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FINAL 1998 BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN NAS FORT WORTH TX

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NAVAL AIR STATION FORT WORTH JRB CARSWELL FIELD TEXAS

ADMINISTRATIVE RECORD COVER SHEET

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HYDRO GeoLogic INC.

HQ Air Force Center for Environmental Excellence

Final
1998 Basewide Groundwater Sampling and Analysis Plan

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

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

April 1998

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HQ Air Force Center for Environmental Excellence

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Prepared by:
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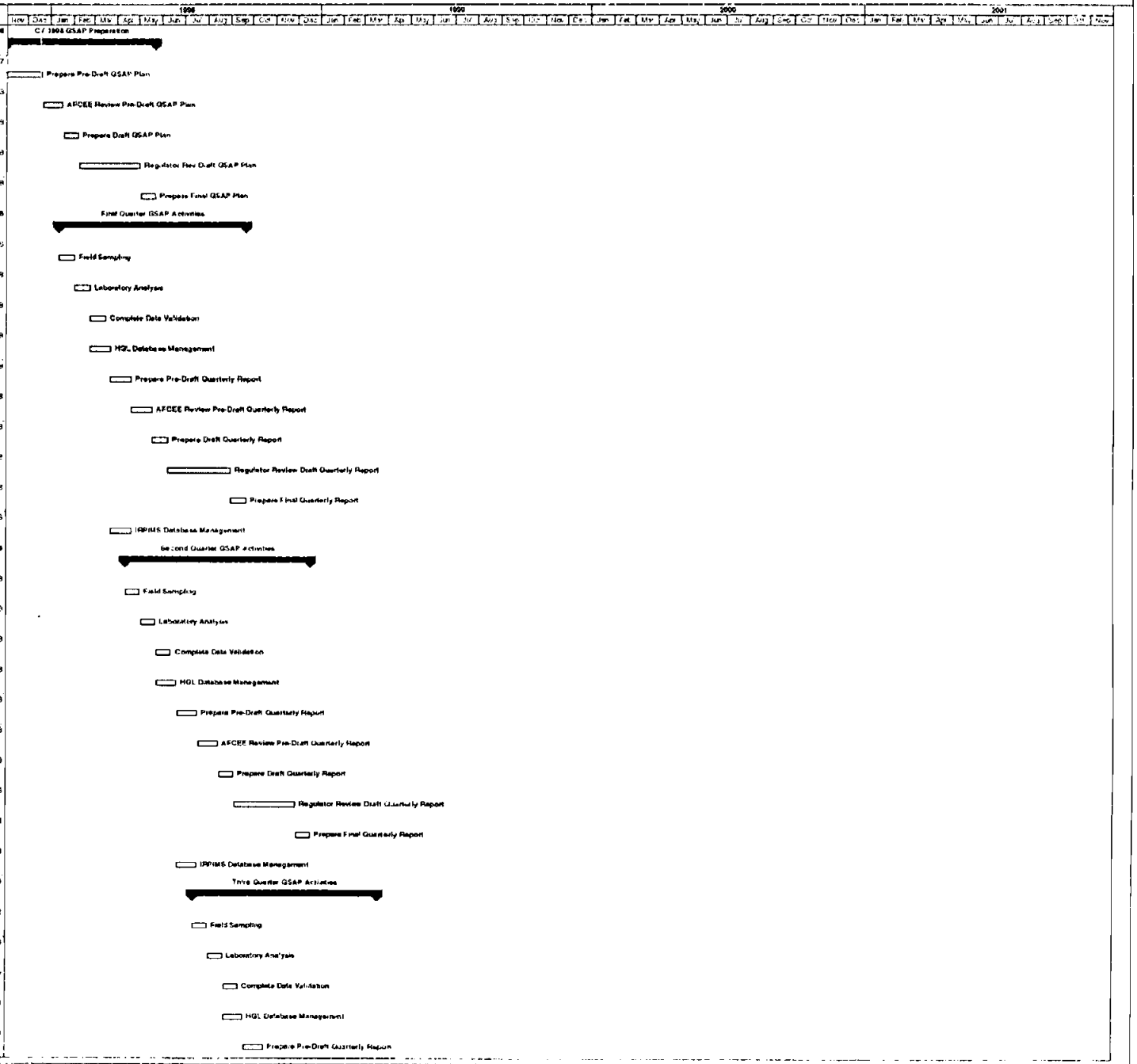
7.0 PROJECT SCHEDULE

A schedule for completion of tasks for each quarterly sampling event as well as preparations for the next year's GSAP is presented in Figure 7.1. This schedule includes GSAP preparations, field sampling, laboratory analyses, data validation, database management, quarterly reports, and the annual report. The schedule for technical report preparation includes a review of a pre-draft documentation by AFCEE and a TRNCC review of the revised draft documentation. Responses to the review comments will be prepared along with revision to the pre-draft and the revised draft documents, resulting in a final document that incorporates AFCEE and TRNCC input.

Figure 7-1
Proposed Project Schedule
GSAP NAS Fort Worth JRB, Texas

ID	Task Name	Start	Duration	Finish
1	CY 1998 GSAP Preparation	11/3/97	165d	6/22/98
2	Prepare Pre-Draft GSAP Plan	11/3/97	35d	12/18/97
3	AFCEE Review Pre-Draft GSAP Plan	12/22/97	20d	1/16/98
4	Prepare Draft GSAP Plan	1/19/98	15d	2/6/98
5	Regulator Rev Draft GSAP Plan	2/9/98	60d	5/1/98
6	Prepare Final GSAP Plan	5/4/98	15d	5/22/98
7	First Quarter GSAP Activities	1/13/98	180d	9/21/98
8	Field Sampling	1/13/98	15d	2/2/98
9	Laboratory Analysis	2/3/98	15d	2/23/98
10	Complete Data Validation	2/24/98	15d	3/10/98
11	HGL Database Management	2/24/98	20d	3/23/98
12	Prepare Pre-Draft Quarterly Report	3/24/98	20d	4/20/98
13	AFCEE Review Pre-Draft Quarterly Report	4/21/98	20d	5/18/98
14	Prepare Draft Quarterly Report	5/19/98	15d	6/9/98
15	Regulator Review Draft Quarterly Report	6/9/98	60d	8/31/98
16	Prepare Final Quarterly Report	8/31/98	15d	9/21/98
17	IRPIMS Database Management	3/24/98	20d	4/20/98
18	Second Quarter GSAP Activities	4/13/98	180d	12/10/98
19	Field Sampling	4/13/98	15d	5/1/98
20	Laboratory Analysis	5/4/98	15d	5/22/98
21	Complete Data Validation	5/25/98	15d	6/12/98
22	HGL Database Management	5/25/98	20d	6/18/98
23	Prepare Pre-Draft Quarterly Report	6/22/98	20d	7/17/98
24	AFCEE Review Pre-Draft Quarterly Report	7/20/98	20d	8/14/98
25	Prepare Draft Quarterly Report	8/17/98	15d	9/4/98
26	Regulator Review Draft Quarterly Report	9/7/98	50d	11/27/98
27	Prepare Final Quarterly Report	11/30/98	15d	12/18/98
28	IRPIMS Database Management	6/22/98	20d	7/17/98
29	Third Quarter GSAP Activities	7/13/98	180d	3/15/99
30	Field Sampling	7/13/98	15d	7/31/98
31	Laboratory Analysis	8/3/98	15d	8/21/98
32	Complete Data Validation	8/24/98	15d	9/11/98
33	HGL Database Management	8/24/98	20d	9/18/98
34	Prepare Pre-Draft Quarterly Report	9/21/98	20d	10/16/98



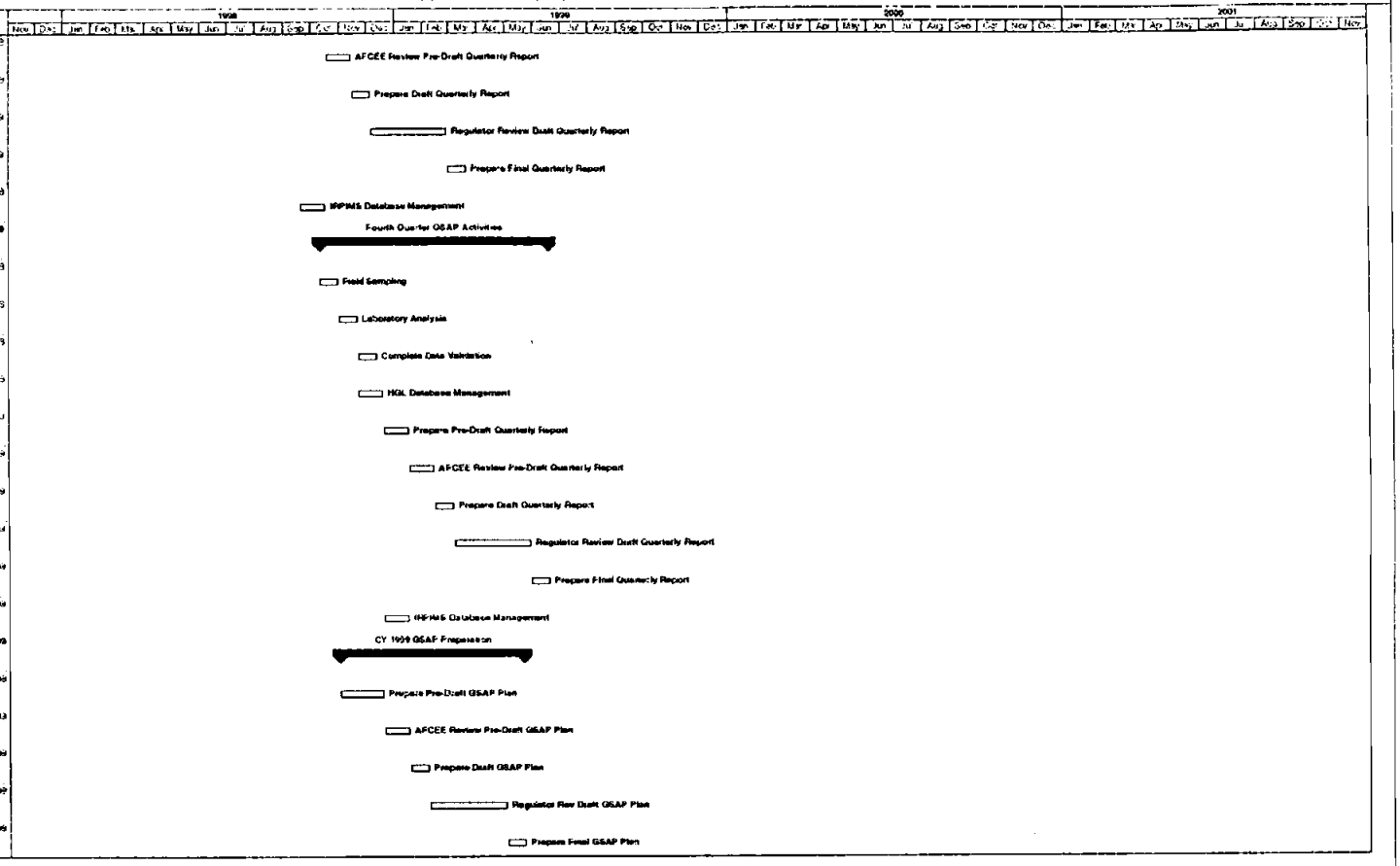
Project: GSAP Schedule
Date: 12/18/97

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

Page 1

Figure 7-1
Proposed Project Schedule
GSAP NAS Fort Worth JRB, Texas

ID	Task Name	Start	Duration	Finish
35	AFCEE Review Pre-Draft Quarterly Report	10/13/99	20d	11/10/99
36	Prepare Draft Quarterly Report	11/10/99	15d	12/1/99
37	Regulator Review Draft Quarterly Report	12/7/99	60d	2/26/00
38	Prepare Final Quarterly Report	3/1/00	15d	3/19/00
39	IRPIMS Database Management	8/21/99	20d	10/15/99
40	Fourth Quarter GSAP Activities	10/12/99	180d	6/19/00
41	Field Sampling	10/12/99	15d	10/30/99
42	Laboratory Analysis	11/2/99	15d	11/20/99
43	Complete Data Validation	11/23/99	15d	12/11/99
44	HGL Database Management	11/23/99	20d	12/18/99
45	Prepare Pre-Draft Quarterly Report	12/21/99	20d	1/15/00
46	AFCEE Review Pre-Draft Quarterly Report	1/18/00	20d	2/11/00
47	Prepare Draft Quarterly Report	2/15/00	15d	3/3/00
48	Regulator Review Draft Quarterly Report	3/6/00	60d	5/26/00
49	Prepare Final Quarterly Report	5/31/00	15d	6/19/00
50	IRPIMS Database Management	12/21/99	20d	1/15/00
51	CY 1999 GSAP Preparation	11/2/99	145d	5/21/00
52	Prepare Pre-Draft GSAP Plan	11/2/99	35d	12/18/99
53	AFCEE Review Pre-Draft GSAP Plan	12/21/99	20d	1/15/00
54	Prepare Draft GSAP Plan	1/18/00	15d	2/5/00
55	Regulator Rev Draft GSAP Plan	2/8/00	60d	4/28/00
56	Prepare Final GSAP Plan	5/2/00	15d	5/21/00



Project: GSAP 6/19/97
Date: 12/18/97

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

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PREFACE

The 1998 Basewide Groundwater Sampling and Analysis Plan (GSAP) was prepared for the Air Force Center for Environmental Excellence (AFCEE) to set forth the proposed groundwater monitoring objectives and activities to be conducted in 1998 at Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), Carswell Field, Texas. This plan was prepared under Contract Number F41624-95-D-8005-0007, Delivery Order 7 issued to HydroGeoLogic, Inc. Activities to be included in this contract were specified in the Statement of Work dated February 14, 1997. The AFCEE Contracting Officer's Representative (COR) is Joseph Dunkle. HydroGeoLogic's Project Manager is Jim Costello.

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EXECUTIVE SUMMARY

The 1998 Basewide Groundwater Sampling and Analysis Plan (GSAP) presents the objectives and monitoring activities to be conducted in 1998 at NAS Fort Worth JRB, Carswell Field, Texas. This program has been designed to fulfill short-term and long-term objectives for addressing groundwater contamination associated with Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs). The following wells will be monitored to fulfill those objectives:

Flightline Area	East Area		Landfill Area
GMI-22-02M	17M	SD13-06	LF05-19
GMI-22-03M	BGSMW03	SD13-07	WHGLTA003
GMI-22-04M	BGSMW05	ST14-02	WHGLTA004
GMI-22-05M	BGSMW06	ST14-03	USGS07T
GMI-22-06M	BSS-B	ST14-04	WP07-10C
GMI-22-07M	LF01-1D	ST14-14	
LSA1628-3	MW-10	ST14-24	
MW-53	WHGLTA005	ST14-26	
SPOT35-5	WHGLTA006	ST14-28	
USGS04T	WHGLTA007	ST14-29	
WITCTA010	WHGLTA008	ST14-W16	
WITCTA024	SAV-2	ST14-W18	
	SD13-01	ST14-W21	
	SD13-02	ST14-W31	
	SD13-04		

The 1998 GSAP monitoring objectives, listed below, are based on the findings of previous investigations, and a current understanding of the remediation/assessment plans anticipated in the coming year.

- *Critical Groundwater Exposure Pathways Evaluation* - collect data to investigate: (1) off-site exposure to groundwater sources used for drinking water; and (2) on-site and off-site exposure to surface water bodies;

- *Current Regulatory Requirements* - conduct sampling to fulfill current long-term monitoring (LTM) requirements associated with closure of SWMUs and AOCs (currently, this includes the three LTM programs discussed in Section 1.4);

- *Additional Source and Plume Delineation* - define horizontal or vertical migration of contamination associated with miscellaneous hot spots and potential source areas where data are not currently available;

- *Natural Attenuation Monitoring* - collect data to demonstrate that natural attenuation of TCE is occurring; and

- *Complement Ongoing Remediation/Assessment Activities* - to support ongoing remediation/assessment monitoring activities.

To meet these objectives, this GSAP outlines procedures for the following activities to be conducted in 1998:

- Water level measurements
- Groundwater quality sampling
- Removal of light non-aqueous phase liquids if necessary
- Water quality analyses
- Well inspection review
- Data management and transfer
- Reporting

Data generated during these activities will be used to evaluate off-site migration potential, changes in the nature and extent of contamination, and changes in basewide groundwater flow patterns. Thus, these evaluations will be used to satisfy the monitoring objectives of the 1998 GSAP.

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13. ABSTRACT (Maximum 200 words)

The 1998 Basewide Groundwater Sampling and Analysis Plan (GSAP) describes the monitoring objectives and activities for the groundwater sampling and analysis program to be implemented at NAS Fort Worth JRB, Texas.

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TAB

1.0

1.0 INTRODUCTION

This report sets forth the groundwater sampling and analysis plan (GSAP) for groundwater monitoring activities to be conducted in 1998 at the Naval Air Station Fort Worth Joint Reserve Base, Carswell Field (NAS Fort Worth JRB). As part of the U.S. Air Force Installation Restoration Program, this GSAP fulfills both short- and long-term groundwater monitoring objectives. The fulfillment of these objectives, except for three units that currently have long-term monitoring (LTM) requirements as part their approved closure plans, is not presently a regulatory requirement. Consequently, the proposed GSAP is a voluntary action on the part of the U.S. Air Force to conduct a base-wide monitoring of the groundwater flow and quality. This introductory section includes: (1) an overview of the IRP program, its objectives, and history of activities, (2) a site description and identification of the units of concern, and (3) a discussion of the groundwater sampling and analysis program objectives and approach.

1.1 THE U.S. AIR FORCE INSTALLATION RESTORATION PROGRAM

The objective of the U.S. Air Force IRP is to assess past hazardous waste disposal and spill sites at U.S. Air Force installations and to develop remedial actions consistent with the National Contingency Plan (NCP) for sites that pose a threat to human health and welfare or the environment. This section presents information on the program origins, objectives, and organization.

The 1976 Resource Conservation and Recovery Act (RCRA) is one of the primary Federal laws governing the disposal of hazardous wastes. Sections 6001 and 6003 of RCRA require Federal agencies to comply with local and state environmental regulations and provide information to the U.S. Environmental Protection Agency (EPA) concerning past disposal practices at Federal sites. The Resource Conservation Recovery Act (RCRA) Section 3012 requires state agencies to inventory past hazardous waste disposal sites and provide information to the EPA concerning those sites.

In 1980, Congress enacted the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (i.e., Superfund). CERCLA outlines the responsibility for identifying and remediating contaminated sites in the United States and its territories. The CERCLA legislation identifies the EPA as the primary policy and enforcement agency regarding contaminated sites.

The 1986 Superfund Amendments and Reauthorization Act (SARA) extends the requirements of CERCLA and modifies CERCLA with respect to goals for remediation and the steps that lead to the selection of a remedial process. Under SARA, technologies that provide permanent removal or destruction of a contaminant are preferable to actions that only contain or isolate the contaminant. SARA also provides for greater interaction with public and state agencies and extends the EPA's role in evaluating health risks associated with contamination. Under SARA, early determination of Applicable or Relevant and Appropriate Requirements (ARARs) is required, and the consideration of potential remediation alternatives is recommended at the initiation of an Remedial Investigation/Feasibility Study (RI/FS). SARA is the primary legislation governing remedial action at past hazardous waste disposal sites.

Executive Order 12580, adopted in 1987, gave various Federal agencies, including the Department of Defense (DoD), the responsibility to act as lead agencies for conducting investigations and implementing remediation efforts when they are the sole or co-contributor to contamination on or off their properties.

To ensure compliance with CERCLA, its regulations, and Executive Order 12580, the DoD developed the IRP, under the Defense Environmental Restoration Program (DERP), to identify potentially contaminated sites, investigate these sites, and evaluate and select remedial actions for potentially contaminated facilities. The DoD issued the Defense Environmental Quality Program Policy Memorandum (DEQPPM) 80-6 regarding the IRP program in June 1980, and implemented the policies outlined in this memorandum in December 1980. The NCP was issued by EPA in 1980 to provide guidance on a process by which (1) contaminant release could be reported, (2) contamination could be identified and quantified, and (3) remedial actions could be selected. The NCP describes the responsibility of Federal and state governments and those responsible for contaminant releases.

The DoD formally revised and expanded the existing IRP directives and amplified all previous directives and memoranda concerning the IRP through DEQPPM 81-5, dated 11 December 1981. The memorandum was implemented by a U.S. Air Force message dated 21 January 1982.

The IRP is the DoD's primary mechanism for response actions on U.S. Air Force installations affected by the provisions of SARA. In November 1986, in response to SARA and other EPA interim guidance, the U.S. Air Force modified the IRP to provide for a RI/FS program. The IRP was modified so that RI/FS studies could be conducted as parallel activities rather than serial activities. The program now includes ARAR determinations, identification and screening of technologies, and development of alternatives. The IRP may include multiple field activities and pilot studies prior to a detailed final analysis of alternatives. Over the years, requirements of the IRP have been developed and modified to ensure that DoD compliance with Federal laws, such as RCRA, NCP, CERCLA, and SARA, can be met.

Although the Air Force developed the IRP in response to CERCLA, Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB) is not listed on the National Priorities List (NPL) and as such is not subject to corrective action under CERCLA. The primary regulatory programs that govern the investigation and potential closure of these sites are RCRA and the Texas Natural Resource Conservation Commission's (TNRCC) Risk Reduction Standards Program (RRS). The TNRCC is the lead regulatory agency for activities to be conducted at the subject sites.

On February 7, 1991 NAS Fort Worth JRB (formerly Carswell AFB) 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.

The primary emphasis of all site investigations is to meet the requirements of Permit Provision VIII of the NAS Fort Worth HW-50289 permit. However, as the IRP, TNRCC's RRS and RCRA

rely heavily on guidance documents prepared under CERCLA, this GSAP has been prepared using guidance documents from all four programs.

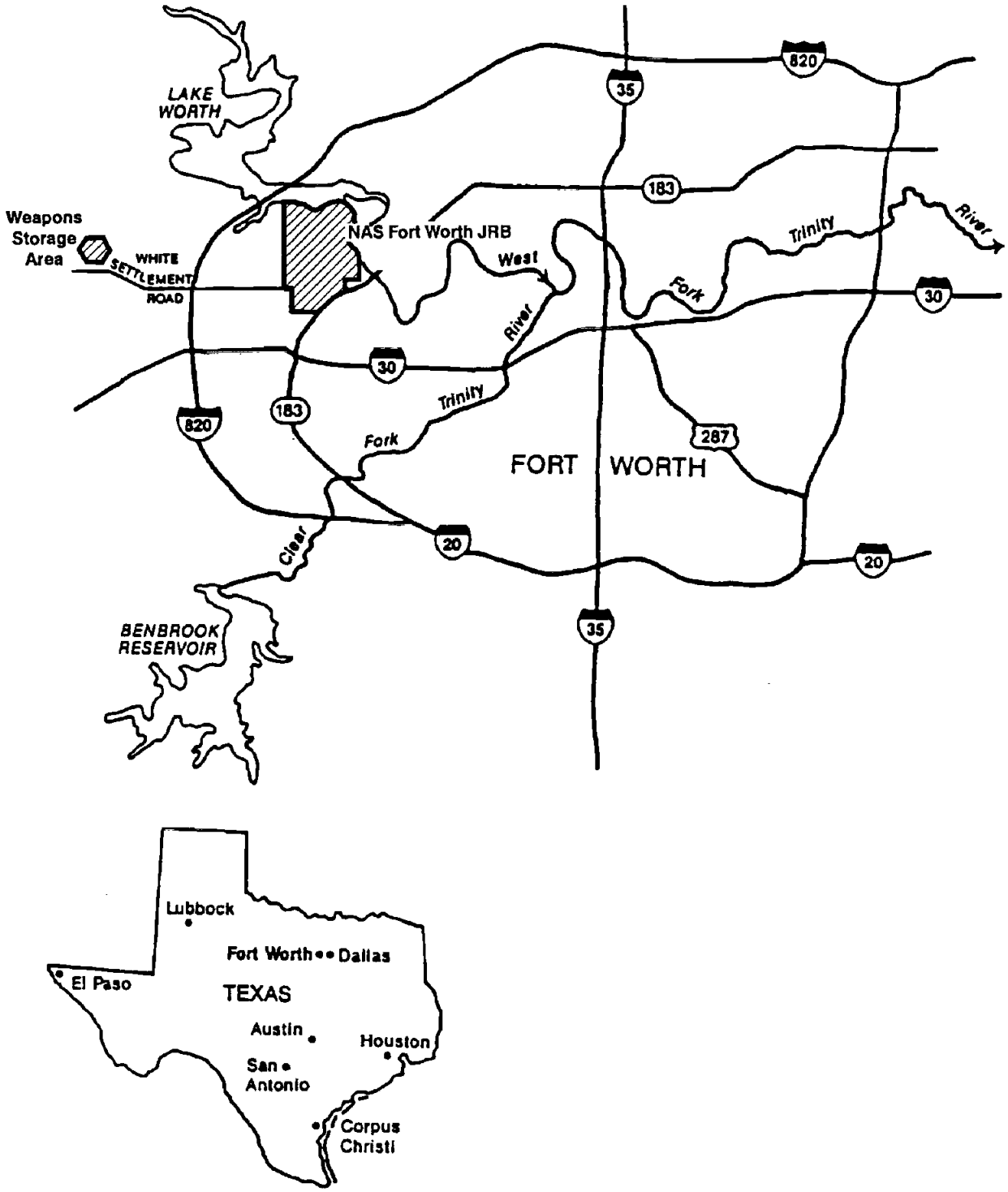
1.2 HISTORY OF PAST IRP WORK AT THE INSTALLATION

The Naval Air Station Fort Worth Joint Reserve Base (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 Weapon 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 Westworth Village to the east, other urban areas of Fort Worth to the northeast and southeast, White Settlement to the west and southwest, and Air Force Plant 4 (AFP 4) to the west (Figure 1.2). 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).

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, 1996a) 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 (Facility 1190) was installed to recover waste materials discharged from the washracks. Non-aqueous materials from oil/water separators were pumped out and disposed of through contractor removal. Aqueous discharge from oil/water separators 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 oil/water separator. This oil/water separator was routinely pumped out by a private contractor and the recovered materials were removed from the Base by the contractor.



HYDRO GeoLogic INC.

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Site

SCALE IN MILES

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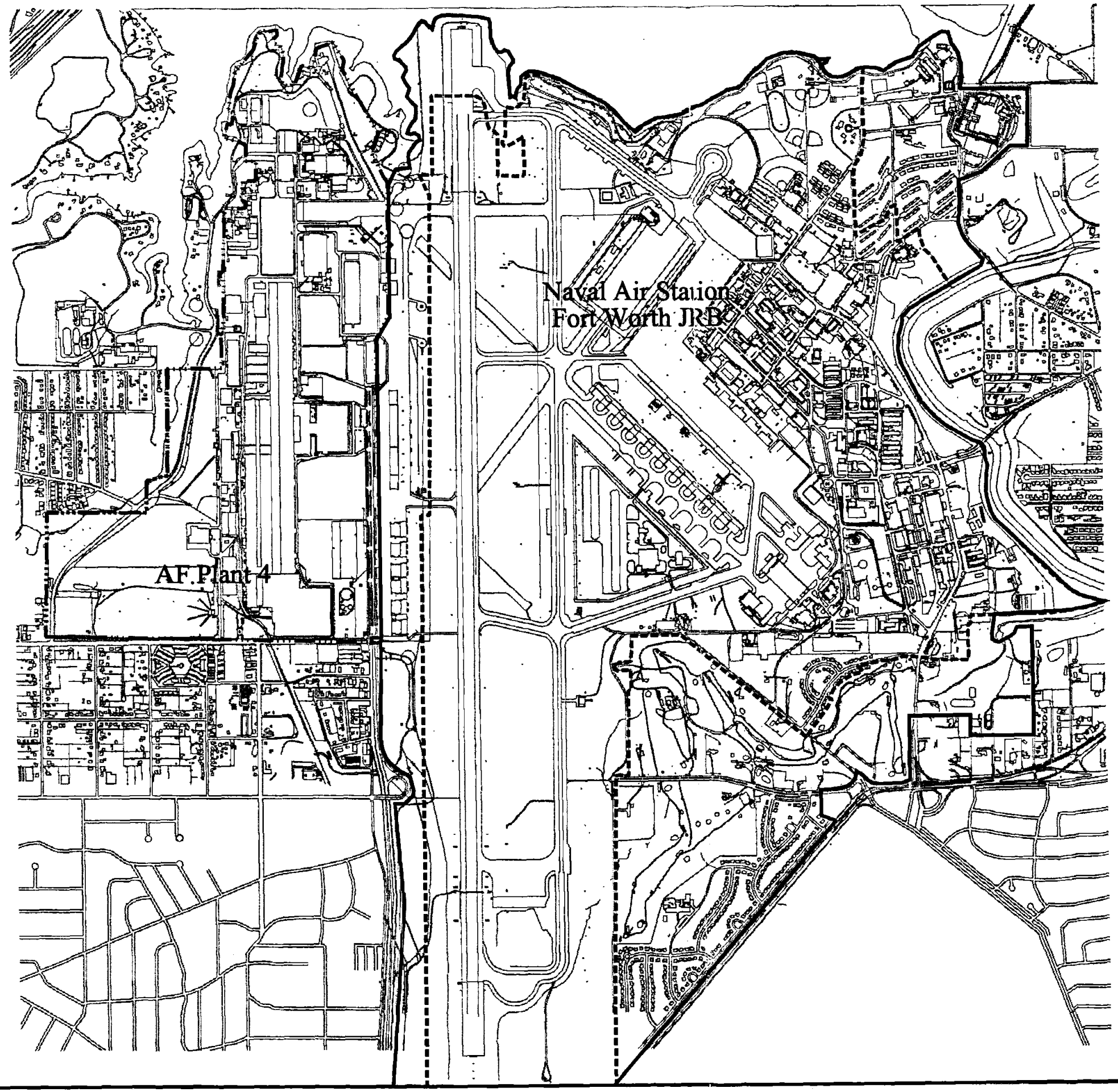
Figure 1.1
NAS Fort Worth JRB
SITE LOCATION MAP
[From Radian, 1989]



HydroGeoLogic, Inc. — Final 1998 GSAP
NAS Fort Worth JRB, Texas

Figure 1.2

BASE BOUNDARIES
NAS Fort Worth JRB

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- NAS Ft. Worth JRB (Carswell Field) Site Boundary
- Former Carswell Air Force Base Property Boundary
- AF Plant 4 Property Boundary

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0 750 1500 3000
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HYDRO GeoLogic INC.

