blindness	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Respiratory support Ingestion: Medical attention immediately

**Table 4.2 (continued)
Acute and Chronic Effects
Symptoms of Overexposure and First Aid Treatment**

Compound	Symptoms of Overexposure	First Aid Treatment	
Hexane	Light-headedness, nausea, headaches, numbness in extremities, weak muscles, eye irritation, nose irritation, dermatitis, chemical pneumonia, giddiness	Eye: Skin: Inhalation: Ingestion:	Irrigate immediately Soap, wash immediately Respiratory support Medical attention immediately

In order to communicate the hazards of these chemicals to site personnel, MSDSs for each of these chemicals will be maintained on site and presented as part of the site-specific training (Section 10.2).

4.3 PHYSICAL HAZARDS

The following section titles identify physical hazards that may be encountered. They include but are not limited to:

- Hot or Cold Work Environments (Stress)
- Noise Hazards
- Materials Handling
- Utility Hazards
- Fall, Trip, and Slip Hazards (Section 11.0)
- Flammable/Explosive Atmospheres (Section 6.0)
- Heavy Equipment/Vehicular Activity (Section 11.0)

Control measures to help protect site personnel from these potential hazards are incorporated in the following subsections and throughout this HSP, specifically Section 11.0, Standard Work Practices, for safety hazards associated with drilling rigs and support vehicles.

4.3.1 Heat Stress

Heat stress can be a problem especially if site activities are required to be performed while wearing PPE in warm, humid weather conditions. The four types of heat illness in increasing order of severity include: heat rash, heat cramps, heat exhaustion, and heat stroke.

- Heat rash may result from continuous exposure to heat or humid air.

- Heat cramps are caused by heavy sweating with inadequate electrolyte replacement. Signs and symptoms include muscle spasms and pain in the hands, feet, and abdomen.

- Heat exhaustion occurs from increased stress on various body organs, including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include: pale, cool, and moist skin; heavy sweating; dizziness, fainting and nausea.

- Heat stroke is the most serious form of heat stress. Temperature regulation fails, and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury or death occurs. When heat stroke is suspected, professional medical help must be obtained immediately. Signs and symptoms include: red, hot, and unusually dry skin; lack of or reduced perspiration; dizziness and confusion; strong, rapid pulse; and coma.

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important, because once someone suffers from heat stroke or heat exhaustion, that person may be predisposed to additional injuries. To avoid heat stress, the following steps should be taken:

- Work schedules should be adjusted. The following guidelines of rest and cooling of the body will be followed to minimize the effects of heat stress:

  - If oral temperature exceeds 99.6°F (37.6°C), shorten the next work cycle by one-third without changing the rest period.
  - If oral temperature still exceeds 99.6°F (37.6°C) at the beginning of the next rest period, shorten the following work cycle by one-third.
  - Do not permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6°F (38.1°C).

Initially, the frequency of physiological monitoring depends on the air temperature adjusted for solar radiation and the level of physical work (See Table 4.3). The length of the work cycle will be governed by the frequency of the required physiological monitoring.

Table 4.3
Suggested Frequency of Physiological Monitoring for Fit and Acclimatized Workers

Adjusted Temperature[1]	Normal Work Ensemble[2]	Impermeable Ensemble
90°F or above	After each 45 minutes of work	After each 15 minutes of work
87.5° - 90°F	After each 60 minutes of work	After each 30 minutes of work
82.5° - 87.5°F	After each 90 minutes of work	After each 60 minutes of work
77.5° - 82.5°F	After each 120 minutes of work	After each 90 minutes of work
72.5° - 77.5°F	After each 150 minutes of work	After each 120 minutes of work

1 Calculate the adjusted air temperature (T_{aj}) by using the equation: T_{aj} (°F) = T (°F) + (13 x % sunshine). Measure air temperature (T) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows)

2 A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants

Source: NIOSH/OSHA/USCG/EPA, 1985

- Shelter (air-conditioners and other cooling devices, if possible) or shaded areas should be provided to protect personnel during rest periods.

- Worker's body fluids should be maintained at normal levels to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water in sweat, which will vary from day to day. The normal thirst mechanism is not sensitive enough to ensure that water intake is sufficient to replace lost sweat. When heavy sweating occurs, the worker should be encouraged to drink more.

Have workers drink fluid (preferably water or diluted drinks) before beginning work. Urge workers to drink a cup or two at each scheduled break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but will depend on actual fluid replacement needs, which will vary depending on the sweat rate.

- The drinking water temperature should be maintained at 50°F to 60°F (10°C to 15.6°C).
- Disposable cups that hold about 16 ounces should be provided.
- Encourage workers to maintain an optimal level of physical fitness. Where indicated, acclimatize workers to site work conditions.
- Train workers to recognize, identify, and treat heat stress.

When heat stress is suspected, the following steps should be taken:

- Get the victim out of the heat
- Loosen tight clothing
- Remove perspiration-soaked clothing
- Apply cool, wet cloths to the skin
- Fan the victim
- If the victim is conscious, give cool water to drink. Do not give electrolyte solutions (i.e., those containing salt) to victims of heat stress because it can cause nausea and vomiting. Only small sips of cool water should be administered to heat stress victims.
- Call for an ambulance if the victim refuses water, vomits, or starts to lose consciousness.

4.3.2 Cold Stress

If site work is to be conducted during the winter, cold stress is a concern to the health and safety of personnel. Especially with regard to the wearing of Tyvek suits because such disposable clothing does not "breathe," perspiration does not evaporate, and the suits can become wet. Wet clothes combined with cold temperatures can lead to hypothermia. If the air temperature is less than 40°F and an employee perspires, the employee must change to dry clothes.

The following are five degrees of cold stress in increasing order of severity:

- Incipient frostbite is a mild form of cold stress characterized by sudden blanching or whitening of the skin.

- Chilblain is an inflammation of the hands and feet caused by exposure to cold moisture. It is characterized by a recurrent localized itching, swelling, and painful inflammation of the fingers, toes, or ears. Such a sequence produces severe spasms, accompanied by pain.

- Second-degree frostbite is manifested by skin with a white, waxy appearance and the skin is firm to the touch. Individuals with this condition are generally not aware of its seriousness, because the underlying nerves are frozen and unable to transmit signals to warm the body. Immediate first aid and medical treatment are required.

- Third-degree frostbite will appear as blue, blotchy skin. The tissue is cold, pale, and solid. Immediate medical attention is required.

- Hypothermia develops when body temperature falls below a critical level. In extreme cases, cardiac failure and death may occur. Immediate medical attention is warranted when the following symptoms are observed: involuntary shivering, irrational behavior, slurred speech, and sluggishness.

To care for any frostbite, handle the area gently. Never rub an affected area because rubbing causes further damage to soft tissues. Warm the affected area gently by soaking the affected part in water no warmer than 105° F. Keep the frostbitten part in the water until it looks red and feels warm. Loosely bandage the affected area with a dry, sterile dressing. If fingers or toes are frostbitten, place cotton or gauze between them. Do not break any blisters caused by frostbite. Obtain professional medical attention as soon as possible.

To care for hypothermia, start by caring for any life-threatening problems and call for emergency medical assistance. Remove any wet clothing and dry the victim. Warm the body gradually by wrapping the victim in blankets or putting on dry clothing and moving him or her to a warm place. If available, apply heat pads or other heat sources to the body but be sure to keep a barrier, such as a blanket, towel, or clothing, between the heat source and the victim to avoid burning the victim. If the victim is alert, give warm liquids to drink. Do not warm the victim too quickly, such as by immersing the victim in warm water, because rapid rewarming can cause dangerous heart problems. In cases of severe hypothermia when the victim may be unconscious, give rescue breathing when necessary and be prepared to administer cardiopulmonary resuscitation (CPR).

4.3.3 Noise Hazards

The SSO or designee will monitor high noise levels when equipment or machinery (e.g. backhoe, drill rig, etc.) is being used on-site. Field personnel working in areas where noise levels can be expected to reach or exceed 85 decibels on the A-weighted scale (dBA) will be issued hearing protection to reduce the level below the 85 dBA threshold. Compliance standards for occupational noise exposure are found in 20 CFR 1910.95.

4.3.4 Materials Handling

The most common type of materials handling accident is when fingers or toes of field personnel get caught between two objects. Special precautions must be implemented during the moving, shifting, or rolling of materials and should never be attempted by a single individual. Workers are required to use proper lifting techniques for handling materials, and oversize or heavy loads require "team lift" procedures.

4.3.5 Utility Hazards

The locations of all underground utilities must be identified and marked prior to initiating any subsurface investigations. In addition, drilling within 20 feet in any direction of overhead powerlines will not be permitted.

4.4 BIOLOGICAL HAZARDS

The biological hazards that could be encountered by site personnel include, but are not limited to, the following:

- Poisonous snakes and spiders
- Stinging insects
- Ticks and chiggers
- Poisonous plants (e.g., poison sumac, poison ivy, poison oak)

Control measures to help protect site personnel from these biological hazards are incorporated in the following sections.

4.4.1 Poisonous Snakes and Spiders

Reactions from a snakebite are aggravated by acute fear and anxiety. Other factors that affect the severity of local and general reaction from a poisonous snakebite include: the amount of venom injected and the speed of absorption of venom into the victim's circulation; the size of the victim; protection from clothing, including shoes and gloves; quick anti-venom therapy; and location of the bite.

Spiders in the United States are generally harmless, with two notable exceptions: the Black Widow spider (Latrodectus Mactans) and the Brown Recluse or violin spider (Lox Osceles Reclusa). The symptoms of a Black Widow spider bite are: slight local reaction, severe pain produced by nerve toxin, profuse sweating, nausea, painful cramps in abdominal muscles, and difficulty in breathing and speaking. Victims recover in almost all cases, but an occasional death is reported.

Field personnel should exercise caution when lifting logs, rocks, covers to manholes, sumps, etc.

4.4.1.1 <u>First Aid Procedures (Snakebite)</u>

The objective of first aid is to reduce the circulation of blood through the bite area, to delay absorption of venom, to prevent aggravation of the local wound, and to sustain respiration. Several steps are listed to properly care for a snakebite victim. The most important step is to get the snakebite victim to the hospital quickly. Since all investigation activities will be performed at NAS Fort Worth JRB, the base hospital will be within reasonable travel time. Meanwhile, take the following first aid measures:

- Keep the victim from moving around.
- Keep the victim as calm as possible and preferably in a lying position.
- Immobilize the bitten extremity and keep it at or below heart level. If the victim can reach a hospital within 4 to 5 hours and if no symptoms develop, no further first aid measures need to be applied.
- If mild-to-moderate symptoms develop, apply a constricting band 2 to 4 inches above the bite, but not around a joint (the elbow, knee, wrist, or ankle) and not around the head, neck, or trunk. The band should be ¾ to 1½ inches wide, not thin like a rubber band. The band should be snug but loose enough for a finger to be slipped underneath. Watch for swelling and loosen the band if it becomes too tight, but do not remove it. Periodically check the pulse in the extremity beyond the bite to insure that the blood flow has not stopped.

Several other factors must be considered in cases of snakebite:

- Shock. Keep the victim lying down and comfortable, and maintain his or her body temperature.
- Breathing and heartbeat. If breathing stops, give mouth-to-mouth resuscitation. If breathing stops and there is no pulse, perform CPR if you have been trained to do so.
- Identifying the snake. If you can kill the snake without risk or delay, bring it to the hospital for identification, but exercise extreme caution in handling the snake.
- Cleaning the bitten area. You may wash the bitten area with soap and water and blot it dry with sterile gauze. You may apply dressings and bandages, but only for a short period of time.
- Medicine to relieve pain. Do not give the victim alcohol, sedatives, aspirin, or any medicine containing aspirin. Consult a doctor or other medical personnel for specific medications that may be used.
- Snakebite kits. Keep a kit accessible for all outings in primitive areas or areas known or suspected to snake infested.

It is not recommended that cold compresses, ice, dry ice, chemical ice packs, spray refrigerants, or other methods of cold therapy be used in the first aid treatment of snakebite.

4.4.1.2 General First Aid for Poisonous Insect Bites

For minor bites and stings use cold applications and soothing lotions, such as calamine. For more severe reactions, take the following first aid measures:

- Apply a constricting band above the injection site on the victim's arm or leg (between the site and the heart). Do not apply tightly. You should be able to slip your index finger under the band when it is in place. Give artificial respiration if necessary;

- Keep the affected part below the level of the victim's heart.

- If medical care is ready available, leave the band in place; otherwise, remove it after 30 minutes.

- Apply ice contained in a towel or plastic bag, or cold cloths, to the site of the sting or bite.

- Give home medicine, such as aspirin, for pain.

- If the victim has a history of allergic reactions to insect bites or is subject to attacks of hay fever or asthma, or if he or she is not promptly relieved of symptoms, call a physician or take the victim immediately to the nearest location where medical treatment is available. In a highly sensitive person, do not wait for symptoms to appear, since delay can be fatal.

- In case of a bee sting, remove and discard the stinging apparatus and venom sac.

Workers who have had severe allergic reactions to bee/wasp stings in the past will inform the SSO when they arrive at the site for the first time.

4.4.2 Ticks and Chiggers

Field personnel should be aware of the presence of ticks (i.e., deer tick) and chiggers at the site. Common carriers of ticks and chiggers are the white-footed mouse and white-tailed deer which are prevalent in the area. The deer tick is about the size of a sesame seed, as distinguished from the dog tick, which is significantly larger. The deer tick is principally found along the Atlantic coast, living in grassy and wooded areas, and feeds on mammals such as mice, shrews, birds, raccoons, opossums, deer, and humans. Common diseases caused by ticks are presented in the following subsections.

Removal of ticks is best accomplished using small tweezers. Do not squeeze the tick's body. Grasp it where the mouth parts enter the skin and tug gently, not firmly, until it releases its hold on the skin. Save the tick in a jar labeled with the date, body location of the bite, and the place where it may have been acquired. Wipe the bite thoroughly with an antiseptic. Seek medical attention in the event tick-related disease symptoms develop.

When in an area suspected of harboring ticks (grassy, bushy, or woodland area) the following precautions can minimize the changes of being bitten by a tick:

- Wear long pants and long-sleeved shirts that fit tightly at the ankles and wrists.
- Wear light colored clothing so ticks can be easily spotted.
- Wearing tick repellents may be useful.
- Inspect clothing frequently while in tick habitat.
- Inspect your head and body thoroughly when you return from the field.
- Remove any attached ticks by tugging with tweezers where the tick's mouth parts enter the skin. Do not squeeze or crush it.

4.4.2.1 Lyme Disease

Lyme disease is an illness caused by a bacterium which may be transmitted by the bite of a tick (Ixodes Dammini), commonly referred to as the "Deer Tick". Not all ticks are infected with the bacterium, however. When an infected tick bites, the bacterium is passed into the bloodstream of the host, where it multiplies. The various stages and symptoms of the disease are well recognized and, if detected early, can be treated with antibiotics.

The illness typically occurs in the summer and is characterized by a slowly expanding red rash, which develops a few days to a few weeks after the bite of an infected tick. This may be accompanied by flu-like symptoms along with headache, stiff neck, fever, muscle aches, and/or general malaise. At this stage treatment by a physician is usually effective; but, if left too long, these early symptoms may disappear and more serious problems may follow. The most common late symptom of the untreated disease is arthritis. Other problems which may occur include meningitis and neurological and cardiac abnormalities. It is important to note that some people do not get the characteristic rash but progress directly to the later manifestations. Treatment of later symptoms is more difficult than early symptoms and is not always successful.

4.4.2.2 Rocky Mountain Spotted Fever

In the eastern and southern United States this tickborne disease is transmitted by the infected Dog Tick (Dermacentor Variabilis). It is important to note that the Dog Tick is significantly larger than the Deer Tick. Nearly all cases of infection occur in the spring and summer, generally several days after exposure to infected ticks. The onset of illness is abrupt and often accompanied by high fever, headache, chills, and severe weakness. After the fourth day of fever, victims develop a spotted pink rash that usually starts on the hands and feet and gradually extends to most of the body. As with Lyme disease, early detection and treatment significantly reduces the severity of illness. The disease responds to antibiotic therapy with tetracycline or chloramphenicol.

4.4.2.3 Other Diseases

Ticks transmit several other diseases, most of which are rare and occur only in specific areas. Babesiosis occurs mainly in the Cape Cod area and eastern Long Island. Colorado tick fever is similarly regional and occurs only among those who live or work at altitudes above 4,000 feet.

4.4.3 Poisonous Plants

The majority of skin reactions following contact with offending plants are allergic in nature and are characterized by general symptoms of headache and fever, itching, redness, and a rash.

Some of the most common and most severe allergic reactions result from contact with plants of the Poison Ivy group including Poison Ivy, Poison Oak and Poison Sumac. The most distinctive features of Poison Ivy and Poison Oak are their leaves, which are composed of three leaflets each. Both plants also have greenish-white flowers and berries that grow in clusters. Such plants produce a severe rash characterized by redness, blisters, swelling, and intense burning and itching. The victim can also develop a high fever and become very ill. Ordinarily, the rash begins within a few hours after exposure, but it may be delayed for 24 to 48 hours.

4.4.3.1 First Aid Procedure

- Remove contaminated clothing.
- Wash all exposed areas thoroughly with soap and water, followed by rubbing alcohol.
- Apply calamine or other soothing skin lotion if the rash is mild.
- Seek medical advice if a severe reaction occurs, or if there is a known history of previous sensitivity.

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5.0 HAZARD COMMUNICATION

The HydroGeoLogic Hazard Communication Program complies with the OSHA Hazard Communication Standard (HCS) found in OSHA Standard 29 CFR 1910.120 and 1926.59, which applies to any chemical present in the workplace in such a manner that employees may be exposed to under normal conditions of use in a foreseeable emergency. Although waste materials are excluded from the OSHA requirements, decontamination chemicals for sampling equipment or protective clothing and calibration standards require MSDSs.

The principle of communicating the hazards of materials used in the workplace by employees applies to company-wide activities, from informational programs on the conduct of hazardous waste activities to the company's insistence upon adequate health and safety training. It is also important for personnel to have an awareness of client concern for Hazard Communication due to Federal, state, and local regulations directly affecting certain client activities.

In order to comply with the HCS, HydroGeoLogic has determined that:

- All containers of hazardous chemicals must be appropriately labeled or tagged to identify the hazard and provide information on effects and appropriate protective measures.
- Labels, tags, or signs must be properly affixed and visible at all times while a hazard is present and removed promptly when the hazard no longer exists.
- Written information (i.e., MSDSs) on hazardous chemicals in the workplace must be available to employees working with the substances.
- Appropriate MSDSs will be available to any contractor or subcontractor employee working on projects under HydroGeoLogic control.

When investigation results indicate potential imminent health risks to contracted or federal personnel, or the public at large, the contracting officer's representative (COR) and the base point of contact (POC) will be notified as soon as practicable. Written notification and supporting documentation will be provided within three days of finding potential imminent health risks during investigation activities.

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6.0 AIR MONITORING

This section presents requirements for the use of real-time air monitoring instruments during site activities involving potential for exposure to site contaminants. It establishes the types of instruments to be used, the frequency of which they are to be used, techniques for their use, action levels for upgrading/downgrading levels of protection, and methods for instrument maintenance and calibration.

6.1 INSTRUMENTS AND USE

A Photo-ionization Detector (PID) equipped with an appropriate lamp will be utilized for detecting the presence of emissions from chemicals of concern. A Draeger pump and colorimetric tubes will be used to confirm any detections observed with the PID in accordance with Table 6.1. Additionally, LEL/O_2 and methane detectors will be used during certain drilling and excavation activities to detect the presence of flammable/explosive atmospheres. The presence of methane will be monitored during field activities in proximity to SWMUs. Visual observation will be used to detect the presence of airborne particulates.

The PID/Draeger pump will be used throughout the execution of these activities:

- Test pit excavations.
- Soil boring installation.
- Monitoring well installation.
- Soil sampling during drilling activities.
- Well development.
- Groundwater sampling.
- Sampling equipment decontamination/equipment (heavy) decontamination.
- Waste characterization and disposal.

LEL/O_2 and methane detector will be used throughout the execution of these activities if flammable contaminants are anticipated:

- Test pit excavations.
- Soil boring/monitoring well installation.

6.2 AIR MONITORING REQUIREMENTS

6.2.1 Photo-Ionization Detector (PID)

Air monitoring with the PID will be initiated at potential sources of vapor emissions (source monitoring) at specified frequencies. The frequencies will be increased where concentrations of constituents are measured. The following potential sources and monitoring frequencies are anticipated:

Bore holes	Upon initial opening and then every 5-foot depth thereafter
Test Pits	Upon initial opening and continuous thereafter
Open well heads	Upon initial opening
Environmental sampling	Every sample set
Surface/subsurface soil sampling	Every 5-foot depth
RFI waste characterization	Every container to be sampled

If source monitoring indicates the presence of airborne emissions, air monitoring will then be initiated in the breathing zones of those workers who could be affected by the emissions. Air monitoring will also occur upon the request of site workers who notice unusual site odors or an increase in their intensity. If work is to be performed downwind of a site, air monitoring will be conducted to determine what type of PPE, if any, is required to protect workers and to determine the potential for an imminent threat to public health.