Filename: AFCEE\NAS Ft Worth\GSAP\BaseBnd.dwg
Revised: 3/30/98 JB
Project: AFC001-024A
Map Source: Jacobs, 1996

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 oil/water separator 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 is reused 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 oil/water separators is also handled by an off-base contractor through DRMO.

1.3 SOLID WASTE MANAGEMENT UNITS AND AREAS OF CONCERN

Since 1942, most hazardous waste generated through operations and activities at the Base has been disposed of in landfills, reused on base, or processed through the Defense Property Disposal Office (DPDO) for off-base recycling or disposal. Since 1984, many of these sites (which include landfills, fire training areas, oil/water separators, and evidence of spills at waste accumulation areas) have been investigated. A total of 68 Solid Waste Management Units (SWMUs) were identified as part of a RCRA Facility Assessment (RFA) conducted for what was then Carswell AFB (USEPA, 1989a). Additionally, 16 Areas of Concern (AOCs) were identified in Permit HW50289 for Carswell Air Force Base issued by the Texas Natural Resources Conservation Commission (formerly Texas Water Commission) on February 13, 1991 (TNRCC, 1991). A number of the SWMUs and AOCs identified have been determined to require no further action (NFA) and are currently considered closed by TNRCC (TNRCC, 1995). All SWMUs and AOCs are listed on Table 1.1 and Table 1.2 and the locations of the active SWMUs and AOCs are shown on Figure 1.3.

Portions of the facility are subject to Air Force Base Realignment and Closure (BRAC) management, while other portions are managed by AFCEE under the Defense Environmental Restoration Account (DERA). These management responsibilities are included on Table 1.1 and Table 1.2. The reader should reference the Site Characterization Summary Informal Technical Information Report (CH2M Hill, 1996a) and the Compliance Plan Application (Waste Policy Institute, 1997) for more information on the description and status of individual SWMUs and AOCs.

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

SWMU	Description	OPR[1]
1	Pathological Waste Incinerator (NFA)	BRAC
2	Pathological Waste Storage Shed (NFA)	BRAC
3	Metal Cans (NFA)	BRAC
4	Facility Dumpsters (NFA)	BRAC
5	Building 1626 Waste Accumulation Area	DERA
6	Building 1628 Wash Rack and Drain	DERA
7	Building 1628 Oil/Water Separator	DERA
8	Building 1628 Sludge Collection Tank	DERA
9	Building 1628 Work Station Waste Accumulation Area (NFA)	DERA
10	Building 1617 Work Station Waste Accumulation Area (NFA)	DERA
11	Building 1617 Waste Accumulation Area	DERA
12	Building 1619 Waste Accumulation Area	DERA
13	Building 1710 Visual Information Center Work Station Waste Accumulation Areas	DERA
14	Building 1060 Bead Blaster Collection Tray (NFA)	DERA
15	Building 1060 Paint Booth Vault (NFA)	DERA
16	Building 1060 Waste Accumulation Area	DERA
17	Landfill No.7	DERA
18	Fire Training Area No.1 (NFA)	BRAC
19	Fire Training Area No.2	BRAC/DERA
20	Waste Fuel Storage Tank	BRAC/DERA
21	Waste Oil Tank	BRAC/DERA
22	Landfill No.4	BRAC
23	Landfill No.5	BRAC
24	Waste Burial Area	BRAC
25	Landfill No.8	BRAC/DERA
26	Landfill No.3	DERA
27	Landfill No.10	DERA
28	Landfill No.1	DERA
29	Landfill No.2	DERA
30	Landfill No.9	DERA
31	Building 1050 Waste Accumulation Area	DERA
32	Building 1410 Waste Accumulation Area	DERA
33	Building 1420 Waste Accumulation Area	DERA
34	Building 1194 Waste Accumulation Area	DERA
35	Vehicle Refueling Shop (Building 1194) Oil/Water Separation System	DERA
36	Building 1191 Waste Accumulation Area	DERA
37	Vehicle Maintenance Shop (Building 1191) Oil/Water Separation System	DERA
38	Building 1269 PCB Transformers Building (NFA)	DERA
39	Building 1643 Waste Accumulation Area	DERA
40	Building 1643 Oil/Water Separation System	DERA
41	Building 1414 Oil/Water Separation System, Field Maintenance Squadron Aerospace Ground Equipment	DERA

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

SWMU	Description	OPR[1]
42	Building 1414 Waste Accumulation Area	DERA
43	Building 1414 NonDestructive Inspection (NDI) Waste Accumulation Point (NFA)	DERA
44	Building 1027 Oil/Water Separation System at the Aircraft Washing Hangar	DERA
45	Building 1027 Waste Oil Tank Vault at the Aircraft Washing Hangar	DERA
46	Building 1027 Waste Accumulation Area (NFA)	DERA
47	Building 1015 Jet Engine Test Cell Oil/Water Separator	DERA
48	Building 1048 Fuel Systems Shop Floor Drains (NFA)	DERA
49	Aircraft Washing Area No.1	DERA
50	Aircraft Washing Area No.2	DERA
51	Building 1190 Central Waste Holding Area	DERA
52	Building 1190 Oil/Water Separation System	DERA
53	Storm Water Drainage System	DERA
54	Storm Water Interceptors	DERA
55	East Gate Oil/Water Separator	DERA
56	Building 1405 Waste Accumulation Area (NFA)	DERA
57	Buildings 1432/1434 Waste Accumulation Area (NFA)	DERA
58	Pesticide Rinse Area	BRAC
59	Building 8503 Weapons Storage Area Waste Accumulation Area	BRAC
60	Building 8503 Radioactive Waste Burial Site	BRAC
61	Building 1320 Power Production Maintenance Facility Waste Accumulation Area	DERA
62	Landfill No.6	DERA
63	Entomology Dry Well (NFA)	DERA
64	French Underdrain System	BRAC/ DERA
65	Weapons Storage Area Disposal Site (NFA)	BRAC
66	Sanitary Sewer System	BRAC/DERA
67	Building 1340 Oil/Water Separator	BRAC/DERA
68	POL Tank Farm	BRAC/DERA

Notes:
[1]OPR is Office of Primary Responsibility

Table 1.2
Areas of Concern (AOCs) at NAS Fort Worth JRB

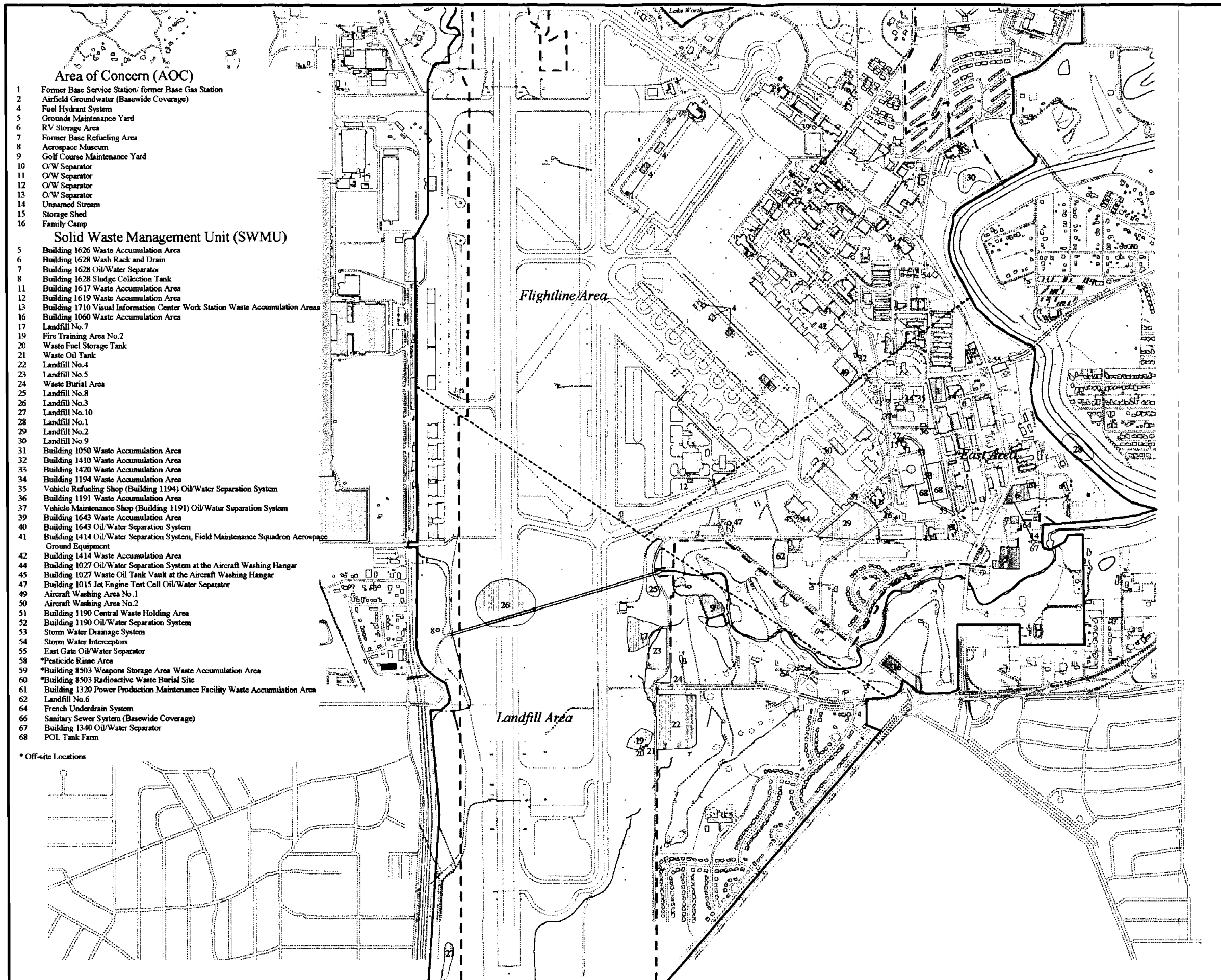
AOC	Description	OPR[1]
1	Former Base Service Station/ former Base Gas Station	BRAC/DERA
2	Airfield Groundwater	DERA
3	Waste Oil Dump (NFA)	DERA
4	Fuel Hydrant System	DERA
5	Grounds Maintenance Yard	BRAC
6	RV Storage Area	DERA
7	Former Base Refueling Area	DERA
8	Aerospace Museum	BRAC
9	Golf Course Maintenance Yard	BRAC
10	O/W Separator	DERA
11	O/W Separator	DERA
12	O/W Separator	DERA
13	O/W Separator	DERA
14	Unnamed Stream	BRAC
15	Storage Shed	DERA
16	Family Camp	BRAC

Notes:
[1]OPR is Office of Primary Responsibility

Figure 1.3

SWMU/AOC LOCATION MAP
NAS Fort Worth JRB

Air Force Center For
Environmental Excellence
Brooks AFB, Texas



Area of Concern (AOC)

1 Former Base Service Station/ former Base Gas Station
2 Airfield Groundwater (Basewide Coverage)
4 Fuel Hydrant System
5 Grounds Maintenance Yard
6 RV Storage Area
7 Former Base Refueling Area
8 Aerospace Museum
9 Golf Course Maintenance Yard
10 O/W Separator
11 O/W Separator
12 O/W Separator
13 O/W Separator
14 Unnamed Stream
15 Storage Shed
16 Family Camp

Solid Waste Management Unit (SWMU)

5 Building 1626 Waste Accumulation Area
6 Building 1628 Wash Rack and Drain
7 Building 1628 Oil/Water Separator
8 Building 1628 Sludge Collection Tank
11 Building 1617 Waste Accumulation Area
12 Building 1619 Waste Accumulation Area
13 Building 1710 Visual Information Center Work Station Waste Accumulation Areas
16 Building 1060 Waste Accumulation Area
17 Landfill No.7
19 Fire Training Area No.2
20 Waste Fuel Storage Tank
21 Waste Oil Tank
22 Landfill No.4
23 Landfill No.5
24 Waste Burial Area
25 Landfill No.8
26 Landfill No.3
27 Landfill No.10
28 Landfill No.1
29 Landfill No.2
30 Landfill No.9
31 Building 1050 Waste Accumulation Area
32 Building 1410 Waste Accumulation Area
33 Building 1420 Waste Accumulation Area
34 Building 1194 Waste Accumulation Area
35 Vehicle Refueling Shop (Building 1194) Oil/Water Separation System
36 Building 1191 Waste Accumulation Area
37 Vehicle Maintenance Shop (Building 1191) Oil/Water Separation System
39 Building 1643 Waste Accumulation Area
40 Building 1643 Oil/Water Separation System
41 Building 1414 Oil/Water Separation System, Field Maintenance Squadron Aerospace Ground Equipment
42 Building 1414 Waste Accumulation Area
44 Building 1027 Oil/Water Separation System at the Aircraft Washing Hangar
45 Building 1027 Waste Oil Tank Vault at the Aircraft Washing Hangar
47 Building 1015 Jet Engine Test Cell Oil/Water Separator
49 Aircraft Washing Area No.1
50 Aircraft Washing Area No.2
51 Building 1190 Central Waste Holding Area
52 Building 1190 Oil/Water Separation System
53 Storm Water Drainage System
54 Storm Water Interceptors
55 East Gate Oil/Water Separator
58 *Pesticide Rinse Area
59 *Building 8503 Weapons Storage Area Waste Accumulation Area
60 *Building 8503 Radioactive Waste Burial Site
61 Building 1320 Power Production Maintenance Facility Waste Accumulation Area
62 Landfill No.6
64 French Underdrain System
66 Sanitary Sewer System (Basewide Coverage)
67 Building 1340 Oil/Water Separator
68 POL Tank Farm

* Off-site Locations

Legend

NAS Fort Worth JRB (Carswell Field)
Former Carswell Air Force Base
Area of Concern (AOC)
68 Solid Waste Management Unit (SWMU)
Groundwater Management Areas

N

500 0 500 1000 1500
Scale in Feet

HYDRO GeoLogic INC.

Filename: AFC001/07IB/FIG1_3
Revised: nzehms 04/10/98
Project: AFC001-07IB
Map Source: Jacobs, 1996

1.4 OVERVIEW OF 1997 GROUNDWATER MONITORING ACTIVITIES AND 1998 PROPOSED ACTIVITIES

Since the publication of the 1997 GSAP, a number of activities have taken place at NAS Fort Worth JRB related to groundwater monitoring; these activities are summarized in Table 1.3. The table also provides a brief description of the anticipated monitoring activities to be conducted in 1998 as part of the ongoing and/or proposed remediation/assessment efforts. This GSAP has been developed based on the understanding of these ongoing and anticipated efforts. In preparation of this GSAP, every effort was made to complement the existing monitoring activities. However, other than the long-term monitoring requirements that have been specified for several of the SWMUs and AOCs with approved remedial or closure plans, all of the proposed GSAP monitoring activities are voluntary; therefore, not required under a specific regulatory action. The following discussion summarizes the long-term monitoring (LTM) requirements. The reader should refer to the documents listed under each activity in Table 1.3 for additional information on the specific monitoring objectives and activities.

As part of the remedial action for SWMUs 64, 67, and 68 and AOC 7 (Sites ST14 and SD13), a total of 22 wells will be used to monitor the nature and extent of dissolved contaminants at these sites (Parsons, 1997). The purpose of these monitoring events is to confirm that source soils are not causing increases in groundwater concentrations and that no unanticipated downgradient migration is occurring. The remedial action calls for quarterly sampling until the appropriate target concentrations are obtained and then an additional two years of verification sampling to ensure plume stability and ongoing compliance. Table 1.4 lists all wells designated for sampling as part of this remedial action. The locations of the wells are shown in Figure 1.4.

As part of the corrective action for AOC 1 (Base Gas Station/Base Service Station), quarterly groundwater monitoring will be conducted for a period of one year, beginning in October 1997 (IT Corporation, 1997a, 1997b). The samples will be collected from six wells (SAV-2, BSS-B, MW-10, BGSMW03, BGSMW05, and BGSMW06) and will be analyzed by EPA Method SW8020 for BTEX compounds and methyl tert-butyl ether (MTBE). In addition, field parameters will be measured in the field at the time of sampling and will include pH, temperature, conductivity, dissolved oxygen, and turbidity. The original LTM requirements specified sampling at monitoring well MW-1. However, construction of a sewer line in the spring of 1997 destroyed this monitoring well; monitoring well SAV-2, located 80 feet to the southwest of monitoring well MW-1, has been monitored as a substitute.

1.5 GSAP OBJECTIVES

A basewide groundwater sampling and analysis program was initiated for NAS Fort Worth JRB in April 1995 to address groundwater contamination associated with various SWMUs and AOCs identified on the Base. Eight rounds of quarterly sampling have been implemented to date: April 1995, July 1995, October 1995, January 1996, January 1997, April 1997, July 1997, and October 1997. This GSAP has been developed based on the results of the four quarterly sampling rounds conducted as part of the 1997 program. It presents the program approach for the 1998 quarterly sampling events. Short- and long-term objectives, established for the 1998 program, are delineated to ensure that adequate data are collected for the evaluation of the critical exposure

Table 1.3
Summary of Groundwater Monitoring Activities Since Publication of 1997 GSAP

Documentation of Project/Activities	Description of Project/Activity	Contractor	post-1997 GSAP Activities	Anticipated Monitoring Activities
Final Remedial Action Plan for the Risk-Based Remediation of SWMUs 64, 67, and 68 and AOC 7 (POL Tank Farm) [Parsons, 1997]	In situ bioventing of the BTEX contaminated soil at the petroleum, oil and lubricants (POL) tank farm	Parsons	N/A	Quarterly sampling of selected wells (22 total) for VOCs, and metals. Nine wells associated with SD-13 will be sampled for Appendix IX in the first quarter. Sampling will continue until concentrations of contaminants are at or below RRS 2 levels. Four of the 22 wells proposed for sampling will be installed in 1998.
Corrective Action Plan for Base Service Station [IT Corporation, 1997a]	Monitoring plans to support closure of Base Station Site	IT Corp	N/A	4 quarterly monitoring events for one year (SAV-2, BSS-B, and MW-10); for BTEX and MTBE (SW8020) and standard field parameters
Corrective Action Plan for Base Gas Station [IT Corporation, 1997b]	Monitoring plans to support closure of Base Gas Station	IT Corp	Installed seven new wells and sampled in August and November	4 quarterly sampling events for one year (BGSMW03, BGSMW05 and BGSMW06); BTEX and MTBE (SW8020) and standard field parameters
AOC-2 Work Plan [CH2M Hill, 1997]	Proposed plan to characterize the TCE Plume underlying Flightline Area	CH2M Hill	N/A	Installing approximately 16 new wells. Sampling is scheduled for December '97 - January '98
Pre-Draft RFI Report for Landfills 4,5, and 8 and Waste Pile 7 (SWMU 22, 23, 24, and 25) [HGL, 1997g]	Complete RFI at Landfills/Waste Pile underlying Flightline Area	HGL	Installed and sampled three new wells in September 1997	Incorporate into Quarterly sampling events.

Table 1.3 (continued)
Summary of Groundwater Monitoring Activities Since Publication of 1997 GSAP

Documentation of Project/Activities	Description of Project/Activity	Contractor	post-1997 GSAP Activities	Anticipated Monitoring Activities
Basewide Groundwater Sampling and Analysis of Quarterly Sampling [CH2M Hill, 1997b, 1997c, HGL, 1997f]	Sampling of monitoring wells basewide	CH2M Hill/ HGL	Four sampling events conducted in January, April, July, and October	Per this report.
Letter Report of LNAPL Removal [Dunkle, 1997]	Summary of six monthly free-product monitoring events	CH2M	Monthly monitoring of free-product from wells (i.e., 17M, SD13-07, SD13-04) during February - August. No significant accumulation (over 0.01 feet) occurred over a monthly period between May - August.	Incorporate these wells into the quarterly monitoring events.
AFP 4 Sampling	Continued monitoring of delineated plume(s) under AFP 4	Jacobs	Sampled thirteen wells on NAS Forth Worth. Wells sampled in January, April, July and October 1997.	Continue interim quarterly monitoring until remediation systems are activated. LTM proposal is currently in regulatory review (includes sampling of 7 wells on Base).
Final Work Plan/RFI of Landfills (SWMU 17, 27, 29, 30, 62) [HGL, 1997h]	Delineate contamination within and underlying 5 landfills	HGL	N/A	Installed approximately 20 new wells. Sample each initially for Appendix IX list. Two additional rounds will include a reduced list.
Final Work Plans for SWMU 26 and 28 [HGL, 1997c, 1997d]	Support closure of units.	HGL	N/A	Installing and sampling wells for Appendix IX constituents.

Table 1.3 (continued)
Summary of Groundwater Monitoring Activities Since Publication of 1997 GSAP

Documentation of Project/Activities	Description of Project/Activity	Contractor	post-1997 GSAP Activities	Anticipated Monitoring Activities
Draft Work Plan for Site Investigation of AOC-4 [HGL, 1997e]	Delineate contamination associated with the abandoned fuel hydrant system located at the Navy Ramp and Alert Apron.	HGL	N/A	17 monitoring wells will be installed and sampled for VOCs and TPH. (Nine of these wells will be newly installed.)
Draft RFI for SWMU 66 (Sanitary Sewer System) [IT Corporation, 1997c]	Delineate contamination associated with the Base sanitary sewer system.	IT Corp	Installed 34 wells; sampled in April 1997.	Incorporate wells in quarterly sampling events if practical.
Background Study [Jacobs, 1997]	Established background concentrations for 24 inorganic constituents (i.e., metals)	Jacobs	Installed 4 new background wells and sampled 12 background wells in December 1996.	Incorporate several background wells into quarterly sampling events.
Characterization of Oil/Water Separators (OWSs)	Review of OWSs and propose remedial actions	Jacobs	N/A	Install 5 wells January '98 (locations have not been proposed) in vicinity of Bldg 1145.
Characterization of Underground Storage Tanks (USTs)	Review of USTs and propose remedial actions	TBD	N/A	Potential installation of wells
Characterization of Waste Accumulation Areas (WAAs)	Review of WAAs and propose remedial actions	TBD	N/A	Potential installation of wells

Table 1.4
Wells Designated for Sampling in Remedial Action Plan for SWMUs 64, 67, 68 and AOC 7 (Sites ST14 and SD13)

Type of Well	Site	Well ID
Upgradient Wells (3 wells)		ST14-14, ST14-24, ST14-26
Plume Wells (16 wells)	SWMU 68 (10 wells) [Site ST14]	ST14-03, ST14-W16, ST14-W18, 17M, ST14-02, ST14-29, ST14-W21, ST14-04, ST14-28, WHGLTA008
	SWMU 64, 67 and AOC 7 (6 wells) [Site SD13]	SD13-01, SD13-02, ST14-W31, SD13-04, SD13-06, WHGLTA007
Downgradient Wells - POC Wells (3 wells)		SD13-07, WHGLTA005, WHGLTA006

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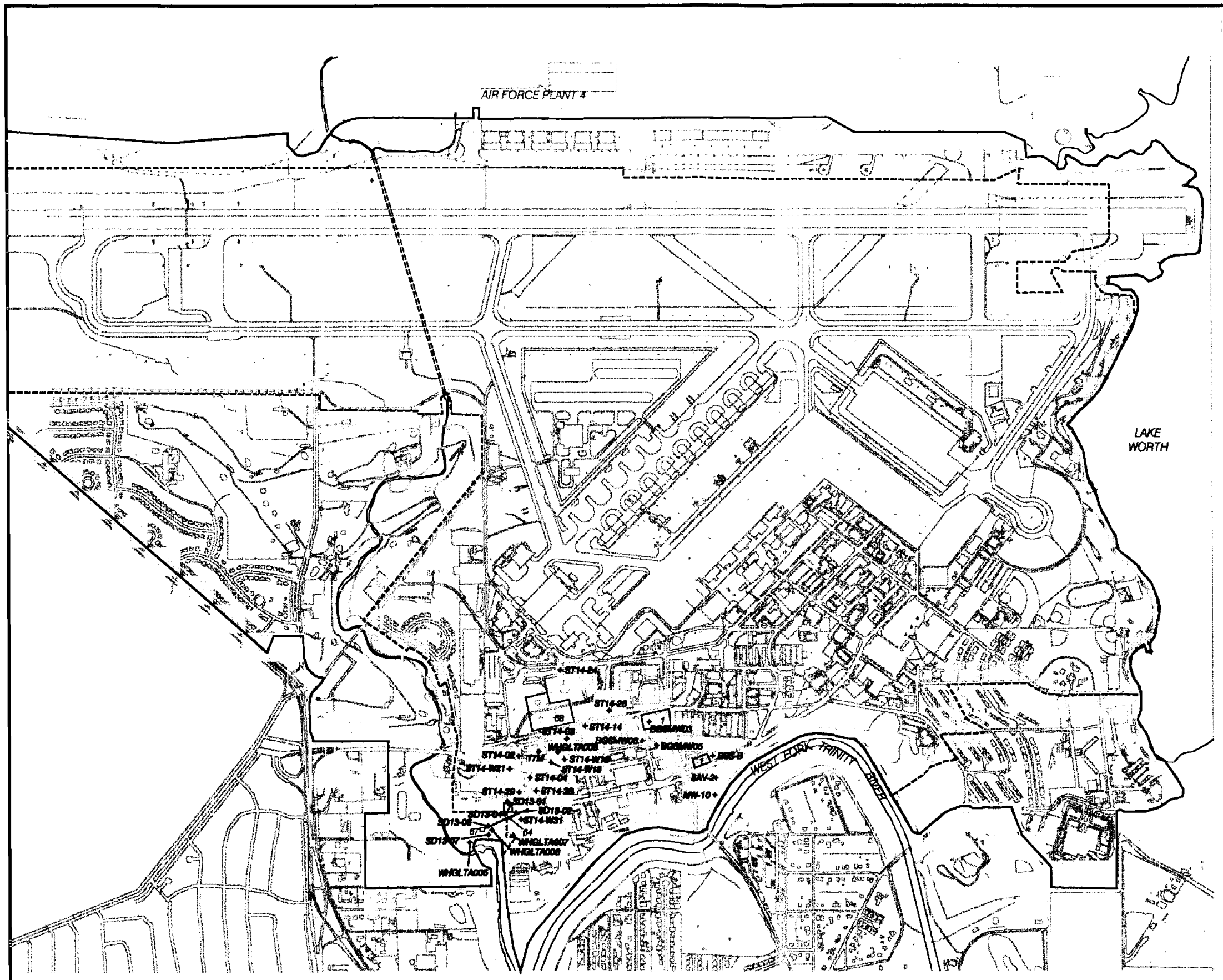
Figure 1.4

NAS Fort Worth JRB WELLS DESIGNATED FOR LONG TERM MONITORING ACTIVITY

Air Force Center
For Environmental Excellence
Brooks AFB, Texas



Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- 7 — Area of Concern (AOC)
- 68 — Solid Waste Management Unit (SWMU)
- + MW-1 — Long Term Monitoring Well For SWMUs 64, 67, and 68 and AOC 7 (ST14 and SD13)
- + SAV-2 — Long Term Monitoring Well For AOC 1 (Base Gas Station / Base Service Station)

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SCALE IN FEET

HYDRO GeoLogic INC.

Filename: AFCEE\NAS Ft Worth\GSAP\Fig1_4.dwg
Revised: 04/10/98 nzehms
Project: AFC001-07IA
Map Source: Jacobs, 1996

pathways involving groundwater. The objectives also address the mandatory monitoring requirements for three units which have approved remedial or closure plans.

1.5.1 Short-Term Objectives

Based on previous investigations, two critical exposure pathways have been identified which potentially threaten human health and the environment surrounding NAS Fort Worth JRB (CH2M Hill, 1996b). They include:

S-1 Off-Site Groundwater - monitor potential migration of contaminated groundwater off-site, and

S-2 On-Site and Off-Site Surface Water - monitor potential on-site and off-site exposure to surface water (i.e., Trinity River and/or Unnamed Stream).

The short-term objective for the groundwater sampling and analysis program is to monitor these two potential exposure pathways. Wells located near the NAS Fort Worth JRB boundaries and/or immediately upgradient of surface water bodies where groundwater may discharge to the surface water will be monitored to meet these objectives.

1.5.2 Long-Term Objectives

The long-term objective of the groundwater sampling and analysis program is to establish a process for collecting data to support closure of SWMUs and AOCs and to identify and/or confirm potential impacts to off-site receptors. The groundwater sampling and analysis program has been structured to provide information to support the following activities in light of the long-term objectives:

L-1 Current Regulatory Requirements - conduct sampling to fulfill current long-term monitoring (LTM) requirements associated with closure of SWMUs and AOCs (currently, this includes the three LTM programs discussed in Section 1.4);

L-2 Additional Source and Plume Delineation - define horizontal or vertical migration of contamination associated with miscellaneous hot spots and potential source areas where data are not currently available;

L-3 Natural Attenuation - collect data to demonstrate that natural attenuation of TCE is occurring; and

L-4 Complement Ongoing Remediation/Assessment Activities - support ongoing remediation/assessment monitoring activities.

The components of the groundwater sampling and analysis program that were designed to support the long-term objectives are based on a review of existing data from previous investigations and a current understanding of the remediation plans for the SWMUs and AOCs. These components may require modification to accommodate new data resulting from ongoing and future

investigations/remedial actions at NAS Fort Worth JRB. If necessary, the GSAP will be amended to reflect modifications to the long-term objectives.

1.6 GSAP APPROACH

This GSAP has been developed to provide a framework to achieve the objectives described above and describes, in detail, the approach for the current program. The locations of the wells, SWMUs, and AOCs considered in development of the GSAP are shown in Figure 1.5. The 1998 GSAP approach includes the following components:

- Water level measurements;
- Groundwater quality samples;
- Methods for water quality analyses;
- Well inspection and review;
- Data management and transfer procedures; and
- Report formats and objectives.

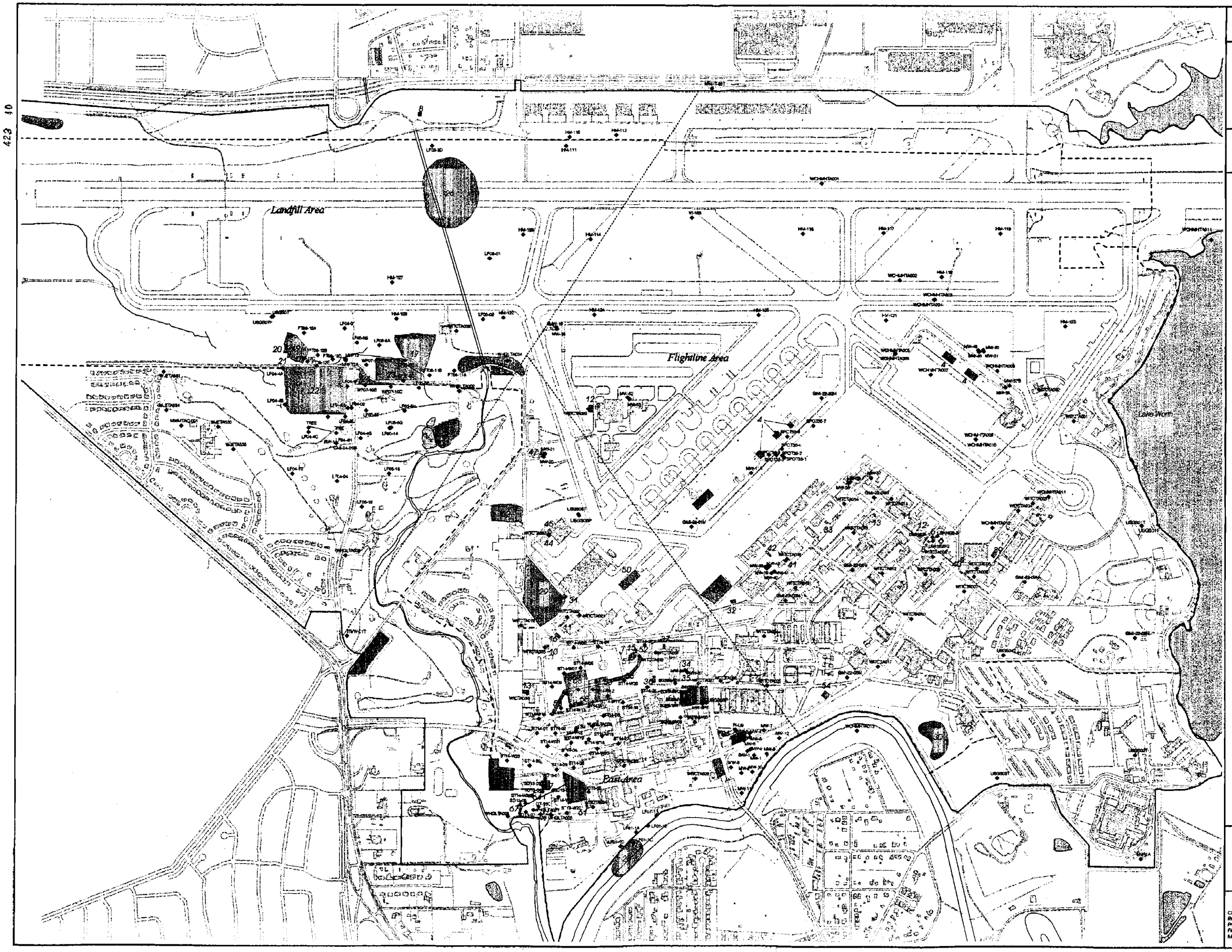
This framework includes sampling of existing wells, recommendations for sampling of wells recently proposed for installation, and recommendations for chemical parameters to be included in the sampling program. The framework is based on a current understanding of the remediation plans for the SWMUs and AOCs. Details for subsequent monitoring rounds will be developed based on results of the last rounds of sampling and the overall remediation strategy for NAS Fort Worth JRB. In addition, the framework may require modification based on results of ongoing and future remediation/assessment programs at NAS Fort Worth JRB. The GSAP will be amended as necessary, to accommodate these modifications to the framework.

This GSAP incorporates by reference the analytical methods and procedures outlined in the Basewide Quality Assurance Project Plan (QAPP) for NAS Fort Worth JRB (HGL, 1997a). An approved Health and Safety Plan (HSP) is currently in place to address all quarterly sampling events conducted under this GSAP (HGL, 1997b).

1.7 REPORT ORGANIZATION

Section 2.0 of this GSAP includes a description of the environmental setting, while Section 3.0 provides a characterization of the nature and extent of groundwater contamination as delineated by the results of the previous four sampling events. Section 4.0 of this report describes the proposed monitoring activities for 1998, with inspection procedures in Section 4.1; the rational and selection of monitoring wells for water level measurements in Section 4.2; and the rationale and selection of monitoring wells for analytical sampling, sampling frequency, and testing methods in Section 4.3. Data management and data quality evaluation procedures are presented in Section 5.0, which includes an outline for the procedures for updating the GSAP. Report requirements

are provided in Section 6.0. Section 7.0 presents the schedule for sampling and reporting, and Section 8.0 lists references. Appendix A presents a list of monitoring wells and location coordinates for NAS Fort Worth JRB, a summary table of well construction information, and procedures for well closure. Field sampling procedures are contained in Appendix B. Appendix C provides the appropriate Field Measurement/Documentation Forms.



HydroGeoLogic, Inc. — Fiscal 1998 GSAP
NAS Fort Worth JRB, Texas

Figure 1.5
MONITORING WELL AND SWMU/AOC LOCATION MAP

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Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- Groundwater Management Areas
- USGS007 Monitoring Wells
- Area of Concern
  - 1 Former Base Service Station/ former Base Gas Station
  - 2 Airfield Groundwater (Bioventing Coverage)
  - 4 Fuel Hydrant System
  - 5 Bioventing Master area Yard
  - 6 RV Storage Area
  - 7 Former Base Refueling Area
  - 8 Aerospace Museum
  - 9 Civil Counter Maintenance Yard
  - 10 OWI Separator
  - 11 OWI Separator
  - 12 OWI Separator
  - 13 OWI Separator
  - 14 Unnamed Stream
  - 15 Storage Shed
  - 16 Family Camp
- Solid Waste Management Unit (SWMU)
  - 5 Building 1608 Waste Accumulation Area
  - 6 Building 1609 Wash Rack and Drain
  - 7 Building 1609 Oil/Water Separator
  - 8 Building 1609 Sludge Co-action Tank
  - 11 Building 1617 Waste Accumulation Area
  - 12 Building 1618 Waste Accumulation Area
  - 13 Building 1710 Visual Informal on Center Work Station Waste Accumulation Areas
  - 16 Building 1080 Waste Accumulation Area
  - 17 Landfill No.7
  - 18 Fire Training Area No.2
  - 20 Waste Fuel Storage Tank
  - 21 Waste Oil Tank
  - 22 Landfill No.4
  - 23 Landfill No.5
  - 24 Waste Burn Area
  - 25 Landfill No.8
  - 26 Landfill No.3
  - 27 Landfill No.10
  - 28 Landfill No.1
  - 29 Landfill No.2
  - 30 Landfill No.9
  - 31 Building 1030 Waste Accumulation Area
  - 32 Building 1410 Waste Accumulation Area
  - 33 Building 1420 Waste Accumulation Area
  - 34 Building 1104 Waste Accumulation Area
  - 35 Vehicle Maintenance Shop (Building 1694) Oil/Water Separation System
  - 36 Building 1101 Waste Accumulation Area
  - 37 Vehicle Maintenance Shop (Building 1691) Oil/Water Separation System
  - 38 Building 1643 Waste Accumulation Area
  - 40 Building 1643 Oil/Water Separation System
  - 41 Building 1414 Oil/Water Separation System, Field Maintenance Equipment/Aerospace Ground Equipment
  - 42 Building 1414 Waste Accumulation Area
  - 44 Building 1027 Oil/Water Separation System at the Aircraft Washing Hangar
  - 45 Building 1027 Waste Oil Tank located at the Aircraft Washing Hangar
  - 47 Building 1018 Jet Engine Test Cell Oil/Water Separator
  - 49 Aircraft Washing Area No.5
  - 50 Aircraft Washing Area No.2
  - 51 Building 1180 Contrail Waste Holding Area
  - 52 Building 1180 Oil/Water Separation System
  - 53 Storm Water Drainage System
  - 54 Storm Water Interceptors
  - 55 Inert Gas Odyssey Reactor
  - 56 Predrick River Area
  - 59 *Building 6803 Weapons Storage Area Waste Accumulation Area
  - 60 *Building 6803 Radioactive Waste Sump Site
  - 61 Building 1600 Power Production Maintenance Facility Waste Accumulation Area
  - 62 Landfill No.6
  - 63 Permit Underground System
  - 65 Sanitary Sewer System (Bioventing Coverage)
  - 67 Building 1640 Oil/Water Separator
  - 68 POL Tank Farm

*Off-site Location

N

500 0 500 1000

Scale in Feet

HYDRO GeoLogic INC.

Created : 12/14/97 rzeh.mx
Revision : 04/10/98 rzehrns
Project: AFCO01-078
Filename: AFCO01.078/FIG1_5.APR
Map Source: Jacobs, 1998

TAB

2.0

2.0 ENVIRONMENTAL SETTING

2.1 PHYSIOGRAPHY

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.

2.2 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 Figures 2.2 and 2.3 (Radian, 1989). The areal limits of surface exposure of these units at NAS Fort Worth JRB are shown in Figure 2.4. 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.

2.3 GROUNDWATER

The water-bearing geologic formations located in the NAS Fort Worth JRB area are 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 (Terrace Alluvium), (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. Table 2.1 presents additional information on the stratigraphic units found beneath NAS Fort Worth JRB. Groundwater elevations for wells located on-site are recorded for January 1997 and July 1997 in Table 2.2. Each of these units is examined in more detail in the following paragraphs. This relationship is illustrated in Figure 2.5.

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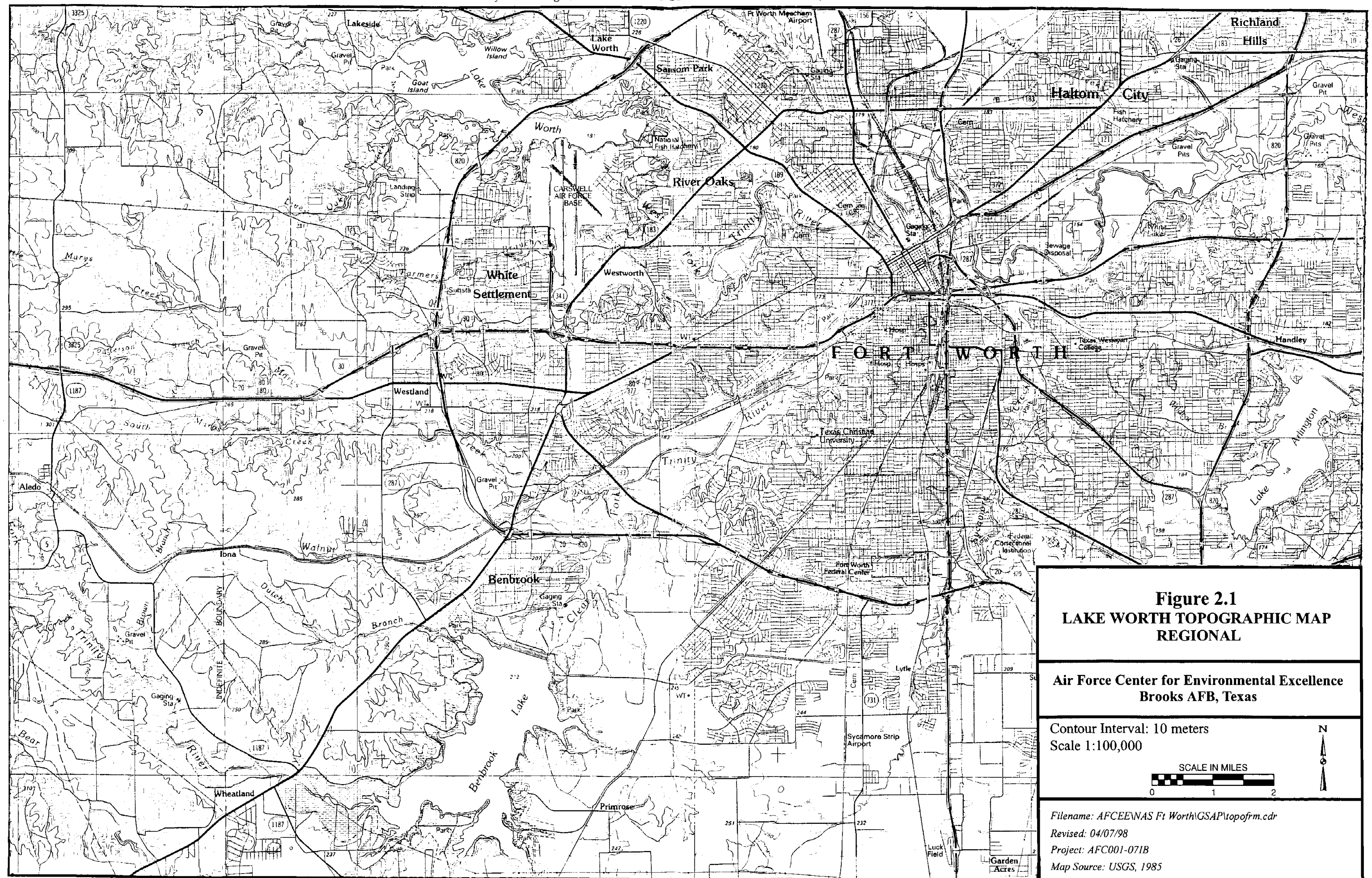

Figure 2.1
LAKE WORTH TOPOGRAPHIC MAP REGIONAL

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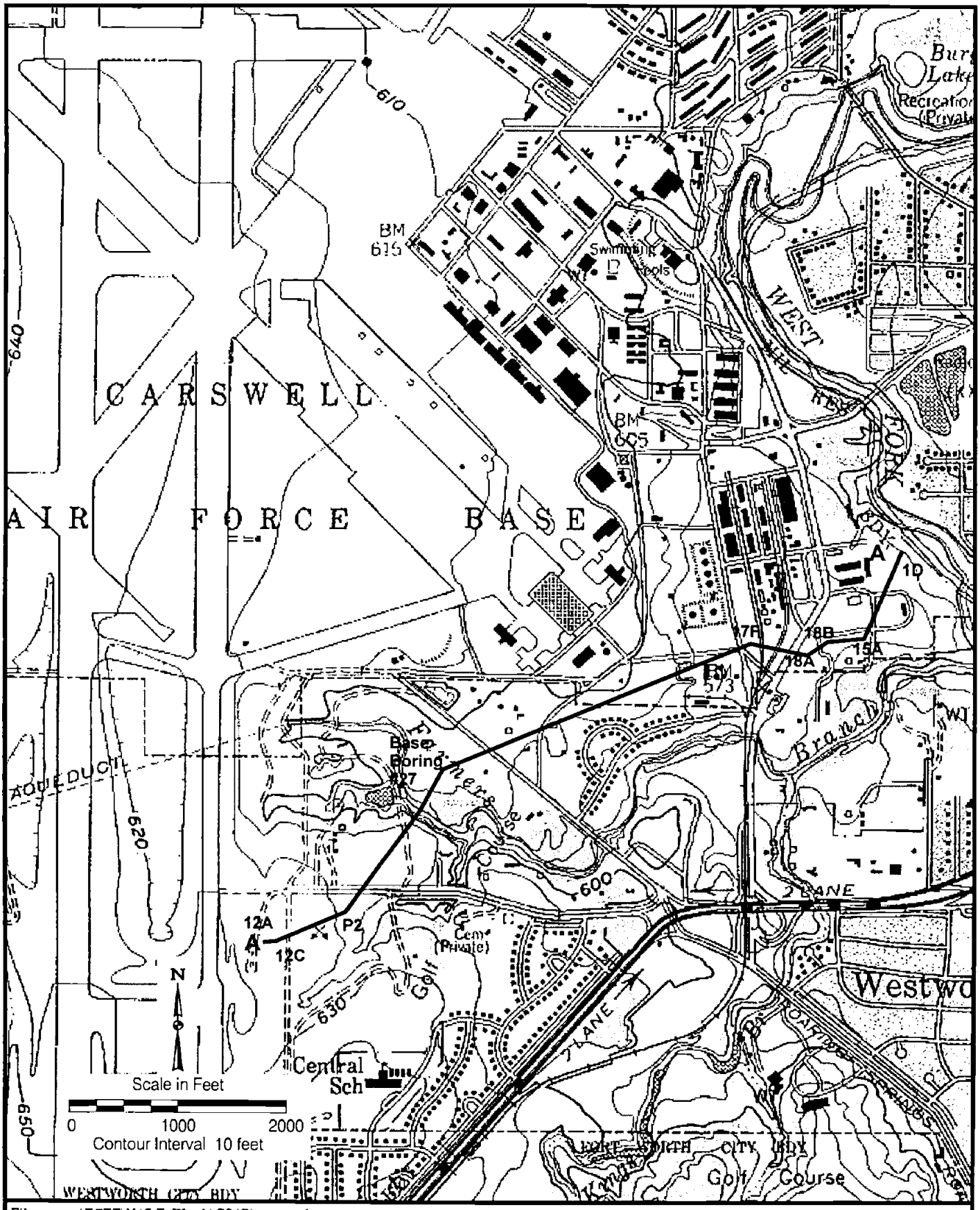
Brooks AFB, Texas

Contour Interval: 10 meters
Scale 1:100,000

SCALE IN MILES
0 1 2

N

Filename: AFCEE\NAS Ft Worth\GSAP\topofrm.cdr
Revised: 04/07/98
Project: AFC001-071B
Map Source: USGS, 1985



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Project: AFC001-07IB
Source: Radian, 1986

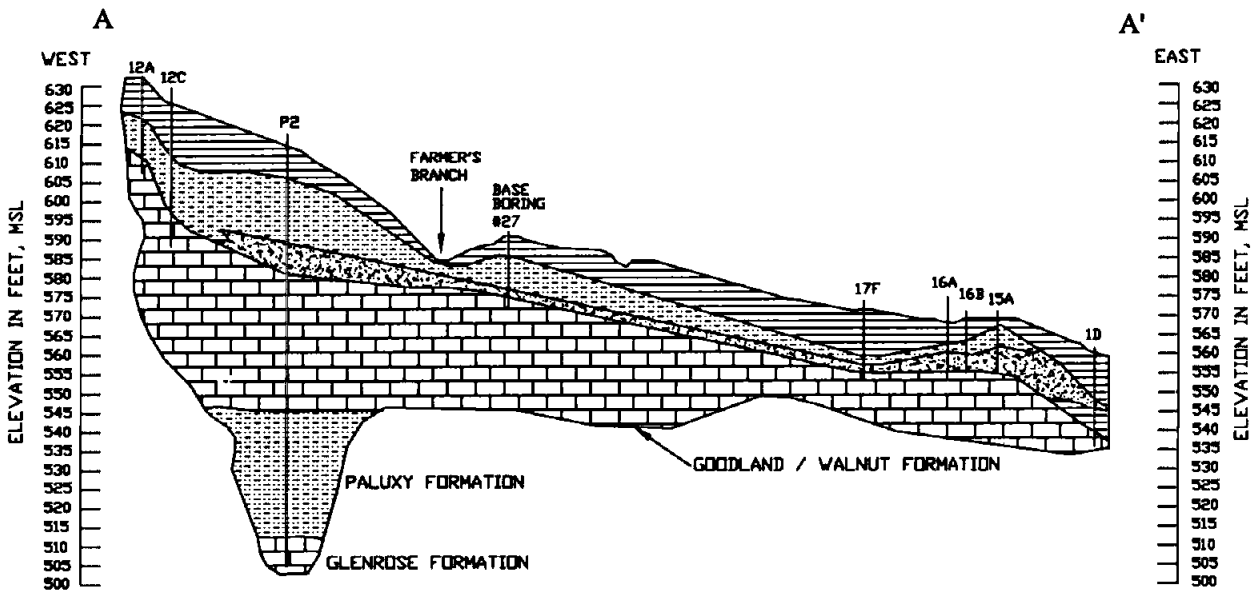
Figure 2.2
NAS Fort Worth JRB
CROSS SECTION LOCATION A - A'

Figure 2.3

NAS Fort Worth JRB

GENERALIZED GEOLOGIC CROSS SECTION A - A'

Air Force Center
For Environmental Excellence
Brooks AFB, Texas



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.

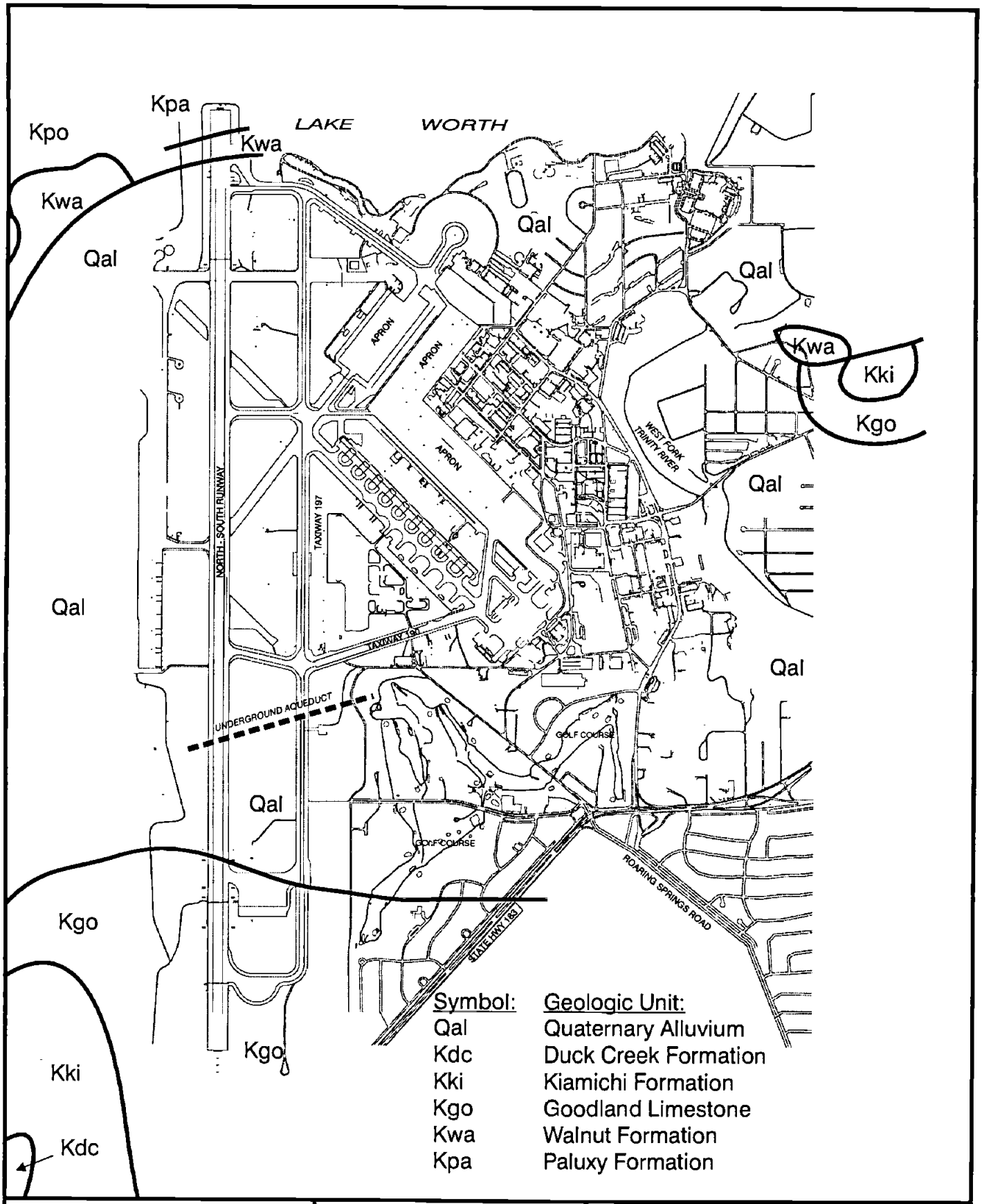
LEGEND

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

N

800 400 0 800
HORIZONTAL SCALE IN FEET
VERTICAL EXAGERATION = 15X

Filename: AFCEE\NAS Ft Worth\GSAP\x-sect.dwg
Revised: 04/07/98
Project: AFC001-07IB
Map Source: Radian, 1986



Filename:
AFCEE\NAS Ft Worth\Annual\geology.cdr
Revised: 04/07/98
Project: AFC001-071B
Map Source: Radian, 1989

Legend

SCALE
0 1000 2000
FEET

N

Figure 2.4

NAS Fort Worth JRB, Texas
AREAL DISTRIBUTION OF GEOLOGIC UNITS

Table 2.1
Stratigraphic Units at NAS Fort Worth JRB, Texas[1]

Era	System	Series/Group	Stratigraphic Unit	Thickness (feet)[2]	Lithologic Characteristics[3]	Water-Yielding Characteristics
Cenozoic	Quaternary (1.8 mya to present)	Holocene	Fill material	0	Construction debris	Permeability varies, gravels and sands permeable
			Recent alluvial deposits	0-50	Gravel, sand, silt, clay	
		Pleistocene	Terrace alluvial deposits	0-60	Gravel, sand, silt, clay	Permeability varies, gravels and sands permeable
	Teritary (1.8 to 65 mya)	Eocene/Wilcox		-	-	-
		Paleocene/Midway		-	-	-
Mesozoic	Cretaceous (65 to 140 mya)	Gulfian		-	-	-
		Comanchean/ Washita		-	-	-
		Comanchean/ Fredericksburg		-	-	-
			Goodland limestone	0-40	White fossiliferous limestone, coarsely nodular, resistant, and dense; contains some marl	Impermeable where not weathered; considered confining unit
			Walnut Formation	0.5-30	Medium to dark grey clay and limestone with shell conglomerates, fossiliferous, Gryphaea beds	Very low permeability; considered confining unit
		Comanchean/ Trinity	Paluxy Formation	130-175	Light grey to greenish-grey sandstone and mudstone; fine-grained to coarse-grained sandstone	Considered aquifer, yields small to moderate quantities of water
			Glen Rose Formation	150, range unknown at AFP 4	Brownish-yellow and gray alternating limestone, marl, shale, and sand	Low permeability-considered confining unit in area of AFP 4
			Twin Mountains Formation[4]	200, range unknown at AFP 4	Fine- to coarse-grained sandstone shale and claystone, basal gravel conglomerate	Coarse sandstones and parts of formation considered aquifer, yields moderate to large quantities of water

[1]Table adapted from USGS, 1996.
[2]Thickness determined from site logs, except for Glen Rose Limestone and Twin Mountains Formation (Baker et al., 1990, Figure 4 in USGS 1996).
[3]Lithologic characteristics determined from field observations and from Winton and Adkins, 1919; University of Texas, Bureau of Economic Geology, 1972; U.S. Army Corps of Engineers, 1986; Baker et al., 1990; Environmental Science and Engineering, Inc., 1994, all in USGS 1996.
[4]This stratigraphic name does not conform in the usage of the U.S. Geological Survey.