The presence of elevated readings in the worker's breathing zone as identified in Table 6.1 require amendments to the HSP before workers are allowed to enter the exclusion zone. Depending on the air monitoring readings, air-purifying respirators may not be acceptable due to the fact that some contaminants of concern have poor warning properties and/or are unable to be filtered from inspired air with chemical cartridges (Table 6.1). Elevated readings will be based on confirmation sampling using a Draeger pump and colorimetric tubes in accordance with Table 6.1.

6.2.2 Drager Pump and Tubes

A hand operated Draeger pump with colorimetric tubes will be used to confirm the results of PID testing. If the results of the PID tests show concentrations greater than 0.5 ppm above background concentrations in the breathing zone, then the colorimetric tubes will be used to identify the contaminants in the breathing zone. Colorimetric tubes to be utilized in the event of elevated PID readings will include: vinyl chloride, benzene, tetrachloroethylene, and/or trichloroethylene in accordance with Table 6.1. The colorimetric tube utilized will depend on the chemical anticipated to be present at the site.

6.2.3 LEL/O_2 and Methane Detectors

Air monitoring with the LEL/O_2 and methane detectors will be conducted during all drilling and excavation activities within bore holes, test pits, and immediately over drill cuttings at every 5-foot depth interval. If elevated (above background) LEL readings are observed, personnel must be advised of the potential explosive nature and must initiate the use of spark proof tools in accordance with Table 6.1. LEL readings in excess of 10 percent requires cessation of drilling and/or test pit activities or abandonment of the drilling and/or test pit location until readings subside.

6.2.4 Visual Observations

If airborne particulates are observed and air monitoring results warrant as indicated in Table 6.1, personnel must don air-purifying respirators equipped with organic vapor cartridges and high efficiency particulate air (HEPA) filters. If airborne particulates are observed due to intrusive activity at these sites, dust control measures will be implemented.

6.3 MODIFICATION OF AIR MONITORING REQUIREMENTS

The action levels and protection measures presented in Table 6.1 are based upon the assumption that the contaminants listed in Table 4.1 are the only contaminants which pose a reasonable health risk to site workers covered by this HSP. In the event that this assumption is found to be invalid through analysis of samples collected, or by some other means, the action levels will be modified as necessary.

6.4 INSTRUMENT MAINTENANCE AND CALIBRATION

Air and noise monitoring instruments are maintained and prefield-calibrated at the HydroGeoLogic office in Herndon, Virginia. Field maintenance will consist of daily cleaning of the instruments using a damp towel or rag to wipe off the instrument's outer casing, overnight battery recharging, and cleaning or replacing of the lamp whenever calibration cannot be attained. Procedures for accomplishing instrument maintenance is contained in the PID User's Manual which will be provided with each instrument. The User's Manual provided with each instrument will be followed to field calibrate the instruments prior to each day of use under the environmental conditions (temperature and humidity) that sampling will occur. Field equipment will also be calibrated at the end of each day to account for instrument drift and reliability.

6.5 RECORDKEEPING

Instrument calibrations and readings will be recorded on the Air Monitoring Log Sheet provided in Section 14.1 of this HSP. Copies of these log sheets will be maintained on site until field activities covered by this HSP have been completed at which time the log sheets will be transmitted to the HydroGeoLogic HSO and to the project file.

LEL/O_2 and methane readings will not be recorded unless flammable/explosive or oxygen deficient/enriched atmospheres are detected in which case entries will be made in the field log book.

LEL/O_2, methane detector, and the PID will undergo daily operational checks. These checks will be recorded in the field log book and Equipment Calibration Log (Section 14.1).

Table 6.1
Hazard Monitoring Methods, Action Levels, and Protection Measures

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Toxic Vapors (as identified in Table 4.1)	PID	0.0 to <0.5 ppm above background based on judgement of SSO	Level D (see Table 7.1)	-continue with regular monitoring of breathing zone
		0.5 ppm above background based on judgement of SSO	Level D (see Table 7.1)	-confirm/deny reading with vinyl chloride and benzene colorimetric tubes. -if confirmed as vinyl chloride and/or benzene, then see vinyl chloride/benzene hazard identified below. -if denied as vinyl chloride and benzene, then continue with regular monitoring of breathing zone.
		≥0.5 ppm to <25 ppm above background based on judgement of SSO (if denied as vinyl chloride and benzene)	Level D (see Table 7.1)	-confirm/deny reading with vinyl chloride and benzene colorimetric tubes. -if confirmed as vinyl chloride and/or benzene, then see vinyl chloride/benzene hazard identified below. -if denied as vinyl chloride and benzene, then continue with regular monitoring of breathing zone. -confirm/deny reading with tetrachloroethylene and TCE colorimetric tubes. -if confirmed , then see hazard identified below. -if denied as tetrachloroethylene or TCE, then continue with regular monitoring of breathing zone.
		≥25 to <250 ppm above background based on judgement of SSO (if denied as vinyl chloride, benzene, and tetrachloroethylene)	Level C (see Table 7.1)	-continue with regular monitoring of breathing zone. - contact HSO and Project Manager. - continue use of tubes, attempt to identify unknown air contaminants.
Vinyl Chloride	Colorimetric Tubes	confirmed 1.0 ppm to 10 ppm above background based on judgement of SSO.	Level C (See Table 7.1)	-continue regular monitoring of breathing zone.
Benzene	Colorimetric Tubes	confirmed 0.5 ppm to 5 ppm above background based on judgement of SSO.	Level C (See Table 7.1)	-continue regular monitoring of breathing zone.
Tetrachloroethylene	Colorimetric Tubes	confirmed 25 ppm to 250 ppm above background based on judgement of SSO.	Level C (See Table 7.1)	-continue regular monitoring of breathing zone.

Table 6.1 (continued)
Hazard Monitoring Methods, Action Levels, and Protection Measures

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Trichloroethylene	Colorimetric Tubes	confirmed 50 ppm to 500 ppm above background based on judgement of SSO.	Level C (See Table 7.1)	-continue regular monitoring of breathing zone.
Flammable/Explosive Gases and/or Vapors	LEL/O_2 and Methane Detector	0.0 to 5.0 percent LEL	-notify sampling team of readings.	-prior to and during sampling activities, monitor all areas suspected of containing flammable/explosive gases and/or vapors. -continue with regular monitoring of breathing zone.
		5.0 to <10.0 percent LEL	-use spark proof equipment/tools	-continue with regular monitoring of breathing zone. - notify HSO and Project Manager
		>10.0 percent LEL	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments unless readings subside.
Toxic Vapors (as identified in Table 4.1) (Cont.)	PID	≥250 above background based on judgement of SSO (if denied as all chemicals listed above)	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires identification of new chemical hazard and HSP amendments.
Vinyl Chloride	Colorimetric Tubes	confirmed 10 ppm or greater above background based on judgement of SSO.	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	- requires HSP amendments
Benzene	Colorimetric Tubes	confirmed 5 ppm or greater above background based on judgement of SSO.	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments.

Table 6.1 (continued)
Hazard Monitoring Methods, Action Levels, and Protection Measures

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Tetrachloroethylene	Colorimetric Tubes	confirmed 250 ppm or greater above background based on judgement of SSO.	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments.
Trichloroethylene	Colorimetric Tubes	confirmed 500 ppm or greater above background based on judgement of SSO.	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	- requires HSP amendments.

7.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

This section presents requirements for the use of personal protective equipment (PPE) for each of the activities being conducted. This section includes anticipated levels of protection for each of the activities, the criteria used for selecting various levels of protection, and criteria for modifying levels of protection based on monitoring instrument readings and personal observations.

7.1 ANTICIPATED LEVELS OF PROTECTION

All work is anticipated to be performed in Level D protection, as defined in Appendix B of OSHA Standard 29 CFR 1910.120. Many activities may require the use of chemical resistant coveralls, gloves, and boot covers as presented in Table 7.1.

The items of PPE anticipated to be used for each activity are presented in Table 7.1. Where overlap in activities occur, the more protective requirement will apply.

Table 7.1
Protective Equipment for On-site Activities

Activity	Level	Protective Equipment
Test Pits MW Installation Groundwater Sampling Surface Soil Sampling Subsurface Soil Sampling	D	• Street clothes or overalls (long sleeves) • Impermeable safety boots/shoes (steel toed) • Safety glasses/goggles (if hazard to eyes exists) • Hard hat (if hazard to head exists) • Gloves (nitrile, neoprene) • Ear plugs/defenders (if hazard exists)
	D (modified)	• Rubber boots; chemically-resistant with steel toe • Gloves (nitrile, neoprene) • Tape for sealing ankle and wrist openings • Hard hat (if hazard to head exists) • Safety glasses/goggles (if hazard to eyes exists) • Uncoated tyvek or equivalent • Ear plugs/defenders (if hazard exists)
	C	• Coated tyvek or equivalent • Rubber boots; chemically-resistant with steel toe • Rubber boot covers • Latex inner gloves • Tape for sealing ankle and wrist openings • Chemical resistant outer gloves (nitrile, neoprene) • Full-face respirator (organic vapor cartridges) • Additional items may be required (site-specific) • Ear plugs/defenders (if hazard exists)

7.2 PPE SELECTION CRITERIA

Respiratory protection is not anticipated for use during the initial stages of work until detectability of site contaminants with air monitoring instruments warrants the donning of respirator protection in accordance with Table 6.1. See Section 7.3 for modification criteria of respiratory protection. Basic requirements of field personnel prior to using respiratory protection include:

- All field personnel will be medically certified to wear a full face respirator and have the proper fit test documentation within the past 12 months prior to assignment.
- Only NIOSH approved respirators are to be used on site. The respirators are to be properly cleaned, inspected, and maintained prior to and at the conclusion of the work day.
- Cartridges to air-purifying respirators will be disposed of at the end of each work day and when load-up or breakthrough occurs.
- Field personnel will be clean shaven in areas which might prevent the seal of the respirator to the face and contact lenses will not be permitted while wearing a respirator.

Hard hats, safety glasses, and steel-toe work boots were selected as minimum protection to reduce the potential for injury resulting from exposure to the physical hazards associated with onsite investigations.

Boot covers, disposable nitrile gloves, and Tyvek coveralls were selected to minimize contamination of work clothes and to prevent direct skin contact with low level contamination. Nitrile gloves of 11 millimeter thickness or greater were selected for activities that may involve direct contact with appreciable concentrations of contaminants thought to be present as site contaminants.

PVC or Saranex coveralls, hoods, and/or splash shields were selected to prevent saturation of work clothes during activities involving large volumes of liquids and/or saturated soils/equipment.

7.3 PPE MODIFICATION CRITERIA

This section presents criteria for upgrading and downgrading chemical protective clothing (CPC) and/or respiratory protection. Where uncertainties arise, the more protective requirement will apply.

7.3.1 CPC Modification Criteria

Tyvek coveralls and boot covers must be worn anytime there is a reasonable potential for contamination of street clothes.

Disposable nitrile gloves must be worn anytime there is a reasonable potential for contact with unsaturated soils or equipment which may contain trace contamination.

Nitrile gloves (11 mil or greater) must be worn anytime there is a reasonable potential for contact with groundwater, saturated soils, and/or soils producing elevated PID readings.

Polyvinyl chloride (PVC) or Saranex coveralls must be worn anytime there is a reasonable potential for saturation of work clothes.

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8.0 DECONTAMINATION

This section describes the steps site personnel will follow to prevent the spread of site contaminants into areas that may affect unprotected, unsuspecting site personnel or the public. It includes requirements for decontamination of personnel, sampling equipment, and augering/ drilling equipment.

8.1 PERSONNEL DECONTAMINATION

The decontamination of personnel and their protective clothing will be performed within the decontamination zone. Table 8.1 presents the six stages for decontamination for Modified Level D protection.

Table 8.1
Six stages for Decontamination for Modified Level D Protection

Stage		Procedure
Stage 1:	Segregated Equipment Drop	Deposit equipment used on site on plastic drop cloths or in assigned containers with plastic liners.
Stage 2:	Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decontamination solution, and rinse with water.
Stage 3:	Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Stage 4:	Remove boots, gloves, and disposable clothing	Deposit in appropriate plastic-lined container. Discard disposable clothing.
Stage 5:	Field wash	Wash hands and face with soap and water.
Stage 6:	Redress	Put on clean clothes.

Wash tubs containing an appropriate decontamination solution and soft-bristle brushes will be used to wash reusable personal protective equipment and boots. Clean water will be used for the final rinse. The choice of decontamination solution is dependent upon the type of materials which must be removed from reuseable protective equipment. Based on the current understanding of potential site contaminants, a detergent and water solution is recommended for general purpose decontamination. Acceptable detergents include laboratory-grade cleaners (e.g., Alconox™, or equivalent), or a high strength consumer detergent such as Liquid Tide™.

Alternative decontamination solutions may be called for if the contaminants encountered are different or in a more concentrated state than anticipated. Alternative solutions include:

1. Dilute acids for removal of basic (caustic) compounds, amines, and hydrazines.
2. Dilute bases (soaps and detergents) for removal of acidic compounds, phenols, thiols and some nitro and sulfonic compounds.
3. Organic solvents for removal of nonpolar compounds (organic).

Gloves and other PPE should be inspected frequently for integrity, and manufacturers' data for breakthrough times should be considered if concentrated contaminants are encountered.

The decontamination of personnel and their protective clothing will be performed in 18 stages for Level C protection, if necessary. The 18 stages are presented in Table 8.2 below.

Table 8.2
18 Stages for Decontamination in Level C Protection

Stage		Procedure
Stage 1:	Segregated Equipment Drop	Deposit equipment used on site on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area.
Stage 2:	Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decon solution of detergent and water.
Stage 3:	Boot Cover and Glove Rinse	Rinse off decon solution from Stage 2 using copious amounts of water.
Stage 4:	Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Stage 5:	Boot Cover Removal	Remove boot covers and deposit in container with plastic liner.
Stage 6:	Outer Glove Removal	Remove outer gloves and deposit in container with plastic liner.
Stage 7:	Suit, Glove, and Boot Wash	Wash splash suit, gloves, and safety boots. Scrub with long-handle scrub brush and decon solution.
Stage 8:	Suit, Glove and Boot Rinse	Rinse off decon solution using water. Repeat as many times as necessary.
Stage 9:	Canister or Mask Change	Perform last step in the decontamination procedure (if worker is leaving exclusion zone to change canister or mask). Worker's canister is exchanged, new outer gloves and boot covers donned, and joints taped; worker returns to duty.
Stage 10:	Safety Boot Removal	Remove safety boots and deposit in container with plastic liner.
Stage 11:	Splash Suit Removal	Remove splash suit with assistance of helper. Deposit in container with plastic liner.
Stage 12:	Inner Glove Wash	Wash inner gloves with decon solution.
Stage 13:	Inner Glove Rinse	Rinse inner gloves with water.

Table 8.2 (continued)
18 Stages for Decontamination in Level C Protection

Stage		Procedure
Stage 14:	Face Piece Removal	Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers. Note: Certain parts of contaminated respirators, such as the harness assembly and leather or cloth components are difficult to decontaminate. If grossly contaminated, they may need to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush. Use a final rinse of water and allow to air dry before using again. Inspect the respirator for damage and wear before and after each use.
Stage 15:	Inner Glove Removal	Remove inner gloves and deposit in lined container.
Stage 16:	Inner Clothing Removal	Remove clothing soaked with perspiration and place in lined container. Do not wear inner clothing off site since there is a possibility that small amounts of contaminants might have been transferred when removing the disposal coveralls.
Stage 17:	Field Wash	Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Stage 18:	Redress	Put on clean clothes.

All decontamination fluids generated will be contained and disposed of as specified in the Work Plan. The decontamination area will be physically identified with rope or flagging and will be sufficiently equipped to be conducive for completion of the stages listed above.

8.1.1 Closure of the Personnel Decontamination Station

All disposable clothing and plastic sheeting used during the operation will be double-bagged and contained on site prior to removal to an approved off-site disposal facility as identified in the Work Plan. Decontamination and rinse solution will be contained on site prior to disposal. Reusable rubber clothing will be dried and prepared for future use. If contamination of non-disposable clothing has occurred, the item will be discarded. All wash tubs, pail containers, etc., will be thoroughly washed, rinsed, and dried prior to removal from the site.

8.1.2 Disposal of Decontamination and Other Wastes

All PPE, polyethylene sheeting and sampling support materials (e.g. paper towers, ziplock bags) will be collected at the end of each work day, placed in plastic trash bags and left at the site overnight. The following day, the air within the plastic trash bag will be tested using the PID. If the air within the bag does not show significant concentrations of organic vapors (greater than 10 ppm above background), the plastic trash bag will be double-bagged and placed in the municipal waste dumpster for disposal.

All other wastes generated during decontamination other than decontamination fluids will be placed into 55-gallon drums; the drums will be fully-opening with a top cover bung (type 17E/H) as identified in the FSP. The drums will be filled partially or completely, depending upon the difficulty of transporting them from the work site. All containers will be numbered and clearly labeled with the boring/well number and date of filling. The mixing of solid and liquid wastes will be avoided. The containers will be stored at a predesignated site for disposal after the analyses of the samples have been obtained.

8.2 EQUIPMENT DECONTAMINATION

All sampling equipment will be decontaminated prior to use, between sampling locations, and at the end of sampling activities to avoid cross-contamination, and to decrease personnel contact with contaminated materials and the probability of removing contamination from the site. The procedures for decontaminating equipment is presented in Section 5.9 of the FSP.

9.0 MEDICAL SURVEILLANCE

9.1 REQUIREMENTS FOR HYDROGEOLOGIC PERSONNEL

All employees involved in field activities will be active participants in the HydroGeoLogic medical surveillance program. All medical examinations and procedures will be performed by or under the supervision of a licensed occupational physician. The examination will include the tests, procedures, and frequencies which comply with the requirements of OSHA Standard 29 CFR 1910.120 (f) and American National Standards Institute (ANSI) Z-88.2 and will be medically qualified to perform hazardous waste site work under respiratory protection. Medical surveillance documents confirming the worker's fitness to perform hazardous waste operations on this project are on file at the HydroGeoLogic headquarters in Herndon, Virginia, and can be made available upon request.

9.2 REQUIREMENTS FOR SUBCONTRACTORS

Subcontractors are also required to obtain a certificate of their ability to perform hazardous waste operations work and to wear respiratory protection. Subcontractors, who have a company medical surveillance program meeting the requirements of the OSHA Standard 29 CFR 1910.120 (f) will be required to submit a letter, on company letterhead, confirming all on-site workers to be utilized for this project are medically qualified to perform the investigation activities. In addition, medical surveillance documents for personnel assigned to this project must be made available upon request.

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10.0 TRAINING REQUIREMENTS

10.1 INITIAL TRAINING

10.1.1 Requirements for HydroGeoLogic Personnel

All investigation personnel to be utilized are currently enrolled in the HydroGeoLogic continuous training program in accordance with OSHA Standard 29 CFR 1910.120. Individuals working on a site have successfully completed an approved 40-hour Hazardous Waste Site Operations (HAZWOPER) Course including 24-hours of actual field experience under the direction of a trained supervisor, and any subsequent annual 8-hour refresher courses. In addition, the on-site field leader will have completed an 8-hour supervisory course. In addition, a majority of HydroGeoLogic field investigation personnel are also current in first aid/CPR training requirements. HydroGeoLogic employee records are on file in the employee's home office in Herndon, Virginia.

10.1.2 Requirements for Subcontractors

All HydroGeoLogic subcontractor personnel must also have completed 40 hours HAZWOPER training course or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e) prior to performing work at the site. In addition, subcontractor personnel must also have successfully completed any subsequent annual 8-hour refresher training.

HydroGeoLogic subcontractors must certify that each subcontractor employee, who will perform work at the site, has had training meeting the requirements of OSHA Standard 29 CFR 1910.120(e). This certification can be accomplished by submitting a letter to HydroGeoLogic, on company letterhead, containing such information.

10.1.3 Requirements for Site Visitors

No person will be allowed in the work zones (exclusion and decontamination) unless they have completed the necessary health and safety training as required by OSHA Standard 29 CFR 1910.120(e) and are wearing the necessary protective equipment as required by this HSP.

10.2 SITE-SPECIFIC TRAINING

HydroGeoLogic will provide site-specific training to all HydroGeoLogic employees and subcontractor personnel who will perform work at the site. Daily health and safety meetings will be held prior to beginning field activities to discuss each day's activities, potential hazards, and any new health and safety issues not previously discussed. Any personnel who does not participate in training will not be permitted to perform work at the site. Site-specific training will include:

- The contents of the HSP.
- Names of personnel and alternates responsible for site health and safety.

- Safety, health, and other hazards present on the site.
- Use of personal protective equipment.
- Work practices by which the employees can minimize risks from hazards.
- Safe use of engineering controls and equipment on the site.
- Medical surveillance requirements, including recognition of symptoms and signs which might indicate overexposure to hazards.
- Decontamination procedures.
- Emergency response procedures.

HydroGeoLogic and subcontractor personnel will be required to sign a statement indicating receipt of site-specific training and understanding of site hazards and control measures. This form is presented in Section 14.1.

11.0 STANDARD WORK PRACTICES

All site investigation activities will follow these appropriate Health and Safety Standard Work Practices.