Table 2.2
Water Table Elevations - January and July 1997

Area	Location	Groundwater Elevation January 1997	Groundwater Elevation July 1997
Flightline	GMI-22-02M	608.789	610.12
	GMI-22-03M	587.294	587.83
	GMI-22-04M	590.662	591.61
	GMI-22-05M	572.56	575.08
	GMI-22-06M	588.322	589.06
	GMI-22-07M	589.69	591.48
	GMI-22-08M	590.582	592.18
	HM-116	610.48	612.95
	HM-117	611.038	613.27
	HM-118	610.244	612.48
	HM-119	611.023	613.28
	HM-120	611.648	614.02
	HM-121	609.163	610.54
	HM-124	607.868	611.40
	HM-125	610.336	613.19
	LSA1628-3	591.242	592.57
	MW-1A	NA	NA
	MW-11A	589.391	590.11
	MW-19	NA	NA
	MW-38	587.929	588.61
	MW-48	608.916	610.23
	MW-53	600.62	602.04
	MW-56	606.291	606.95
	MW-57	600.088	601.66
	MW-57B	606.086	606.76
	SPOT35-1	590.7	591.45
	SPOT35-2	591.875	592.68
	SPOT35-4	591.969	592.80
	SPOT35-5	591.88	592.74
	SPOT35-7	608.678	609.89
	USGS01P	NF	574.39
	USGS01T	593.255	594.43
	USGS02T	585.906	NF
	USGS03T	571.285	571.42
	USGS04T	586.783	588.06
	W-153	610.238	612.96
East	15B	559.139	559.62
	17I	567.019	568.35
	17J	568.323	569.83
	17K	565.359	566.73
	17L	566.511	567.97
	17M	NA	NA
	BSS-A	561.433	561.88

Table 2.2
Water Table Elevations - January and July 1997 (continued)

Area	Location	Groundwater Elevation January 1997	Groundwater Elevation July 1997
East	BSS-B	559.645	560.20
	LF01-1B	546.592	550.44
	LF01-1C	544.788	548.74
	LF01-1D	545.359	549.73
	LF01-1E	545.153	548.95
	MW-1 (SAV-2)[1]	548.725	553.37
	MW-2	546.26	549.63
	MW-3	564.875	566.23
	MW-5	560.447	560.63
	MW-6	560.553	560.82
	MW-7	558.9	559.87
	MW-8	549.586	552.76
	MW-9	549.558	553.93
	MW-10	545.146	549.25
	MW-11	531.987	536.04
	MW-12	550.421	554.65
	MW-20	591.93	591.95
	MW-37	581.579	581.93
	MW1-16	NA	NA
	PI-U9	NA	NA
	SD13-01	560.829	561.41
	SD13-02	560.119	560.65
	SD13-03	560.244	560.75
	SD13-04	559.418	559.98
	SD13-05	562.405	562.72
	SD13-06	547.467	547.77
	SD13-07	542.576	543.86
	ST14-01	562.055	562.83
	ST14-02	563.363	564.24
	ST14-03	566.899	568.70
	ST14-04	563.047	563.91
	ST14-14	NA	NA
	ST14-24	582.956	583.39
	ST14-25	NA	NA
	ST14-26	NA	NA
	ST14-27	NA	NA
	ST14-28	NA	NA
	ST14-29	561.846	562.57
	ST14-30	561.252	561.67
	ST14-W05	585.092	585.83
	ST14-W06	571.757	573.13
	ST14-W07	568.11	569.76
	ST14-W08	569.695	571.30

Table 2.2
Water Table Elevations - January and July 1997 (continued)

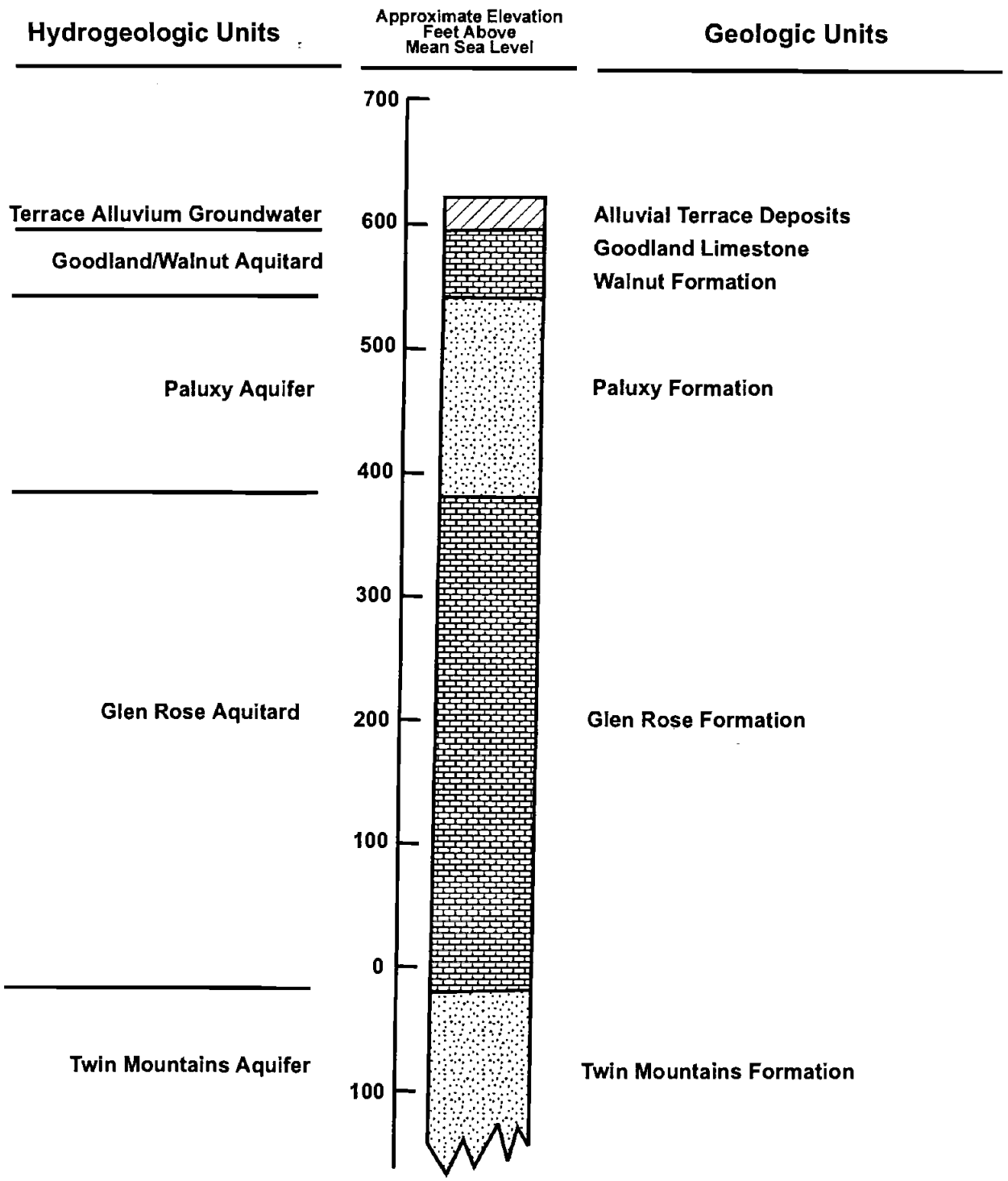
Area	Location	Groundwater Elevation January 1997	Groundwater Elevation July 1997
East	ST14-W09	567.07	568.65
	ST14-W10	567.505	568.93
	ST14-W11	569.018	570.46
	ST14-W12	569.777	571.19
	ST14-W13	566.177	567.54
	ST14-W15	562.984	563.63
	ST14-W16	565.21	566.55
	ST14-W18	564.599	565.71
	ST14-W19	563.662	564.53
	ST14-W20	564.31	565.13
	ST14-W21	562.614	563.33
	ST14-W22	561.311	561.74
	ST14-W23	559.551	560.21
	ST14-W31	560.704	561.22
	ST14-W32	NA	NA
	USGS05P	NF	538.99
	USGS06P	NF	548.79
	USGS06T	588.313	589.46
Landfill	FT08-11A	596.093	600.17
	FT08-11B	597.407	600.39
	FT09-12A	617.374	621.19
	FT09-12B	595.294	598.42
	FT09-12C	594.923	598.01
	FT09-12D	595.51	598.72
	FT09-12E	594.988	598.07
	GMI-04-01M	NA	595.22
	HM-111	610.204	614.07
	HM-114	NA	NA
	HM-122	599.991	602.37
	HM-123	597.392	601.12
	HM-126	607.748	NF
	HM-127	598.148	586.21
	ITMW-01T	NA	NA
	LF04-01	596.664	600.17
	LF04-02	593.721	596.31
	LF04-04	592.414	592.57
	LF04-10	592.722	595.21
	LF04-4A	612.25	617.65
	LF04-4B	600.353	602.47
	LF04-4C	593.242	595.93
	LF04-4D	593.636	596.35
	LF04-4E	593.619	596.20
	LF04-4F	594.69	597.62

Table 2.2
Water Table Elevations - January and July 1997 (continued)

Area	Location	Groundwater Elevation January 1997	Groundwater Elevation July 1997
Landfill	LF04-4G	591.824	594.70
	LF04-4H	NA	NA
	LF05-01	601.904	604.55
	LF05-02	596.602	599.16
	LF05-14	NA	594.96
	LF05-18	592.018	593.56
	LF05-19	591.37	592.79
	LF05-5A	596.859	600.32
	LF05-5B	592.474	593.73
	LF05-5C	596.151	598.94
	LF05-5D	597.247	601.92
	LF05-5E	596.593	600.18
	LF05-5F	NA	NA
	LF05-5G	593.309	594.92
	LF05-5H	593.802	595.43
	MW-12A	NA	NA
	MW-IT-02T	NA	NA
	OT-15C	555.811	556.33
	USGS07P	NF	545.26
	USGS07T	620.646	624.24
	WP07-10A	596.22	599.79
	WP07-10B	594.683	597.12
	WP07-10C	595.849	597.98

Notes:
NA = Data not available due to missing survey data.
NF = Well not found during monitoring event.

[1]The water level measurement was taken in monitoring well MW-1 in January and monitoring well SAV-2 in July. Well MW-1 was destroyed during sewer construction and well SAV-2 will take its place in future sampling events.



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Legend

- Alluvium
- Limestone
- Sandstone

Figure 2.5
NAS Fort Worth JRB, Texas
STRATIGRAPHIC COLUMN CORRELATING HYDROGEOLOGIC UNITS AND GEOLOGIC UNITS
[From Radian, 1989]

2.3.1 Terrace Alluvium Deposits

The uppermost groundwater in the area occurs within the pore space of the grains of silt, clay, sand and gravels deposited by the Trinity River. In some parts of Tarrant County, primarily in those areas adjacent to the Trinity River, groundwater from the terrace deposits is used for irrigation and residential use. However, groundwater from the terrace deposits in the vicinity of NAS Fort Worth JRB is not used as a source of potable water due to its limited distribution, poor yield, and susceptibility to surface/stormwater pollution (USGS, 1996). No potable water supply wells are completed in the Terrace Alluvium with in 0.5 miles of NAS Fort Worth JRB, Carswell Field.

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 fuel feeder lines, sewer systems, storm drains, and cooling water systems. This inflow of water to the shallow aquifer locally affects groundwater flow patterns and contamination transport. The estimated hydraulic conductivity of the alluvial aquifer is 4.57 gallons per day per square foot (gpd/ft2) (Radian, 1989).

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

Potentiometric maps of NAS Fort Worth JRB and AFP 4 alluvial terrace groundwater are presented in Figure 2.6 and Figure 2.7 (HGL, 1997f). Both the January 1997 and July 1997 groundwater elevation data show an easterly trend in groundwater flow over the Base toward the West Fork of the Trinity River.

2.3.2 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 Formations. The primary inhibitors to vertical groundwater movement within these units are the fine- grained clay and shale layers that are interbedded with layers of limestone. Some groundwater movement does occur between the individual bedding planes of both of these units, but the vertical hydraulic conductivity has been calculated to range between 1.2E-09 centimeters per second (cm/sec) to 7.3E-11 cm/sec for the NAS Fort Worth JRB and AFP 4 area. This corresponds to a vertical advective velocity rate that ranges between 1.16E-03 feet per day (ft/d) to 5.22E-03 ft/d (ESE, 1994). At the AFP 4 "window area," the Goodland/Walnut Aquitard is breached, and the alluvial terrace groundwater is in direct communication with the groundwater in the Paluxy Aquifer. A significant number of wells and borings have been advanced on NAS Fort Worth JRB, and there

Figure 2.6

NAS Fort Worth JRB GROUNDWATER ELEVATIONS JANUARY 1997

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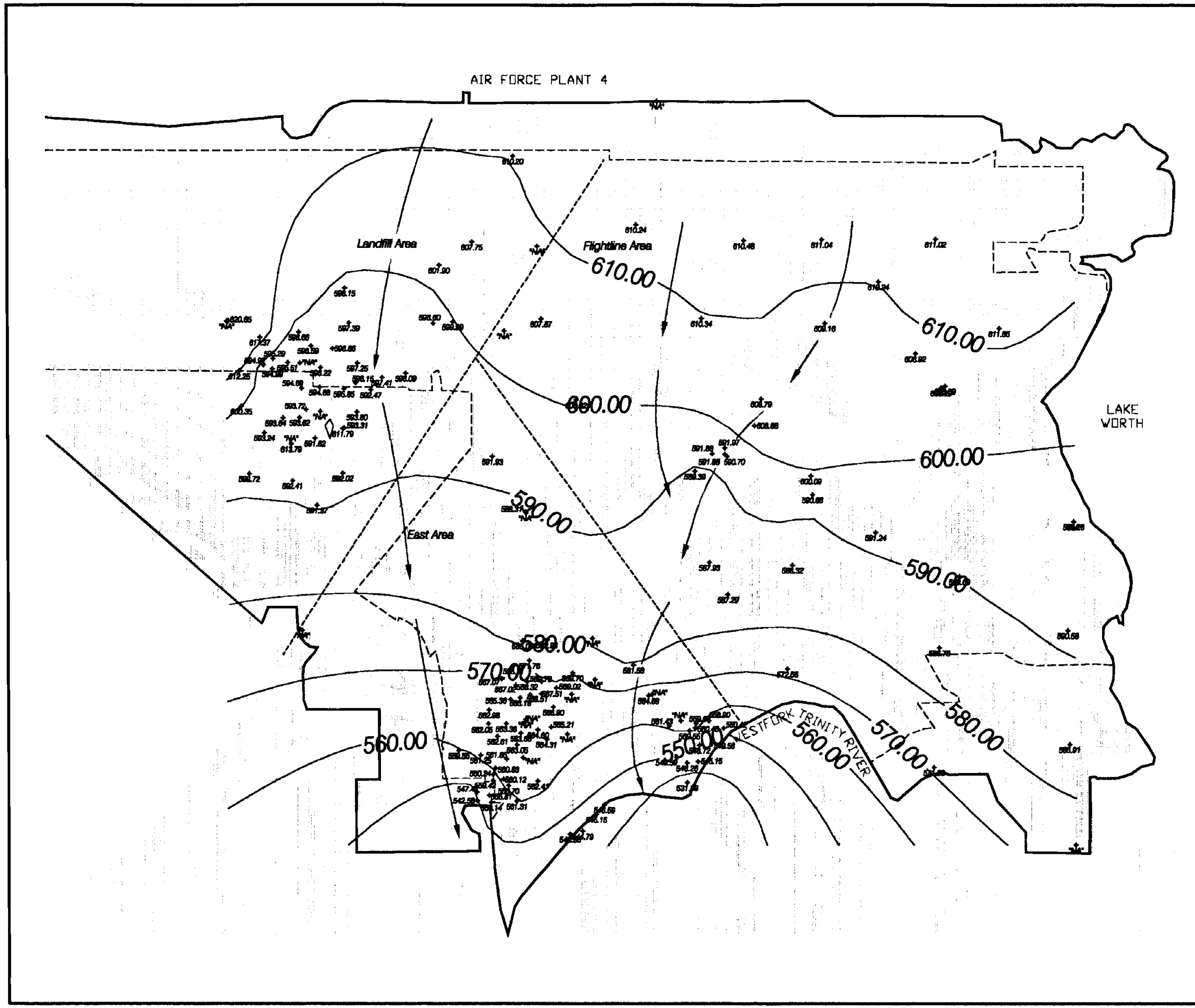

LEGEND

- Approximate Groundwater Management Areas
- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- 614.02 — Monitoring Well Groundwater Elevation (ft NVGD)
- 610 — Groundwater Contour Interval
- Generalized Direction of Flow
- NA — Data Not Available

N

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SCALE IN FEET

HYDRO GeoLogic INC.

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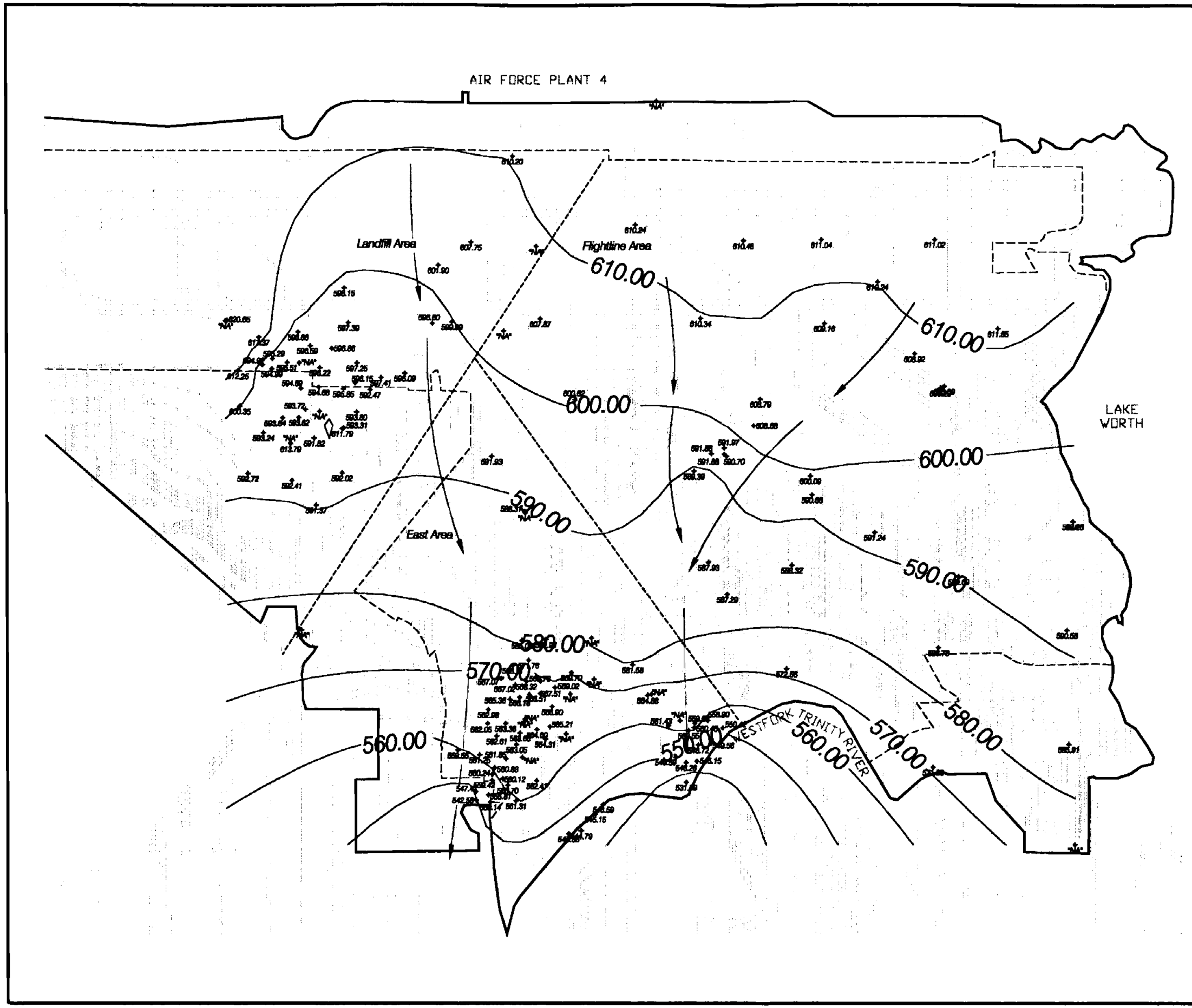
Revised: 04/09/98 nzehms
Project: AFC001-07GBB
Map Source: Jacobs, 1996



HydroGeoLogic, Inc. — Final 1998 GSAP
NAS Fort Worth JRB, Texas

Figure 2.7

NAS Fort Worth JRB GROUNDWATER ELEVATIONS JULY 1997

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- Approximate Groundwater Management Areas
- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- 614.02 — Monitoring Well Groundwater Elevation (ft NVGD)
- 610 — Groundwater Contour Interval
- Generalized Direction of Flow
- NA — Data Not Available

N

0 600 1200 2400
SCALE IN FEET

HYDRO GeoLogic INC.

Filename: AFCEE\NAS Ft Worth\ANNUAL\FIG2_7.dwg
Revised: 04/09/98 nzehms
Project: AFC001-07GBB
Map Source: Jacobs, 1996

is no evidence that a similar window exists on the Base property. Additionally, no evidence of contamination of the Paluxy aquifer has been found beneath NAS Fort Worth JRB.

2.3.3 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 aquifer is also used in some of the surrounding farms and ranches for agricultural purposes. Due to the extensive use of the Paluxy aquifer, water levels have declined significantly over the years. Water levels in the NAS Fort Worth JRB vicinity have not decreased as much as in the Fort Worth area, due to its proximity to the Lake Worth recharge area and the fact that the Base does not develop water from the Paluxy aquifer. Drinking water at the Base is supplied by the City of Fort Worth which uses Lake Worth as its water source. The groundwater of the Paluxy aquifer is contained within the openings created by gaps between bedding planes, cracks, and fissures in the sandstones of the Paluxy Formation. Just as the Paluxy Formation is divided into upper and lower sand members, the aquifer is likewise divided into upper and lower aquifers. The upper sand is finer grained and contains a higher percentage of shale than the lower sand. Radian (1989) estimated the hydraulic conductivity and transmissivity to be 130 to 140 gpd/ft^{2}and 1263 to 13808 gallons per day per foot (gpd/ft), respectively.

2.3.4 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.

2.3.5 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 follows the regional eastward slope of the bedrock. 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).

2.4 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 approximately 2,500 acres. Lake Worth receives a limited

amount of stormwater runoff from NAS Fort Worth JRB during and immediately after rainfall events. 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 downstream of the dam do not extend more than 400 feet from the center of the river or any of the tributaries.

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. Most of the Base drainage is intercepted by a series of storm drains and culverts, directed to oil/water separators, and discharged to the West Fork of the Trinity River downstream of Lake Worth. A small portion of the north end of the Base drains directly into Lake Worth.

2.5 CLIMATE

The climate in the Fort Worth area is classified as subhumid with long, hot summers and short, 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 days per year. The maximum precipitation recorded in a 24 hour period is 5.9 inches. On the average, measurable snowfall occurs two days per year.

TAB

3.0

3.0 NATURE AND EXTENT OF GROUNDWATER CONTAMINATION

This section of the report discusses the nature and extent of groundwater contamination known or suspected across the Base. The discussion of groundwater sampling results is divided into three geographic areas:

- Flightline Area Groundwater
- East Area Groundwater
- Landfill Area Groundwater

The nomenclature and designation of groundwater management areas has no regulatory significance and is merely used to facilitate discussion of SWMUs and AOCs located in geographic areas having similar hydrogeologic or contaminant characteristics. AOC 2, Airfield Groundwater Plume, is located in all of the groundwater management areas on the east side of the runway where TCE is detected in groundwater. AOC-2 will be discussed separately since it is included in all three groundwater management areas. The locations of the groundwater management areas, SWMUs, and AOCs are shown on Figure 3.1. The SWMUs and AOCs associated with each groundwater management area are listed in Table 3.1.

3.1 AVAILABLE ANALYTICAL DATA

During the development of this GSAP, the available analytical data collected during studies conducted in 1997 at NAS Fort Worth JRB and AFP 4 were reviewed to evaluate the nature and extent of groundwater contamination. These data came from the following studies:

- NAS Fort Worth JRB Basewide Sampling - During 1997, four rounds of quarterly groundwater sampling were performed by CH2M Hill and HydroGeoLogic, Inc. as part of the basewide groundwater sampling program (CH2M Hill, 1996b). Fifty-two monitoring wells were included in each of these sampling events, with analytes for individual wells chosen based on results from past sampling events and information about source contaminants. The objective of the sampling program was to determine the configuration of the groundwater potentiometric surface, and to assess variations of groundwater flow direction and the extent of previously identified contamination in the groundwater on a basewide scale.

- AFP 4 Basewide Sampling - In a effort to monitor the contamination resulting from past activities at AFP 4, Jacobs has been sampling wells on AFP 4 property, as well as several wells on western portion of NAS Fort Worth JRB property. Analytical results from Jacob's sampling at thirteen monitoring wells on NAS Fort Worth JRB property in January 1997 have been included in this summary.

- Sanitary Sewer RFI (SWMU 66) - SWMU 66 (Sanitary Sewer System) consists of a network of underground pipes which collect sanitary and industrial wastewater. As part of an RCRA Feasibility Investigation for SWMU 66, IT Corporation installed and sampled

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Figure 3.1

NAS Fort Worth JRB GROUNDWATER MANAGEMENT AREAS

Air Force Center
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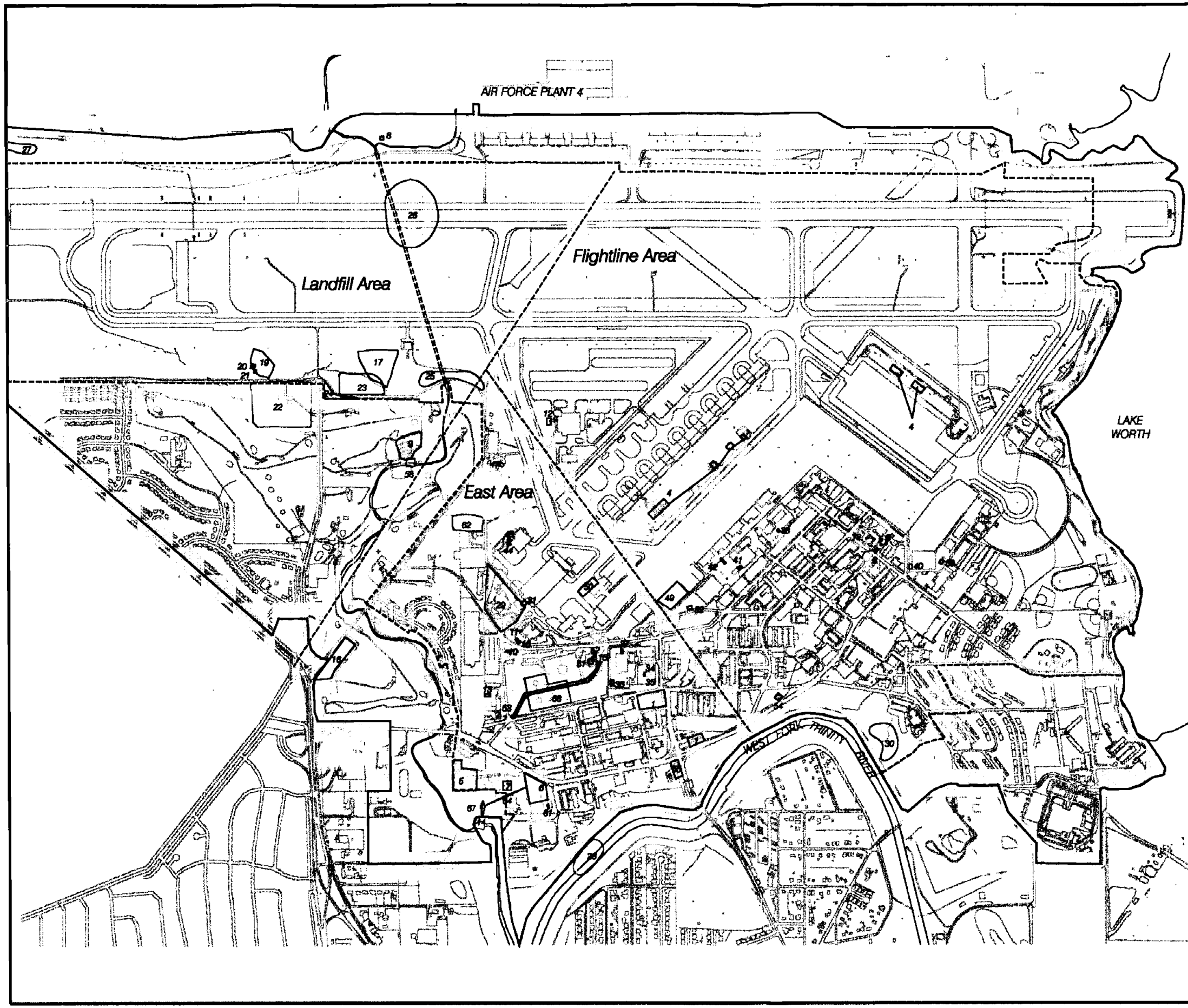
Brooks AFB, Texas



LEGEND

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- Area of Concern (AOC)
- Solid Waste Management Unit (SWMU)
- Approximate Groundwater Management Areas

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HYDRO GeoLogic INC.

Filename: AFCEE\NAS Ft Worth\GSAP\GSAP_3_1.dwg
Revised: 3/31/98 JB
Project: AFC001-071A
Map Source: Jacobs, 1996

Table 3.1
SWMUs and AOCs Associated with Each Groundwater Area

Area	Associated SWMUs[1,3]	Associated AOCs[1]
Landfill Area	17, 19, 20, 21, 22, 23, 24, 25, 26, 27, 58, 66[3]	2[4], 8, 9
East Area	16, 28, 29, 31, 34, 35, 36, 37, 44, 45, 47, 50, 51, 52, 53, 55, 61, 62, 64, 66[3], 67, 68	1, 2[4], 5, 6, 7, 10, 11, 13, 14, 15, 16
Flightline Area	5, 6, 7, 8, 11, 12, 13, 30, 32, 33, 39, 40, 41, 42, 49, 54, 66[3]	2[4], 4, 12

[1] All SWMUs and AOCs designated as No Further Action (NFA) by Texas Natural Resources Conservation Commission (TNRCC, 1995) are not listed in this table.
[2] SWMUs 59 and 60 are located off-site and are not shown on the map.
[3] SWMU 66 is the sanitary sewer system and is located in all three areas.
[4] AOC 2 is OT-18, Airfield TCE Plume, and appears in groundwater in all three areas.

34 new monitoring wells and sampled six existing monitoring wells in April/May 1997 (IT Corporation, 1997c). The results of this sampling event have been included in this summary section.

3.2 CONTAMINANT EVALUATION

To facilitate discussion of contamination at NAS Fort Worth JRB, levels of contamination determined from analytical sampling were compared to several threshold values. First, the results of metals analyses were compared to established background concentrations (Jacobs, 1997), while the results of the volatile organic compounds (VOCs) analyses were compared to practical quantitation limits (PQLs). These comparisons indicated locations where contamination is likely and monitoring should be continued to provide further characterization. In addition, both metals and VOCs were compared to the Texas Natural Resources Conservation Commission (TNRCC) Risk Reduction Standard 2 (RRS 2) values. This risk-based comparison indicates areas which will likely be the focus of ongoing and future monitoring and remediation activities.

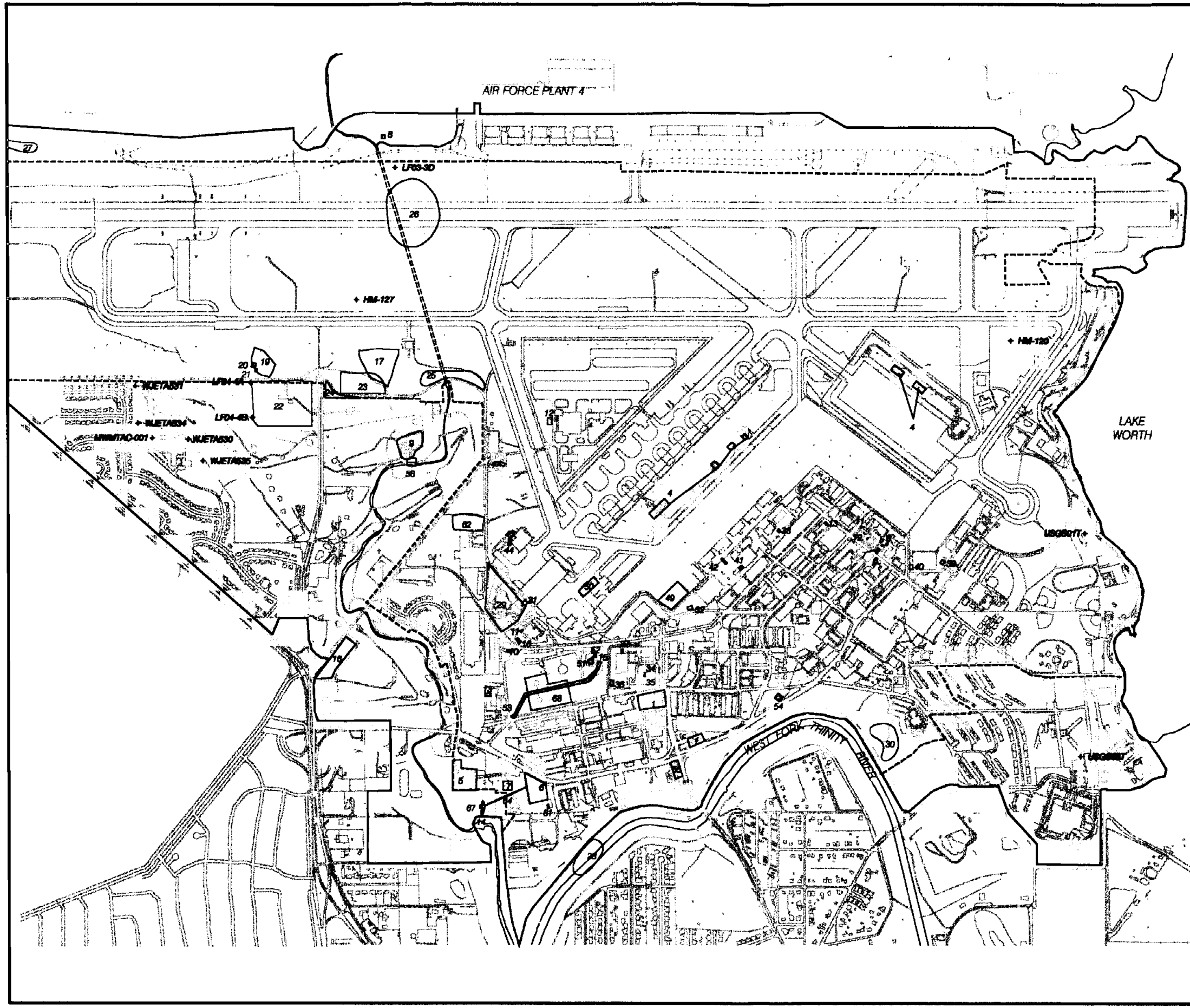
3.2.1 Background Concentrations

Background concentrations were determined for 24 inorganic constituents at NAS Fort Worth JRB (Jacobs, 1997). A single groundwater sample was taken from each of twelve background wells in December 1996 using a low-stress technique to approximate filtered samples. The groundwater monitoring wells sampled, both newly installed and existing, were located up- and cross-gradient from wells that were known to contain volatile and semivolatile compounds. Locations of the twelve background wells sampled are shown in Figure 3.2.

The Tolerance Interval (TI) method suggested by EPA (1989b, 1992) was used to estimate background concentrations for the 24 inorganic constituents for comparison to compliance wells. Tolerance intervals are useful for groundwater data analysis because it is important to ensure that, at most, a small fraction of the compliance wells sampled exceed a specific concentration level (EPA, 1992). Two coefficients are associated with any tolerance interval. One is the proportion of the population that the interval is supposed to contain, called the coverage. The second is the degree of confidence with which the interval reaches the specified coverage, known as the tolerance coefficient. The $UTL_{95,95}$ is the upper tolerance limit (UTL) of a TI with a coverage of 95 percent and a tolerance coefficient of 95 percent. The $UTL_{95,95}$ was determined by Jacobs (1997) as the background concentration for comparison to contaminant concentrations. These values are provided in Table 3.2.

3.2.2 Practical Quantitation Limits (PQLs)

The practical quantitation limit (PQL) is the lowest level that can reasonably be achieved within specified limits of precision and accuracy during routine laboratory conditions. The PQL value is higher than the method detection limit (MDL), which is the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. Sample concentrations falling in between the MDL and PQL are assigned an "F" flag indicating the variability of the result (HGL, 1997a). Since a background concentration for organic compounds is not appropriate, the PQL is used as a



HydroGeoLogic, Inc. — Final 1998 GSAP
NAS Fort Worth JRB, Texas

Figure 3.2

NAS Fort Worth JRB BACKGROUND WELLS

Air Force Center
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Brooks AFB, Texas

LEGEND

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- 7 — Area of Concern (AOC)
- 68 — Solid Waste Management Unit (SWMU)
- HM-120 — Background Monitoring Well Location

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Revised: 3/31/98 JB
Project: AFC001-071A
Map Source: Jacobs, 1996

Table 3.2
Background and Risk Reduction Standard 2 (RRS 2) Values for Inorganic Constituents

Metal	Background Value (ug/L)	RRS 2 Value (ug/L)	RRS 2 Value Source[1]
Aluminum	1,332	200	Derived
Antimony	2	6	TNRCC
Arsenic	4.9	50	TNRCC
Barium	587	2,000	TNRCC
Beryllium	0.3	4	TNRCC
Cadmium	0.5	5	TNRCC
Calcium	266,300	--	Essential Nutrient[2]
Chromium	6	100	TNRCC
Cobalt	8.9	6,100	Derived
Copper	2.8	1,300	Derived
Iron	223.9	300	Derived
Lead	1.6	15	TNRCC
Magnesium	37,800	--	Essential Nutrient[2]
Manganese	175	2,400	Derived
Mercury	0.1	2	TNRCC
Molybdenum	14.4	510	Derived
Nickel	20.4	100	TNRCC
Potassium	15,030	--	Essential Nutrient[2]
Selenium	7.7	50	TNRCC
Silver	0.2	183	TNRCC
Sodium	167,200	--	Essential Nutrient[2]
Thallium	63.2	8.2	Derived
Vanadium	12.3	710	Derived
Zinc	118	5,000	Derived

Notes:
[1]Source of all values was Texas Natural Resource Conservation Commission (TNRCC) Risk Reduction Standards 2 (30 TAC 335). Those noted as "Derived" were derived based on procedures presented in the regulations.
[2]Essential Nutrient - no risk values available.

comparison to determine those compounds which can be detected within established limits of precision and accuracy.

3.2.3 Risk Reduction Standard 2 (RRS 2)

RRS 2 values are the chemical-specific, clean-up levels for remediation of groundwater that has been contaminated by a release(s) from a SWMU/AOC. These values are established from health-based standards and criteria (Texas and/or Federal) pursuant to the TNRCC Regulations, 30 TAC 335.551-335.569. If the practical quantitation limit (PQL) and/or background concentration for a given chemical is greater than the RRS 2 level, the greater of the PQL or background is to be used for determining compliance with requirements of the groundwater remediation. If RRS 2 values are not available, or do not provide appropriate protection for human health, or the environment, cleanup levels based on other numeric criteria, referred to as Medium Specific Concentrations (MSCs) must be established. Formulas to develop MSCs, based on exposure factors and pathways and chemical-specific toxicity, are provided in 30 TAC 335.558 (i.e., Medium Specific Concentrations for Risk Reduction Standard Number 2). RRS 2 values for metals and VOCs are provided in Table 3.2 and Table 3.3, respectively.

3.3 AREA OF CONCERN 2 (AOC 2) - AIRFIELD GROUNDWATER PLUME

AOC 2, Airfield Groundwater Plume, includes all areas on the east side of the runway where TCE is detected in groundwater (CH2M Hill, 1997i). However, the AOC 2 groundwater contamination is not limited to TCE, and may include other contaminants; in particular, cis-1,2- dichloroethene (cis-1,2-DCE) and those related to activities involving fuel products (benzene, toluene, ethylbenzene, and xylenes or BTEX). The portion of the plume which is migrating west to east in the Flightline Area is referred to as the North Lobe, while the portion migrating west to east in the Landfill Area is referred to as the South Lobe.

Figure 3.3 provides the approximate boundaries of the TCE and cis-1,2-DCE plumes (above RRS 2 values) plotted from the July 1997 basewide sampling data. Tables 3.4 and 3.5 give analytical results for detections above PQLs and detections above RRS 2, respectively for all VOCs. Wells within the TCE plume are marked with an asterisk in both tables. TCE concentrations in these wells ranged from 2.2 μg/L to 4,340 μg/L during the 1997 sampling events. The highest concentrations of TCE in the North Lobe occurred in April 1997 in monitoring wells GMI-22-04M (956 μg/L) and LSA1628-3 (790 μg/L), with concentrations of TCE in both wells going down in July 1997. A similar pattern was evident in these wells for cis- 1,2-DCE. Concentrations of cis-1,2-DCE in April 1997, in monitoring wells GMI-22-04M and LSA1628-3, were 182 μg/L and 150 μg/L, respectively. However, cis-1,2-DCE was not detected in either well above the PQL in July 1997. The highest concentrations of TCE and cis-1,2-DCE in the South Lobe occurred in monitoring well LF04-4F in April 1997, with concentrations of 4,340 μg/L and 1,190 μg/L for TCE and cis-1,2-DCE, respectively. In July 1997, TCE and cis- 1,2-DCE were 2,300 μg/L and 390 μg/L, respectively.

Data on VOC contamination were also collected in 1997 as part of AFP 4's basewide sampling program. Results of sampling for VOCs in January 1997 in monitoring wells on NAS Fort Worth

Table 3.3
Risk Reduction Standard 2 (RRS 2)
Values for Volatile Organic Compounds (VOCs)

VOC	RRS2 Value (ug/L)	RRS2 Value Source[1]
1,1,1,2-Tetrachloroethane	32.8	TNRCC
1,1,1-Trichloroethane	200	TNRCC
1,1,2,2-Tetrachloroethane	4.26	TNRCC
1,1,2-Trichloroethane	5	TNRCC
1,1-Dichloroethane	3,650	TNRCC
1,1-Dichloroethene	7	TNRCC
1,2,3-Trichloropropane	219	TNRCC
1,2,4-Trichlorobenzene	70	TNRCC
1,2,4-Trimethylbenzene	5,100	Derived
1,2-Dichlorobenzene	600	TNRCC
1,2-Dichloroethane	5	TNRCC
1,2-Dichloropropane	5	TNRCC
1,3,5-Trimethylbenzene	5,100	Derived
1,3-Dichlorobenzene	600	TNRCC
1,4-Dichlorobenzene	75	TNRCC
2-Methylnaphthalene	4,100	Derived
Benzene	5	TNRCC
Bromodichloromethane	100	TNRCC
Bromoform	100	TNRCC
Bromomethane	51.1	TNRCC
Carbon tetrachloride	5	TNRCC
Chlorobenzene	100	TNRCC
Chloroethane	730	TNRCC
Chloroform	100	TNRCC
Chloromethane	5	TNRCC
cis-1,2-Dichloroethene	70	TNRCC
Dibromochloromethane	100	TNRCC
Dichlorodifluoromethane	7,300	TNRCC
Ethylbenzene	700	TNRCC
Hexachlorobutadiene	10.9	TNRCC
Isopropylbenzene	10,000	TNRCC
m-Xylene & p-Xylene	10,000	Derived
Methylene chloride	5	TNRCC
n-Butylbenzene	1,000	Derived
n-Propylbenzene	10,000	Derived
Naphthalene	1,460	TNRCC
o-Xylene	10,000	TNRCC
p-Isopropyltoluene	1,000	Derived
sec-Butylbenzene	1,020	Derived
tert-Butylbenzene	1,020	Derived
Tetrachloroethene	5	TNRCC
Toluene	1,000	TNRCC
trans-1,2-Dichloroethene	100	TNRCC
Trichloroethene	5	TNRCC
Trichlorofluoromethane	11,000	TNRCC
Vinyl chloride	2	TNRCC

Notes:

[1]Source of all values was Texas Natural Resource Conservation Commission (TNRCC) Risk Reduction Standards 2 (30 TAC 335). Those noted as "Derived" were derived based on procedures presented in the regulations.

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Figure 3.3

NAS Fort Worth JRB CONTAMINANT PLUME BOUNDARY MAP

Air Force Center
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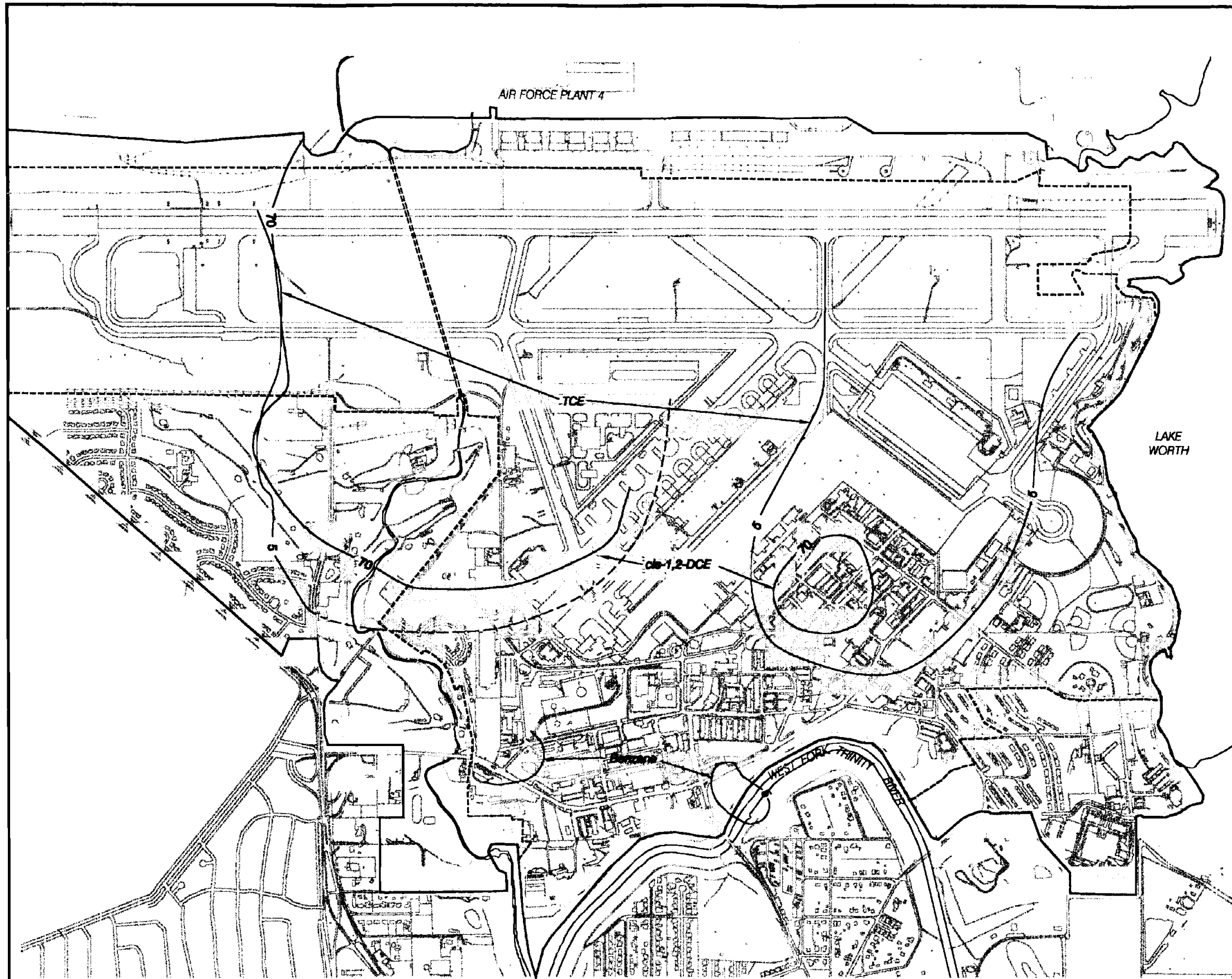
Brooks AFB, Texas



LEGEND

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- Trichloroethene Groundwater Plume Boundary set at 5 ug/L (RRS 2 Standards)
- cis-1,2-Dichloroethene Groundwater Plume Boundary set at 70 ug/L (RRS 2 Standards)
- Benzene Groundwater Plume Boundary set at 5 ug/L (RRS 2 Standards)

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Project: AFC001-071A
Map Source: Jacobs, 1996

Table 3.4
Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997

Area	Location[1]	January 1997	April 1997	July 1997	October 1997
Flightline	GMI-22-02M	(none)	(none)	(none)	
	GMI-22-04M*	Chloroform (0.52 ug/L) cis-1,2-Dichloroethene (61 ug/L) trans-1,2-Dichloroethene (8.23 ug/L) Trichloroethene (388 ug/L)	1,1-Dichloroethene (1.4 ug/L) cis-1,2-Dichloroethene (182 ug/L) trans-1,2-Dichloroethene (15.5 ug/L) Trichloroethene (956 ug/L)	Trichloroethene (440 ug/L)	cis-1,2-Dichloroethene (68 ug/L) Trichloroethene (480 ug/L)
	GMI-22-05M	(none)	(none)	Ethylbenzene (0.7 ug/L) m-Xylene & p-Xylene (3 ug/L) o-Xylene (1.3 ug/L) Toluene (1.9 ug/L)	(none)
	GMI-22-06M*	cis-1,2-Dichloroethene (44.6 ug/L) trans-1,2-Dichloroethene (48.1 ug/L) Trichloroethene (298 ug/L) Vinyl chloride (4.23 ug/L)	1,1-Dichloroethene (1.9 ug/L) Benzene (0.71 ug/L) cis-1,2-Dichloroethene (239 ug/L) trans-1,2-Dichloroethene (98 ug/L) Trichloroethene (533 ug/L) Vinyl Chloride (11.4 ug/L)	cis-1,2-Dichloroethene (99 ug/L) trans-1,2-Dichloroethene (67 ug/L) Trichloroethene (220 ug/L)	cis-1,2-Dichloroethene (35 ug/L) trans-1,2-Dichloroethene (29 ug/L) Trichloroethene (120 ug/L)
	GMI-22-07M	(none)	(none)	(none)	(none)
	LSA1628-3*	Chloroform (0.33 ug/L) cis-1,2-Dichloroethene (57 ug/L) Tetrachloroethene (1.04 ug/L) trans-1,2-Dichloroethene (30.2 ug/L) Trichloroethene (329 ug/L) Vinyl chloride (1.09 ug/L)	cis-1,2-Dichloroethene (150 ug/L) trans-1,2-Dichloroethene (64 ug/L) Trichloroethene (790 ug/L) Vinyl Chloride (2.2 ug/L)	Trichloroethene (400 ug/L)	cis-1,2-Dichloroethene (32 ug/L) trans-1,2-Dichloroethene (17 ug/L) Trichloroethene (320 ug/L)
	SPOT35-2	Benzene (1.12 ug/L) Ethylbenzene (0.62 ug/L) n-Propylbenzene (21.9 ug/L) Naphthalene (20 ug/L) p-Isopropyltoluene (3.16 ug/L) sec-Butylbenzene (6.83 ug/L) tert-Butylbenzene (1.44 ug/L) Trichloroethene (1.02 ug/L)	Benzene (1.1 ug/L) Isopropylbenzene (0.69 ug/L) n-Butylbenzene (1.8 ug/L) n-Propylbenzene (8.4 ug/L) Naphthalene (58.6 ug/L) p-Isopropyltoluene (1.2 ug/L) sec-Butylbenzene (2.4 ug/L)	Isopropylbenzene (24 ug/L) n-Propylbenzene (24 ug/L) Naphthalene (140 ug/L)	Isopropylbenzene (46 ug/L) m-Xylene & p-Xylene (2.7 ug/L) n-Propylbenzene (46 ug/L) Naphthalene (73 ug/L) sec-Butylbenzene (25 ug/L)
	SPOT35-4	n-Butylbenzene (4.48 ug/L) n-Propylbenzene (64.3 ug/L) Naphthalene (25.6 ug/L) sec-Butylbenzene (19.1 ug/L) tert-Butylbenzene (4.61 ug/L)	Naphthalene (38.4 ug/L) tert-Butylbenzene (3.3 ug/L)	Isopropylbenzene (38 ug/L) n-Propylbenzene (38 ug/L) Naphthalene (72 ug/L) sec-Butylbenzene (13 ug/L)	Isopropylbenzene (49 ug/L) n-Propylbenzene (51 ug/L) Naphthalene (100 ug/L) sec-Butylbenzene (22 ug/L)

Table 3.4
Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location[1]	January 1997	April 1997	July 1997	October 1997
Flightline	SPOT35-5	Benzene (1.28 ug/L) m,p-Xylene (0.86 ug/L) n-Propylbenzene (35.7 ug/L) Naphthalene (63.8 ug/L) sec-Butylbenzene (8.84 ug/L) tert-Butylbenzene (2.28 ug/L)	Ethylbenzene (0.87 ug/L) Isopropylbenzene (1.1 ug/L) m,p-Xylene (2.5 ug/L) n-Butylbenzene (1.1 ug/L) n-Propylbenzene (7.4 ug/L) Naphthalene (35.2 ug/L) o-Xylene (1.3 ug/L) sec-Butylbenzene (3.9 ug/L) tert-Butylbenzene (1.6 ug/L) Toluene (1.2 ug/L)	Isopropylbenzene (29 ug/L) n-Propylbenzene (31 ug/L) Naphthalene (76 ug/L)	Isopropylbenzene (48 ug/L) n-Propylbenzene (52 ug/L) Naphthalene (110 ug/L) sec-Butylbenzene (16 ug/L)
	USGS04T	(none)	(none)	(none)	(none)
East	17M	(not sampled)	1,2-Dichlorobenzene (7.2J ug/L) Ethyl benzene (0.77J ug/L) Xylenes (2.65J ug/L)	(none)	(none)
	BSS-A	(none)	(none)	(none)	(none)
	BSS-B	(not sampled)	Ethyl benzene (1830 ug/L) Toluene (11900 ug/L) Xylenes (12400 ug/L)	Ethylbenzene (1600 ug/L) Toluene (9100 ug/L)	Ethylbenzene (1800 ug/L) Toluene (9100 ug/L)
	LF01-1B	(none)	(none)	m-Xylene & p-Xylene (2.1 ug/L) Toluene (1.8 ug/L)	(none)
	LF01-1C	sec-Butylbenzene (2.97 ug/L) tert-Butylbenzene (1.4 ug/L)	(none)	Isopropylbenzene (2 ug/L) sec-Butylbenzene (5.7 ug/L)	Isopropylbenzene (1.6 ug/L) p-Isopropyltoluene (6.3 ug/L) sec-Butylbenzene (2.5 ug/L) tert-Butylbenzene (1.5 ug/L)
	LF01-1D	(none)	n-Butylbenzene (1.6 ug/L) n-Propylbenzene (0.92 ug/L) sec-Butylbenzene (3.7 ug/L)	m-Xylene & p-Xylene (0.94 ug/L)	Chlorobenzene (0.7 ug/L)
	LF01-1E	(none)	Chlorobenzene (2.1 ug/L)	Chlorobenzene (2 ug/L)	Benzene (0.44 ug/L) Chlorobenzene (0.65 ug/L)
	MW-1 (SAV-2)[2]	Benzene (1750 ug/L) Ethyl benzene (5030 ug/L) m,p-Xylene (7130 ug/L) o-xylene (887 ug/L) Toluene (336 ug/L)	1,2-Dichlorobenzene (994 ug/L) Benzene (678 ug/L) Ethyl benzene (2470 ug/L) Toluene (174 ug/L) Xylenes (3240 ug/L)	Benzene (3200 ug/L) Ethylbenzene (1700 ug/L) Toluene (240 ug/L)	Benzene (3000 ug/L) Ethylbenzene (1700 ug/L) Toluene (160 ug/L)

Table 3.4
Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location[1]	January 1997	April 1997	July 1997	October 1997
East	MW-10	1,2,3-Trichloropropane (5.44 ug/L) 1,2,4-Trimethylbenzene (666 ug/L) 1,3,5-Trimethylbenzene (879 ug/L) Benzene (6250 ug/L) Ethylbenzene (5110 ug/L) m,p-Xylene (9630 ug/L) n-Propylbenzene (342 ug/L) Naphthalene (172 ug/L) o-Xylene (3680 ug/L) p-Isopropyltoluene (17.4 ug/L) sec-Butylbenzene (19.3 ug/L) Toluene (10300 ug/L)	1,3,5-Trimethylbenzene (727 ug/L) Benzene (4540 ug/L) Ethyl benzene (4920 ug/L) Isopropylbenzene (3430 ug/L) m,p-Xylene (9630 ug/L) n-Propylbenzene (384 ug/L) Naphthalene (1010 ug/L) o-Xylene (3320 ug/L) Toluene (10600 ug/L)	1,2,4-Trimethylbenzene (2600 ug/L) 1,3,5-Trimethylbenzene (650 ug/L) Benzene (4200 ug/L) Ethylbenzene (4800 ug/L) m-Xylene & p-Xylene (9400 ug/L) n-Propylbenzene (400 ug/L) Naphthalene (770 ug/L) o-Xylene (3700 ug/L) Toluene (9000 ug/L)	1,2,4-Trimethylbenzene (3000 ug/L) 1,3,5-Trimethylbenzene (780 ug/L) Benzene (5500 ug/L) Ethylbenzene (6000 ug/L) Isopropylbenzene (300 ug/L) m-Xylene & p-Xylene (11000 ug/L) Naphthalene (950 ug/L) o-Xylene (4300 ug/L) Toluene (8700 ug/L)
	MW-11	(none)	(none)	Ethylbenzene (1.7 ug/L) m-Xylene & p-Xylene (3.3 ug/L) Naphthalene (0.49 ug/L) Toluene (1.5 ug/L)	(none)
	MW-12	(none)	(none)	m-Xylene & p-Xylene (0.56 ug/L)	(none)
	MW-3	(none)	(none)	(none)	(none)
	MW-5	Benzene (29.7 ug/L) Ethyl benzene (68.9 ug/L) m,p-Xylene (22.9 ug/L) o-xylene (3.32 ug/L) Toluene (8.24 ug/L)	Benzene (2.06 ug/L)	Benzene (65 ug/L) Ethylbenzene (360 ug/L) Toluene (18 ug/L)	Benzene (4 ug/L) Ethylbenzene (15 ug/L)
	MW-8	(none)	Toluene (5.25 ug/L)	(none)	(none)
	MW-9	Methylene chloride (0.81 ug/L)	(none)	(none)	(none)
	OT-15C	(none)	Tetrachloroethene (4.1 ug/L)	Chloroform (0.36 ug/L) m-Xylene & p-Xylene (0.79 ug/L)	(none)
	SD13-01	Ethyl benzene (4.88 ug/L) m,p-Xylene (10.7 ug/L) o-xylene (7.75 ug/L)	(none)	(none)	(none)
	SD 13-02	(none)	Toluene (2.02 ug/L) Xylenes (5.99 ug/L)	(none)	(none)
	SD13-04	(not sampled)	1,2-Dichlorobenzene (24.8 ug/L)	(none)	(none)

Table 3.4
Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location	January 1997	April 1997	July 1997	October 1997
East	SD13-06	(not sampled)	(none)	Ethylbenzene (0.6 ug/L) m-Xylene & p-Xylene (0.94 ug/L)	Isopropylbenzene (2.1 ug/L) n-Propylbenzene (0.77 ug/L)
	ST14-02	(none)	(none)	Benzene (6.1 ug/L)	(none)
	ST14-03	(none)	(none)	(none)	(none)
	ST14-04	Ethyl benzene (6.25 ug/L) m,p-Xylene (12.1 ug/L) o-xylene (9.78 ug/L)	1,2-Dichlorobenzene (3.6J ug/L) Chlorobenzene (1.29J ug/L) Ethyl benzene (0.65J ug/L) Toluene (0.28J ug/L) Xylenes (1.08J ug/L)	(none)	(none)
	ST14-14	(none)	(none)	(none)	(none)
	ST14-24	(none)	(none)	Vinyl chloride (1.4 ug/L)	Vinyl chloride (3.4 ug/L)
	ST14-26	(none)	(none)	(none)	(none)
	ST14-28	Ethyl benzene (7.16 ug/L) m,p-Xylene (11.8 ug/L)	1,2-Dichlorobenzene (33.1J ug/L) 1,3-Dichlorobenzene (9.28J ug/L) Toluene (4.76J ug/L)	(none)	(none)
	ST14-29	Ethyl benzene (7.39 ug/L) m,p-Xylene (10.9 ug/L) o-xylene (9.79 ug/L)	1,2-Dichlorobenzene (23.8J ug/L) Chlorobenzene (1.65J ug/L) Ethyl benzene (1.5J ug/L)	(none)	Toluene (2.5 ug/L)
	ST14-W16	Benzene (59.9 ug/L) m,p-Xylene (2.07 ug/L) o-xylene (2.29 ug/L)	Benzene (5.96J ug/L)	Benzene (6.6 ug/L)	Benzene (6 ug/L)
	ST14-W18	Ethyl benzene (5.28 ug/L) m,p-Xylene (8.93 ug/L)	1,2-Dichlorobenzene (22.4J ug/L) 1,3-Dichlorobenzene (25.3J ug/L) Ethyl benzene (2.66J ug/L) Xylenes (5.37J ug/L)	Benzene (2.7 ug/L)	Ethylbenzene (9 ug/L) Toluene (41 ug/L)
	ST14-W21	Benzene (20.4 ug/L)	Ethyl benzene (1J ug/L) Toluene (0.25J ug/L) Xylenes (1.28J ug/L)	Benzene (9.3 ug/L)	(none)
	ST14-W31	m,p-Xylene (3.31 ug/L) Toluene (2.22 ug/L)	(none)	(none)	(none)