11.1 GENERAL REQUIREMENTS/PROHIBITIONS

- A copy of this HSP will be available on-site for all field personnel, including visitors, to reference during investigation activities.
- No running or horseplay.
- Eating, drinking, chewing gum or tobacco, taking medication, applying cosmetics, and/or smoking are prohibited in the exclusion and decontamination zones, or any location where a possibility for contact with site contaminants exists.
- The required level of PPE must be worn by all on site personnel to include at a minimum steel-toed safety boots, safety glasses, and hard hat, if necessary.
- Upon leaving the exclusion zone, hands and face must be thoroughly washed. Any protective outer clothing is to be decontaminated and removed as specified in this HSP, and left at a designated area prior to entering the clean area.
- Contact with potentially contaminated substances must be avoided. Contact with the ground or with contaminated equipment must also be avoided. Air monitoring equipment must not be placed on potentially contaminated surfaces.
- No facial hair, which interferes with a satisfactory fit of the mask-to-face seal, is permitted on personnel required to wear respiratory protective equipment.
- All personnel must satisfy medical monitoring procedures.
- No flames or open fires will be permitted on site.
- All personnel must be aware of and follow the action levels presented in this HSP for upgrading respiratory protection.
- Any new analytical data must be promptly conveyed via telephone to the project HSO by the laboratory technician or field leader.
- Personnel must develop hand signals with users of heavy equipment (i.e., drillers, geoprobe operators, etc.). Standard hand signals to be used by personnel for nonverbal communication include:

Stop	With arm extended to the side and palm down, hold position rigidly.

Hoist	With forearm and forefinger pointing up, move hand in small horizontal circle.
Lower	With forearm extended and forefinger pointing down, move hand in a small horizontal circle.
Travel	With palm up, fingers closed, and thumb pointing in the direction of motion, jerk hand horizontally.
Slow Move	Use one hand to give any motion signal, and place the other hand motionless in front of the hand giving the motion signal.
Emergency Stop	With arm extended to the side and palm down, move hand rapidly right and left.

Standard hand signals will be discussed during each daily health and safety meeting when the use of heavy equipment is anticipated.

- A copy of the OSHA "Job Safety and Health Protection" poster must be prominently posted at each site.

- Only equipment which has been approved by the manufacturer may be used in conjunction with site equipment.

- Medicine and alcohol can potentate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel on operations where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Alcoholic beverage intake will not be allowed at anytime, including during breaks.

- No person will enter the exclusion zone alone.

- Safety devices on equipment must be left intact and used as designed.

- Equipment and tools will be kept clean and in good repair and used only for their intended purpose.

- Eye protection must be worn when any hammering or pounding is performed that may product flying particles or slivers.

- Field personnel are not allowed to lift more than 60 pounds. Rules to remember when attempting to lift heavy objects include:

  - Size up the load before trying to lift it, test the weight and get help if needed
  - Bend the knees and look up to keep the neck and back straight
  - Do not twist or turn your body once you have made the lift
  - Make sure you can carry the load where you need to go before lifting it
  - Set the load down properly, lower slowly by bending the knees
  - Always push, not pull, the object when possible

- Heavy lifting (more than 60 pounds per worker) must be accomplished using mechanical lifting equipment. Mechanical lifting equipment that will be available on site will include forklifts, hoists, dollies, backhoe/trackhoe and other types of equipment that can be easily rented from an off-site location.

- Leather gloves must be worn when handling objects that may produce slivers (e.g., driving wood stakes, handling drill rods/augers).

- No person shall climb the drill mast without the use of ANSI approved fall protection (i.e., approved belts, lanyards, and a fall protection slide rail) or portable ladder which meets the requirements of OSHA standards.

- The SSO must make an entry into the site field logbook at least daily, to include:

  - Weather conditions
  - Site Personnel
  - New arrivals and their clearance for site work
  - Air monitoring data summary
  - Monitoring instrument calibration
  - Indications of inhalation exposure
  - PPE used per task
  - Deviations from HSP
  - Inspection and cleaning of respiratory equipment
  - General health and safety problems/corrective actions

- If personnel note any warning properties of chemicals (irritation, odors, symptoms, etc.) or even remotely suspect the occurrence of exposure, they must immediately notify the SSO for further direction.

11.2 DRILLING ACTIVITIES

Prior to the commencement of drilling activities, all locations will be surveyed and marked for underground utilities. In addition, a hand auger or probe will be used to a depth of three feet to assure the absence of underground utilities at the location of interest. If any uncertainties exist, the location will be moved to an adjacent area.

The following general drilling practices must be adhered to during investigation activities:

- All drilling equipment (i.e., rigging, derrick, hoists, augers, etc.) must be inspected by the drilling crew and SSO prior to starting work. Defective equipment will be removed from service and replaced.

- No drilling within 20 feet in any direction of overhead power lines will be permitted. The locations of all underground utilities must be identified and marked prior to initiating any subsurface activities.

- All drill rigs and other machinery with exposed moving parts must be equipped with an operational emergency stop device. Drillers and geologists must be aware of the location of this device. This device must be tested prior to job initiation, and periodically thereafter. The driller and helper shall not simultaneously handle moving augers or flights unless there is a standby person to activate the emergency stop.

- Prior to raising the mast, the drill rig operator shall ensure that the proper stabilization measures have been taken. The drill rig shall not be moved while the mast is in the raised position.

- The driller must never leave the controls while the tools are rotating unless all personnel are clear of the rotating equipment.

- Drillers must wear hearing protection unless the employer can provide documentation that noise exposures are less than a dose of 50 percent as required by OSHA Standard 29 CFR 1910.95.

- Drilling activities shall immediately cease when inclement weather (e.g., heavy rains, lightning) and high winds occurs at the site. All site personnel should immediately seek shelter.

- To maintain a clean operation, drill cuttings shall be promptly containerized as they are generated. A long-handled shovel or equivalent must be used to clear drill cuttings away from the hole and from rotating tools. Hands and/or feet are not to be used for this purpose.

- A remote sampling device must be used to sample drill cuttings if the tools are rotating. Samplers must not reach into or near the rotating equipment. If personnel must work near any tools, which could rotate, the driller must shut down the rig prior to initiating such work.

- Drillers, helpers, and samplers must secure all loose clothing when in the vicinity of drilling operations.

- Only equipment that has been approved by the manufacturer may be used in conjunction with site equipment and specifically to attach sections of drilling tools together. Pins that protrude from augers shall not be allowed.

A variety of additional work practices (i.e., hoisting, cat line, pipe and auger handling, etc.) are to be adhered to by the drilling crew, which will not be addressed in this HSP. If the on-site field team leader or site supervisor observe any operations or actions that are perceived as threatening to the health and safety of site personnel, drilling operations will be temporarily suspended until a mutual understand of the action(s) in question are addressed and/or corrected.

Soil borings have the potential for releases to the environment and exposure to personnel. Gases and vapors that have a vapor density less than 1.0 are lighter-than-air and tend to migrate upward in the atmosphere and disperse (i.e., methane). Heavier-than-air gases and vapors tend to stay close to the ground and may migrate to low-lying areas (i.e., hydrogen sulfide). In general, the only containment that can be done for a release to the air is termination of the release at the source, i.e., plug the boring. Depending on the contaminant encountered, it may be necessary to evacuate persons downwind of the area of the release. Emergency response personnel should be notified (Section 13.6) if air concentrations at the perimeter of the exclusion zone exceed threshold limit values (TLVs) or Permissible Exposure Levels (PELs).

11.3 TEST PITS

- Before a sample is collected the backhoe bucket must be resting on level ground; the sampling person will then make eye contact with the operator, who will use hand signals to notify the sampler it is safe to approach the bucket. No personnel, under any circumstances, will enter a test pit. Personnel must use remote sampling equipment to collect samples from test pits or collect the samples from the backhoe bucket.

- No sampling of drums is to occur during test pit operations without prior approval and written procedures from the HSO. The backhoe operator must take care not to puncture drums, if uncovered.

- Personnel must stand a minimum of two feet from the edge of any test pit and are prohibited from leaning over the edge of any test pits. Unstable pits must be sloped at the sides to prevent cave-ins. Equipment and excavated soil should be kept at least four feet away from the edge of the excavation. The SSO may increase these distances if noncohesive soils (sands and gravels) are encountered.

- Equipment operators will be advised during the daily safety meeting of each worker who will be in the immediate vicinity during excavation of test pits, and the operators will be responsible for visual verification of workers' locations before moving equipment.

- Personnel must develop hand signals with the backhoe operator prior to digging.

- If for any reason a pit must be left unattended during working hours, access will be restricted using a visible physical barricade around the workzone and plywood sheeting or equivalent to securely cover the test pit opening. No pits will be left open and unattended overnight under any circumstances without the approval of the COR.

- Material excavated from the test pits will be placed on a ground sheet to protect the underlying ground surface. After sampling is complete, material will be returned to the same test pit that it was removed from, and the underlying ground sheet will be disposed of.

- The backhoe operator will not undermine the excavation.

- Personnel must stand upwind from the test pits and away from the reach of the backhoe, tires, and outrigging.

- The SSO will inspect the test pits for slide or cave-in potential on several occasions during the excavation.

- Test pits will not be left open and unguarded overnight - at the end of each day, any open pit must be completely surrounded by protective fencing.

- Excavation of test pits may result in an unexpected release to the atmosphere.

Excavations have the potential for release to the atmosphere. Gases and vapors may be either lighter-than-air or heavier-than-air. In general, the only containment that can be done for a release to the air is termination of the release at the source, i.e., cover the excavated area with soil. Depending on the nature of the release, it may be necessary to evacuate persons located downwind of the area of the release to an upwind location. Emergency response personnel should be notified (Section 13.6) if air concentrations at the perimeter of the exclusion zone exceed TLVs or PELs.

11.4 HOUSEKEEPING

Housekeeping is a very important aspect of an investigation program and will be strongly stressed in all aspects of field work. Good housekeeping plays a key role in occupational health protection and is a way of preventing dispersion of dangerous contaminants. All work areas will be kept as clean as possible at all time and spills will be cleaned up immediately. Housekeeping will be the responsibility of all employees.

HydroGeoLogic will implement a housekeeping program for the field activities to minimize the spread of contamination beyond the work site. The program will include:

- Daily scheduling to police the area of debris including paper products, cans, and other materials brought on site.

- Changing of wash and rinse water for hands, face, and equipment as needed.

- Periodic (daily minimum) removal of all garbage bags and containers used to dispose of food products, plastic inner gloves, and contaminated disposable clothing.

11.5 WORK LIMITATIONS

All investigation activities will be performed during normal daylight hours.

11.6 CONFINED SPACE ENTRY

Site personnel are not to undertake any activity which could be considered a confined-space entry. Personnel must not enter test pits under any circumstances.

11.7 SPILL CONTAINMENT

The procedures defined in this section comprise the spill containment activities in place at the site.

- All drums and containers used during the clean-up will meet the appropriate Department of Transportation (DOT), OSHA, and EPA regulators for the waste that they will contain.

- Drums and containers will be inspected and their integrity assured prior to being moved. Drums or containers that cannot be inspected before being moved because of storage conditions, will be positioned in an accessible location and inspected prior to further handling.

- Operations on site will be organized so as to minimize the amount of drum or container movement.

- Employees involved in the drum or container operations will be warned of the hazards associated with the containers.

- Where spills, leaks, or ruptures may occur, adequate quantities of spill containment equipment (absorbent, pillows, etc.) will be stationed in the immediate area. The spill containment program must be sufficient to contain and isolate the entire volume of hazardous substances being transferred.

- Drums or containers that cannot be moved without failure, will be emptied into a sound container.

- Fire extinguishing equipment meeting 29 CFR Part 1910.Subpart 1 shall be on hand and ready for use to control fires.

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12.0 SITE CONTROL

12.1 WORK ZONES

Each investigation location will be physically barricaded with rope flagging or caution tape to control entry and exit into and from the area. These barricaded areas will be referred to as the exclusion zones. The exclusion zone will be identified by the site supervisor and consist of a twenty foot radius surrounding the drilling or test pit location. Each person leaving an exclusion zone will proceed directly to the decontamination zone which will be located adjacent to the exclusion zone and also identified by physical barriers. The decontamination zone will consist of a low-lying area covered with a plastic sheeting. At the completion of decontamination procedures at each location, the debris will be enclosed in the plastic sheeting and deposited into 55-gallon type 17 E/H drums for later disposal as identified in the Work Plan and Field Sampling Plan. Only personnel who are cleared by the HydroGeoLogic field leader and SSO will be permitted in the exclusion zones and/or decontamination zones. Clearance for accessing these areas will only be given to personnel who meet the training and medical surveillance requirements of OSHA Standard 29 CFR 1910.120 and are wearing the appropriate PPE required for the work activity.

The support zone, where the administrative, communications, and other support services will be based, will be in a controlled area off the site or on the far end upwind of potential site contamination or areas of potential exposure. Only persons and equipment that are free of contamination will be permitted in the support zone.

12.2 ON-SITE/OFF-SITE COMMUNICATIONS

Communications will consist of a centrally located telephone within the designated support zone (i.e., trailer, office) in addition to a mobile phone stationed within the on-site vehicle utilized for transportation. Field personnel may also utilize telephones located at NAS Fort Worth JRB in emergency situations.

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13.0 EMERGENCY RESPONSE

This HSP has been develop in an attempt to prevent the occurrence of situations that may jeopardize the health and safety of on-site personnel. However, supplemental emergency procedures must be identified in the event that an unforeseen health and safety accident or incident occurs. In general, HydroGeoLogic will evacuate their employees and subcontractors from the workplace if an emergency involving chemical spills, chemical fires, chemical exposure, and/or chemical emissions occurs. For this reason, Emergency Response planning will be in accordance with OSHA Standard 29 CFR 1910.38(a).

13.1 PREPLANNING

Upon initial arrival at the site, the HydroGeoLogic field leader and SSO will visit the AFB's fire department to determine the status of emergency response services. This meeting will include a determination as to the need for further coordination with local rescue and police services.

Another aspect of preplanning for emergencies includes completion of the medical data sheet (Section 14.1). This sheet must be completed by all HydroGeoLogic personnel and subcontractors so that, in the event of personal injury or illness, the examining physician has background information readily available on the injured/ill party.

13.2 EMERGENCY PROCEDURES AND ASSIGNMENTS

Upon notification of a site emergency requiring evacuation, all HydroGeoLogic personnel and subcontractors will proceed directly to the support zone (i.e., trailer, office). If personnel cannot reach the support zone without endangering life or health, an alternate meeting point will be specified by the HydroGeoLogic SSO. Emergency egress routes and meeting points will be discussed at each daily health and safety briefing.

In the event of an emergency, the following procedures will be implemented:

- The site supervisor will evaluate the incident, assess the need for assistance, and call the appropriate contacts, if necessary.

- The site supervisor will act as the point of contact for outside emergency personnel and on site personnel.

- The site supervisor will advise emergency response and emergency room personnel to the types of contamination potentially contacted by injured workers receiving emergency care.

- The site supervisor will ensure that the SSO promptly notifies the HydroGeoLogic PM and HSO of the incident.

13.2.1 Chemical Inhalation

It is nor anticipated that chemicals of concern are present at the site in concentrations to cause immediate danger to life and health. However, any field personnel exhibiting or complaining of symptoms of chemical exposure as described in Section 4.1 will be removed from the work zone and transported to the designated medical facility for examination and treatment.

13.2.2 Eye and Skin Contact

Field personnel who have come into contact with contaminants while in the exclusion zone will immediately proceed to the decontamination zone, where an eyewash station will be located. Do not decontaminate prior to using the eyewash. Remove necessary PPE to perform the eyewash procedures. Flush the eye with the clean water for at least 15 minutes and arrange for prompt transport to the designated medical facility.

Unless skin contact with contaminants is severe proceed through the decontamination zone. Field personnel should remove any contaminated PPE and wash the affected area for at least 15 minutes. If the personnel show signs of skin irritation, they will be transported to the designated facility.

13.3 PROCEDURES FOR PERSONNEL REMAINING ON SITE

No HydroGeoLogic or subcontractor personnel will remain on site to operate critical site emergency operations.

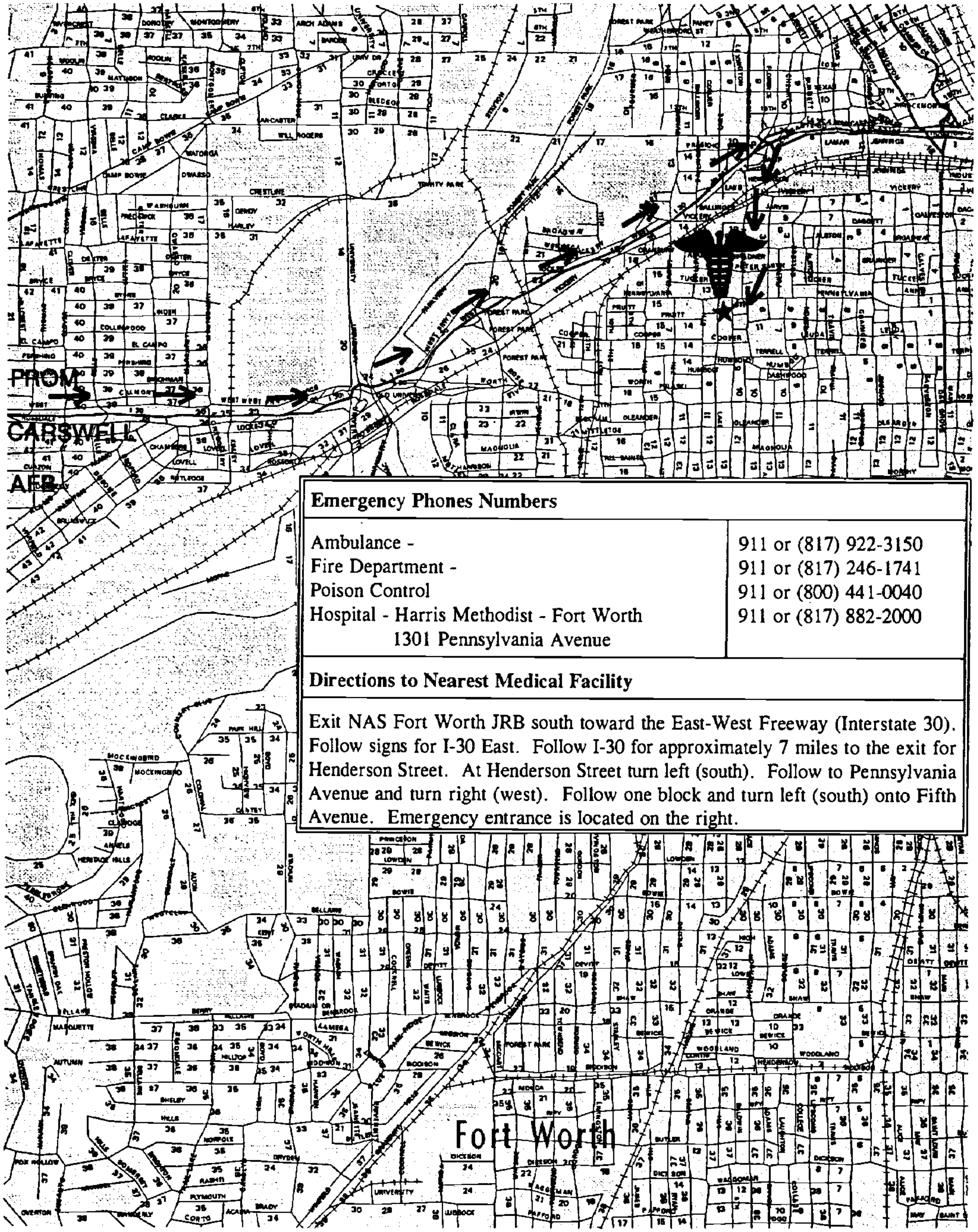
13.4 PROCEDURES TO ACCOUNT FOR SITE PERSONNEL

The HydroGeoLogic and subcontractor work force will be small enough so that accounting for site personnel will not be a problem. The HydroGeoLogic field leader and SSO will ensure that the whereabouts of all personnel are known.

13.5 RESCUE AND MEDICAL DUTIES

Only those persons who have been trained by the American Red Cross, or equivalent, will be permitted to rescue, first aid, and/or CPR treatment. Outside emergency services and medical facilities will be the primary providers of such services. At least one person who is currently certified in first aid and CPR will be on-site at all times during field activities. A "physicians approved" first aid kit, an ANSI approved eye wash station with 15-minutes of free-flowing freshwater, and a Class ABC fire extinguisher will be readily available on site.

Any HydroGeoLogic employee who shows signs of symptoms of overexposure must immediately be examined by a licensed physician. Subcontractor personnel who show signs or symptoms of overexposure will be encouraged to visit a licensed physician as well. Figure 13.1 describes the directions to the nearest medical facility.



Emergency Phones Numbers

Ambulance -	911 or (817) 922-3150
Fire Department -	911 or (817) 246-1741
Poison Control	911 or (800) 441-0040
Hospital - Harris Methodist - Fort Worth 1301 Pennsylvania Avenue	911 or (817) 882-2000

Directions to Nearest Medical Facility

Exit NAS Fort Worth JRB south toward the East-West Freeway (Interstate 30). Follow signs for I-30 East. Follow I-30 for approximately 7 miles to the exit for Henderson Street. At Henderson Street turn left (south). Follow to Pennsylvania Avenue and turn right (west). Follow one block and turn left (south) onto Fifth Avenue. Emergency entrance is located on the right.

HYDRO GeoLogic INC.