Table 3.4
Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location[1]	January 1997	April 1997	July 1997	October 1997
Landfill	FT09-12C*	1,2-Dichlorobenzene (3.45 ug/L) 1,4-Dichlorobenzene (1.99 ug/L) cis-1,2-Dichloroethene (22.7 ug/L) tert-Butylbenzene (1.07 ug/L) Vinyl chloride (7.35 ug/L)	1,2-Dichlorobenzene (2.3 ug/L) 1,4-Dichlorobenzene (1.7 ug/L) Benzene (0.81 ug/L) cis-1,2-Dichloroethene (93.2 ug/L) trans-1,2-Dichloroethene (1 ug/L) Trichloroethene (2.2 ug/L) Vinyl Chloride (9 ug/L)	1,2-Dichlorobenzene (2.6 ug/L) 1,4-Dichlorobenzene (1.4 ug/L) Benzene (3 ug/L) cis-1,2-Dichloroethene (43 ug/L) Trichloroethene (3.3 ug/L) Vinyl chloride (6.6 ug/L)	1,2-Dichlorobenzene (3.7 ug/L) 1,4-Dichlorobenzene (2 ug/L) Benzene (5 ug/L) cis-1,2-Dichloroethene (60 ug/L) Trichloroethene (5.9 ug/L) Vinyl chloride (11 ug/L)
	GMI-04-01M*	(not sampled)	(not sampled)	cis-1,2-Dichloroethene (280 ug/L) Trichloroethene (1400 ug/L)	cis-1,2-Dichloroethene (240 ug/L) trans-1,2-Dichloroethene (41 ug/L) Trichloroethene (880 ug/L)
	LF04-10*	cis-1,2-Dichloroethene (1.39 ug/L) Trichloroethene (1.94 ug/L)	1,2-Dichlorobenzene (1.9 ug/L) 1,3-Dichlorobenzene (0.25 ug/L) 1,4-Dichlorobenzene (1.4 ug/L) Benzene (0.69 ug/L) Chlorobenzene (0.23 ug/L) cis-1,2-Dichloroethene (85.2 ug/L) Tetrachloroethene (0.73 ug/L) trans-1,2-Dichloroethene (0.94 ug/L) Trichloroethene (2.2 ug/L) Vinyl Chloride (7.9 ug/L)	(none)	(none)
	LF04-4F*	1,1-Dichloroethene (1.66 ug/L) 1,2,4-Trimethylbenzene (7.61 ug/L) 1,3,5-Trimethylbenzene (9.42 ug/L) Benzene (1.84 ug/L) Chloroform (0.69 ug/L) cis-1,2-Dichloroethene (370 ug/L) Ethylbenzene (7.54 ug/L) Isopropylbenzene (10.6 ug/L) m,p-Xylene (16.6 ug/L) n-Propylbenzene (3.94 ug/L) Naphthalene (161 ug/L) o-Xylene (4.94 ug/L) Toluene (5.12 ug/L) trans-1,2-Dichloroethene (30.6 ug/L) Trichloroethene (2970 ug/L) Vinyl chloride (12.9 ug/L)	1,1-Dichloroethene (2.5 ug/L) cis-1,2-Dichloroethene (1190 ug/L) Trichloroethene (4340 ug/L) Vinyl Chloride (12.2 ug/L)	cis-1,2-Dichloroethene (390 ug/L) Trichloroethene (2300 ug/L)	cis-1,2-Dichloroethene (600 ug/L) Trichloroethene (2700 ug/L)

Table 3.4
Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location	January 1997	April 1997	July 1997	October 1997
Landfill	LF05-02*	cis-1,2-Dichloroethene (199 ug/L) trans-1,2-Dichloroethene (22 ug/L) Trichloroethene (115 ug/L) Vinyl chloride (10.5 ug/L)	cis-1,2-Dichloroethene (218 ug/L) trans-1,2-Dichloroethene (10.1 ug/L) Trichloroethene (61.6 ug/L) Vinyl Chloride (7 ug/L)	cis-1,2-Dichloroethene (370 ug/L) trans-1,2-Dichloroethene (35 ug/L) Trichloroethene (130 ug/L)	cis-1,2-Dichloroethene (650 ug/L) trans-1,2-Dichloroethene (46 ug/L) Trichloroethene (210 ug/L)
	LF05-18*	1,1-Dichloroethene (42.2J ug/L) Chlorobenzene (0.66 ug/L) cis-1,2-Dichloroethene (293 ug/L) Trichloroethene (970 ug/L) Vinyl chloride (10.3 ug/L)	1,1-Dichloroethane (1.4 ug/L) 1,1-Dichloroethene (3.6 ug/L) 1,4-Dichlorobenzene (0.55 ug/L) Benzene (0.44 ug/L) Chlorobenzene (0.7 ug/L) cis-1,2-Dichloroethene (364 ug/L) Trichloroethene (1150 ug/L) Vinyl Chloride (13.3 ug/L)	cis-1,2-Dichloroethene (200 ug/L) Trichloroethene (660 ug/L)	cis-1,2-Dichloroethene (310 ug/L) trans-1,2-Dichloroethene (41 ug/L) Trichloroethene (860 ug/L)
	LF05-19*	Chloroform (0.55 ug/L) cis-1,2-Dichloroethene (293 ug/L) trans-1,2-Dichloroethene (15.2 ug/L) Trichloroethene (998 ug/L)	1,1,1-Trichloroethane (0.39J ug/L) 1,1-Dichloroethene (1.6J ug/L) 1,2-Dichloroethane (0.36J ug/L) Chlorobenzene (0.2J ug/L) cis-1,2-Dichloroethene (822J ug/L) trans-1,2-Dichloroethene (12.9J ug/L) Trichloroethene (1710J ug/L)	cis-1,2-Dichloroethene (85 ug/L) Trichloroethene (310 ug/L)	cis-1,2-Dichloroethene (22 ug/L) m-Xylene & p-Xylene (4.9 ug/L) Toluene (6.2 ug/L) Trichloroethene (68 ug/L)
	LF05-5G*	1,1-Dichloroethene (2.46 ug/L) 1,3,5-Trimethylbenzene (1.14 ug/L) 1,4-Dichlorobenzene (0.97 ug/L) Benzene (34.2 ug/L) Chloroform (0.73 ug/L) cis-1,2-Dichloroethene (219 ug/L) Ethyl benzene (2020 ug/L) Isopropylbenzene (3.27 ug/L) m,p-Xylene (7760 ug/L) n-Propylbenzene (0.54 ug/L) Naphthalene (25.4 ug/L) o-xylene (3300 ug/L) Toluene (13500 ug/L) trans-1,2-Dichloroethene (13.9 ug/L) Trichloroethene (595 ug/L) Vinyl chloride (10.9 ug/L)	1,1-Dichloroethene (2.8 ug/L) 1,2-Dichlorobenzene (0.31 ug/L) cis-1,2-Dichloroethene (488 ug/L) trans-1,2-Dichloroethene (12.1 ug/L) Trichloroethene (1240 ug/L) Vinyl Chloride (2.6 ug/L)	cis-1,2-Dichloroethene (140 ug/L) Trichloroethene (420 ug/L)	cis-1,2-Dichloroethene (220 ug/L) Trichloroethene (590 ug/L)

Table 3.4
Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location[1]	January 1997	April 1997	July 1997	October 1997
Landfill	WP07-10B*	1,1-Dichloroethene (1.89 ug/L) 1,4-Dichlorobenzene (1 ug/L) Chloroform (0.94 ug/L) cis-1,2-Dichloroethene (267 ug/L) Tetrachloroethene (14.4 ug/L) trans-1,2-Dichloroethene (32.5 ug/L) Trichloroethene (3010J ug/L) Vinyl chloride (21J ug/L)	1,1-Dichloroethene (7.4 ug/L) 1,4-Dichlorobenzene (0.49 ug/L) cis-1,2-Dichloroethene (404 ug/L) Ethyl benzene (0.81 ug/L) Isopropylbenzene (1.2 ug/L) m,p-Xylene (3.2 ug/L) o-Xylene (1.6 ug/L) Tetrachloroethene (5 ug/L) Toluene (1.1 ug/L) trans-1,2-Dichloroethene (123J ug/L) Trichloroethene (3060 ug/L) Vinyl Chloride (84.2 ug/L)	cis-1,2-Dichloroethene (320 ug/L) trans-1,2-Dichloroethene (42F ug/L) Trichloroethene (2800 ug/L)	cis-1,2-Dichloroethene (450 ug/L) Trichloroethene (2500 ug/L)
	WP07-10C*	1,1-Dichloroethene (5.26 ug/L) 1,4-Dichlorobenzene (4.14 ug/L) Benzene (0.76 ug/L) Chlorobenzene (0.78 ug/L) Chloroform (0.37 ug/L) cis-1,2-Dichloroethene (167 ug/L) m,p-Xylene (0.61 ug/L) trans-1,2-Dichloroethene (16.7 ug/L) Trichloroethene (733 ug/L) Vinyl chloride (21.9 ug/L)	1,1-Dichloroethene (11.6 ug/L) 1,4-Dichlorobenzene (7.1 ug/L) Benzene (0.88 ug/L) Chlorobenzene (0.98 ug/L) Trichloroethene (816 ug/L) Vinyl Chloride (53.6 ug/L)	cis-1,2-Dichloroethene (230 ug/L) Trichloroethene (1400 ug/L)	cis-1,2-Dichloroethene (220 ug/L) Trichloroethene (990 ug/L)

Notes:

[1]All wells sampled are included in this table, although in some cases no contaminants above PQL were found. An asterick next to the well name indicates the well is within the AOC 2 trichloroethene (TCE) plume.

[2]Samples were taken from monitoring well MW-1 in January and April and from monitoring well SAV-2 in July and October. Monitoring well MW-1 was destroyed during sewer construction and monitoring well SAV-2 will take its place in future sampling events.

Table 3.5
Volatile Organic Compounds (VOCs) Detected Above Risk Reduction Standard 2 (RRS 2)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997

Area	Location[1]	January 1997	April 1997	July 1997	October 1997
Flightline	GMI-22-04M*	Trichloroethene (388 ug/L)	cis-1,2-Dichloroethene (182 ug/L) Trichloroethene (956 ug/L)	Trichloroethene (440 ug/L)	Trichloroethene (480 ug/L)
	GMI-22-06M*	Trichloroethene (298 ug/L) Vinyl chloride (4.23 ug/L)	cis-1,2-Dichloroethene (239 ug/L) Trichloroethene (533 ug/L) Vinyl Chloride (11.4 ug/L)	cis-1,2-Dichloroethene (99 ug/L) Trichloroethene (220 ug/L)	Trichloroethene (120 ug/L)
	LSA1628-3*	Trichloroethene (329 ug/L)	cis-1,2-Dichloroethene (150 ug/L) Trichloroethene (790 ug/L) Vinyl Chloride (2.2 ug/L)	Trichloroethene (400 ug/L)	Trichloroethene (320 ug/L)
East	BSS-B	(not sampled)	Ethyl benzene (1830 ug/L) Toluene (11900 ug/L) Xylenes (12400 ug/L)	Benzene (21U ug/L) Ethyl benzene (1600J ug/L) Toluene (9100 ug/L)	Ethylbenzene (1800 ug/L) Toluene (9100 ug/L)
	MW-1 (SAV-2)[2]	Benzene (1750 ug/L) Ethyl benzene (5030 ug/L)	1,2-Dichlorobenzene (994 ug/L) Benzene (678 ug/L) Ethyl benzene (2470 ug/L)	Benzene (3200J ug/L) Ethyl benzene (1700 ug/L)	Benzene (3000 ug/L) Ethylbenzene (1700 ug/L)
	MW-10	Benzene (6250 ug/L) Ethylbenzene (5110 ug/L) Toluene (10300 ug/L)	Benzene (4540 ug/L) Ethyl benzene (4920 ug/L) Toluene (10600 ug/L)	Benzene (4200 ug/L) Ethyl benzene (4800 ug/L) Toluene (9000 ug/L) Xylene (13100 ug/L)	Benzene (5500 ug/L) Ethylbenzene (6000 ug/L) m-Xylene & p-Xylene (11000 ug/L) Toluene (8700 ug/L)
	MW-5	Benzene (29.7 ug/L)	(none)	Benzene (65J ug/L)	(none)
	ST14-02	(none)	(none)	Benzene (6.1 ug/L)	(none)
	ST14-24	(none)	(none)	(none)	Vinyl chloride (3.4 ug/L)
	ST14-W16	Benzene (59.9 ug/L)	Benzene (5.96J ug/L)	Benzene (6.6J ug/L)	Benzene (6 ug/L)
	ST14-W21	Benzene (20.4 ug/L)	(none)	Benzene (9.3J ug/L)	(none)
Landfill	FT09-12C*	Vinyl chloride (7.35 ug/L)	cis-1,2-Dichloroethene (93.2 ug/L) Vinyl Chloride (9 ug/L)	Vinyl chloride (6.6 ug/L)	Trichloroethene (5.9 ug/L) Vinyl chloride (11 ug/L)
	GMI-04-01M*	(not sampled)	(not sampled)	Trichloroethene (1400 ug/L) cis-1,2-Dichloroethene (280 ug/L)	cis-1,2-Dichloroethene (240 ug/L) Trichloroethene (880 ug/L)
	LF04-10*	(none)	cis-1,2-Dichloroethene (85.2 ug/L) Vinyl Chloride (7.9 ug/L)	(none)	
	LF04-4F*	cis-1,2-Dichloroethene (370 ug/L) Trichloroethene (2970 ug/L) Vinyl chloride (12.9 ug/L)	cis-1,2-Dichloroethene (1190 ug/L) Trichloroethene (4340 ug/L) Vinyl Chloride (12.2 ug/L)	Trichloroethene (2300 ug/L) cis-1,2-Dichloroethene (390 ug/L)	cis-1,2-Dichloroethene (600 ug/L) Trichloroethene (2700 ug/L)
	LF05-02*	cis-1,2-Dichloroethene (199 ug/L) Trichloroethene (115 ug/L) Vinyl chloride (10.5 ug/L)	cis-1,2-Dichloroethene (218 ug/L) Trichloroethene (61.6 ug/L) Vinyl Chloride (7 ug/L)	Trichloroethene (130 ug/L) cis-1,2-Dichloroethene (370 ug/L)	cis-1,2-Dichloroethene (650 ug/L) Trichloroethene (210 ug/L)

Table 3.5
Volatile Organic Compounds (VOCs) Detected Above Risk Reduction Standard 2 (RRS 2)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location[1]	January 1997	April 1997	July 1997	October 1997
Landfill	LF05-18*	1,1-Dichloroethene (42.2J ug/L) cis-1,2-Dichloroethene (293 ug/L) Trichloroethene (970 ug/L) Vinyl chloride (10.3 ug/L)	cis-1,2-Dichloroethene (364 ug/L) Trichloroethene (1150 ug/L) Vinyl Chloride (13.3 ug/L)	Trichloroethene (660 ug/L) cis-1,2-Dichloroethene (200 ug/L)	cis-1,2-Dichloroethene (310 ug/L) Trichloroethene (860 ug/L)
	LF05-19*	cis-1,2-Dichloroethene (293 ug/L) Trichloroethene (998 ug/L)	cis-1,2-Dichloroethene (822J ug/L) Trichloroethene (1710J ug/L)	Trichloroethene (310J ug/L) cis-1,2-Dichloroethene (85 ug/L)	Trichloroethene (68 ug/L)
	LF05-5G*	Benzene (34.2 ug/L) cis-1,2-Dichloroethene (219 ug/L) Ethyl benzene (2020 ug/L) Toluene (13500 ug/L) Trichloroethene (595 ug/L) Vinyl chloride (10.9 ug/L)	cis-1,2-Dichloroethene (488 ug/L) Trichloroethene (1240 ug/L) Vinyl Chloride (2.6 ug/L)	Trichloroethene (420 ug/L) cis-1,2-Dichloroethene (140 ug/L)	cis-1,2-Dichloroethene (220 ug/L) Trichloroethene (590 ug/L)
	WP07-10B*	cis-1,2-Dichloroethene (267 ug/L) Tetrachloroethene (14.4 ug/L) Trichloroethene (3010J ug/L) Vinyl chloride (21J ug/L)	1,1-Dichloroethene (7.4 ug/L) cis-1,2-Dichloroethene (404 ug/L) trans-1,2-Dichloroethene (123J ug/L) Trichloroethene (3060 ug/L) Vinyl Chloride (84.2 ug/L)	Trichloroethene (2800 ug/L) cis-1,2-Dichloroethene (320 ug/L)	cis-1,2-Dichloroethene (450 ug/L) Trichloroethene (2500 ug/L)
	WP07-10C*	cis-1,2-Dichloroethene (167 ug/L) Trichloroethene (733 ug/L) Vinyl chloride (21.9 ug/L)	1,1-Dichloroethene (11.6 ug/L) Trichloroethene (816 ug/L) Vinyl Chloride (53.6 ug/L)	Trichloroethene (1400 ug/L) cis-1,2-Dichloroethene (230 ug/L)	cis-1,2-Dichloroethene (220 ug/L) Trichloroethene (990 ug/L)

Notes:

[1]Only wells with at least one contaminant above RRS 2 are included in this table. See Table 3-4 for all wells sampled. An asterick next to the well name indicates the well is within the AOC 2 trichloroethene (TCE) plume.

[2]Samples were taken from monitoring well MW-1 in January and April and from monitoring well SAV-2 in July and October. Monitoring well MW-1 was destroyed during sewer construction and monitoring well SAV-2 will take its place in future sampling events.

JRB property are included in Table 3.6. TCE concentrations ranged from 7.26 μg/L to 4,310 μg/L, with the highest concentrations occurring in monitoring well HM-123. This well is located approximately 1,000 feet upgradient of monitoring well LF04-4F, the well that showed the highest concentration of TCE in NAS Fort Worth JRB basewide sampling in April 1997. Monitoring well HM-123 also contained high concentrations of cis-1,2-DCE at 548 μg/L.

Additional data were also collected during an April 1997 RFI for SWMU 66, Sanitary Sewer System (IT Corporation, 1997c). The results of the VOC analysis from this study are provided in Table 3.7. These results help to further define the TCE and cis-1,2-DCE plumes.

3.4 FLIGHTLINE AREA GROUNDWATER

The Flightline Groundwater Area includes AOC 2 (Airfield Groundwater), AOC 4 (the Fuel Hydrant System), AOC 12, and several SWMUs. Groundwater contamination has not been associated with any SWMUs or AOCs in this area, with the exceptions of AOC 2 and AOC 4. Discussions of sampling results at AOC 4 and Building 1628 are included in this section. Results of sampling for AOC 2 are included in the previous section.

3.4.1 Area of Concern 4 (AOC 4) - Fuel Hydrant System

AOC 4 includes the Fuel Hydrant System and Spot 35. The Fuel Hydrant System, which had distributed fuel from the tank farms to the flight apron fueling areas since the opening of the base in the 1940s, was removed from operation and dismantled during various investigations in the early 1990s. Groundwater contamination in this area is believed to be the result of JP-4 jet fuel releases from the fuel hydrant system. Groundwater monitoring conducted in this area between 1990 and 1992 (USACE, 1992) encountered generally low concentrations of BTEX constituents, although during the last sampling round in 1992, benzene was detected in four monitoring wells at concentrations between 51 μg/L and 767 μg/L, all above the RRS 2 value of 5 μg/L for benzene. None of the wells associated with AOC 4 were sampled in the 1995/1996 basewide monitoring program (LAW, 1996a, 1996b).

During the 1997 basewide monitoring program, three SPOT 35 monitoring wells (SPOT35-2, SPOT35-4, SPOT35-5) were sampled for VOCs. A number of benzene-related compounds were found in all three wells above the PQLs (Table 3.4), but no contaminants were found above RRS 2 values during any sampling event (Table 3.5). No VOCs above PQL were detected in monitoring well GMI-22-02M, upgradient of SPOT 35. A RCRA Site Investigation is currently underway at AOC 4 (HGL, 1997e). The Work Plan recommends installation of six additional monitoring wells to further characterize this site.

3.4.2 Building 1628 Groundwater (SWMUs 5, 6, 7, and 8)

Building 1628 was formerly the Aerospace Ground Equipment (AGE) Maintenance Shop, and operations included corrosion control activities. Wastes generated included antifreeze, paint strippers, and thinners. Three monitoring wells were installed as part of a limited site investigation (LSA) during the 1993 removal of three underground storage tanks located near

Table 3.6
Contaminants Detected at NAS Fort Worth JRB
AFP4 Basewide Sampling January 1997

Area	Location	VOCs Detected Above PQL	VOCs Detected Above RRS 2	Metals Detected Above Backgound	Metals Detected Above RRS 2
Flightline	HM-119	Tetrachloroethene (2.49 ug/L) Trichloroethene (31.9 ug/L)	Trichloroethene (31.9 ug/L)	(not sampled)	(not sampled)
	HM-120	(none)	(none)	(not sampled)	(not sampled)
	HM-125	cis-1,2-Dichloroethene (9.14 ug/L) Trichloroethene (70.3 ug/L)	Trichloroethene (70.3 ug/L)	(not sampled)	(not sampled)
	MW-IT-02T	cis-1,2-Dichloroethene (847 ug/L) Trichloroethene (4150 ug/L)	cis-1,2-Dichloroethene (847 ug/L) Trichloroethene (4150 ug/L)	Chromium (153 ug/L)	Chromium (153 ug/L)
Landfill	HM-114	cis-1,2-Dichloroethene (83.9 ug/L) Trichloroethene (610 ug/L)	cis-1,2-Dichloroethene (83.9 ug/L) Trichloroethene (610 ug/L)	(not sampled)	(not sampled)
	HM-123	cis-1,2-Dichloroethene (548 ug/L) Trichloroethene (4310 ug/L)	cis-1,2-Dichloroethene (548 ug/L) Trichloroethene (4310 ug/L)	(not sampled)	(not sampled)
	HM-127	(none)	(none)	(not sampled)	(not sampled)
	LF04-02	cis-1,2-Dichloroethene (294 ug/L) Trichloroethene (2680 ug/L)	cis-1,2-Dichloroethene (294 ug/L) Trichloroethene (2680 ug/L)	(not sampled)	(not sampled)
	LF04-10	Trichloroethene (2.46 ug/L)	(none)	(not sampled)	(not sampled)
	LF04-4C	cis-1,2-Dichloroethene (5.12 ug/L) Trichloroethene (7.26 ug/L)	Trichloroethene (7.26 ug/L)	(not sampled)	(not sampled)
	LF05-19	cis-1,2-Dichloroethene (354 ug/L) Trichloroethene (1560 ug/L)	cis-1,2-Dichloroethene (354 ug/L) Trichloroethene (1560 ug/L)	Iron (2030 ug/L)	Iron (2030 ug/L) Aluminum (1110 ug/L)
	LF05-5A	cis-1,2-Dichloroethene (521 ug/L) trans-1,2-Dichloroethene (19.6 ug/L) Trichloroethene (2850 ug/L)	cis-1,2-Dichloroethene (521 ug/L) Trichloroethene (2850 ug/L)	(not sampled)	(not sampled)
	MW-IT-01T	cis-1,2-Dichloroethene (30.2 ug/L) Trichloroethene (68.1 ug/L)	Trichloroethene (68.1 ug/L)	(not sampled)	(not sampled)

Table 3.7
Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs) and Risk Reduction Standard 2 (RRS 2) Sanitary Sewer System RFI April 1997

Area	Location	Detections Above PQL	Detections Above RRS 2
Flightline	GMI-22-05M	Methylene chloride (0.4 ug/L) Trichloroethene (0.51 ug/L)	(none)
	LSA1628-3	cis-1,2-Dichloroethene (74 ug/L) Methylene chloride (110 ug/L) Trichloroethene (410 ug/L)	cis-1,2-Dichloroethene (74 ug/L) Methylene chloride (110 ug/L) Trichloroethene (410 ug/L)
	WITCTA001	Bromodichloromethane (1 ug/L) Chloroform (1.7 ug/L) Methylene chloride (0.68 ug/L)	(none)
	WITCTA002	Chloroform (0.51 ug/L) Diethyl phthalate (2.6 ug/L) Methylene chloride (0.25 ug/L)	(none)
	WITCTA003	Methylene chloride (0.59 ug/L) Trichloroethene (0.33 ug/L)	(none)
	WITCTA004	cis-1,2-Dichloroethene (1.4 ug/L) Methylene chloride (0.56 ug/L) Trichloroethene (4.6 ug/L)	(none)
	WITCTA005	cis-1,2-Dichloroethene (97 ug/L) Methylene chloride (8.8 ug/L) Trichloroethene (310 ug/L)	cis-1,2-Dichloroethene (97 ug/L) Methylene chloride (8.8 ug/L) Trichloroethene (310 ug/L)
	WITCTA006	cis-1,2-Dichloroethene (110 ug/L) Methylene chloride (3.2 ug/L) Trichloroethene (25 ug/L)	cis-1,2-Dichloroethene (110 ug/L) Trichloroethene (25 ug/L)
	WITCTA007	cis-1,2-Dichloroethene (57 ug/L) Methylene chloride (1.1 ug/L) trans-1,2-Dichloroethene (0.46 ug/L) Trichloroethene (54 ug/L)	Trichloroethene (54 ug/L)
	WITCTA008	Chloroform (12J ug/L) cis-1,2-Dichloroethene (24 ug/L) Methylene chloride (20 ug/L) Trichloroethene (620 ug/L)	Methylene chloride (20 ug/L) Trichloroethene (620 ug/L)
	WITCTA009	cis-1,2-Dichloroethene (33J ug/L) Methylene chloride (39 ug/L) Trichloroethene (650 ug/L)	Methylene chloride (39 ug/L) Trichloroethene (650 ug/L)
	WITCTA010	cis-1,2-Dichloroethene (1.8 ug/L) Methylene chloride (0.44 ug/L)	(none)
	WITCTA011	Chloroform (15J ug/L) cis-1,2-Dichloroethene (58J ug/L) Trichloroethene (550 ug/L)	Trichloroethene (550 ug/L)
	WITCTA012	cis-1,2-Dichloroethene (94 ug/L) Methylene chloride (1.8 ug/L) Trichloroethene (6.8 ug/L)	cis-1,2-Dichloroethene (94 ug/L) Trichloroethene (6.8 ug/L)
	WITCTA013	cis-1,2-Dichloroethene (50 ug/L) Methylene chloride (17 ug/L) Trichloroethene (330 ug/L)	Methylene chloride (17 ug/L) Trichloroethene (330 ug/L)
	WITCTA014	cis-1,2-Dichloroethene (15 ug/L) Methylene chloride (1.7 ug/L) Trichloroethene (92 ug/L)	Trichloroethene (92 ug/L)

Table 3.7
Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs) and Risk Reduction Standard 2 (RRS 2) Sanitary Sewer System RFI April 1997 (continued)

Area	Location	Detections Above PQL	Detections Above RRS 2
Flightline	WITCTA015	Chloroform (4.8 ug/L) cis-1,2-Dichloroethene (240 ug/L) Methylene chloride (7.4 ug/L) Tetrachloroethene (11 ug/L)	cis-1,2-Dichloroethene (240 ug/L) Methylene chloride (7.4 ug/L) Tetrachloroethene (11 ug/L)
	WITCTA016	cis-1,2-Dichloroethene (72 ug/L) Methylene chloride (1.7 ug/L) Trichloroethene (29 ug/L)	cis-1,2-Dichloroethene (72 ug/L) Trichloroethene (29 ug/L)
	WITCTA017	Chloroform (0.25 ug/L) cis-1,2-Dichloroethene (0.22 ug/L) Methylene chloride (0.85 ug/L) Trichloroethene (0.76 ug/L)	(none)
	WITCTA020	Methylene chloride (0.58 ug/L) Trichloroethene (7.8 ug/L)	Trichloroethene (7.8 ug/L)
	WITCTA024	1,2,4-Trimethylbenzene (64 ug/L) 1,3,5-Trimethylbenzene (3.5 ug/L) Isopropylbenzene (1.3 ug/L) Methylene chloride (3.3 ug/L) n-Propylbenzene (3.7 ug/L) Naphthalene (4.1 ug/L) p-Isopropyltoluene (3.4 ug/L) sec-Butylbenzene (3.1 ug/L) tert-Butylbenzene (2.4 ug/L)	(none)
	WITCTA025	cis-1,2-Dichloroethene (71 ug/L) Methylene chloride (4.9 ug/L) Tetrachloroethene (14 ug/L)	cis-1,2-Dichloroethene (71 ug/L) Tetrachloroethene (14 ug/L)
East	BGSMW01	Methylene chloride (1.9 ug/L)	(none)
	ST14MW24	Methylene chloride (1.8 ug/L) trans-1,2-Dichloroethene (0.45 ug/L)	(none)
	ST14MW27	Methylene chloride (1.3 ug/L) tert-Butylbenzene (9.6 ug/L)	(none)
	ST14-W05	Methylene chloride (1.7 ug/L)	(none)
	WITCTA019	cis-1,2-Dichloroethene (1.5 ug/L) Methylene chloride (0.5 ug/L) Trichloroethene (0.28 ug/L)	(none)
	WITCTA021	Methylene chloride (0.29 ug/L) Trichloroethene (0.43 ug/L) Vinyl chloride (9.9 ug/L)	Vinyl chloride (9.9 ug/L)
	WITCTA022	cis-1,2-Dichloroethene (0.55 ug/L) Isopropylbenzene (1.1 ug/L) Methylene chloride (0.62 ug/L) n-Butylbenzene (0.44 ug/L) sec-Butylbenzene (0.39 ug/L) Trichloroethene (2.1 ug/L) Trichlorofluoromethane (5.5 ug/L)	(none)
	WITCTA026	Methylene chloride (0.45 ug/L)	(none)
	WITCTA027	Methylene chloride (0.62 ug/L) Trichloroethene (0.25 ug/L)	(none)
	WITCTA028	Methylene chloride (0.91 ug/L)	(none)

Table 3.7
Volatile Organic Compounds (VOCs) Detected Above Practical Quantitation Limits (PQLs) and Risk Reduction Standard 2 (RRS 2) Sanitary Sewer System RFI April 1997 (continued)

Area	Location	Detections Above PQL	Detections Above RRS 2
East	WITCTA031	cis-1,2-Dichloroethene (0.69 ug/L) Methylene chloride (0.29 ug/L) Vinyl chloride (2.2 ug/L)	Vinyl chloride (2.2 ug/L)
	WITCTA032	Methylene chloride (0.76 ug/L) p-Isopropyltoluene (1 ug/L) sec-Butylbenzene (0.66 ug/L)	(none)
	WITCTA033	Methylene chloride (0.73 ug/L) p-Isopropyltoluene (10 ug/L)	(none)
	WITCTA034	Methylene chloride (0.63 ug/L) Tetrachloroethene (0.46 ug/L)	(none)
	WITCTA035	cis-1,2-Dichloroethene (0.37 ug/L) Methylene chloride (0.28 ug/L) Vinyl chloride (4.8 ug/L)	Vinyl chloride (4.8 ug/L)
	WITCTA036	1,1,1-Trichloroethane (28000J ug/L) 1,2,4-Trimethylbenzene (750000 ug/L) 1,3,5-Trimethylbenzene (190000 ug/L) 2-Methylnaphthalene (200000J ug/L) Ethylbenzene (120000 ug/L) n-Propylbenzene (94000 ug/L) Naphthalene (320000 ug/L) o-Xylene (230000 ug/L) Toluene (180000 ug/L)	1,1,1-Trichloroethane (28000J ug/L) 1,2,4-Trimethylbenzene (750000 ug/L) 1,3,5-Trimethylbenzene (190000 ug/L) Ethylbenzene (120000 ug/L) n-Propylbenzene (94000 ug/L) Naphthalene (320000 ug/L) o-Xylene (230000 ug/L) Toluene (180000 ug/L)
	WITCTA037	cis-1,2-Dichloroethene (8.4 ug/L) Methylene chloride (1.9 ug/L) Trichloroethene (58 ug/L)	Trichloroethene (58 ug/L)
Landfill	WITCTA039	cis-1,2-Dichloroethene (230 ug/L) Methylene chloride (7.8 ug/L) Trichloroethene (39 ug/L) Vinyl chloride (22 ug/L)	cis-1,2-Dichloroethene (230 ug/L) Methylene chloride (7.8 ug/L) Trichloroethene (39 ug/L) Vinyl chloride (22 ug/L)

Building 1628 (USACE, 1993). The LSA identified BTEX compounds and total petroleum hydrocarbons (TPH) in the wells. During basewide sampling in January 1996, LNAPL was encountered in well LSA1628-1 and benzene in LSA1628-2. The contamination is highly localized and appears to be the result of product releases from one or more of the tanks. Monitoring well LSA1628-3 was monitored as part of the 1997 basewide monitoring program (Table 3.4 and Table 3.5) and also as part of the sanitary sewer RFI sampling program in April 1997 (Table 3.7 and Table 3.8). LNAPL, benzene, and benzene related compounds were not found above PQL during any sampling period. Antimony was the only metal found at LSA1628-3 above RRS 2.

3.5 EAST AREA GROUNDWATER

This geographic area includes a number of SWMUs and AOCs, including SWMU 28 (Landfill 1), SWMU 29 (Landfill 2), SWMU 62 (Landfill 6), SWMU 68 (POL Tank Farm), SWMU 67 (Building 1340 oil/Water Separator), SWMU 64 (French Underdrain System), AOC 7 (Base Refueling Area), and AOC 1 (Base Service Station/Base Gas Station). A complete list of SWMUs and AOCs associated with the East Area is provided in Table 3.1. Two distinct BTEX plumes occur in this area. The first plume is associated with SWMUs 64, 67, 68, and AOC 7 (referred to in this document as the Tank Farm area). A second plume is associated with AOC 1 (Base Service Station/Base Gas Station). These plumes are shown on Figure 3.3.

3.5.1 Tank Farm Area

BTEX contamination in the tank farm area is believed to be the result of eastward migration of BTEX compounds from either SWMU 68 (POL Tank Farm) or the former underground storage tanks at AOC 7 (these tanks were removed in the 1970s). During 1997 basewide sampling, BTEX compounds and halogenated benzenes above PQL were found in several of the wells sampled (Table 3.4). However, only benzene was found at levels slightly above RRS 2; detections of benzene from 6.1 μg/L to 9.3J μg/L occurred in three wells between SWMU 68 and AOC 7 (Table 3.5). In wells sampled for metals in the tank farm area, arsenic, antimony, iron, lead, and aluminum were found at levels above RRS 2 in several of the wells (Table 3.10). As part of the Remedial Action Plan for this area (including SWMUs 64, 67, and 68 and AOC 7), long-term monitoring (LTM) is required (Parsons, 1997). The selected wells (listed in Table 1.3) will be sampled as part of the proposed monitoring activities (see Section 4.0).

3.5.2 AOC 1 (Base Service Station/Base Gas Station).

In the area of AOC 1, a BTEX plume exists and is believed to be the result of leaking underground gasoline storage tanks formerly located at the base service station. The plume appears to be confined to the immediate vicinity of the facility (i.e, where three gasoline storage tanks and a waste oil tank were removed in May 1993). The results of the basewide sampling indicate BTEX compounds, alkylbenzenes, chlorobenzene, trimethylbenzenes, and naphthalene above PQLs in the downgradient wells associated with this site (Table 3.4). BTEX compounds above RRS 2 were detected in four downgradient wells in July 1997 (Table 3.5). Benzene concentrations of 3,200J μg/L and 4,200 μg/L were found in monitoring wells SAV-2 and MW- 10, respectively. Ethylbenzene concentrations were above 1,600 μg/L in three wells, and toluene concentrations were above 9,000 μg/L in two wells. Iron and manganese concentrations were above RRS 2

Table 3.8
Metals Detected Above Background Concentrations and Risk Reduction Standard 2 (RRS 2) Sanitary Sewer System RFI April 1997

Area	Location	Detections Above Background	Detections Above RRS 2
Flightline	GMI-22-05M	Antimony (24.5 ug/L) Iron (1340 ug/L) Manganese (404 ug/L) Mercury (0.11 ug/L)	Antimony (24.5 ug/L) Iron (1340 ug/L)
	LSA1628-3	Antimony (19.5 ug/L) Beryllium (0.56 ug/L) Manganese (825 ug/L)	Antimony (19.5 ug/L)
	WITCTA004	Iron (1470 ug/L) Manganese (977 ug/L) Sodium (177000 ug/L)	Iron (1470 ug/L)
	WITCTA005	Antimony (23.7 ug/L) Manganese (3400 ug/L)	Antimony (23.7 ug/L) Manganese (3400 ug/L)
	WITCTA006	Arsenic (28.2 ug/L) Iron (1740 ug/L) Manganese (1660 ug/L)	Aluminum (1210 ug/L) Iron (1740 ug/L)
	WITCTA007	Iron (1210 ug/L) Manganese (346 ug/L)	Aluminum (315B ug/L) Iron (1210 ug/L)
	WITCTA009	Manganese (675 ug/L) Silver (4.1 ug/L)	(none)
	WITCTA010	Iron (1280 ug/L) Manganese (954 ug/L)	Aluminum (661 ug/L) Iron (1280 ug/L)
	WITCTA011	Arsenic (24.4B ug/L) Iron (799 ug/L) Manganese (630 ug/L)	Aluminum (592 ug/L) Iron (799 ug/L)
	WITCTA012	Iron (3560 ug/L) Manganese (587 ug/L) Sodium (238000 ug/L)	Iron (3560 ug/L)
	WITCTA013	Iron (434 ug/L)	Iron (434 ug/L)
	WITCTA014	Iron (2720 ug/L)	Aluminum (423 ug/L) Iron (2720 ug/L)
	WITCTA016	Iron (249 ug/L)	(none)
	WITCTA017	Iron (954 ug/L) Silver (4.8 ug/L)	Aluminum (395 ug/L) Iron (954 ug/L)
	WITCTA020	Beryllium (0.51 ug/L) Iron (306 ug/L)	Iron (306 ug/L)
	WITCTA024	Iron (248 ug/L)	(none)
	WITCTA025	Silver (3.7 ug/L)	(none)
East	BGSMW01	Iron (2310 ug/L) Manganese (528 ug/L) Mercury (0.11 ug/L)	Iron (2310 ug/L)
	ST14-24	Antimony (19 ug/L)	Antimony (19 ug/L)

Table 3.8
Metals Detected Above Background Concentrations
and Risk Reduction Standard 2 (RRS 2)
Sanitary Sewer System RFI April 1997 (continued)

Area	Location	Detections Above Background	Detections Above RRS 2
East	ST14-27	Beryllium (0.48 ug/L) Chromium (30.7 ug/L) Iron (2870 ug/L) Manganese (1440 ug/L) Nickel (28.4 ug/L)	Aluminum (771 ug/L) Iron (2870 ug/L)
	ST14-W05	Antimony (23.7 ug/L) Beryllium (0.49 ug/L) Iron (993 ug/L) Manganese (1150 ug/L)	Antimony (23.7 ug/L) Iron (993 ug/L)
	WITCTA019	Beryllium (0.51 ug/L) Manganese (315 ug/L)	(none)
	WITCTA021	Arsenic (24.7 ug/L) Manganese (2310 ug/L)	(none)
	WITCTA022	Beryllium (0.37 ug/L) Iron (444 ug/L)	Iron (444 ug/L)
	WITCTA027	Iron (2870 ug/L) Silver (4.6 ug/L)	Iron (2870 ug/L)
	WITCTA028	Iron (439 ug/L) Manganese (562 ug/L)	Iron (439 ug/L)
	WITCTA031	Arsenic (51.7 ug/L) Barium (1490 ug/L) Iron (5350 ug/L) Manganese (1720 ug/L)	Arsenic (51.7 ug/L) Iron (5350 ug/L)
	WITCTA032	Arsenic (35.8 ug/L) Iron (4880 ug/L) Manganese (663 ug/L)	Aluminum (278 ug/L) Iron (4880 ug/L)
	WITCTA033	Iron (781 ug/L)	Iron (781 ug/L)
	WITCTA035	Iron (1070 ug/L) Manganese (965 ug/L)	Iron (1070 ug/L)
	WITCTA037	Beryllium (0.36 ug/L)	(none)

values in monitoring wells MW-9 and MW-10 (Table 3.10). As part of the Corrective Action Plan for AOC 1 (IT Corporation, 1997a, 1997b), six wells (BSS-B, SAV-2, MW-10, BGSMW02, BGSMW05, BGSMW06) are required to be monitored quarterly for BTEX compounds and methyl tert-butyl ether (MTBE).

3.5.3 SWMUs 28, 29, and 62 (Landfills 1, 2, and 6)

SWMU 28 (Landfill 1) was the original base landfill used during the 1940s. No records are available concerning historical disposal practices (CH2M Hill, 1996a). Monitoring wells characterizing SWMU 28 include: LF01-1B, LF01-1C, LF01-1D, and LF01-1E. VOCs detected in these wells during 1997 include: BTEX compounds, other alkylbenzenes, and chlorobenzene (Table 3.4 and Table 3.5). However, none of these contaminants were detected above RRS 2 values. Metals detected in these wells above RRS 2 include: aluminum, chromium, iron, manganese, and nickel (Table 3.9 and Table 3.10). SWMU 28 (Landfill 1) is the subject of a Limited Site Investigation (HGL, 1997d). This study indicates that the original location of SWMU was incorrect and that the sampled wells listed above are actually upgradient of the landfill instead of downgradient as previously thought. As part of this investigation, one new monitoring well will be installed to provide downgradient coverage.

Currently, no studies have been conducted to characterize SWMU 29 and SWMU 62 (Landfills 2 and 6). SWMU 29 (Landfill 2) was reportedly a borrow pit for runway construction during the 1940s and then used as a landfill. SWMU 62 (Landfill 6) was originally a gravel pit used for base construction activities from 1975 to 1978 (CH2M Hill, 1996a). Both SWMUs will be studied as part of an upcoming RFI of several landfills at NAS Fort Worth JRB (HGL, 1997h).

3.6 LANDFILL AREA GROUNDWATER

This area encompasses the following active SWMUs and AOCs: landfill SWMUs 17, 22, 23, 25, 26, and 27 (Landfills 7, 4, 5, 8, 3, and 10, respectively); SWMU 19 (Fire Training Area 2); SWMU 24 (Waste Burial Area); and several smaller SWMUs and AOCs.

Several of the wells sampled in the landfill area contained TCE and cis-1,2-DCE at concentrations above RRS 2 in July 1997. These VOCs are believed to have originated from previous waste activities associated with one or more of these sites, and from AFP 4, located upgradient of the site. In addition, vinyl chloride at concentrations above RRS 2 was detected in several of the wells over 1997, although it was only found above RRS 2 in monitoring well FT09-12C in July 1997 (Table 3.4 and Table 3.5). Air Force Plant 4 (AFP 4) basewide sampling found similar contaminants in wells sampled on NAS Fort Worth JRB in January 1997 (Table 3.6).

During basewide sampling in 1997, monitoring wells LF05-18 and LF05-19, both located downgradient of the landfills, were sampled for metals (Table 3.9 and Table 3.10). During July 1997, chromium was the only metal which was detected above background (monitoring well LF05-19). No metals were detected above RRS 2 in either well during any quarter of basewide sampling. However, January 1997 basewide sampling at AFP 4 detected iron and aluminum above RRS 2 in well LF05-19 (Table 3.6).

Table 3.9
Metals Detected Above Background Concentrations
NAS Fort Worth JRB Basewide Groundwater Sampling 1997

Area	Location	January 1997	April 1997	July 1997	October 1997
Flightline	GMI-22-05M	Chromium (43.35F ug/L) Cobalt (15.15F ug/L) Copper (12.73F ug/L) Iron (2812.6 ug/L) Lead (5.4 ug/L) Manganese (462.01 ug/L) Nickel (39.45F ug/L)	Chromium (190 ug/L) Copper (60 ug/L) Iron (5250 ug/L) Lead (40 ug/L) Manganese (320 ug/L) Molybdenum (20F ug/L) Nickel (140F ug/L)	Copper (7F ug/L) Iron (280 ug/L)	Iron (880 ug/L)
	USGS04T	Antimony (12.53F ug/L) Copper (4.18F ug/L) Iron (359.7J ug/L) Manganese (360.71 ug/L)	Chromium (10F ug/L) Copper (40F ug/L) Iron (3820 ug/L) Lead (9.3 ug/L) Manganese (300 ug/L)	Copper (5.3F ug/L) Iron (610 ug/L) Manganese (250 ug/L)	Iron (1300 ug/L)
East	LF01-1B	Aluminum (2839 ug/L) Chromium (74.18 ug/L) Copper (10F ug/L) Iron (2794 ug/L) Lead (4.49F ug/L) Manganese (1510.8 ug/L) Nickel (54.47F ug/L)	Chromium (10F ug/L) Cobalt (70 ug/L) Copper (10F ug/L) Iron (260 ug/L) Lead (5.57 ug/L) Manganese (890 ug/L)	Aluminum (12800 ug/L) Antimony (4.6F ug/L) Chromium (1400 ug/L) Cobalt (70 ug/L) Copper (41F ug/L) Iron (18400 ug/L) Lead (8.1 ug/L) Manganese (2300 ug/L) Molybdenum (250 ug/L) Nickel (1300 ug/L) Silver (4.1 ug/L) Vanadium (25F ug/L)	Copper (25F ug/L) Iron (1200 ug/L) Lead (6.8F ug/L) Manganese (1800 ug/L) Zinc (120 ug/L)
	LF01-1C	Arsenic (25.1F ug/L) Copper (4.28F ug/L) Iron (12086J ug/L) Manganese (1696.3 ug/L)	Arsenic (10 ug/L) Copper (10F ug/L) Iron (8660 ug/L) Lead (10 ug/L) Manganese (2100 ug/L)	Arsenic (22 ug/L) Copper (5.3F ug/L) Iron (12000 ug/L) Manganese (1700 ug/L)	Arsenic (26F ug/L) Copper (3.4F ug/L) Iron (13500 ug/L) Manganese (1300 ug/L) Selenium (8.4F ug/L)

Table 3.9
Metals Detected Above Background Concentrations
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location	January 1997	April 1997	July 1997	October 1997
East	LF01-1D	Chromium (8.89F ug/L) Copper (7.51F ug/L) Iron (3672.1J ug/L) Lead (3.48F ug/L) Manganese (433.04 ug/L)	Cobalt (9.79F ug/L) Copper (80 ug/L) Iron (1780 ug/L) Lead (10 ug/L) Manganese (660 ug/L) Cobalt (10F ug/L)	Copper (4.3F ug/L) Iron (2900 ug/L) Manganese (490 ug/L)	Copper (3.2F ug/L) Iron (3200 ug/L) Manganese (300 ug/L)
	LF01-1E	Antimony (16.07F ug/L) Iron (237.91J ug/L) Manganese (3932.6 ug/L)	Copper (10F ug/L) Lead (10 ug/L) Manganese (12800 ug/L)	Copper (4.1F ug/L) Iron (260 ug/L) Manganese (3800 ug/L)	Copper (3.5F ug/L) Iron (1200 ug/L) Manganese (3300 ug/L)
	MW-10	Copper (7.57F ug/L) Iron (8725.34 ug/L) Lead (9.15 ug/L) Manganese (6396 ug/L)	Arsenic (10 ug/L) Cobalt (10F ug/L) Copper (10F ug/L) Iron (7620 ug/L) Lead (6.6 ug/L) Manganese (6060 ug/L)	Arsenic (19 ug/L) Copper (4.7F ug/L) Iron (6300 ug/L) Lead (5 ug/L) Manganese (5900 ug/L)	Arsenic (23F ug/L) Iron (6900 ug/L) Lead (6.4F ug/L) Manganese (5400 ug/L)
	MW-11	Chromium (23.43F ug/L) Iron (798.26J ug/L) Lead (3.11F ug/L) Manganese (391.07 ug/L)	Chromium (10F ug/L) Copper (30F ug/L) Lead (20FD ug/L) Mercury (0.104F ug/L)	Copper (5.2F ug/L) Iron (250 ug/L)	Iron (1500 ug/L) Manganese (800 ug/L)
	MW-12	Copper (13F ug/L) Lead (1.84F ug/L)	Calcium (272000 ug/L) Chromium (10F ug/L) Copper (10F ug/L) Lead (10 ug/L)	Calcium (294000 ug/L) Copper (5.1F ug/L)	Copper (3.9F ug/L) Iron (1600 ug/L)
	MW-9	Copper (6.58F ug/L) Iron (5080.1J ug/L) Lead (1.92F ug/L) Manganese (3756.8 ug/L)	Copper (8.51F ug/L) Iron (3660 ug/L) Lead (20 ug/L) Manganese (3070 ug/L)	Copper (3.9F ug/L) Iron (3300 ug/L) Manganese (3700 ug/L)	Arsenic (5.1F ug/L) Copper (3.1F ug/L) Iron (4000 ug/L) Manganese (3100 ug/L)
	OT-15C	Copper (10.84F ug/L)	Chromium (7.97F ug/L) Copper (6.36F ug/L) Iron (350 ug/L)	Copper (5.2F ug/L)	Copper (3.9F ug/L) Iron (930 ug/L)

Table 3.9
Metals Detected Above Background Concentrations
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location	January 1997	April 1997	July 1997	October 1997
East	SD13-06	(not sampled)	Arsenic (4200 ug/L) Chromium (10F ug/L) Copper (50F ug/L) Iron (3000 ug/L) Lead (30 ug/L)	Copper (24F ug/L) Iron (1600 ug/L)	Arsenic (7.7F ug/L) Copper (4.6F ug/L) Iron (8400 ug/L) Manganese (710 ug/L)
	ST14-02	Iron (11593 ug/L) Lead (1.72F ug/L) Manganese (293.45 ug/L)	Arsenic (8.9 ug/L) Copper (10F ug/L) Iron (10700 ug/L) Lead (7.5 ug/L) Manganese (270 ug/L)	Arsenic (7.8 ug/L) Iron (11200 ug/L) Manganese (270 ug/L) Silver (0.8 ug/L)	Arsenic (11F ug/L) Iron (9700 ug/L) Manganese (220 ug/L)
	ST14-14	Chromium (13.91F ug/L) Copper (5.03F ug/L) Iron (2277.5 ug/L) Lead (2.03F ug/L) Manganese (256.34 ug/L)	Copper (10F ug/L) Iron (1770 ug/L) Manganese (230 ug/L)	Iron (1500 ug/L) Manganese (240 ug/L)	Iron (1800 ug/L)
	ST14-24	Iron (744.11 ug/L)	Copper (70 ug/L)	Copper (4.8F ug/L) Iron (1100 ug/L)	Iron (780 ug/L)
	ST14-26	Copper (5.81F ug/L) Iron (2298.7FD ug/L) Vanadium (22.39F ug/L)	Antimony (10F ug/L) Copper (8.2F ug/L) Iron (390 ug/L)	Copper (3.8F ug/L)	Copper (3.3F ug/L) Iron (1900 ug/L) Lead (2.1F ug/L) Silver (0.33F ug/L) Vanadium (18F ug/L)
	ST14-W18	Aluminum (1847.2 ug/L) Arsenic (64.52F ug/L) Chromium (33.68F ug/L) Copper (6.15F ug/L) Iron (18308 ug/L) Lead (18.72F ug/L) Manganese (217.45 ug/L) Nickel (25.1F ug/L)	Antimony (10F ug/L) Arsenic (30 ug/L) Copper (10F ug/L) Iron (9430 ug/L)	Arsenic (58 ug/L) Copper (5.5F ug/L) Iron (14000 ug/L) Lead (14 ug/L) Manganese (210 ug/L)	Antimony (10F ug/L) Arsenic (70F ug/L) Copper (4.5F ug/L) Iron (13000 ug/L) Lead (20F ug/L) Manganese (180 ug/L) Selenium (10F ug/L)

Table 3.9
Metals Detected Above Background Concentrations
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location	January 1997	April 1997	July 1997	October 1997
East	ST14-W21	Arsenic (141.56F ug/L) Iron (18323 ug/L) Lead (1.72F ug/L) Manganese (680.25 ug/L)	Antimony (10F ug/L) Arsenic (80 ug/L) Copper (7.8F ug/L) Iron (17600 ug/L) Manganese (630 ug/L)	Aluminum (3200 ug/L) Arsenic (47 ug/L) Copper (5.8F ug/L) Iron (10200 ug/L) Lead (3.5F ug/L) Manganese (630 ug/L)	Arsenic (68F ug/L) Chromium (8.8F ug/L) Copper (4.5F ug/L) Iron (8700 ug/L) Lead (2.8F ug/L) Manganese (440 ug/L)
Landfill	LF05-18	Antimony (12.58F ug/L) Chromium (13.35F ug/L) Copper (8.27F ug/L) Lead (1.91F ug/L) Mercury (0.11F ug/L)	Chromium (8F ug/L) Copper (20F ug/L) Lead (6.7 ug/L)	(none)	Iron (1100 ug/L)
	LF05-19	Antimony (13.48F ug/L) Copper (8.72F ug/L) Lead (2F ug/L)	Copper (30F ug/L) Iron (230J ug/L) Lead (10 ug/L)	Copper (5.2F ug/L)	Iron (980 ug/L) Silver (0.41F ug/L)

Table 3.10
Metals Detected Detected Above Risk Reduction Standard 2 (RRS 2)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997

Area	Location	January 1997	April 1997	July 1997	October 1997
Flightline	GMI-22-05M	Aluminum (301.77F ug/L) Iron (2812.6 ug/L)	Aluminum (930 ug/L) Chromium (190 ug/L) Iron (5250 ug/L) Lead (40 ug/L) Nickel (140F ug/L)	(none)	Iron (880 ug/L)
	USGS04T	Antimony (12.53F ug/L) Iron (359.7J ug/L)	Aluminum (1070 ug/L) Iron (3820 ug/L)	Iron (610 ug/L)	Iron (1300 ug/L)
East	LF01-1B	Aluminum (2839 ug/L) Iron (2794 ug/L)	(none)	Aluminum (12800 ug/L) Chromium (1400 ug/L) Iron (18400 ug/L) Nickel (1300 ug/L)	Iron (1200 ug/L)
	LF01-1C	Iron (12086J ug/L)	Aluminum (280F ug/L) Iron (8660 ug/L)	Iron (12000 ug/L)	Iron (13500 ug/L)
	LF01-1D	Iron (3672.1J ug/L)	Iron (1780 ug/L)	Iron (2900 ug/L)	Iron (3200 ug/L)
	LF01-1E	Antimony (16.07F ug/L) Manganese (3932.6 ug/L)	Aluminum (290F ug/L) Manganese (12800 ug/L)	Manganese (3800 ug/L)	Iron (1200 ug/L) Manganese (3300 ug/L)
	MW-10	Iron (8725.34 ug/L) Manganese (6396 ug/L)	Iron (7620 ug/L) Manganese (6060 ug/L)	Iron (6300 ug/L) Manganese (5900 ug/L)	Iron (6900 ug/L) Manganese (5400 ug/L)
	MW-11	Iron (798.26J ug/L)	Lead (20FD ug/L)	(none)	Iron (1500 ug/L)
	MW-12	(none)	(none)	(none)	Iron (1600 ug/L)
	MW-9	Iron (5080.1J ug/L) Manganese (3756.8 ug/L)	Iron (3660 ug/L) Lead (20 ug/L) Manganese (3070 ug/L)	Iron (3300 ug/L) Manganese (3700 ug/L)	Iron (4000 ug/L) Manganese (3100 ug/L)
	OT-15C	(none)	Iron (350 ug/L)	Iron (1600 ug/L)	Iron (930 ug/L)
	SD13-06	(not sampled)	Arsenic (4200 ug/L) Iron (3000 ug/L) Lead (30 ug/L)	(none)	Iron (8400 ug/L)
	ST14-02	Iron (11593 ug/L)	Iron (10700 ug/L)	Iron (11200 ug/L)	Iron (9700 ug/L)
	ST14-14	Aluminum (419.45F ug/L) Iron (2277.5 ug/L)	Iron (1770 ug/L)	Iron (1500 ug/L)	Iron (1800 ug/L)

Table 3.10
Metals Detected Detected Above Risk Reduction Standard 2 (RRS 2)
NAS Fort Worth JRB Basewide Groundwater Sampling 1997 (continued)

Area	Location	January 1997	April 1997	July 1997	October 1997
East	ST14-24	Iron (744.11 ug/L)	(none)	Aluminum (1100 ug/L) Iron (1100 ug/L)	Iron (780 ug/L)
	ST14-26	Aluminum (1036.5FD ug/L) Iron (2298.7FD ug/L)	Antimony (10F ug/L) Iron (390 ug/L)	(none)	Aluminum (460F ug/L) Iron (1900 ug/L)
	ST14-W18	Aluminum (1847.2 ug/L) Arsenic (64.52F ug/L) Iron (18308 ug/L) Lead (18.72F ug/L)	Antimony (10F ug/L) Iron (9430 ug/L)	Aluminum (590 ug/L) Arsenic (58 ug/L) Iron (14000 ug/L)	Antimony (10F ug/L) Arsenic (70F ug/L) Iron (13000 ug/L) Lead (20F ug/L)
	ST14-W21	Arsenic (141.56F ug/L) Iron (18323 ug/L)	Antimony (10F ug/L) Arsenic (80 ug/L) Iron (17600 ug/L)	Aluminum (3200 ug/L) Iron (10200 ug/L)	Aluminum (420F ug/L) Arsenic (68F ug/L) Iron (8700 ug/L)
Landfill	LF05-18	(none)	(none)	(none)	Iron (1100 ug/L)
	LF05-19	(none)	(none)	(none)	Iron (980 ug/L)

3.7 OTHER POTENTIAL GROUNDWATER CONTAMINATION SOURCES

While a number of SWMUs and AOCs define the primary sources of contamination in the three major groundwater plumes, other SWMUs and AOCs located within the groundwater management areas may also impact the groundwater quality. These SWMUs and AOCs may be characterized as various waste accumulation areas, oil/water separators, and underground storage tanks. This section identifies those SWMUs and AOCs and describes, when possible, the nature and extent of contamination associated with them.

3.7.1 Waste Accumulation Areas

Waste accumulation areas are on-site storage, prior to disposal or off-site shipment, for aircraft- and vehicle-maintenance related wastes. These areas are evenly distributed between the Flightline and East Area Groundwater Management areas. In general, data relating to the nature and extent of contamination at waste accumulation areas in the groundwater management areas are not available. A site characterization study of waste accumulation areas is planned for the future.

3.7.2 Oil/Water Separators

Oil/water separators may also act as secondary sources of groundwater contamination. The majority of oil/water separators are located in the East Area Groundwater Management Area. An investigation of 11 of the 14 oil/water separators under the purview of DERA was conducted in 1995 (LAW, 1995). During the sampling program, surface and subsurface soil samples were collected from the perimeter of each oil/water separator and analyzed for metals and VOCs. Additional oil/water separator characterization is planned for the future.

3.7.3 Underground Storage Tanks

Fuel storage and transmission at various locations at NAS Fort Worth JRB have occurred since operations began in the 1940s. Fuel has been stored and supplied to aircraft, military vehicles, and personal vehicles (CH2M Hill, 1996a). The major fuel storage and use areas include SWMU 68 (POL Tank Farm), AOC 4 (Fuel Hydrant System) and AOC 1 (Base Service Station/Base Gas Station); these sites are all currently being studied or remediated. In addition to these localized area of fuel storage and use, miscellaneous underground storage tanks (USTs) located throughout the Base have been in use. At least 60 USTs have been removed since 1995 and at least 38 more are presently in use. Products stored in the fuel tanks have included, but are not limited to JP-4, diesel fuel, Mogas (unleaded gasoline), leaded gasoline, waste oil, n-hydrazine, and waste JP-10. A study to further characterize USTs and related contamination is planned for the future.

TAB

4.0

4.0 PROPOSED MONITORING ACTIVITIES FOR 1998

This section describes the proposed monitoring activities to be conducted in 1998 for the basewide groundwater sampling and analysis program for NAS Fort Worth JRB. These activities, which include well inspection, water level measurements, and analytical sampling, have been proposed to complement the ongoing monitoring activities, as well as those anticipated to begin in the coming year. The results and observations generated from these monitoring activities will be evaluated and adjusted, if needed, after each quarterly sampling event to ensure that short- and long-term objectives are continuously being satisfied.

4.1 MONITORING WELL INSPECTION

In the 1997 GSAP, 180 monitoring wells were considered for sampling at NAS Fort Worth JRB. Four of these are screened in the Paluxy aquifer, and one location was misidentified as a well. These five wells were dropped from the original list of 180 wells. Six background wells have been added to the 1997 well list (Jacobs, 1997), along with 20 wells to be installed prior to the first quarter basewide sampling event in 1998. An additional 34 wells were installed to support the Sanitary Sewer RFI (IT Corporation, 1997c), and 3 wells installed for further coverage in the Landfill Area. Therefore, a total of 246 wells are being considered for the 1998 GSAP. These wells are plotted on the NAS Fort Worth JRB base map shown in Figure 1.5. Table 4.1 provides a total inventory of monitoring wells which were considered for the 1998 GSAP. Table A.1 in Appendix A lists the monitoring well identification numbers, survey coordinates, and top of casing elevations for all of the wells being considered for the 1998 GSAP. A summary of well construction information is provided in Table A.2 of Appendix A. Well construction information was unavailable for each of the 246 wells prior to submitting this report. These selected wells are highlighted in Table A.2.