Legend

HOSPITAL

ROUTE TO HOSPITAL

N

Figure 13.1

Nearest Medical Facility to NAS Fort Worth JRB

13.6 EMERGENCY COMMUNICATION PROCEDURES, CONTACTS AND PHONE NUMBERS

Persons who observe an emergency situation must immediately notify the HydroGeoLogic field leader and/or SSO. The field leader or SSO will then immediately assess the emergency and appoint someone to telephone appropriate outside emergency services and will coordinate site evacuation. Emergency telephone numbers and directions to the nearest medical facility are included as Table 13.1, a copy of which will be posted at the nearest telephone. In addition, Figure 13.1 illustrates the directions to the nearest medical facility.

13.7 ACCIDENT/INCIDENT FOLLOW-UP AND REPORTING

On receiving a report of incident (or near-incident) occurrence the SSO shall immediately investigate the circumstances and shall make appropriate recommendations to prevent recurrence. The HSO shall also be immediately notified by telephone on occurrence of a serious accident or incident. At his discretion, he may also participate in the investigation.

Details of the incident shall be documented on the Accident/Incident Report form (Section 14.1) within 24 hours of the incident and shall be distributed to the Project Manager, HSO and COR. A copy of this report shall also be sent to the appropriate administrative contact for inclusion into the OSHA Form 101 and 200 log. Incident report forms will be available at the site support facilities.

Table 13.1
Emergency Telephone Numbers, Contacts, and Directions to Nearest Medical Facility

Key Personnel	Number
James Costello - Project Manager	(703) 736-4507
Christopher Spill - Health and Safety Officer	(703) 736-4529
Claire Black - Law Engineering	(770) 499-6603
John Robertson - Executive Vice President	(703) 736-4560
Alan Flolo - Base Point of Contact (AFBCA)	(817) 731-8973 ext 18
Joseph Dunkle - AFCEE/ERD Contracting Officer's Representative	(210) 536-5290
Emergency Phones Numbers	
Ambulance -	911 or (817) 922-3150
Fire Department -	911 or (817) 246-1741
Poison Control	911 or (800) 441-0040
Hospital - Harris Methodist - Fort Worth 1301 Pennsylvania Avenue	911 or (817) 882-2000
Directions to Nearest Medical Facility (Figure 13.1)	
Exit NAS Fort Worth JRB south toward the East-West Freeway (Interstate 30). Follow signs for I-30 East. Follow I-30 for approximately 7 miles to the exit for Henderson Street. At Henderson Street turn left (south). Follow to Pennsylvania Avenue and turn right (west). Follow one block and turn left (south) onto Fifth Avenue. Emergency entrance is located on the right.	

14.0 DOCUMENTATION AND EQUIPMENT

This section summarizes the documentation and equipment needs for the project as specified in the HSP. Its purpose is to serve as a partial checklist to help ensure all of the necessary resources are available to carry out the requirements of the HSP.

14.1 DOCUMENTATION AND FORMS

The following documents are presented in the following pages for use during site operations:

- Site Safety Briefing Forms
- HSP Compliance Agreement Forms
- HSP Amendments Forms
- Accident/Incident Report Forms
- Personnel Medical Data Sheets
- Equipment Calibration Logs
- Air Monitoring Logs

In addition, the following documentation will be present on-site during site operations:

- Approved HSP (Signed copy)
- OSHA poster
- MSDSs
- Employee training and medical surveillance certificates
- Subcontractor training and medical surveillance certificates

14.2 EMERGENCY, HEALTH AND SAFETY EQUIPMENT

- First aid kit
- Eye wash
- Inner latex or vinyl gloves
- Outer nitrile gloves (disposable and 11 millimeter thickness)
- Boot covers
- Hard hats and safety glasses
- Tyvek
- PVC and/or Saranex (with hoods)
- Ear defenders/plugs
- Decontamination kit
- Fire extinguisher
- Fall protection devices (body harness and lanyard)
- Duct tape
- LEL/O_2 meter
- Methane Detector
- PID

The site supervisor and/or site safety officer shall be responsible for maintaining first aid kits and fire extinguishers at each site where field activities are taking place. The location of first aid kits and fire extinguishers will be discussed during each daily health and safety meeting.

15.0 REFERENCES

Federal Acquisition Regulation, FAR Clause 52.236-13: Accident Prevention.

NIOSH/OSHA/USCG/EPA, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985. (DHHS (NIOSH) Publication No. 85-115); EPA "Standard Operating Safety Guides," June 1992. (NTIS Publication No. 9285.1-03).

Occupational Safety and Health Administration (OSHA) General Industry Standards, 29 CFR 1910, and Construction Industry Standards, 29 CFR 1926; especially 29 CFR 1910.120/29 CFR 1926.65, " Hazardous Waste Site Operations and Emergency Response."

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health (NIOSH), Pocket Guide to Chemical Hazards, June 1994.

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SITE SAFETY BRIEFING FORM

Project ____________________

Date ____________ Time ____________ Job No. ____________

Location ____________________

Type of Work ____________________

____

____

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment ____________________

____

Chemical Hazards ____________________

____

Physical Hazards ____________________

____

Emergency Procedures ____________________

____

Hospital/Clinic ____________________ Phone ____________

Hospital Address ____________________

Special Equipment ____________________

____

Other ____________________

____

____

____

ATTENDEES

Name (Printed)	Signature

Meeting Conducted by: ____________________

Site Safety Officer: ____________________

HEALTH AND SAFETY PLAN

COMPLIANCE AGREEMENT FORM

PROJECT: RCRA Facility Investigations

CLIENT: U.S. Air Force Center for Environmental Excellence

LOCATION: NAS Fort Worth JRB, Carswell Field, Texas

PROJECT NO: AFC001-0005

I, ______________________________, have received a copy of the Health and Safety Plan for the above-referenced project. I have read the plan, understand it, and agree to comply with all its provisions. I understand that I can be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Signed:

______________________________ ______________________________

Signature Date

____

Company

HEALTH AND SAFETY PLAN AMENDMENTS FORM

Change in field activities or hazards: ______________________________

____

____

____

____

____

____

Proposed Amendments: ______________________________

____

____

____

____

____

____

Proposed by: ______________________ Date: ______________

Approved by: ______________________________

Accented: __________ Declined: __________ Date: ______________

Amendment Number: ______________

Amendment Effective Date: ______________

HYDROGEOLOGIC, INC.
Accident/Incident/Near Miss Investigation Form

Employee's Name:______________________________
Address:______________________________
______________________________ SS#______________
Job Title:______________ Supervisor's Name:______________
Office Location:______________________________
Location at Time of Incident:______________________________
Date/Time of Incident:______________________________

Describe clearly how the accident occurred:______________________________

Was incident: Physical______________ Chemical______________
Parts of body affected ______________ Exposure: Dermal______________
right left Inhalation______________
Ingestion______________

Witnesses: 1)______________ 2)______________

Conditions/acts contributing to this incident______________________________

Managers must complete this section:
Explain specifically the corrective action you have taken to prevent a recurrence:______________

Did injured go to doctor:______________ Where:______________
When:______________
Did injured go to hospital:______________ Where:______________
When:______________

Signatures:

Employee	Reporting Manager	Health & Safety Officer
Date	Date	Date

Accidents must be reported immediately; this form must be completed and returned to the Health and Safety Officer within **24 hours.**

MEDICAL DATA SHEET

This brief Medical Data Sheet will be completed by all onsite personnel and will be kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project ____________________

Name ____________________ Home Telephone ____________________

Address ____________________

Age ____________ Height ____________ Weight ____________

Name of Next of Kin ____________________

Drug or other Allergies ____________________

Particular Sensitivities ____________________

Do You Wear Contacts? ____________________

Provide a Checklist of Previous Illnesses or Exposure to Hazardous Chemicals.

____

____

What medications are you presently using? ____________________

____

____

Do you have any medical restrictions? ____________________

____

____

Name, Address, and Phone Number of personal physician: ____________________

____

____

____

____

____

I am the individual described above. I have read and understand this HSP:

____

____________________ ____________________

Signature Date

DAILY EQUIPMENT CALIBRATION LOG

Project Name:

Project No:

DATE/TIME	INITIALS	INSTRUMENT	CALIBRATION SOLUTION OR GAS CONCENTRATION	ADJUSTMENTS REQUIRED/ COMMENTS

Project ____________________

HEALTH AND SAFETY/AIR MONITORING LOG

Date: ______________________ Logged by: ______________________________

Weather: ____
Field Tasks: ____

HydroGeoLogic Personnel (or subs) working on the site (name and affiliation):

HydroGeoLogic Personnel (or subs) working in restricted zone:

HydroGeoLogic Site Visitors:

Air Quality Monitoring Measurements:

Time	Instrument	Parameter	Concentration	Locations

Background:

Exclusion zone:

Level of PPE: ____

Comments on other safety-related matters:

(including infractions, accidents, injuries, unusual occurrences, physical complaints)

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TAB

Appendix A Groundwater Analytical Results, Jan 1996 Quarterly Sampling Event

Table A.1
Groundwater Analytical Results
January 1996 Quarterly Sampling Event
Law Environmental, Inc.
NAS Fort Worth JRB, Texas

Parameter [1]	Background Level [2]	TNRCC RRS #2 [3]	BSS-A 01/10/96	BSS-B 01/15/96	FT08-11A 01/14/96	FT08-11B 01/14/96	FT09-12A 01/13/96	FT09-12B 01/14/96	FT09-12C 1/13/96	GMI-22-02 01/13/96	GMI-22-03 01/14/96	GMI-22-04 01/14/96	GMI-22-05 01/12/96	GMI-22-06 01/15/96	GMI-22-07 01/11/96	GMI-22-08 01/11/96	LF01-1A 1/12/96	LF01-1C 01/12/96
Inorganics (mg/L)																		
Aluminum	1.332	NA	16.2	1.83	2.52	-	7.54	-	2.01	29.8	41.5	10.7	-	31.3	8.49	5.61 J	1.25	7.84
Arsenic	ND at 0.0049	0.05	0.0065	(0.0781)	-	0.0106	-	-	0.0068	-	0.0127	-	-	0.0067	-	-	-	0.0209
Barium	0.587	2	0.306	0.142	0.156	0.116	0.127	0.128	0.165	0.251	0.365	0.265	0.149	0.388	0.218	0.108	0.110	0.219
Beryllium	0.0003	0.004	-	-	-	-	-	-	-	-	(0.004)	-	-	0.003	-	-	-	-
Calcium	266.3	NA	362	154	182	146	186	131	193	253	945	295	154	485	129	102	115	167
Chromium	0.006	0.1	-	-	-	-	-	-	-	-	0.083	-	-	-	-	-	-	-
Cobalt	ND at 0.0089	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	0.0028	NA	0.059	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	0.2239	NA	45.7	58.3	2.44	3.21	8.68	1.13	5.25	47.1	71.9	29.8	1.96	82.8	20.7	12.9	6.26	21.5
Lead	ND at 0.0016	0.015	(0.037)	(0.024)	0.006	-	-	-	-	(0.0282)	(0.033)	.009	-	(0.0259)	0.0093	0.0076	-	0.0052
Magnesium	37.8	NA	10	11.6	9.76	8.41	5.57	4.54	7.56	11.4	25.2	11.4	12.1	21.7	13.3	10.5	7.14	10.9
Manganese	0.175	NA	1.76	0.534	0.170	1.04	0.152	0.588	2.94	1.29	1.08	1.52	0.506	2.87	0.96	1.01	0.31 A	1.21
Mercury	ND at 0.0001	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	ND at 0.0144	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	0.0204	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	15.03	NA	3.92	1.2	3.11	1.12	2.63	-	0.951	6.66	13.9	3.86	3.89	7.54	4.69	4.59	2.56	1.75
Sodium	167.2	NA	57.8	75.0	21.5	48.1	15.2	20.5	27.4	7.49	125	134	105	159	32.3	31.4	24.9	32.7
Vanadium	0.123	NA	0.113	-	-	-	-	-	-	0.098	0.127	0.057	-	0.152	-	-	-	-
Zinc	0.118	NA	1.3	-	-	-	.015	-	-	0.082	0.071	0.038	-	0.079	0.028	0.020	0.043	0.012
Organics (µg/L)																		
Bromodichloro-methane	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.4	-
Benzene	ND	5	-	(930 JQ)	-	0.201 JQ	-	0.351 JQ	1.56	-	-	-	-	-	-	-	0.265 JQ	-
Chlorobenzene	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.608	-
Dibromochloro-methane	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.24	-
Chloroform	ND	100	-	-	-	-	-	-	-	-	-	-	-	2.04 JQ	-	-	0.781	-
Toluene	ND	1000	-	(18200)	-	0.296 JQ	-	-	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane-D4	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A.1 (continued)
Groundwater Analytical Results
January 1996 Quarterly Sampling Event
Law Environmental, Inc.
NAS Fort Worth JRB, Texas

Parameter [1]	Background Level [2]	TNRCC RRS #2 [3]	BSS-A 01/10/96	BSS-B 01/15/96	FT08-11A 01/14/96	FT08-11B 01/14/96	FT09-12A 01/13/96	FT09-12B 01/14/96	FT09-12C 1/13/96	GMI-22-02 01/13/96	GMI-22-03 01/14/96	GMI-22-04 01/14/96	GMI-22-05 01/12/96	GMI-22-06 01/15/96	GMI-22-07 01/11/96	GMI-22-08 01/11/96	LF01-1A 1/12/96	LF01-1C 01/12/96
Ethylbenzene	ND	700	-	(1590)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Xylenes	ND	NA	-	8060	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dimethyl Phthalate	ND	NA	-	109	-	-	-	-	-	-	-	-	-	-	-	-	-	-
o-cresol	ND	1830	-	14.7 JQ	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p-cresol	ND	1830	-	29.9 JQ	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2-Methylnaphthalene	ND	NA	-	176	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Naphthalene	ND	1460	-	564	-	-	-	-	-	-	-	-	-	-	-	-	-	-
cis-1,2-Dichloroethene	ND	70	0.436 JQ	-	8.39	29	-	10.7	26.9	-	24.1	59	0.508	48.9	-	-	-	-
trans-1,2-Dichloroethene	ND	100	-	-	0.834	4.24	-	6.07	0.337 JQ	-	43.2	4.66 JQ	-	38.4	-	-	-	-
Tetrachloroethene	ND	5	-	-	-	-	-	(13.7)	0.323 JQ	-	(11.6)	-	-	-	-	-	-	-
Trichloroethene	ND	5	-	-	(5.76)	(37.4)	-	(37.2)	1.43	-	(30)	(463)	-	(340)	-	-	-	-
Vinyl Chloride	ND	2	-	-	-	-	-	-	6.08	-	-	-	-	-	-	-	-	-
Butylbenzyl Phthalate	ND	-	-	-	-	45.6	1.19 JQ	41.7	4.47 JQ	6.52 JQ	-	-	-	15 2	-	2.36 JQ	47.1	5.2 JQ
1,2-Dichlorobenzene	ND	600	-	-	-	-	-	-	1.98 JQ	-	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl) phthalate	ND	6.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.42 JQ	-
Isophorone	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	ND	2190	-	-	-	-	-	-	-	-	-	-	-	-	-	-	43.7	-
1,1,-Dichloroethane	ND	3650	-	-	-	-	-	-	0.517	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	ND	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Di-n-Butylphthalate	ND	3650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.60 JQ	-
Acenaphthalene	ND	3650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.07 JQ
Fluorene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.467 JQ
Phenanthrene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.75 JL
Dibenzofuran	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benz[a]anthracene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A.1 (continued)
Groundwater Analytical Results
January 1996 Quarterly Sampling Event
Law Environmental, Inc.
NAS Fort Worth JRB, Texas

Parameter [1]	Background Level [2]	TNRCC RRS #2 [3]	LF01-1D 01/12/96	LF01-1E 01/12/96	LF04-04 01/13/96	LF04-10 01/13/96	LF04-4A 01/13/96	LF04-4B 01/13/96	LF04-4D 1/15/96	LF04-4E 01/14/96	LF04-4F 01/14/96	LF05-02 01/13/96	LF05-18 01/13/96	LF05-5C 01/15/96	LF05-5D 01/14/96	LF05-5G 01/15/96	LSA1628-2 1/15/96	LSA1628-3 01/14/96
Inorganics (mg/L)																		
Aluminum	1.332	NA	-	2.64	-	0.636	7.15	-	0.91	1.03	1.69	-	1.61	-	-	12.4	-	1.06
Arsenic	ND at 0.0049	0.05	-	-	-	-	-	-	-	-	-	0.0085	-	-	0.009	-	0.0332	0.0185
Barium	0.587	2	0.090	0.596	0.075	0.117	0.108	0.097	0.193	0.102	0.074	0.177	0.181	0.229	0.202	0.199	0.652	0.374
Beryllium	0.0003	0.004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	266.3	NA	156	138	144	179	171	124	165	157	162	118	197	138	143	269	83.5	138
Chromium	0.006	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cobalt	ND at 0.0089	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	0.0028	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iron	0.2239	NA	1.41	4.21	0.109	1.18	8.71	0.425	2.8	2.3	3.45	3.04	2.39	0.936	2.98	15.4	9.34	5.46
Lead	ND at 0.0016	0.015	-	-	-	-	0.0056	-	-	-	-	-	-	-	-	0.0147	-	-
Magnesium	37.8	NA	8.58	8.98	7.41	5.95	6.48	5.48	8.27	6.01	5.83	6.68	10.1	6.87	9.32	16.9	17.3	15.1
Manganese	0.175	NA	0.222	12.7	0.070	0.103	0.989	0.119	1.61	0.479	0.117	1.02	0.124	0.893	3.26	0.559	0.424	3.67
Mercury	ND at 0.0001	2	-	-	-	-	-	-	-	-	-	-	0.00065	-	-	-	-	-
Molybdenum	ND at 0.0144	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	0.0204	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Potassium	15.03	NA	2.02	0.831	1.77	0.802	2.58	1.29	2.0	1.67	1.5	1.56	2.02	1.61	7.24	4.28	1.45	1.74
Sodium	167.2	NA	26.8	19.7	24.4	25.6	35.1	39.1	24.6	19.9	20	18.7	45.1	22.3	20.1	58.9	156	91
Vanadium	0.123	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	0.118	NA	-	-	-	-	0.042	0.025	0.010	-	-	-	0.016	-	-	0.028	0.010	0.018
Organics (µg/L)																		
Bromodichloro-methane	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	ND	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1020	-
Chlorobenzene	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibromochloro-methane	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloroform	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	ND	1000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14.8 JQ	-
1,2-Dichloroethane-D4	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A.1 (continued)
Groundwater Analytical Results
January 1996 Quarterly Sampling Event
Law Environmental, Inc.
NAS Fort Worth JRB, Texas

Parameter [1]	Background Level [2]	TNRCC RRS #2 [3]	LF01-1D 01/12/96	LF01-1E 01/12/96	LF04-04 01/13/96	LF04-10 01/13/96	LF04-4A 01/13/96	LF04-4B 01/13/96	LF04-4D 1/15/96	LF04-4E 01/14/96	LF04-4F 01/14/96	LF05-02 01/13/96	LF05-18 01/13/96	LF05-5C 01/15/96	LF05-5D 01/14/96	LF05-5G 01/15/96	LSA1628-2 1/15/96	LSA1628-3 01/14/96
Ethylbenzene	ND	700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	191	-
Xylenes	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	97.3	-
Dimethyl Phthalate	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
o-cresol	ND	1830	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p-cresol	ND	1830	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2-Methylnaphthalene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	32 JQ	-
Naphthalene	ND	1460	-	-	-	-	-	-	-	-	-	-	-	-	-	-	53.9 JQ	-
cis-1,2-Dichloroethene	ND	70	-	-	(359)	-	-	-	(366)	(326)	(366)	(604)	(308)	(244)	(386)	(248)	25.4 JQ	10.6
trans-1,2-Dichloroethene	ND	100	-	-	-	-	-	-	9.61 JQ	-	-	57.7	-	19.2 JQ	67.8	8.75 JQ	52.3	7.74
Tetrachloroethene	ND	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethene	ND	5	-	-	-	-	0.399 JQ	-	(1330)	(1530)	(1950)	-	-	(939)	(1110)	(702)	(59.3)	(34.8)
Vinyl Chloride	ND	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Butylbenzyl Phthalate	ND	-	9.5 JQ	5.18 JQ	38.8	31.0	3.78 JQ	-	-	12.7	9.92 JQ	-	19.8	39.1	44.9	8.19 JQ	189	1.53 JQ
1,2-Dichlorobenzene	ND	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl) phthalate	ND	6.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(1030)	-
Isophorone	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	ND	2190	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1,-Dichloroethane	ND	3650	-	-	-	-	-	-	0.517	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	ND	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Di-n-Butylphthalate	ND	3650	-	-	0.652 JQ	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenaphthalene	ND	3650	1.07 JQ	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fluorene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenanthrene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibenzofuran	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benz*[a]*anthracene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A.1 (continued)
Groundwater Analytical Results
January 1996 Quarterly Sampling Event
Law Environmental, Inc.
NAS Fort Worth JRB, Texas

Parameter[1]	Background Level[2]	TNRCC RRS #2[3]	MW-10 01/15/96	MW-11 01/10/96	MW-12 01/10/96	MW-5 01/15/96	MW-7 01/10/96	MW-8 01/10/96	MW-9 1/10/96	OT-15C 01/12/96	SD13-01 01/15/96	SD13-02 01/11/96	SD13-03 01/11/96	SD13-05 01/12/96	SD13-06 01/12/96	ST14-01 01/11/96	ST14-02 1/13/96	ST14-03 01/12/96
Inorganics (mg/L)																		
Aluminum	1.332	NA	0.539	0.932	-	4.58	-	1.64	-	49.6	3.79	-	-	0.554	-	6.8	6.63	28.0
Arsenic	ND at 0.0049	0.05	0.0177	-	-	0.0178	-	0.0177	-	-	0.0323	0.0245	0.025 JL	-	-	(0.173)	0.006	0.0135
Barium	0.587	2	0.234	0.129	0.088	0.144	0.095	0.146	0.138	(4.56 JL)	0.223	0.187	0.414	0.171	0.204	0.390	0.153	0.308
Beryllium	0.0003	0.004	-	-	-	-	-	-	-	(0.004)	-	-	-	-	-	-	-	-
Calcium	266.3	NA	199	129	157	120	162	128	170	846	202	146	544	133	136	251	211	377
Chromium	0.006	0.1	-	-	-	-	-	-	-	0.065	-	-	-	-	-	0.093	-	-
Cobalt	ND at 0.0089	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	0.0028	NA	-	-	-	-	-	-	-	0.062	-	-	0.070	-	-	-	-	-
Iron	0.2239	NA	2.94	4.96	0.807	5.82	0.605	4.06	4.26	44.3	28.1	3.36	63.6	1.19 J	3.19	84.9	28.5	39.9 J
Lead	ND at 0.0016	0.015	0.0111	-	-	(0.0173)	-	-	-	(0.0499)	(0.0179)	-	(0.0693)	-	-	(0.0224)	(0.0295)	(0.0326)
Magnesium	37.8	NA	14.4	8.33	12.3	5.36	21.4	7.96	12.6	16.2	6.54	6.07	11.9	4.24	9.41	8.99	8.10	12.20
Manganese	0.175	NA	6.55	0.276	0.347	0.204	0.068	1.31	3.53	1.86	0.299	0.438	0.790	0.141	0.255	1.02	0.519	0.670
Mercury	ND at 0.0001	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	ND at 0.0144	NA	-	-	-	-	-	-	-	-	-	-	25.6	-	-	-	-	-
Nickel	0.0204	0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	0.059	-	-
Potassium	15.03	NA	-	1.24	0.858	9.0	1.5	1.29	-	8.61	1.74	1.96	4.65	1.77	0.804	4.23	3.25	6.33
Sodium	167.2	NA	61.2	59.2	78	28.9	101	37.5	82.4	28.4	23.8	21.6		21.7	23.4	20.2	23.2	27.8
Vanadium	0.123	NA	-	-	-	-	-	-	-	0.102	-	-	-	-	-	0.072	0.052	0.136
Zinc	0.118	NA	-	0.010	-	0.041	0.012	0.018	-	0.098	0.030	-	0.108	0.026	-	0.028	0.055	0.115 J
Organics (µg/L)																		
Bromodichloro-methane	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	ND	5	(5650 JH)	-	-	4.95	-	-	-	-	-	-	-	-	-	-	2.53	-
Chlorobenzene	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibromochloro-methane	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloroform	ND	100	-	-	-	0.586	-	-	-	-	-	-	-	0.214 JQ	-	-	-	-
Toluene	ND	1000	7920	-	-	1.74	-	-	-	-	-	-	-	-	-	-	-	-
1,2-Dichloroethane-D4	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A.1 (continued)
Groundwater Analytical Results
January 1996 Quarterly Sampling Event
Law Environmental, Inc.
NAS Fort Worth JRB, Texas

Parameter[1]	Background Level[2]	TNRCC RRS #2[3]	MW-10 01/15/96	MW-11 01/10/96	MW-12 01/10/96	MW-5 01/15/96	MW-7 01/10/96	MW-8 01/10/96	MW-9 1/10/96	OT-15C 01/12/96	SD13-01 01/15/96	SD13-02 01/11/96	SD13-03 01/11/96	SD13-05 01/12/96	SD13-06 01/12/96	ST14-01 01/11/96	ST14-02 1/13/96	ST14-03 01/12/96
Ethylbenzene	ND	700	3670	-	-	16.4	-	-	-	-	-	-	-	-	-	-	-	-
Xylenes	ND	NA	10300	-	-	2.78	-	-	-	-	-	-	-	-	-	-	-	-
Dimethyl Phthalate	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
o-cresol	ND	1830	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p-cresol	ND	1830	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2-Methylnaphthalene	ND	NA	59.5 JQ	-	-	-	-	-	-	-	13.3	-	-	-	-	-	-	-
Naphthalene	ND	1460	598	-	-	7.25 JB	-	-	-	-	1.99 JB	-	1.73 JQ	-	-	-	-	-
cis-1,2-Dichloroethene	ND	70	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	ND	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Trichloroethene	ND	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vinyl Chloride	ND	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Butylbenzyl Phthalate	ND	-	29.4 JQ	1.33 JQ	1.43 JQ	-	2.29 JQ	4.36 JQ	-	15.4	-	-	15.3	7.09 JQ	6.86 JQ	23.0	3.48 JQ	2.96 JQ
1,2-Dichlorobenzene	ND	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl) phthalate	ND	6.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isophorone	ND	NA	-	-	-	-	-	-	-	-	-	-	12.9	-	-	-	-	-
Phenol	ND	2190	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1,-Dichloroethane	ND	3650	-	-	-	-	-	-	0.517	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	ND	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Di-n-Butylphthalate	ND	3650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acenaphthalene	ND	3650	-	-	-	-	-	-	-	-	-	-	-	0.96 JQ	-	-	-	-
Fluorene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenanthrene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibenzofuran	ND	NA	-	-	-	-	-	-	-	-	-	-	1.52 JQ	-	-	-	-	-
Benz*[a]*anthracene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	1.23 JQ	-	-	-	-

Table A.1 (continued)
Groundwater Analytical Results
January 1996 Quarterly Sampling Event
Law Environmental, Inc.
NAS Fort Worth JRB, Texas

Parameter [1]	Background Level [2]	TNRCC RRS #2 [3]	SD14-04 01/13/96	SD14-W05 01/11/96	SD14-W06 01/11/96	SD14-W07 01/12/96	SD14-W08 01/12/96	ST14-W09 01/13/96	ST14-W11 1/11/96	ST14-W13 01/11/96	SD14-W15 01/13/96	SD14-W16 01/12/96	SD14-W19 01/12/96	SD14-W20 01/12/96	SD14-W21 01/12/96	ST14-W22 01/12/96	ST14-W23 1/11/96	USGS01T 01/11/96
Inorganics (mg/L)																		
Aluminum	1.332	NA	16.9	4.36	1.43	27.0	10.8	18.0	4.47	7.03	31.7	1.46	4.12	1.22 J	20.1	10.3	13.7	47.5
Arsenic	ND at 0.0049	0.05	0.0195	0.0092	-	-	0.0162	-	-	-	-	0.0388	0.0285	(0.0528)	0.019	-	-	0.0017
Barium	0.587	2	0.301	0.312	0.230	0.291	0.109	0.225	0.122	0.143	0.330	0.119	0.188	0.150	0.326	0.203	0.173	0.545
Beryllium	0.0003	0.004	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(0.007)
Calcium	266.3	NA	366	179	162	510	176	352	253	172	293	159	162	139	460	292	318	509
Chromium	0.006	0.1	-	-	-	-	-	-	-	-	0.054	-	-	-	0.050	-	-	0.067
Cobalt	ND at 0.0089	NA	-	-	-	-	-	-	-	-	-	0.072	-	-	-	-	-	-
Copper	0.0028	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.050	0.081
Iron	0.2239	NA	41.6	8.13	2.37	22.3	14.1	19.9	5.32	16.9	97.2	43.8	19.7	13.2	82.3	24.1	11.3	182.00
Lead	ND at 0.0016	0.015	(0.0355)	-	-	(0.0228)	0.0141	0.0116	0.0051	0.0108	(0.0475)	(0.159)	(0.0236)	-	(0.053)	0.0149	0.00834	(0.0639)
Magnesium	37.8	NA	10.5	8.24	8.11	14.3	9.42	11.5	7.41	8.48	13.8	6.80	6.37	5.36	11.2	10.3	7.29	42.4
Manganese	0.175	NA	0.533	1.56	1.69	0.413	0.636	0.422	0.200	0.322	0.670	0.395	0.236	0.219 J	1.47	0.395	0.381	5.76
Mercury	ND at 0.0001	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Molybdenum	ND at 0.0144	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nickel	0.0204	0.1	-	-	-	-	-	-	-	-	0.066	-	-	-	-	-	-	(0.118)
Potassium	15.03	NA	4.74	5.64	5.79	10.4	2.72	5.95	2.61	4.56	9.81	1.64	1.90	1.16	5.02	4.88	3.46	12.5
Sodium	167.2	NA	29.3	25.8	23.0	22.0	27.1	17.1	26.5	21.4	19.8	25.7	24.3	22.3	16.4	23.9	20.4	27.3
Vanadium	0.123	NA	0.091	-	-	0.076	-	-	-	-	0.242	-	-	-	0.110	0.050	-	0.317
Zinc	0.118	NA	0.102	0.013	0.011	0.100	0.040	0.052	0.058	0.043	0.225	0.033	0.064	0.010	0.144	0.051	0.045	0.255
Organics (μg/L)																		
Bromodichloro-methane	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Benzene	ND	5	-	-	-	-	0.411 JQ	-	-	-	-	1.58	(77.8)	-	-	-	-	-
Chlorobenzene	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibromochloro-methane	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chloroform	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Toluene	ND	1000	-	-	-	-	-	-	-	-	-	-	-	0.275 JB	-	-	-	-
1,2-Dichloroethane-D4	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A.1 (continued)
Groundwater Analytical Results
January 1996 Quarterly Sampling Event
Law Environmental, Inc.
NAS Fort Worth JRB, Texas

Parameter [1]	Background Level [2]	TNRCC RRS #2 [3]	SD14-04 01/13/96	SD14-W05 01/11/96	SD14-W06 01/11/96	SD14-W07 01/12/96	SD14-W08 01/12/96	ST14-W09 01/13/96	ST14-W11 1/11/96	ST14-W13 01/11/96	SD14-W15 01/13/96	SD14-W16 01/12/96	SD14-W19 01/12/96	SD14-W20 01/12/96	SD14-W21 01/12/96	ST14-W22 01/12/96	ST14-W23 1/11/96	USGS01T 01/11/96
Ethylbenzene	ND	700	-	-	-	-	0.153 JQ	-	-	-	-	-	22.9	-	-	-	-	-
Xylenes	ND	NA	-	-	-	-	-	-	-	-	-	-	8.0	-	-	-	-	-
Dimethyl Phthalate	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
o-cresol	ND	1830	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
p-cresol	ND	1830	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2-Methylnaphthalene	ND	NA	-	-	-	-	-	-	-	-	-	3.7 JQ	34.9	-	-	-	-	-
Naphthalene	ND	1460	-	-	-	-	-	-	-	-	-	12.2	46.1	-	-	-	-	-
cis-1,2-Dichloroethene	ND	70	-	-	-	-	-	0.809	-	-	-	-	-	-	-	-	-	-
trans-1,2-Dichloroethene	ND	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tetrachloroethene	ND	5	-	-	-	-	-	-	-	-	-	-	-	-	-	(6.13)	-	-
Trichloroethene	ND	5	-	-	-	-	-	1.5	-	-	-	-	-	-	-	-	-	-
Vinyl Chloride	ND	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Butylbenzyl Phthalate	ND	-	21.7	2.72 JQ	4.4 JQ	15.2	18.2	1.87 JQ	2.56 JQ	4.39 JQ	2.77 JQ	4.93 JQ	14.5	5.08 JQ	19.9	12.0	3.08 JQ	-
1,2-Dichlorobenzene	ND	600	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bis(2-ethylhexyl) phthalate	ND	6.08	-	-	-	-	-	-	-	-	-	4.46 JQ	(46.3)	-	-	-	-	-
Isophorone	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Phenol	ND	2190	-	-	-	11.1	-	-	-	-	-	-	-	-	-	-	-	-
1,1,-Dichloroethane	ND	3650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1,1-Dichloroethene	ND	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Di-n-Butylphthalate	ND	3650	-	-	-	-	-	-	-	-	-	-	0.893 JQ	-	-	-	-	-
Acenaphthalene	ND	3650	-	-	-	-	-	-	-	-	-	-	0.759 JQ	-	-	-	-	-
Fluorene	ND	NA	-	-	-	-	-	-	-	-	-	-	0.446 JQ	-	-	-	-	-
Phenanthrene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Dibenzofuran	ND	NA	-	-	-	-	-	-	-	-	-	-	1.95 JQ	-	-	-	-	-
Benz*[a]*anthracene	ND	NA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table A.1 (continued)
Groundwater Analytical Results
January 1996 Quarterly Sampling Event
Law Environmental, Inc.
NAS Fort Worth JRB, Texas

Parameter [1]	Background Level [2]	TNRCC RRS #2 [3]	USGS03T 01/10/96	USGS04T 01/11/96	USGS06T 01/14/96	USGS07T 01/13/96	WP07-10B 01/15/96	WP07-10C 01/15/96
Inorganics (mg/L)								
Aluminum	1.332	NA	17.8	12.1	1.35	-	-	-
Arsenic	ND at 0.0049	0.05	-	0.0015	-	-	-	0.0254
Barium	0.587	2	0.186	0.075	0.077	0.132	0.094	0.124
Beryllium	0.0003	0.004	-	-	-	10.1	-	-
Calcium	266.3	NA	247	216	183	329	145	155
Chromium	0.006	0.1	-	-	-	-	-	-
Cobalt	ND at 0.0089	NA	-	-	-	-	-	-
Copper	0.0028	NA	-	0.050	-	-	-	-
Iron	0.2239	NA	44.1	69.1	3.48	12.9	0.723	8.98
Lead	ND at 0.0016	0.015	0.0254	0.0148	-	0.0072	-	-
Magnesium	37.8	NA	14.7	14.6	4.79	8.39	5.91	11.1
Manganese	0.175	NA	2.2	3.02	0.242	0.758	0.063	0.518
Mercury	ND at 0.0001	2	-	-	-	-	-	-
Molybdenum	ND at 0.0144	NA	-	-	-	41.4	-	-
Nickel	0.0204	0.1	-	-	-	-	-	-
Potassium	15.03	NA	5.83	7.67	1.40	3.09	1.23	2.32
Sodium	167.2	NA	33.8	33.6	14.4	-	16.9	43.5
Vanadium	0.123	NA	0.076	0.103	-	-	-	-
Zinc	0.118	NA	0.108	0.067	-	0.027	-	-
Organics (μg/L)								
Bromodichloro-methane	ND	100	-	-	-	-	-	-
Benzene	ND	5	-	-	-	-	-	-
Chlorobenzene	ND	100	-	-	-	-		
Dibromochloro-methane	ND	100	-	-	-	-	-	-
Chloroform	ND	100	-	-	-	0.369 JQ	-	-
Toluene	ND	1000	-	-	-	-	-	-
1,2-Dichloroethane-D4	-	-	-	-	-	-	-	-
Ethylbenzene	ND	700	-	-	-	-	-	-

Table A.1 (continued)
Groundwater Analytical Results
January 1996 Quarterly Sampling Event
Law Environmental, Inc.
NAS Fort Worth JRB, Texas

Parameter [1]	Background Level [2]	TNRCC RRS #2 [3]	USGS03T 01/10/96	USGS04T 01/11/96	USGS06T 01/14/96	USGS07T 01/13/96	WP07-10B 01/15/96	WP07-10C 01/15/96
Xylenes	ND	NA	-	-	-	-	-	-
Dimethyl Phthalate	ND	NA	-	-	-	-	-	-
o-cresol	ND	1830	-	-	-	-	-	-
p-cresol	ND	1830	-	-	-	-	-	-
2-Methylnaphthalene	ND	NA	-	-	-	-	-	-
Naphthalene	ND	1460	-	-	-	-	-	-
cis-1,2-Dichloroethene	ND	70	-	-	0.509	0.41 JQ	268	193
trans-1,2-Dichloroethene	ND	100	-	-	-	-	-	-
Tetrachloroethene	ND	5	-	-	-	0.18 JQ	-	-
Trichloroethene	ND	5	-	-	10.5	0.718	2550	761
Vinyl Chloride	ND	2	-	-	-	-	-	-
Butylbenzyl Phthalate	ND	-	-	2.8 JQ	-	-	-	41.1
1,2-Dichlorobenzene	ND	600	-	-	-	-	-	-
Bis(2-ethylhexyl) phthalate	ND	6.08	-	-	-	-	-	14.9
Isophorone	ND	NA	-	-	-	-	-	-
Phenol	ND	2190	-	-	-	-	-	-
1,1,-Dichloroethane	ND	3650	-	-	-	0.254 JQ	-	-
1,1-Dichloroethene	ND	7	-	-	-	0.575	-	-
Di-n-Butylphthalate	ND	3650	-	-	-	-	-	-
Acenaphthalene	ND	3650	-	-	-	-	-	-
Fluorene	ND	NA	-	-	-	-	-	-
Phenanthrene	ND	NA	-	-	-	-	-	-
Dibenzofuran	ND	NA	-	-	-	-	-	-
Benz[a]anthracene	ND	NA	-	-	-	-	-	-

Notes:

[1] Source: RI/FS Stage 2 Final Report (Radian, 1989)
J = Estimated quantitation based upon QC data
JB = Estimated quantitation: possibly biased high or a false positive based upon blank data
JL = Estimated quantitation: possibly biased low or a false negative based upon QC data
JM = Estimated quantitation: possibly biased high based upon QC data
JQ = Estimated quantitation: detected below Practical Quantitation Limit
\- = Parameter was not analyzed

[2] Source: Jacobs Engineering Group, 1997, NAS Fort Worth JRB, Texas Basewide Background Study, Volume 1. ND = Non Detect

[3] Risk Reduction Standard #2. Maximum Concentration in Groundwater for residential exposure conditions. Medium-Specific Concentrations (NA=Not Available), Standards and Criteria for Health Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

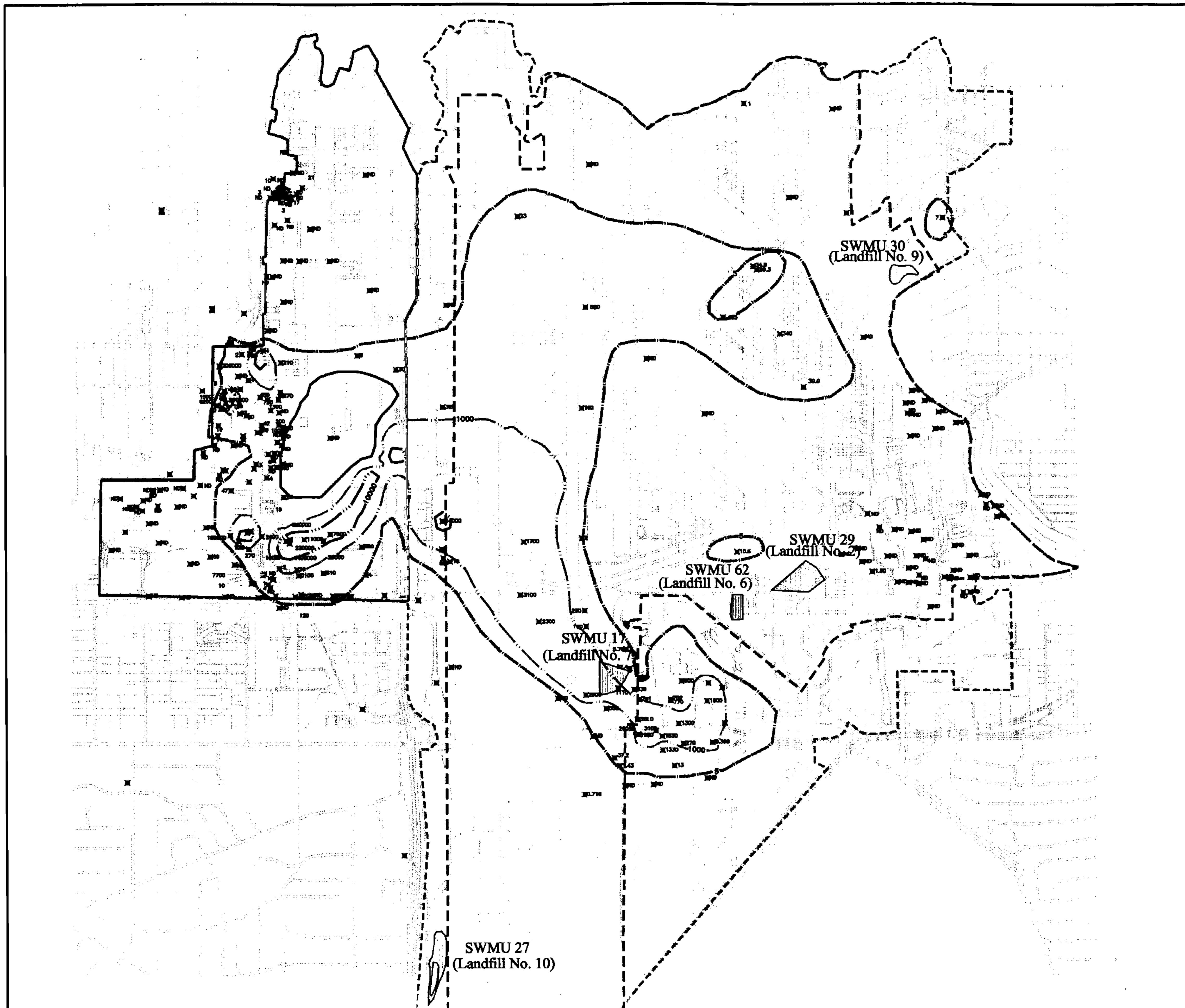


Figure A.1

NAS Fort Worth JRB
TCE Plume Map
October/ November 1995

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- Former Property Boundary of Carswell AFB
- Property Boundary of AF Plant 4
- Approximate NAS Fort Worth JRB Site Boundary
- SWMU's Locations
- TCE concentration in µg/L

NOTE:
Data Source(s): Jacobs, 1996
Law, 1996b

Contour Interval Key µg/L TCE

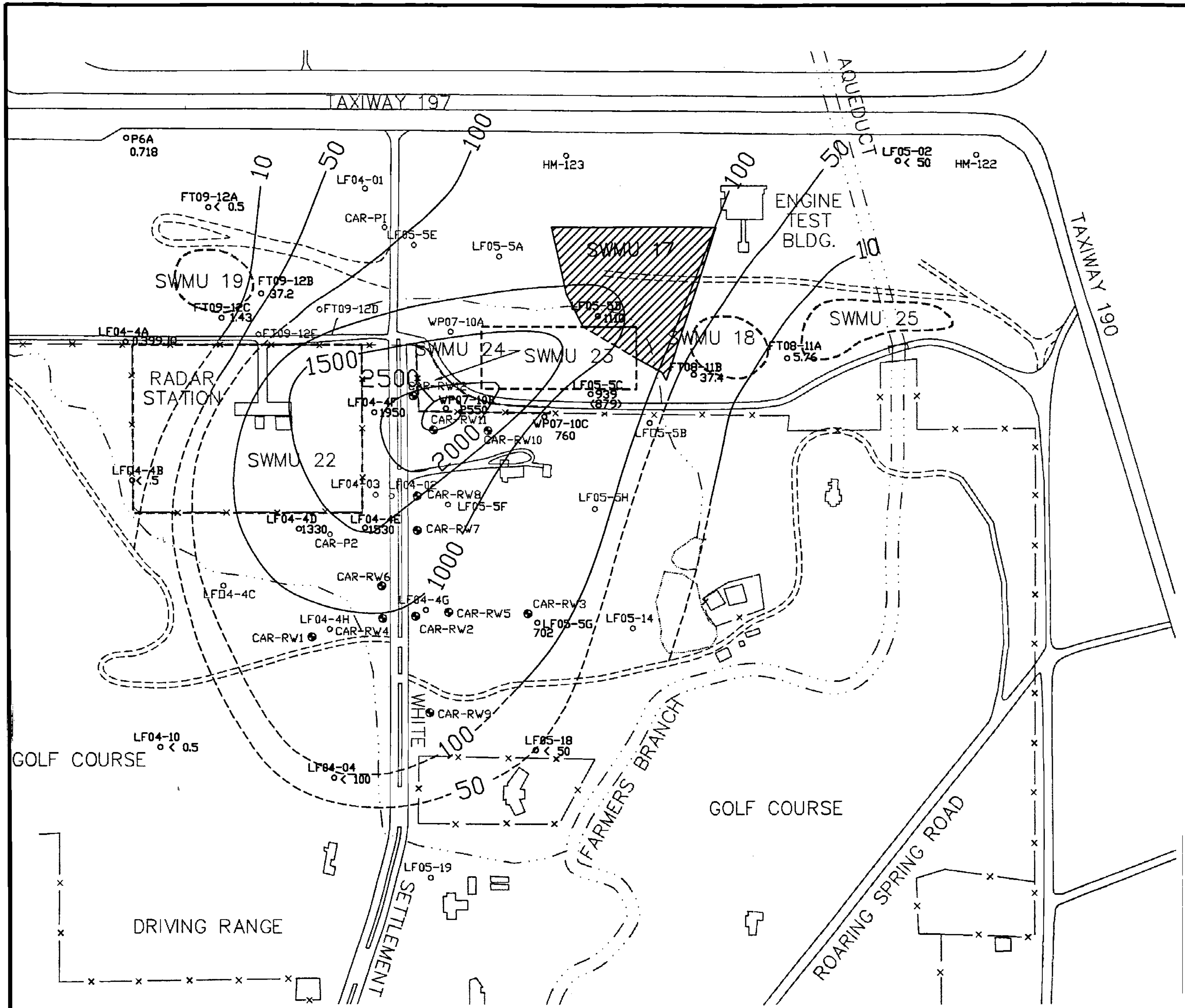
- +10,000
- 1,000-10,000
- 1-1,000
- 0

0 500 1000 2000
SCALE IN FEET

N

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG1-4.DWG		

Map Source:
JACOBS, 1996



HydroGeoLogic, Inc.—Final RFI Work Plan
NAS Fort Worth JRB, Texas

Figure A.2

Flightline Area TCE Plume Map (January 1996)

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- ROAD
- STREAM
- FENCE
- HM-123 MONITORING WELL
- RECOVERY WELL LOCATION
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RFI/CMS
- 50 TCE CONCENTRATIONS CONTOUR (µg/L)
- 50 ESTIMATED TCE CONCENTRATIONS CONTOUR (µg/L)
- JQ ESTIMATED QUANTITATION DETECTED BELOW THE PRACTICAL QUANTITATION LIMIT

N

SCALE
0 300 600 FEET

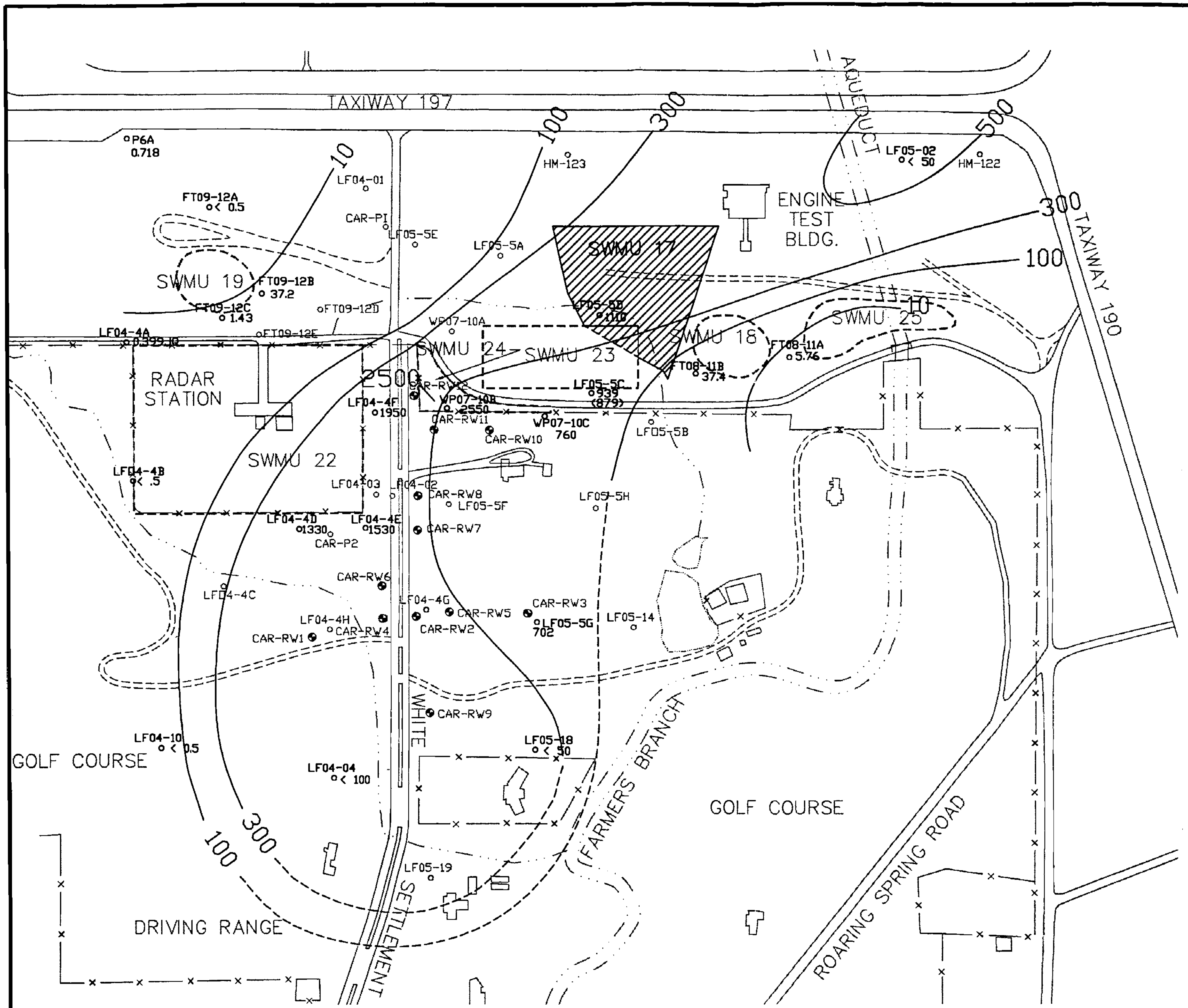
Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG1-5.DWG		

Map Source: IT CORP., 1993

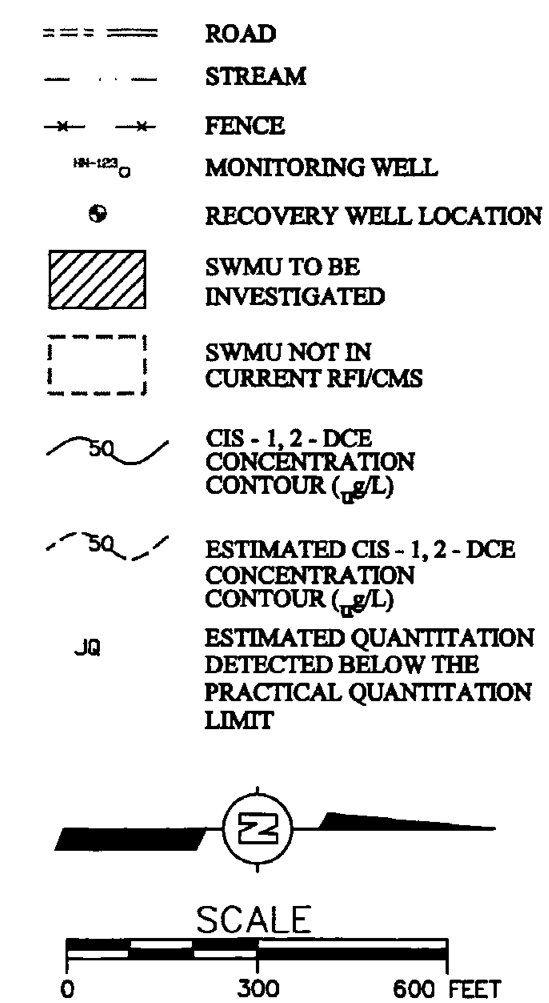
Figure A.3

Flightline Area
Cis-1, 2 - DCE Plume Map
(January 1996)

Air Force Center
For Environmental Excellence
Brooks AFB, Texas



LEGEND



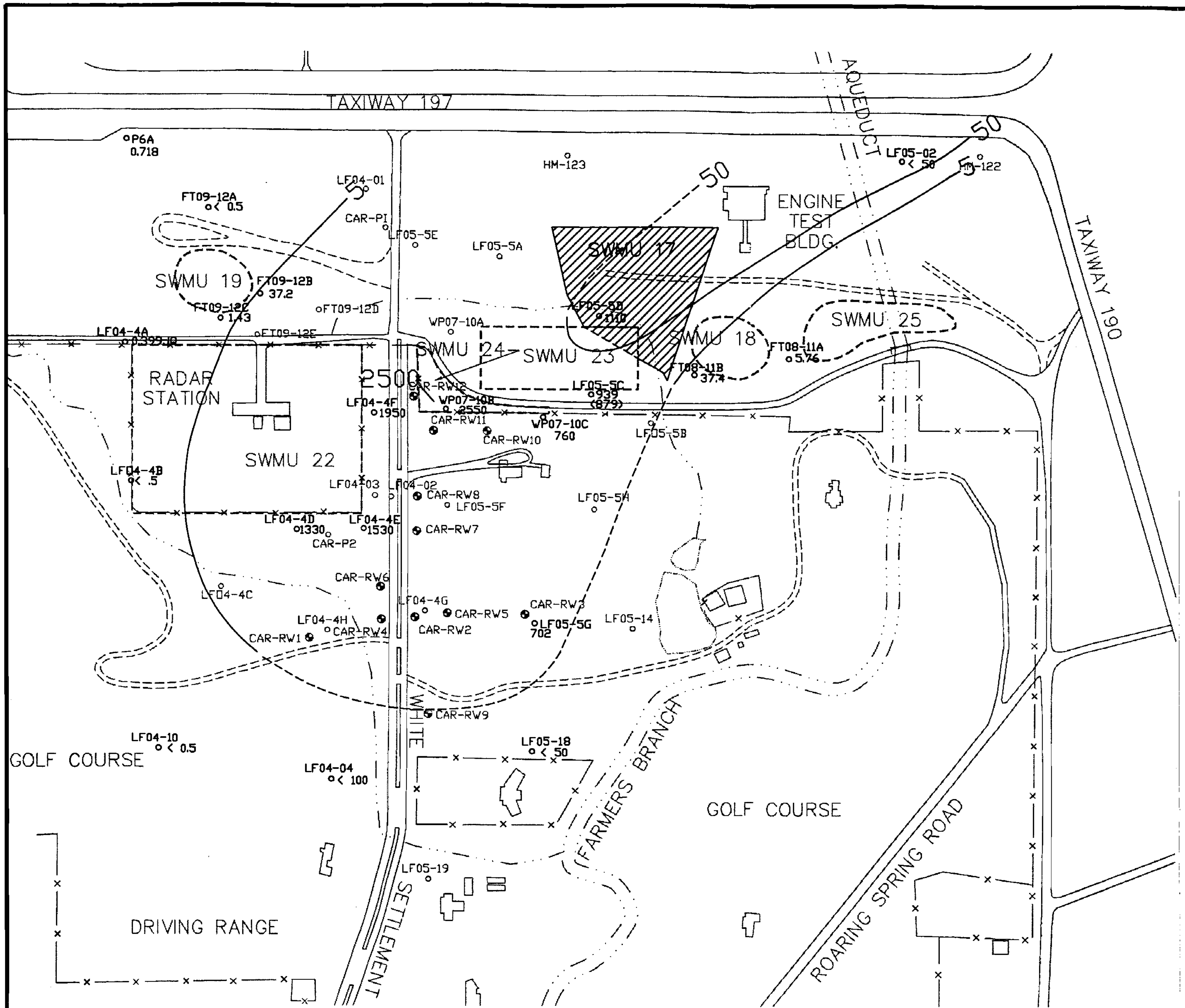
Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG1-6.DWG		

Map Source:
IT CORP., 1993

Figure A.4

Flightline Area
Trans-1, 2 - DCE Plume Map
(January 1996)

Air Force Center
For Environmental Excellence
Brooks AFB, Texas



LEGEND

- ROAD
- STREAM
- FENCE
- MONITORING WELL
- RECOVERY WELL LOCATION
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RFI/CMS
- TRANS - 1, 2 - DCE CONCENTRATION CONTOUR (µg/L)
- ESTIMATED TRANS - 1, 2 - DCE CONCENTRATIONS CONTOUR (µg/L)
- JQ ESTIMATED QUANTITATION DETECTED BELOW THE PRACTICAL QUANTITATION LIMIT

N

SCALE
0 300 600 FEET

Drawn By:	M. LAWLOR	Date:	6/12/97
Checked By:	K. HURLEY	Date:	6/12/97
Filename:	FIG1-7.DWG		

Map Source:
IT CORP., 1993

TAB

Appendix B

Preliminary Identified ARAR's

Table B.1
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Location Specific	National Environmental Policy Act (NEPA)	40 CFR 1500	Council on environmental quality regulations	Evaluates impacts of remediation on the environment
		40 CFR 6	EPA NEPA regulations	Regulations specific to EPA actions
		32 CFR 989 32 CFR 265	DOD-Air Force NEPA regulations DOD-Natural Resources Programs	Regulations specific to DOD-Air Force actions; the Air Force must evaluate and disclose impacts that will occur as a result of remediation
	National Historic Preservation Act (1966)	36 CFR 60, 62, 63, 65, 800	Culture resources regulations	Regulations pertaining to the protection of cultural resources. Includes Executive Order 11593
	Archaeological Resources Protection Act (1979)	36 CFR 296	Cultural resources regulations	Regulations pertaining to the protection of cultural resources. Includes Executive Order 11593
	Archaeological and Historical Preservation Act (1974)	40 CFR 6.301	Cultural resources regulations	Provides for data collection/ preservation listing on the National Registry of National Landmarks, etc. If any building and/or other landmarks/ resources are considered eligible, compliance must be accomplished prior to remediation.
	Floodplains/Wetlands	E.O. 11988 E.O. 11990	Floodplain Management Protection of Wetlands	Executive orders adopted to avoid long and short term impacts associated with wetlands destruction and occupancy and modification of floodplains.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Location Specific (continued)	Migratory Bird Treaty Act	16 U.S.C. 703-712 50 CFR 10, 20, and 21	Regulates the taking of migratory birds	This act prohibits the "taking" of migratory birds without a permit. Accidental killing of birds by pollution from CAF B could be considered "taking".
Action Specific	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	40 CFR 300	National oil and hazardous substances pollution contingency plan	Regulations setting forth the procedures for reporting, responsibilities, and planning actions to remediate releases. OSWER Directive 9355.3-01 is applicable.
	Superfund Amendments and Reauthorization Act (SARA)	40 CFR 355, 370, 372	Emergency planning and reporting	Pertains to hazardous and toxic chemical reporting and planning requirements.
	Fish and Wildlife Coordination Act	16 USC 661-666	Requires consultation when Federal department or agency proposes or authorizes any modification of any stream or other water body and adequate provision for protection of fish and wildlife resources.	This requirement would be applicable if modification of Farmers Branch Creek may be required. Consultation with the U.S. Fish and Wildlife Service and the appropriate state agency is required.
	Endangered Species Act	50 CFR 200, 402	Requires action to conserve endangered species within critical habitats upon which endangered species depend; includes consultation with Department of Interior.	This requirement would be most applicable to bird and fish species found in Farmers Branch Creek ecosystems. Consultation with Federal and state agencies can be accomplished simultaneously with requirements under the Fish and Wildlife Coordination Act.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Action Specific (continued)	Clean Water Act (CWA)	33 CFR 322	Structures or work within navigable waters of the United States	May be applicable to Farmers Branch Creek.
		33 CFR 323 33 CFR 328 33 CFR 329	Discharges of dredge or fill material to waters of the United States	May be applicable to Farmers Branch Creek.
		40 CFR 109	Criteria for state, local, and regional oil removal contingency plans	Applicable if oil may be managed or used during remediation due to proximity to Farmers Branch Creek.
		40 CFR 110	Oil discharge	May be applicable if determined that oil has contaminated or may contaminate adjacent water bodies.
		40 CFR 112	Oil pollution prevention	Applicable to prevent oil spills into adjacent water bodies. Requires that persons who may discharge oil in harmful quantities must prepare a Spill Prevention Control and Countermeasure (SPCC) plan (40 CFR 112.1, [b]).
		Texas Administrative Code (TAC), Title 31, Chapter 343	Oil and hazardous substances	Provides for immediate cleanup of hazardous substances without obtaining a permit (Texas Water Code, Chapter 26).
		Texas Water Code, Title 2, Chapter 26, Subchapter G	Oil and hazardous substances spill prevention and control	Also known as Texas Hazardous Substances Spill Prevention and Control Act. Establishes policy to prevent the spill or discharge of hazardous substances into waters of the state of Texas.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Action Specific (continued)	CWA (continued)	Texas Water Code, Title 2, Chapter 26, Subchapter I	Underground and aboveground storage tanks	Refers to state of Texas Solid Waste Law as related to water quality.
		Natural Resources Code, Title 2, Subtitle 6, Chapter 40	Texas Oil Spill Prevention and Response Act	Established policy for protection of all waters of the state, but focuses on coastal waters.
		TAC, Title 31, Chapter 55	Pollution/fish kill investigations	May be applicable if a fish kill is suspected or confirmed as a result of the release of hazardous substances.
		TAC, Title 31, Chapter 343	Texas oil and hazardous substances regulations	Implements regulations under the Texas Water Code (TWC), Chapter 26, Subchapter G.
		40 CFR 122	Natural Pollutant Discharge Elimination System (NPDES) program	Requires permits for the discharge of pollutants from a point source into waters of the United States.
		40 CFR 125	Criteria and standards for the NPDES	Includes effluent discharge and stormwater discharge.
		TAC, Title 31, Part IX, Chapter 305	Texas consolidated NPDES permit rules	Set standards and requirements for applications, permits, and actions by the Texas Water Commission.
		TAC, Title 31, Part IX, Chapter 315	Texas criteria and standards for the NPDES; pre-treatment regulations	May be applicable depending on selected alternative.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Action Specific (continued)	CWA (continued)	TAC, Title 31, Part IX, Chapter 319	General regulations incorporated into permit	Established allowable concentrations of hazardous metals to inland waters. Includes toxic pollutant quality control (319.26) and groundwater protection (319.27).
		TAC, Title 31, Part IX, Chapter 323	Waste disposal approvals	Applies to the collection of waste in floodplains, and groundwater protection requirements.
		TAC, Title 31, Chapter 331	Underground injection control	Applies to the injection of chemicals into non-potable aquifers to facilitate remediation.
	Hazardous Materials Transportation Act (HMTA)	49 CFR 107	Hazardous materials program procedures	
		49 CFR 171, 172, 173, 174, 177	Hazardous materials regulations	Includes general information communication requirements, emergency response information, and carriage by rail and public highway. Carriage by vessel or aircraft is not anticipated.
	Resource Conservation and Recovery Act (RCRA)	40 CFR 241	Land disposal of solid waste	May be applicable to four SWMUs if excavation is required.
		40 CFR 256	State solid waste management plans	May be applicable if excavation of the four SWMUs reclassifies the sites as an "open dump".

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Action Specific (continued)	RCRA (continued)	40 CFR 257	Classification of disposal facilities and practices	May be applicable to the four SWMUs if determined that they pose an adverse environmental or health risk.
		40 CFR 260	Identification and listing of hazardous wastes	Identifies solid waste subject to regulations as hazardous waste.
		40 CFR 262	Hazardous waste generator standards	Waste will be generated as a result of remediation.
		40 CFR 263	Hazardous waste transportation standards	Waste will be transported, including samples, as a result of remediation. Manifests are required
		40 CFR 264	Standards for treatment, storage, and disposal (TSD) facilities	Waste may be stored on-site during remediation.
		40 CFR 265	Interim status standards	May be applicable if CAFB is required to be a RCRA permitted facility.
		40 CFR 266	Management of specific wastes	
		40 CFR 268	Land disposal restrictions (LDRs)	Identifies wastes restricted from land disposal unless specific exemptions exist. Applicable to several contaminants of concern.
		40 CFR 270	Hazardous waste permit program	May be applicable if CAFB is required to be a RCRA permitted facility.
		40 CFR 280	Underground storage tank regulations	Applies to owners/operators of underground storage tanks.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Action Specific (continued)	RCRA (continued)	Texas Solid Waste Disposal Act	Texas civil statutes Public Article 4477-7	Includes implementation of the Federal Resource Conservation and Recovery Act.
		Texas Underground Storage Tanks Act	Texas water code, Title 2, Chapter 26	Includes underground and aboveground storage tanks. Aboveground tanks pertain only to petroleum products.
		TAC, Title 31, Part IX, Chapter 334	Underground Storage Tank Rules	Applicable to underground storage tanks storing hazardous or petroleum products, and aboveground storage tanks containing petroleum.
		TAC, Title 31, Part IX, Chapter 330	Solid waste management regulations	Includes regulation of both hazardous and non-hazardous waste; however, targets municipal solid waste disposal.
		TAC, Title 31, Chapter 335	Texas industrial waste management regulations	Regulates the management and control of municipal hazardous waste and industrial wastes. Includes generators, transporters, and owners/operators of TSD facilities.
		TAC, Title 31, Chapter 330	Disposal of lead acid batteries	May be applicable if batteries are disposed in any of the four SWMUs.
	Occupational Safety and Health Act (OSHA)	29 CFR 1900	Implementation of OSHA	Address standard safety practices including personal protective equipment.
Chemical Specific	CWA	40 CFR 129	Toxic pollutant effluent standards	Applicable if any toxic pollutants listed at 129.4 (including PCBs) are discovered.
		TAC, Title 31, Chapter 314	Texas toxic pollutant effluent standards	Adopts 40 CFR 129, by reference.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Chemical Specific (continued)	CWA (continued)	40 CFR 130	Water quality planning and management	Water quality planning, management, and program implementation.
		40 CFR 131	Water quality standards	Procedures for development, review, and approval of state water quality standards.
		TAC, Title 31, Chapter 307	Texas surface water quality standards	Standards of the state to maintain the quality water consistent with public health and enjoyment.
		TAC, Title 31, Chapter 311	Watershed protection	Includes Lake Worth regarding wastewater disposal and effluent requirements.
	Safe Drinking Water Act (SDWA)	40 CFR 141, 143	National primary and secondary drinking water standards	Establishes maximum contaminant levels (MCLs) for organics, inorganics, radioactivity, and turbidity. The standards also serve as groundwater cleanup standards at RCRA sites. Trichloroethene is the primary contaminants of concern.
		TAC, Title 31, Part IX, Chapter 290	Texas drinking water standards	Essentially adopts 40 CFR 141, 143, and establishes standards for bacteriological, chemical, and radiological quality.
	Clean Air Act (CAA)	40 CFR 50	National primary and secondary ambient air quality standards	Establishes standards for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.
		40 CFR 52 Subpart 55	Texas state implementation plan	Incorporates and cites revisions to Texas' 1972 original submittal of a state implementation plan.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Chemical Specific (continued)	CAA (continued)	Texas CAA	Abatement of air pollution and contaminants	Includes dust, smoke, particulate matter, fumes, gas, vapor, odor produced by processes other than natural.
		TAC, Title 31, Part III, Chapter 101	Texas Air Pollution control regulations: General Provisions	Implements the Texas CAA.
			Section 101.4 Nuisance	Requires that air pollutants can not be discharged that may be adverse to, or may be injurious to humans, animals, vegetation, and property.
			Section 101.20 and 101.21	Compliance with National Standards
		TAC, Title 31, Part III, Chapter 111	Visible emissions and particulate matter	Includes incineration of hazardous waste.
			Section 111.145	Dust control required for land clearing, construction, etc., if more than one area.
		40 CFR 61	National Emission Standards for Hazardous Air Pollutants (NESHAPS)	Possible applicable due to trichloroethane.
		TAC, Title 31, Part III, Chapter 115	Control of air pollution for volatile organic compounds	a.k.a. "Texas Regulation V"; regulates synthetic organic chemicals including benzene, methylene chloride, and vinyl chloride which are contaminants of concern.

Table B.1 (continued)
Preliminary Identified ARARs
NAS Fort Worth JRB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Chemical Specific (continued)	CAA (continued)	TAC, Title 31, Part III, Chapter 120	Control of air pollution from hazardous waste or solid waste sites	Applies to all hazardous waste facilities required to obtain a permit pursuant to the Texas Solid Waste Disposal Act.
	Toxic Substances Control Act (TSCA)	40 CFR 761	Regulation of PCBs	Applicable if PCBs discovered.
		40 CFR 763	Regulation of Asbestos	Applicable if asbestos containing materials are included in remediation.

Source: Rust Geotech, 1995

TAB

Appendix C
Summary of Background Values (Jacobs 1997)

Table C.1
Summary of Background Values for Surface Soil
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL $_{95,95}$	Outlier?
Aluminum	0.0%	30 / 30	0.927	0.896 Accept	0.960 Accept	1790	19900	10775	5072	22035	No
Antimony	80.0%	6 / 30	-----	---- ----	---- ----	<0.215	0.56	nc	nc	0.56	----
Arsenic	0.0%	30 / 30	0.927	0.851 Reject	0.959 Accept	1.23	5.88	3.504	1.059	5.855	No
Barium	0.0%	30 / 30	0.927	0.810 Reject	0.281 Reject	24.9	1980	145.3	349.3	233.0	Yes
Beryllium	0.0%	30 / 30	0.927	0.808 Reject	0.911 Reject	0.164	1.02	0.6552	0.2432	1.0200	No
Calcium	0.0%	30 / 30	0.927	0.969 Accept	0.687 Reject	418	111000	20991	28270	167788	No
Cadmium	6.7%	28 / 30	0.927	0.928 Accept	0.809 Reject	0.054	0.625	0.2118	0.1119	0.5562	No
Chromium	0.0%	30 / 30	0.927	0.952 Accept	0.965 Accept	5.06	20.1	11.73	4.203	21.056	No
Cobalt	0.0%	30 / 30	0.927	0.961 Accept	0.953 Accept	1.54	10.2	4.751	1.851	11.050	No
Copper	0.0%	30 / 30	0.927	0.909 Reject	0.964 Accept	4.44	16.7	10.77	2.974	17.373	No
Iron	0.0%	30 / 30	0.927	0.879 Reject	0.946 Accept	3460	15500	10199	3386	17717	No
Lead	0.0%	30 / 30	0.927	0.927 Reject	0.750 Reject	6.08	40.5	14.59	6.628	30.97	Yes
Magnesium	0.0%	30 / 30	0.927	0.830 Reject	0.968 Accept	112	2830	1369	736	3003	No
Manganese	0.0%	30 / 30	0.927	0.923 Reject	0.624 Reject	132	1420	336.8	237.9	849.1	Yes
Mercury	93.3%	2 / 30	----	---- ----	---- ----	<0.031	0.14	nc	nc	0.14	----
Molybdenum	80.0%	6 / 30	----	---- ----	---- ----	<0.657	1.460	nc	nc	1.460	----
Nickel	0.0%	30 / 30	0.927	0.856 Reject	0.918 Reject	3.74	14.6	9.746	3.276	14.6	No
Potassium	0.0%	30 / 30	0.927	0.963 Accept	0.950 Accept	434	2790	1253	489.1	2895	No
Selenium	40.0%	18 / 30	0.927	0.857 Reject	0.840 Reject	0.059	0.637	0.212	0.1606	0.9072	No
Silver	3.3%	29 / 30	0.927	0.918 Reject	0.821 Reject	<0.025	0.213	0.0701	0.0352	0.213	No

Table C.1 (continued)
Summary of Background Values for Surface Soil
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	$UTL_{95,95}$	Outlier?
Sodium	3.3%	29 / 30	0.927	0.723 Reject	0.467 Reject	<2.57	37300	3482	8804	25800	Yes
Thallium	16.7%	25 / 30	0.927	0.683 Reject	0.857 Reject	0.555	107	35.54	24.89	63.9	Yes
Vanadium	0.0%	30 / 30	0.927	0.884 Reject	0.966 Accept	5.82	48.5	23.89	10.08	46.26	No
Zinc	0.0%	30 / 30	0.927	0.819 Reject	0.488 Reject	13.3	124	29.30	18.96	38.8	Yes

Notes:

All units are in milligrams per kilogram (mg/kg).
---- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.
W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)
Source: Draft Basewide Background Summary (Jacobs, 1997)

418 342

Table C.2
Summary of Background Values for Subsurface Soil
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL $_{95,95}$	Outlier?
Aluminum	0.0%	30 / 30	0.927	0.960 Accept	0.955 Accept	3780	17700	9905	3277	17180	No
Antimony	80.0%	6 / 30	0.927	---- ----	---- ----	<0.21	0.712	nc	nc	0.712	----
Arsenic	0.0%	30 / 30	0.927	0.963 Accept	0.942 Accept	1.42	5.31	3.0317	1.1266	5.533	No
Barium	0.0%	30 / 30	0.927	0.922 Reject	0.974 Accept	16.4	127	65.83	28.03	128.1	No
Beryllium	0.0%	30 / 30	0.927	0.966 Accept	0.969 Accept	0.208	1.07	0.5629	0.1776	0.957	No
Calcium	0.0%	30 / 30	0.927	0.733 Reject	0.853 Reject	751	347000	91395	76216	272000	Yes
Cadmium	33.3%	20 / 30	0.927	0.829 Reject	0.390 Reject	0.055	1.48	0.1754	0.2540	0.5891	Yes
Chromium	0.0%	30 / 30	0.927	0.937 Accept	0.847 Reject	5.77	17.90	9.494	2.766	16.31	No
Cobalt	10.0%	27 / 30	0.927	0.762 Reject	0.954 Accept	0.4395	5.5	3.181	1.356	6.191	No
Copper	0.0%	30 / 30	0.927	0.848 Reject	0.952 Accept	2.61	13.30	8.119	2.524	13.72	No
Iron	0.0%	30 / 30	0.927	0.936 Accept	0.941 Accept	3840	16900	9185	2720	15224	No
Lead	6.7%	28 / 30	0.927	0.746 Reject	0.949 Accept	0.073	14.3	5.280	3.325	12.66	No
Magnesium	0.0%	30 / 30	0.927	0.697 Reject	0.843 Reject	292	2420	1569	582.1	2420	No
Manganese	0.0%	30 / 30	0.927	0.904 Reject	0.964 Accept	28.7	317	169.6	82.03	351.7	No
Mercury	100.0%	0 / 30	0.927	---- ----	---- ----	<0.03	<0.035	nc	nc	ND at 0.035	----
Molybdenum	80.0%	6 / 30	0.927	---- ----	---- ----	<0.638	1.930	nc	nc	1.930	----
Nickel	0.0%	30 / 30	0.927	0.959 Accept	0.837 Reject	4.17	22.1	9.166	3.862	19.76	Bi
Potassium	0.0%	30 / 30	0.927	0.909 Reject	0.977 Accept	271	1900	1000	322.8	1717	No
Selenium	80.0%	6 / 30	0.927	---- ----	---- ----	<0.12	0.3130	nc	nc	0.3130	----
Silver	33.3%	20 / 20	0.927	0.862 Reject	0.847 Reject	<0.021	0.0928	0.0354	0.0273	0.1277	No

Table C.2 (continued)
Summary of Background Values for Subsurface Soil
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	$UTL_{95,95}$	Outlier?
Sodium	10.0%	27 / 30	0.927	0.898 Reject	0.426 Reject	1.1	53200	4225	11762	53200	No
Thallium	13.3%	26 / 30	0.927	0.630 Reject	0.858 Reject	0.575	65.4	34.74	19.84	65.4	No
Vanadium	0.0%	30 / 30	0.927	0.980 Accept	0.926 Reject	9.7	37.8	20.33	6.245	37.39	No
Zinc	0.0%	30 / 30	0.927	0.851 Reject	0.963 Accept	5.9	31	18.70	5.663	31.27	No

Notes:

All units are in milligrams per kilogram (mg/kg).

---- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.
W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)
Source: Draft Basewide Background Summary (Jacobs, 1997)

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Table C.3
Summary of Background Values for Low-Stress Groundwater Samples
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL $_{95,95}$	Outlier?
Aluminum	25.0%	9 / 12	0.859	0.930 Accept	0.505 Reject	0.052	0.472	0.0754	0.1910	1.332	No
Antimony	100.0%	0 / 12	0.859	---- ----	---- ----	<0.002	<0.002	nc	nc	ND at 0.002	----
Arsenic	100.0%	0 / 12	0.859	---- ----	---- ----	<0.0049	<0.0049	nc	nc	ND at 0.0049	----
Barium	0.0%	12 / 12	0.859	0.887 Accept	0.647 Reject	0.052	0.472	0.135	0.114	0.587	Yes
Beryllium	91.7%	1 / 12	0.859	---- ----	---- ----	<0.0003	0.0003	nc	nc	0.0003	----
Calcium	0.0%	12 / 12	0.859	0.855 Reject	0.905 Accept	56.5	193	141.7	45.5	266.3	No
Cadmium	100.0%	0 / 12	0.859	---- ----	---- ----	<0.0005	<0.0005	nc	nc	ND at 0.0005	----
Chromium	91.7%	1 / 12	0.859	---- ----	---- ----	<0.0053	0.0064	nc	nc	0.006	----
Cobalt	100.0%	0 / 12	0.859	---- ----	---- ----	<0.0089	<0.0089	nc	nc	ND at 0.0089	----
Copper	91.7%	1 / 12	0.859	---- ----	---- ----	<0.0008	0.0028	nc	nc	0.0028	----
Iron	0.0%	12 / 12	0.859	0.874 Accept	0.872 Accept	0.0049	0.072	0.0253	0.0194	0.2239	No
Lead	100.0%	0 / 12	0.859	---- ----	---- ----	<0.0016	<0.0016	nc	nc	ND at 0.0016	----
Magnesium	0.0%	12 / 12	0.859	0.839 Reject	0.639 Reject	2.76	37.8	10.32	10.49	37.80	No
Manganese	0.0%	12 / 12	0.859	0.820 Reject	0.376 Reject	0.0019	2.86	0.2713	0.8177	0.175	Yes
Mercury	100.0%	0 / 12	0.859	---- ----	---- ----	<0.0001	<0.0001	nc	nc	ND at 0.0001	----
Molybdenum	100.0%	0 / 12	0.859	---- ----	---- ----	<0.0144	<0.0144	nc	nc	ND at 0.0144	----
Nickel	75.0%	3 / 12	0.859	---- ----	---- ----	<0.002	0.0204	nc	nc	0.0204	----
Potassium	33.3%	8 / 12	0.859	0.890 Accept	0.665 Reject	0.233	5.55	1.277	2.079	15.03	No
Selenium	25.0%	9 / 12	0.859	0.823 Reject	0.882 Accept	0.00055	0.0046	0.0021	0.0012	0.0077	No
Silver	91.7%	1 / 12	0.859	---- ----	---- ----	<0.0002	0.0002	nc	nc	0.0002	----

Table C.3 (continued)
Summary of Background Values for Low-Stress Groundwater Samples
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	$UTL_{95,95}$	Outlier?
Sodium	0.0%	12 / 12	0.859	0.885 Accept	0.519 Reject	6.17	144	28.76	37.05	167.2	Yes
Thallium	100.0%	0 / 12	0.859	---- ----	---- ----	<0.0632	<0.0632	nc	nc	ND at 0.0632	----
Vanadium	18.2%	9 / 11	0.859	0.893 Accept	0.863 Accept	<0.0029	0.0074	0.0034	0.0018	0.0123	No
Zinc	36.4%	7 / 11	0.859	0.877 Accept	0.622 Reject	0.00195	0.0487	0.0101	0.0170	0.1180	No

Notes:

All units are in milligrams per liter (mg/L).

---- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.
W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)
Source: Draft Basewide Background Summary (Jacobs, 1997)

Table C.4
Summary of Background Values for Unfiltered Groundwater Samples
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL $_{95,95}$	Outlier?
Aluminum	0.0%	12 / 12	0.859	0.950 Accept	0.779 Reject	0.0699	2.45	0.8072	0.8586	11.07	No
Antimony	91.7%	1 / 12	0.859	---- ----	---- ----	<0.002	0.0024	nc	nc	0.0024	----
Arsenic	91.7%	1 / 12	0.859	---- ----	---- ----	<0.0049	0.0067	nc	nc	0.0067	----
Barium	0.0%	12 / 12	0.859	0.982 Accept	0.882 Accept	0.0358	0.513	0.1931	0.1362	1.133	No
Beryllium	66.7%	4 / 12	0.859	---- ----	---- ----	<0.003	0.0019	nc	nc	0.0019	----
Calcium	0.0%	12 / 12	0.859	0.916 Accept	0.806 Reject	102	881	406.6	300.8	2438	No
Cadmium	66.7%	4 / 12	0.859	---- ----	---- ----	<0.0005	0.0016	nc	nc	0.0016	----
Chromium	58.3%	5 / 12	0.859	---- ----	---- ----	<0.0053	0.0136	nc	nc	0.0136	----
Cobalt	91.7%	1 / 12	0.859	---- ----	---- ----	<0.0089	0.01	nc	nc	0.01	----
Copper	50.0%	6 / 12	0.859	---- ----	---- ----	<0.0008	0.0101	nc	nc	0.0101	----
Iron	0.0%	12 / 12	0.859	0.984 Accept	0.828 Reject	0.0768	2.64	0.7838	0.7026	7.234	No
Lead	100.0%	0 / 12	0.859	---- ----	---- ----	<0.0016	<0.0016	nc	nc	ND at 0.0016	----
Magnesium	0.0%	12 / 12	0.859	0.905 Accept	0.735 Reject	3.79	35.6	11.91	10.65	68.78	No
Manganese	0.0%	12 / 12	0.859	0.958 Accept	0.863 Accept	0.0393	2.17	0.7055	0.6592	10.57	No
Mercury	100.0%	0 / 12	0.859	---- ----	---- ----	<0.0001	<0.0001	nc	nc	ND at 0.0001	----
Molybdenum	100.0%	0 / 12	0.859	---- ----	---- ----	<0.0144	<0.0144	nc	nc	ND at 0.0144	----
Nickel	0.0%	12 / 12	0.859	0.92 Accept	0.78 Reject	0.0022	0.0203	0.0068	0.0055	0.0364	No
Potassium	50.0%	6 / 12	0.859	---- ----	---- ----	<0.466	3.9	nc	nc	3.9	----
Selenium	16.7%	10 / 12	0.859	0.891 Accept	0.851 Reject	<0.0011	0.0042	0.0018	0.0009	0.0072	No
Silver	91.7%	1 / 12	0.859	---- ----	---- ----	<0.0002	0.0003	nc	nc	0.0003	----

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Table C.4 (continued)
Summary of Background Values for Unfiltered Groundwater Samples
NAS Fort Worth JRB, Texas

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL $_{95,95}$	Outlier?
Sodium	0.0%	12 / 12	0.859	0.960 Accept	0.630 Reject	1.96	91.5	20.24	23.68	176.2	No
Thallium	100.0%	0 / 12	0.859	---- ----	---- ----	<0.0632	<0.0632	nc	nc	ND at 0.0632	----
Vanadium	9.1%	10 / 11	0.859	0.943 Accept	0.920 Accept	0.00145	0.0247	0.0093	0.0066	0.0653	No
Zinc	9.1%	10 / 11	0.859	0.964 Accept	0.874 Accept	0.00195	0.0307	0.0107	0.0082	0.0682	No

Notes:

All units are in milligrams per kilogram (mg/kg).
---- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.
W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)
Source: Draft Basewide Background Summary (Jacobs, 1997)

Table C.5
Summary of Background Values for Surface Water
Naval Air Station Fort Worth

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL $_{95,95}$	Outlier?
Aluminum	0.0%	8 / 8	0.818	0.848 Accept	0.729 Reject	0.0509	0.178	0.0842	0.0410	0.2716	Yes
Antimony	75.0%	2 / 8	0.818	---- ----	---- ----	<0.002	0.0031	nc	nc	0.0031	----
Arsenic	100.0%	0 / 8	0.818	---- ----	---- ----	<0.0049	<0.0049	nc	nc	ND at 0.0049	----
Barium	0.0%	8 / 8	0.818	0.957 Accept	0.928 Accept	0.0759	0.124	0.0953	0.0146	0.151	No
Beryllium	100.0%	0 / 8	0.818	---- ----	---- ----	<0.0003	<0.0003	nc	nc	ND at 0.0003	----
Calcium	0.0%	8 / 8	0.818	0.908 Accept	0.879 Accept	84.1	118	96.01	10.61	133.7	No
Cadmium	87.5%	1 / 8	0.818	---- ----	---- ----	<0.0005	0.0005	nc	nc	ND at 0.0005	----
Chromium	62.5%	3 / 8	0.818	---- ----	---- ----	<0.0053	0.0078	nc	nc	0.0078	----
Cobalt	100.0%	0 / 8	0.818	---- ----	---- ----	<0.0089	<0.0089	nc	nc	ND at 0.0089	----
Copper	25.0%	6 / 8	0.818	0.566 Reject	0.566 Reject	<0.0004	0.0101	0.0077	0.0045	0.0101	No
Iron	0.0%	8 / 8	0.818	0.930 Accept	0.989 Accept	0.0221	0.223	0.1128	0.0633	0.9208	No
Lead	100.0%	0 / 8	0.818	---- ----	---- ----	<0.0016	<0.0016	nc	nc	ND at 0.0016	----
Magnesium	0.0%	8 / 8	0.818	0.993 Accept	0.976 Accept	2.07	5.52	3.58	1.114	9.353	No
Manganese	0.0%	8 / 8	0.818	0.937 Accept	0.864 Accept	0.0038	0.0716	0.0251	0.0218	0.4193	No
Mercury	87.5%	1 / 8	0.818	---- ----	---- ----	<0.0001	0.0001	nc	nc	0.0001	----
Molybdenum	100.0%	0 / 8	0.818	---- ----	---- ----	<0.0144	<0.0144	nc	nc	ND at 0.0144	----
Nickel	87.5%	1 / 8	0.818	---- ----	---- ----	<0.002	0.0178	nc	nc	0.0178	----
Potassium	0.0%	8 / 8	0.818	0.893 Accept	0.924 Accept	2.06	3.93	3.001	0.6836	6.347	No
Selenium	25.0%	6 / 8	0.818	0.689 Reject	0.779 Reject	0.00055	0.0025	0.0018	0.0008	0.0115	No
Silver	75.0%	2 / 8	0.818	---- ----	---- ----	<0.0002	0.0003	nc	nc	0.0003	----

Table C.5 (continued)
Summary of Background Values for Surface Water
Naval Air Station Fort Worth

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL $_{95,95}$	Outlier?
Sodium	0.0%	8 / 8	0.818	0.959 Accept	0.943 Accept	19.3	32.9	25.74	4.752	45.46	No
Thallium	100.0%	0 / 8	0.818	---- ----	---- ----	<0.0632	<0.0632	nc	nc	ND at 0.0632	----
Vanadium	25.0%	6 / 8	0.818	0.882 Accept	0.941 Accept	<0.0029 7	0.0058	nc	nc	0.0159	----
Zinc	75.0%	2 / 8	0.818	---- ----	---- ----	<0.0039	0.0122	nc	nc	0.0122	No

Notes:

All units are in milligrams per liter (mg/L).
---- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.
W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)
Source: Draft Basewide Background Summary (Jacobs, 1997)

Table C.6
Summary of Background Values for Stream Sediment Samples
Naval Air Station Fort Worth

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL $_{95,95}$	Outlier?
Aluminum	0.0%	8 / 8	0.818	0.892 Accept	0.924 Accept	2280	9240	5540	2679	28767	No
Antimony	87.5%	1 / 8	0.818	---- ----	---- ----	<0.244	0.33	nc	nc	0.33	----
Arsenic	0.0%	8 / 8	0.818	0.951 Accept	0.925 Accept	2.85	5.27	3.7488	0.7848	0.7018	No
Barium	0.0%	8 / 8	0.818	0.920 Accept	0.918 Accept	21.9	76.8	48.03	19.60	180.4	No
Beryllium	0.0%	8 / 8	0.818	0.912 Accept	0.912 Accept	0.194	0.557	0.3734	0.1336	1.189	No
Calcium	0.0%	8 / 8	0.818	0.877 Accept	0.928 Accept	75100	189000	139888	35825	337544	No
Cadmium	0.0%	8 / 8	0.818	0.859 Accept	0.866 Accept	0.152	0.292	0.2164	0.0588	0.5071	No
Chromium	0.0%	8 / 8	0.818	0.869 Accept	0.885 Accept	4.81	9.59	7.546	1.840	17.0	No
Cobalt	0.0%	8 / 8	0.818	0.882 Accept	0.872 Accept	1.59	3.43	2.51	0.7757	6.651	No
Copper	0.0%	8 / 8	0.818	0.961 Accept	0.953 Accept	4.28	11.7	7.428	2.627	22.18	No
Iron	0.0%	8 / 8	0.818	0.807 Reject	0.832 Accept	5030	8080	6923	1184	10696	No
Lead	0.0%	8 / 8	0.818	0.956 Accept	0.818 Reject	2.21	26.9	9.1	8.330	104.1	No
Magnesium	0.0%	8 / 8	0.818	0.912 Accept	0.938 Accept	1450	2140	1876	221.7	2772	No
Manganese	0.0%	8 / 8	0.818	0.840 Accept	0.743 Reject	143	362	198.4	71.16	491.3	Yes
Mercury	87.5%	1 / 8	0.818	---- ----	---- ----	<0.037	0.0360	nc	nc	0.0360	----
Molybdenum	12.5%	7 / 8	0.818	0.894 Accept	0.963 Accept	0.4355	2.68	1.659	0.7692	9.693	No
Nickel	0.0%	8 / 8	0.818	0.937 Accept	0.958 Accept	5.55	12	9.0475	2.147	19.76	No
Potassium	0.0%	8 / 8	0.818	0.904 Accept	0.929 Accept	386	1300	788.4	340	3227	No
Selenium	87.5%	1 / 8	0.818	---- ----	---- ----	<0.134	0.214	nc	nc	0.214	----
Silver	0.0%	8 / 8	0.818	0.965 Accept	0.888 Accept	0.0311	0.0929	0.0532	0.0188	0.144	No

Table C.6 (continued)
Summary of Background Values for Stream Sediment Samples
Naval Air Station Fort Worth

Analyte	% Non-detects	Detects/ Total	W (crit)	W (log)	W (raw)	Min	Max	Mean	Standard Deviation	UTL $_{95,95}$	Outlier?
Sodium	75.0%	2 / 8	0.818	---- ----	---- ----	<2.44	6.07	nc	nc	6.07	----
Thallium	0.0%	8 / 8	0.818	0.912 Accept	0.936 Accept	22.2	43.4	33.41	7.443	69.74	No
Vanadium	0.0%	8 / 8	0.818	0.902 Accept	0.896 Accept	15.4	24.1	19.26	3.206	32.26	No
Zinc	0.0%	8 / 8	0.818	0.971 Accept	0.853 Accept	11.3	53.9	25.48	13.11	101.3	No

Notes:

All units are in milligrams per kilogram (mg/kg).
---- = not applicable
nc = not calculated
ND = not detected
$UTL_{95,95}$ = Upper Tolerance Level (95% confidence and 95% coverage)
Outlier? = Result of test to determine if the maximum value is a potential outlier.
W (crit) = Shapiro-Wilk critical value
W (log) = calculated W using log-transformed data and result when compared to W (crit)
W (raw) = calculated W using raw data and result when compared to W (crit)
Source: Draft Basewide Background Summary (Jacobs, 1997)

TAB

Appendix D Field Forms

BORING LOG

Borehole ID: __________
Sheet _____ of ____

Location	

Project Name	Project Number	LTCCODE (IRPIMS)	Site ID	LPRCODE (IRPIMS)
Drilling Company	Driller	Ground Elevation	Total Drilled Depth	

Drilling Equipment	Drilling Method	Borehole Diameter	Date/Time Drilling Started	Date/Time Total Depth Reached

Type of Sampling Device	Water Level (bgs) First Final
Sample Hammer Type Driving Wt. Drop	Hydrogeologist | Checked by/Date
Location Description (include sketch in field logbook)	

Depth	Interval	Recovery	Blow Counts	Description (Include lithology, grain size, sorting, angularity, Munsell color name & notation, minerology, bedding, plasticity, density, consistency, etc., as applicable)	USCS Symbol	Lithology	Water Content	Remarks (Include all sample types & depth, odor, organic vapor measurements, etc.)

WELL CONSTRUCTION DETAILS AND ABANDONMENT FORM

HYDRO GeoLogic INC.

FIELD REPRESENTATIVE: ____________________

DRILLING CONTRACTOR: ____________________

DRILLING TECHNIQUE: ____________________
AUGER SIZE AND TYPE: ____________________

BOREHOLE IDENTIFICATION: ____________________
BOREHOLE DIAMETER: ____________________
WELL IDENTIFICATION: ____________________

WELL CONSTRUCTION START DATE: ____________
WELL CONSTRUCTION COMPLETE DATE: ____________

SCREEN MATERIAL: ____________________
SCREEN DIAMETER: ____________________
STRATUM-SCREENED INTERVAL (FT): ____________

CASING MATERIAL: ____________________
CASING DIAMETER: ____________________

TYPE OF FILTER PACK: ____________________
GRADIATION: ____________________
AMOUNT OF FILTER PACK USED: ____________

TYPE OF BENTONITE: ____________________
AMOUNT BENTONITE USED: ____________________

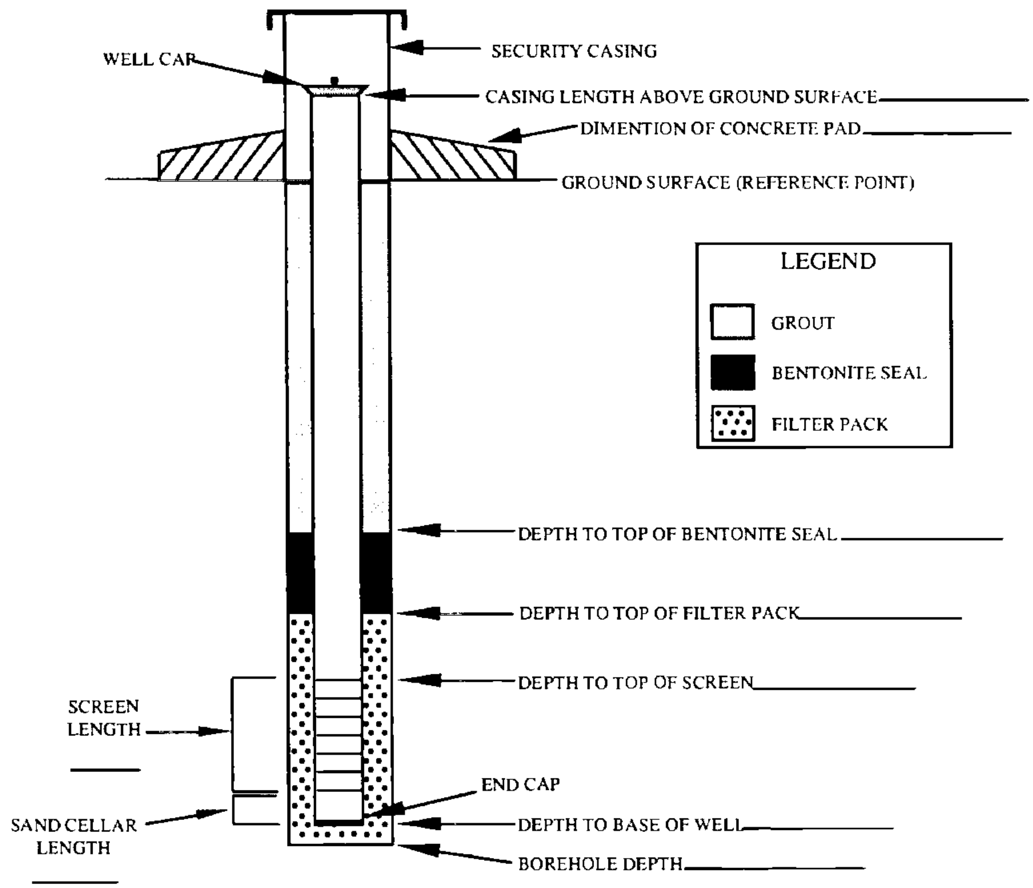
TYPE OF CEMENT: ____________________
AMOUNT CEMENT USED: ____________________
GROUT MATERIALS USED: ____________________

DIMENSIONS OF SECURITY CASING: ____________

TYPE OF WELL CAP: ____________________
TYPE OF END CAP: ____________________

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



NOT TO SCALE

INSTALLED BY: ____________________ INSTALLATION OBSERVED BY: ____________________

DISCREPANCIES: ____

WELL DEVELOPMENT RECORD

HYDRO GeoLogic INC.

WELL/PIEZOMETER ID ______
SHEET ______ of ______

PROJECT NAME: ________________ PROJECT NO. : ____________________ DATE: ________________

LOCATION: ____________________ DATE INSTALLED: ____________________________________

TOTAL DEPTH (FTOC) ____________ CASING DIAMETER ____________________________________

METHODS OF DEVELOPMENT

☐ Swabbing ☐ Bailing ☐ Pumping ☐ Describe ____________________

Equipment decomtaminated prior to development ☐ Yes ☐ NO

Describe ____

EQUIPMENT NUMBERS:

pH Meter ______________ EC Meter ______________ Turbidity Meter ______________ Thermometer ______________

CASING VOLUME INFORMATION:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION:

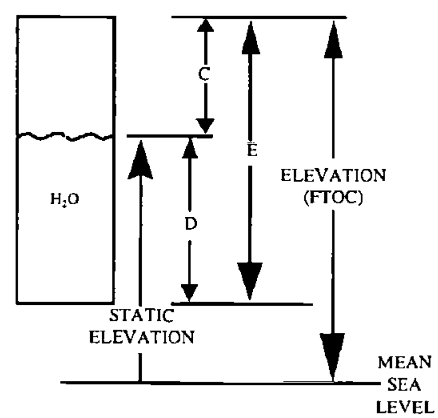
Measured Well Depth (B) ____________________ ft.

Measured Water Level Depth (C) ____________________ ft.

Length of Static Water Column (D) ________ - ________ = ________ ft.
(B) (C)

Casing Water Volume (E) + ________ x ________ = ________ gal
(A) (D)

Total Purge Volume = ________ (gal)



Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC	Temperature F or C	Turbidity/ Sand (ppm)	Comments

WASTE INVENTORY TRACKING FORM

LOCATION : ______________________________

PROJECT NAME: ______________________________

ACTIVITIES: ______________________________

Date Waste Generated	Activity Generating Waste (borehole # / well #)	Description of Waste	Field Evidence of Contamination	Estimated Volume	Type of Container (storage ID#)	Location of Container	Waste Characterization	Comments

Note: Describe whether soil or water samples have been collected for waste characterization, include date, if known.

Signature: ______________________________

4 1 8 . 3 5 8

HYDRO GeoLogic INC.

MONITOR WELL STATIC WATER LEVEL FORM

PROJECT NAME: ______________________ DATE: ______________

WATER LEVEL INDICATOR ID # __________ FIELD BOOK # __________

LOCATION: ______________________ PAGE # ______________

Monitor Well Number	Time	Depth to Static Water Level (from T.O.C.)	Total Well Depth (ft)	Explosimeter Reading (above background)	PID Reading (above background)

Note: Total well depth to be measured at time of gauging.

Comments: ____

____

____

Sampler ______________________ Observer ______________________

AFCEE FORM WL.0

MONITOR WELL PURGING FORM

PROJECT : ______________________ DATE: ____________

LOCATION: ______________________ EXPLOSIMETER BOREHOLE READING ________

WELL ID: ______________________ PURGE VOLUME (3 WELLBORE VOLUMES): ____________ (gal)

WELL DEPTH: ______________________

Time	Depth to Water (ft)	Flow Meter Reading	Volume Purged (gal)	Temp. (°C)	pH	Electrical Conductivity (mmho)	Turbidity N.T.U	Comments

Note: Condition of the well: ______________________________

pH - Calibrate at start and before last reading.

Sampler ______________________ Observer ______________________

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HYDRO GeoLogic INC.

FIELD SAMPLING REPORT

LOCATION: ______________________ PROJECT : ______________________

SITE: ______________________

SAMPLE INFORMATION

MATRIX ______________________ SAMPLE ID: ______________________

SAMPLING METHOD ______________ DUP./REP. OF : ______________________

BEGINNING DEPTH ______________ MATRIX SPIKE/MATRIX SPIKE DUPLICATE YES ( ) NO ( )

END DEPTH ______________________

GRAB ( ) COMPOSITE ( ) DATE: ____________ TIME: ____________

CONTAINER SIZE/TYPE	#	PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANALYSIS

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR:	
2nd	ODOR:	
	OTHER:	

GENERAL INFORMATION

WEATHER: SUN/CLEAR _____ OVERCAST/RAIN _____ WIND DRIECTION _______ AMBIENT TEMP ______

SHIPMENT VIA: FED-X _____ HAND DELIVER ______ COURIER _______ OTHER _______

SHIPPED TO: ____

COMMENTS: ____

SAMPLER: ______________________ OBSERVER: ______________________

MATRIX TYPE CODES

DC=DRILL CUTTINGS
WG=GROUND WATER
LH=HAZARDOUS LIQUID WASTE
SH=HAZARDOUS SOLID WASTE
SE=SEDIMENT
SL=SLUDGE
SO=SOIL
GS=SOIL GAS
WS=SURFACE WATER
SW=SWAP\WIPE

SAMPLING METHOD CODES

B=BAILER
BR=BRASS RING
CS=COMPOSITE SAMPLE
C=CONTINUOUS FLIGHT AUGER
DT=DRIVEN TUBE
W=SWAB\WIPE
G=GRAB
HA=HAND AUGER
H=HOLLOW STEM AUGER
HP=HYDRO PUNCH
SS=SPLIT SPOON
SP=SUBMERSIBLE PUMP

HYDRO GeoLogic INC.

CALIBRATION LOG

Project Name: ____________________ By: ____________________

Project No.: ____________________ Page ______ of ______

Date/Time	Instrument	STD	STD CONC ppm	Meter Reading	Comments

CHAIN OF CUSTODY RECORD

HYDRO GeoLogic INC.
1155 Herndon Parkway
Suite 900
Herndon, VA 20170

Client: ______

Project Name/No.: ______

Project Manager: ______

Sampler: ______

Phone: (703) 478-5186 Fax: (703) 471-4180

APPLICABLE REGULATION
- ☐ RCRA
- ☐ ECRA
- ☐ CERCLA
- ☐ NPDES
- ☐ CWA
- ☐ SDWA
- ☐ OTHER

SAMPLE IDENTIFICATION	DATE COLL.	TIME COLL.	GRAB	COMPOSITE	MATRIX: SOIL	MATRIX: WATER	MATRIX: OTHER	TOTAL NO. OF CONTAINERS	ANALYSIS REQUIRED								REMARKS OR SAMPLE LOCATION

Special Instructions

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return to Client ☐ Disposal by Lab ☐ Archive for ______ Months

Turn Around Time Required
☐ Normal ☐ Rush

QC Level
☐ I. ☐ II. ☐ III.

Project Specific (specify)

1. Relinquished by	Date	Time	1. Received by	Date	Time
2. Relinquished by	Date	Time	2. Received by	Date	Time
3. Relinquished by	Date	Time	3. Received by	Date	Time

Comments

LOG OF DAILY TIME AND MATERIALS

HydroGeoLogic Inc.

Project Name: ______________________

Project Number: ______________________

Subcontractor: ______________________

Boring or Well No: ______________________ Date: ______________________

ITEM	NO. UNITS
Drilling /ft	
______-inch augerhole	/ft
______-inch mud rotary hole	/ft
______-inch air rotary	/ft
Split spoon samples	
Shelby tube samples	
______-rock coring	/ft
Driven casing ______-inch	/ft
Well Materials	
______-inch stainless steel riser pipe	/ft
______-inch stainless steel screen	/ft
______-inch PVC riser pipe	/ft
______-inch PVC screen	/ft
Couplings	
Bottom caps	
Top caps	
Protective casings /w locking caps	
Well installation	/ft
Revert (bags)	
Bentonite powder (bags)	
Bentonite pellets (buckets)	
Sand (bags)	
Cement (bags)	
Other Charges	
Standby	/hr
Decontamination	/hr
Well development	/hr
Spoil Disposal (barrels)	

Other ____

____

HydroGeoLogic Site Representative: ______________________

Subcontractor Site Representative: ______________________

FINAL PAGE

ADMINISTRATIVE RECORD

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ADMINISTRATIVE RECORD

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