All monitoring wells will be inspected to ensure that representative samples are collected. As part of the well inspection procedure, the integrity of the surface features will be thoroughly examined and any maintenance needs recorded. Actual maintenance of wells will not be completed at the time of the inspection. For each well, the water levels and the condition of the well will be recorded on a checklist similar to the one in Appendix C, which will contain the following information:

- Date, inspector's initials, monitoring well identification number
- Depth to water, and total depth of the well
- Description of conditions for gasket, lock, and well casing, and if applicable, the security posts, well pad, security casing, and dedicated sampling components

Each well will be checked for total depth to determine whether fine materials have accumulated inside the well casing. For wells that contain an accumulation of fine material, and the thickness of the accumulation is greater than 20 percent of the screened interval, the well will be considered for redevelopment.

Table 4.1
1998 GSAP Well Inventory Database

Description of Wells		
180	Total Number of Wells Considered in 97 GSAP	add
4	Paluxy Wells	drop
1	Misidentified as a well	drop
1	One well identified in IRPIMS	add
6	Background Wells[1] (Jacobs, 1996)	add
7	Wells installed for Base Gas Station Corrective Action Plan	add
34	Wells installed in 1997 for Sanitary Sewer RFI	add
3	HGL's newly installed wells	add
4	Proposed wells for POL Tank Farm Area	add
16	Proposed wells for AOC-2	add
246	Total Number of Wells Considered for '98 GSAP	

[1] Jacobs used 12 wells for the background study; 6 of them were already in the '97 GSAP.

In addition, each well will be inspected for free-product (i.e., LNAPL). Field notes will document whether an odor, sheen, or measurable free product (>0.01 feet thickness) is present. If greater than 0.01 feet of free-product is present, it will be removed (via skimming sock) until it is no longer measurable. At least sixteen wells have emitted petroleum odors over the past four sampling events: BGSMW-3, BSS-B, BSS-A, 17M, ST14-W12, LF04-04, SPOT35-2, SPOT35-5, SPOT35-7, ST14-W15, SD13-01, SD13-02, SD13-04, SD13-05, SD13-07, MW-10. Three of these wells, SD13-04, SD13-07, and 17M, had greater than 0.01 feet of free product during the first quarter 1997 sampling event (CH2M Hill, 1997b, 1997c; HydroGeoLogic, 1997f). Product was removed and re-checked over a four month period (May through August), and no significant accumulation (over 0.01 feet) occurred in any monthly period (Dunkle, 1997).

4.2 WATER LEVEL MEASUREMENTS

The purpose of monitoring the water level measurements is to characterize the groundwater flow directions across the Base. This information will be used to assess the fate and transport of contaminants within the uppermost aquifer. Water level elevations were measured quarterly between April 1995 and January 1996, and semi-annually in 1997 (i.e., January and July). A review of these water level elevations shows little seasonal or annual fluctuation indicating a steady trend in groundwater flow directions from west to east across the site.

4.2.1 Selection of Monitoring Wells for Water Level Measurements

Water level elevations for all of the wells considered for this GSAP will be measured during the first quarterly sampling event (i.e., 246 wells). This will provide an initial inspection of all wells and will provide a basis to recommend a list of wells for possible closure. The subsequent round of water level measurements will be a subset of the wells measured in the first round. This subset of wells will be determined based on a review of (1) visual well inspections, (2) the vicinity of a well to another selected well, (3) the impact on the utility of existing data (i.e., previous water-level measurements), and (4) the delineation of flow aberration.

Wells being considered for closure will follow 30 TAC 238.50 standards for plugging wells that penetrate undesirable water or constituent zones. Appendix A-3 contains a copy of the TNRCC Rule for Well Plugging. The purpose of sealing an abandoned well is to prevent any further disturbance of the pre-existing hydrogeologic conditions that exist within the subsurface. The plug should prevent vertical movement within the borehole and confine the water to the original zone of occurrence.

4.2.2 Frequency of Water Level Measurements

Water levels will be checked on a semiannual basis to evaluate base-wide groundwater flow. This monitoring frequency was selected following review of the previous data collected and verification of relatively consistent groundwater elevations throughout the year. Water level elevations will be measured in wells selected for analytical sampling during each sampling event.

4.3 GROUNDWATER QUALITY SAMPLING

The process for selecting the monitoring wells to be sampled and the analytical tests to be conducted on each sample is based on the short-term and long-term monitoring objectives presented in Section 1. It should be noted that the total number of wells selected for sampling in the 1998 GSAP is different from previous monitoring efforts. Sampling objectives for the basewide sampling program may change in the future as more current results are incorporated into the overall understanding of the site. Therefore, the location and number of wells to be sampled may also require updating.

Table 4.2 presents the sampling matrix, including wells selected for sampling, rationale for their selection (i.e., a specific reference to an objective), and chemical parameters to be tested for each well. Table 4.3 provides a list of wells for each monitoring objective and the type of analyses that are necessary to support each objective. Table 4.2 and 4.3 can be cross-referenced in order to identify the rationale for each well selection. Figure 4.1 shows the location of the wells that were selected for sampling. The figure also shows the extent of the TCE, cis-1,2-DCE, and benzene plumes above their respectives RRS 2 values, based on July 1997 monitoring data. The criteria for well and chemical parameter selection are described in detail in the following subsections.

4.3.1 Well Selection

Once the wells were selected for inspection and water level measurement, they were plotted on a large-scale map showing existing plume boundaries. All available data on well construction, screen intervals, and lithology were compiled for reference. These data appear in Appendix A.2 of this document. Those wells that were sampled in the past were highlighted. Selection of the wells for sampling followed a seven-step process as illustrated in Figure 4.2.

Any wells not screened in the Terrace Alluvium or with a screen length greater than 20 feet were immediately rejected. All wells associated with the current long-term monitoring programs discussed in Section 1.4 were selected for sampling. Next, each monitoring objective was considered and wells that fulfilled each monitoring objective were evaluated. When a well appeared to be a candidate to fulfill a particular objective, wells that were analyzed in the past were given higher priority than those without historical data. Also, if a well could fulfill several objectives, based on its location and historical contamination, it was given greater consideration than wells which might only fulfill one objective. The selection process was an iterative operation; as additional wells were reviewed, they often replaced wells that had been chosen previously.

Once a preliminary list of wells was selected, the value of each well was again reviewed. This process removed any wells from the system that were considered repetitive. As the list of wells was finalized, each well was designated as to its function in the total monitoring system. Designations were based on relative location of the well to known or suspected areas/sources of contamination and to physical features on the site, such as water bodies and site boundaries. Well designations and definitions are provided in Table 4.4.

Table 4.2
Monitoring Wells Selected for 1998 Sampling Program

Area	Well	Objective	Well Type	Chemical Parameters[1]					
				App. IX[2]	VOCs	BTEX	MTBE[3]	Metals	Natural Attenuation[4]
Flightline	GMI-22-02M	L-2	Plume		X				X
	GMI-22-03M	L-2, L-3	Plume		X				X
	GMI-22-04M	L-2, L-3	Plume		X				X
	GMI-22-05M	S-1, S-2	Perimeter		X			X	
	GMI-22-06M	L-2, L-3	Plume		X				X
	GMI-22-07M	L-2	Sentry		X				
	LSA1628-3	L-2, L-3	Plume		X				X
	MW-53	L-2, L-3	Plume		X				X
	SPOT35-5	L-2	Plume		X				X
	USGS04T	S-1	Perimeter		X			X	
	WITCTA010	L-2, L-3	Plume		X				X
	WITCTA024	L-2	Sentry		X				
East	17M	L-1	Plume			X			X
	BGSMW03	L-1	POC			X	X		
	BGSMW05	L-1	POC			X	X		
	BGSMW06	L-1	POC			X	X		
	BSS-B	L-1	POC			X	X		
	LF01-1D	S-1, S-2, L-4	Perimeter	X (Jan.)	X			X	
	SAV-2[5]	L-1	POC			X	X		
	MW-10	L-1, S-1, S-2	POC/Perimeter			X	X	X	
	WHGLTA005	L-1, S-1, S-2	POC/Perimeter	X (Jan.)	X	X		X	X
	WHGLTA006	L-1, S-1, S-2	POC/Perimeter	X (Jan.)	X	X		X	X
	WHGLTA007	L-1	Plume	X (Jan.)	X	X		X	X
	WHGLTA008	L-1	Plume		X	X		X	X
	SD13-01	L-1	Plume	X (Jan.)		X			X
	SD13-02	L-1	Plume	X (Jan.)		X			X
	SD13-04	L-1	Plume	X (Jan.)		X			X
	SD13-06	L-1	Plume	X (Jan.)	X			X	X
	SD13-07	L-1, S-1, S-2	POC/Perimeter	X (Jan.)	X			X	X
	ST14-02	L-1	Plume			X		X	X
	ST14-03	L-1	Plume			X			X
	ST14-04	L-1	Plume			X			X
	ST14-14	L-1	Upgradient		X			X	X
	ST14-24	L-1	Upgradient		X			X	X

Table 4.2
Monitoring Wells Selected for 1998 Sampling Program (continued)

Area	Well	Objective	Well Type	Chemical Parameters[1]					
				App. IX[2]	VOCs	BTEX	MTBE[3]	Metals	Natural Attenuation[4]
East	ST14-26	L-1	Upgradient		X			X	X
	ST14-28	L-1	Plume			X			X
	ST14-29	L-1	Plume			X			X
	ST14-W16	L-1	Plume			X			X
	ST14-W18	L-1	Plume			X		X	X
	ST14-W21	L-1	Plume			X		X	X
	ST14-W31	L-1	Plume	X (Jan.)		X			X
Landfill	LF05-19	L-2, L-3	Plume	X (Jan.)	X			X	X
	WHGLTA003	L-2, L-3	Plume		X				X
	WHGLTA004	L-2, L-3	Plume		X				X
	USGS07T	L-2, L-4	Sentry		X				
	WP07-10C	L-2, L-3, L-4	Plume	X (Jan.)	X			X	X

Notes:

[1]Samples from all wells will also be tested for the following standard field parameters: temperature, pH, electrical conductance (EC), dissolved oxygen (DO), oxidation-reduction potential (Eh), and turbidity.

[2]Analysis for Appendix IX constituents will be completed during the January 1998 sampling event only. The remaining sampling events will include the listed parameters and

[3]Methyl tert-butyl ether (MTBE) can be sampled as part of the BTEX suite (SW8020).

[4]Natural attenuation parameters to be sampled are common anions (chloride, nitrate, sulfate), total organic carbon (TOC), Fe(II), alkalinity, and methane.

[5]This well replaces monitoring well MW-1, which was apparently destroyed during construction of a sewer line.

Table 4.3
Wells Listed by Monitoring Objective

Area/Unit	Wells	Analyses
Analyses for Wells Fulfilling Short-Term Monitoring Objectives (S-1 and S-2)		
Flightline Area	GMI-22-05M, USGS04T	VOCs, metals
East Area	LF01-1D, MW-10, SD13-07, WHGLTA005, WHGLTA006,	
Landfill Area	WHGLTA003	
Analyses for Wells Fulfilling Long-Term Monitoring Objectives L-1		
East Area/SWMUs 64, 67, and 68 and AOC 7	ST14-14, ST14-26, ST14-24, SD13-06, SD13-07, WHGLTA005, WHGLTA006	VOCs
	ST14-03, ST14-04, ST14-02, ST14-16, 17M, ST14-W18, ST14-W21, ST14-28, ST14-29, SD13-01, SD13-02, SD13-04, WHGLTA007, WHGLTA008	BTEX
	ST14-02, ST14-14, ST14-W18, ST14-W21, ST14-24, ST14-26, SD13-06, SD13-07, WHGLTA005, WHGLTA006, WHGLTA007, WHGLTA008	Metals
AOC 1	BGSMW03, BGSMW05, BGSMW06, BSS-B, MW-10, SAV-2	BTEX, MTBE
Analyses for Wells Fulfilling Long-Term Monitoring Objective L-2		
Flightline Area/ AOC 4	SPOT35-5	VOCs
Flightline Area/ TCE Plume	GMI-22-02M, GMI-22-03M, GMI-22-04M, GMI-22-06M, GMI-22-07M, LSA1628-3, MW-53, WITCTA010, WITCTA024	
Landfill Area/ TCE Plume	LF05-19, WHGLTA003, WHGLTA004, USGS07T, WP07-10C	
Analyses for Wells Fulfilling Long-Term Monitoring Objective L-3		
Flightline Area/ AOC 4	SPOT35-5	Nitrate, ferrous iron, sulfate, methane, ethene, TOC, chloride, dissolved oxygen
Flightline Area/ TCE Plume	GMI-22-03M, GMI-22-04M, GMI-22-06M, LSA1628-3, MW-53, WITCTA010, WITCTA024	
Landfill Area/ TCE Plume	LF05-19, WHGLTA003, WHGLTA004, USGS07T, WP07-10C	

Table 4.3 (continued)
Wells Listed by Monitoring Objective

Area/Unit	Wells	Analyses
Analyses for Wells Fulfilling Long-Term Monitoring Objective L-4		
Basewide/RFI (SWMUs 17, 27, 29, 30 and 62)	LF05-19C, WP07-10C	Appendix IX in January[1]
East Area/Work Plan (SWMUs 26 and 28)	LF01-1D	Appendix IX in January[1]
Flightline Area (AOC 4)	GMI-22-02M, SPOT 35-5	TPH, PAH

Notes:
[1]These wells will be sampled for RCRA Appendix IX constituents in January 1998. The results of the sampling will determine which analytes will be sampled for throughout the rest of the year. At a minimum monitoring well LF01-1D will be sampled for VOCs and metals (perimeter well) and monitoring wells LF05-19C and WP07-10C will be sampled for VOCs and natural attenuation parameters.

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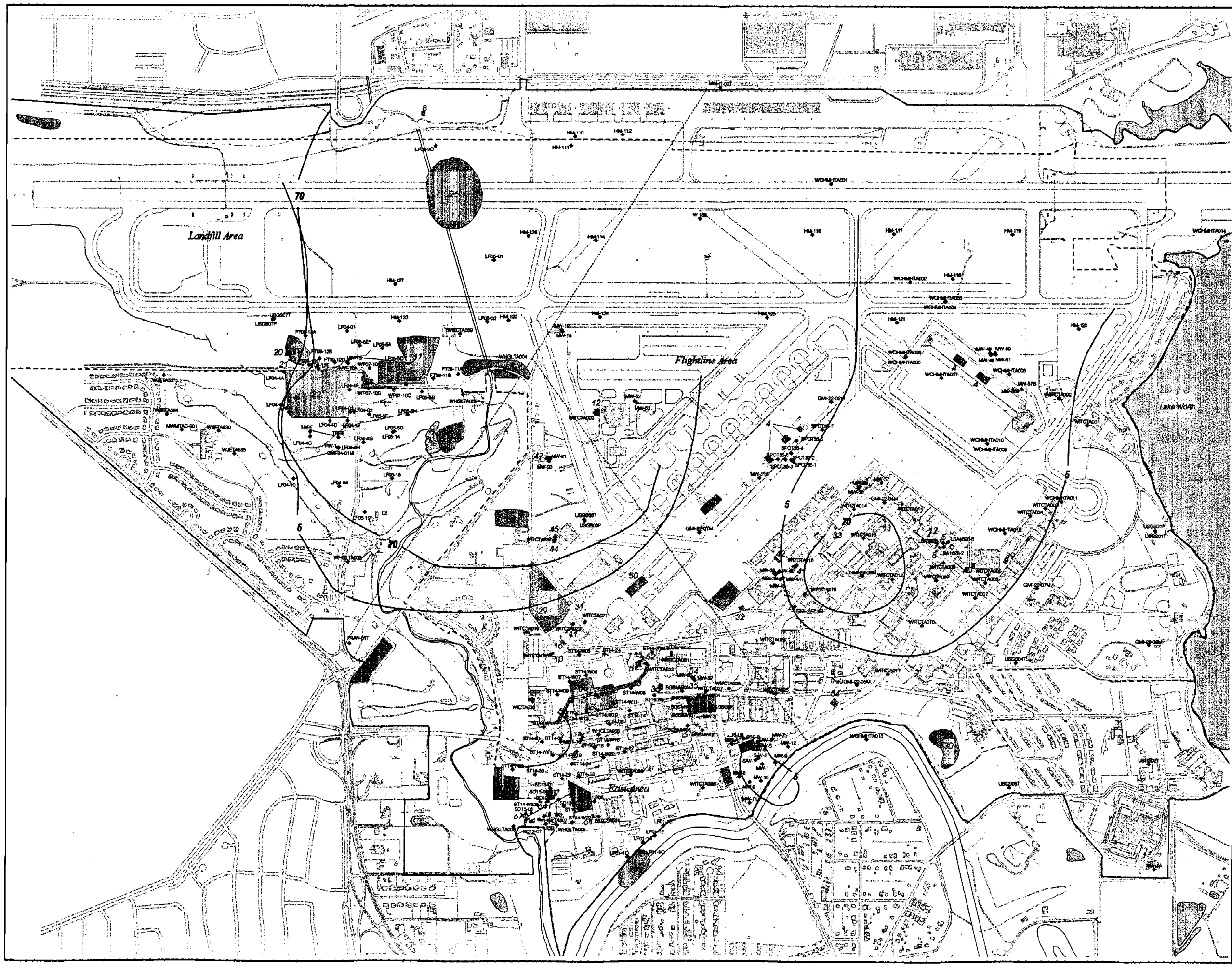


HydroGeoLogic, Inc. — Final 1998 GSAP
NAS Fort Worth JRB, Texas

Figure 4.1
PROPOSED GROUNDWATER SAMPLING LOCATIONS

Air Force Center For
Environmental Excellence
Brooks AFB, Texas

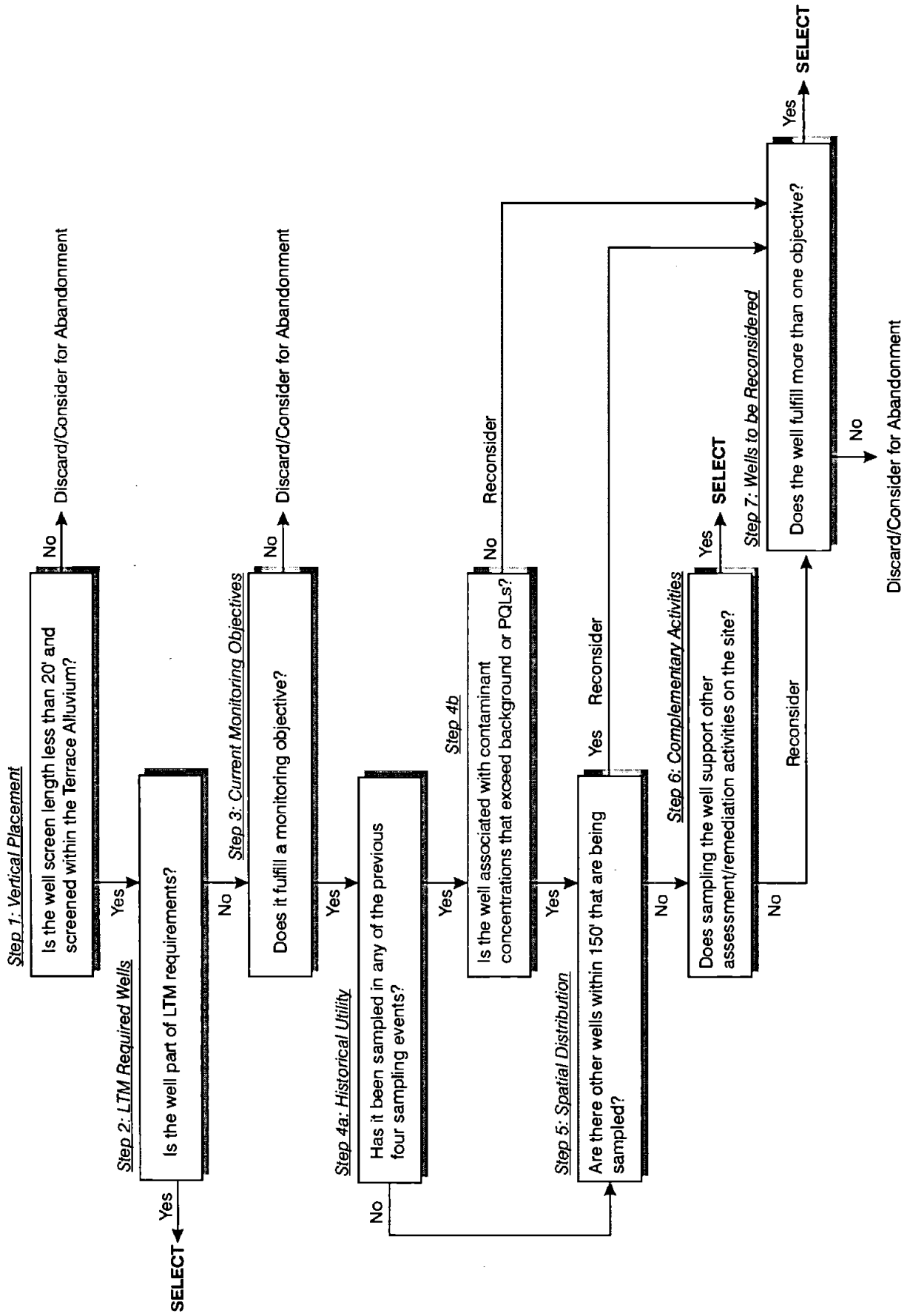
Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- Groundwater Management Areas
- Monitoring Wells Screened in the Terrace Alluvium (not sampled)
- Sampled Monitoring Wells
- Monitoring Wells Screened in the Paluxi Aquifer (not sampled)
- Trichloroethene Groundwater Plume Boundary set at 5 ug/L (RRS 2 Standards)
- cis-1,2-Dichloroethene Groundwater Plume Boundary set at 70 ug/L (RRS 2 Standards)
- Benzene Groundwater Plume Boundary set at 5 ug/L (RRS 2 Standards)
- Area of Concern
- Solid Waste Management Unit (SWMU)

HYDRO GeoLogic INC.

Created: 12/14/97 nsmith
Revision: 04/10/98 nsmith
Project: AFCEE01-078
Filename: AFCEE01078FIG4_1.APR
Map Source: Jacobs, 1996

Figure 4.2 Well Selection Flow Chart



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Project: AFC001-07G1B
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Table 4.4
Well Designations

Designation	Definition
Perimeter Wells	wells located near the Base boundaries and/or immediately upgradient of surface water bodies where groundwater may discharge to surface water; results will be used to monitor potential for off-site migration.
Upgradient Wells	wells located upgradient of the impacted groundwater; results will be used to evaluate background conditions specific to a known source of contamination
Plume Wells	wells located within or at the lateral edges of the dissolved contaminant plume; results will be used to evaluate the rate of contaminant removal by natural attenuation
Sentry Wells	wells located at the edge or downgradient of the contaminant plume; results will be used to verify the absence of contamination
Point-of-Compliance (POC) Wells	wells associated with a specific SWMU/AOC's groundwater monitoring closure requirements; results will be used to confirm contamination at or below compliance concentrations

4.3.2 Chemical Parameter Selection

Three components were considered in developing the water quality sampling approach: well location relative to an area/source of contamination, type of contamination suspected and/or detected, and specified monitoring requirements resulting from ongoing or previous investigations. Criteria for each of these components were identified and used to develop a sampling matrix for each of the selected wells (Table 4.2). The analytical tests proposed for a selected well reflects the monitoring objective(s) that it supports. For example, when a selected well supports both the natural attenuation objective as well as complements an existing remediation/assessment activity, the list of analytical tests reflect the analysis needed to fulfill both objectives (e.g., natural attenuation parameters, VOCs, and metals).

4.3.2.1 Analyses for Wells Fulfilling Short-Term Monitoring Objectives (S-1 and S-2)

Several wells located near the base boundaries, and/or immediately upgradient of surface water bodies where groundwater discharges to surface water, were selected to monitor potential for off-site migration. These perimeter wells will be sampled for VOCs and metals, and the concentration data for these parameters will be used to evaluate the potential for off-site impacts. The metals data from the current rounds will be used to compare concentrations of metals at the facility boundaries to background levels.

4.3.2.2 Analyses for Wells Fulfilling Long-Term Monitoring Objective L-1

As previously described in Section 1.4, LTM is required for SWMUs 64, 67, and 68 and AOC 7 (ST14/SD13 area) and AOC 1 (Base Gas Station/Base Service Station). The LTM requirements for each area are described in Table 4.3. For the ST14/SD13 area, nine of the 22 wells associated with SD13 will be tested for RCRA Appendix IX constituents during the first sampling round only. The remaining rounds will be sampled for the compounds listed in Table 4.3. If contaminants in analyis methods not found on Table 4.3 are detected in the scan of RCRA Appendix IX constituents, these analyses will be included in the subsequent sampling rounds.

4.3.2.3 Analyses for Wells Fulfilling Long-Term Monitoring Objective L-2

Some wells located in the TCE plume, and the East Area BTEX plumes were selected to provide additional source and plume delineation. These wells will be analyzed for the contaminants specific to the plume in which they are located. Consequently, wells located in a TCE plume will be analyzed for VOCs using EPA Method SW8260 and wells located in a BTEX plume will be analyzed for BTEX and MTBE using EPA Method SW8020.

4.3.2.4 Analyses for Wells Fulfilling Long-Term Monitoring Objective L-3

Wells located within a plume (upgradient and downgradient wells) containing chlorinated hydrocarbons (e.g., TCE) will be analyzed for natural attenuation parameters to determine the degree to which biodegradation is acting to reduce contaminant concentrations in groundwater. These parameters include: dissolved oxygen, nitrate, ferrous iron, sulfate, methane, ethene, chloride, ORP, and alkalinity.

The most important process for the natural biodegradation of highly chlorinated solvents is reductive dechlorination in which the chlorinated hydrocarbon is used as an electron acceptor and a chlorine atom is removed (i.e., TCE ---> DCE ---> VC). Therefore, reductive dechlorination of chlorinated hydrocarbons is associated with the accumulation of daughter products (i.e., DCE and VC) and an increase in the concentration of chloride ions. In addition, reductive dechlorination has been demonstrated under nitrate- and iron-reducing conditions, but the most rapid biodegradation rates affecting the widest range of chlorinated aliphatic hydrocarbons, occur under sulfate-reducing and methanogenic conditions. There must be appropriate source of carbon for microbial growth in order for the process to occur (AFCEE, 1996).

4.3.2.5 Analyses for Wells Fulfilling Long-Term Monitoring Objective L-4

Wells were selected to maximize the number of objectives met by an individual well and also to minimize the total number of wells sampled. When possible, additional analyses were recommended in order to complement ongoing remediation/assessment activities and thereby reduce the number of wells sampled. Table 4.3 lists the wells that complement ongoing remediation/assessment activities on the site requiring sampling. Each activity has a unique set of analytical tests that will be implemented for the wells listed.

4.4 ANALYSIS, SAMPLING, AND REPORTING PROCEDURES

Analytical specifications for all sampling rounds will be conducted in accordance with the Basewide Quality Assurance Project Plan (HGL, 1997a). Standard sampling and documentation procedures have been developed for water level measurements and monitoring well sampling. Use of these procedures will promote consistency in field procedures and comparability of the data over time. These standard operating procedures are included as Appendix B.

TAB

5.0

5.0 DATA EVALUATION, DATA MANAGEMENT, AND DATA TRANSFER

Standard procedures for evaluation, management, and transfer of monitoring well data are presented in this section. Adherence to these procedures will ensure that these activities are consistent and efficient. This is especially important because multiple contractors, laboratories, and data users will be involved in producing and handling the data over time. Coordination and communication lines will be established among representatives of all involved parties to ensure that any procedural modifications and new personnel are integrated into ongoing activities.

5.1 DATA EVALUATION

Data evaluation will be conducted as described in the Quality Assurance Project Plan (QAPP) (HGL, 1997a). All field data, analytical data and supporting information will be entered into a database management system after collection and/or receipt of laboratory results. This system allows for data manipulation and evaluation, preparation of summary tables, and links to several types of graphics systems for the production of maps, all of which will be utilized in the preparation of technical reports for each of the groundwater sampling events. Data entries will be checked for accuracy and completeness before any technical reports or IRPIMS submittals are prepared.

5.2 DATA MANAGEMENT

Data management activities will include loading or entering, storing, transferring, and reporting field measurements and analytical results using a structured database. The database structure and software will be standardized and flexible enough to allow the data to be easily exchanged among contractors and transferred to data interpretation software such as computer-assisted drafting and design (CADD) or geographic information system (GIS). Initial system requirement specifications will be prepared and approved by involved contractors and AFCEE to ensure that the database capabilities will meet program objectives. Quality Assurance (QA) procedures for database security and integrity will also be established to ensure that the data collected are complete, accurate, and defensible.

5.3 DATA TRANSFER

Electronic Data File (EDF) transfer is a critical data management contractor responsibility. Data must be easily transferred to data users, among contractors, and to the IRPIMS. The system will support standard formats and have the flexibility to prepare files that can be imported into other software systems. The primary format for EDF transfer to AFCEE and other contractors will be the IRPIMS format because this format is a standard that most contractors support. IRPIMS deliverables to AFCEE will be submitted on a regular basis. Other formats may be needed to allow data to be imported into CADD or GIS systems for data interpretation and mapping water levels, preparing contour plots of contaminants, statistical analysis, or other interpretive tools.

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6.0 REPORTING REQUIREMENTS

During implementation of the groundwater sampling and analysis program for NAS Fort Worth JRB, submittal of technical reports will be required to document the monitoring activities and evaluation of monitoring results. In addition, the GSAP may require periodic modification based on evaluations and recommendations contained in the quarterly technical reports. This section provides a description of the requirements for technical reports (i.e., Quarterly Reports and Annual Reports) and GSAP updates. Also addressed are notification requirements if hazards are encountered during performance of the work.

6.1 TECHNICAL REPORTS

6.1.1 Quarterly Reports

The quarterly reports will tabulate and graphically represent all monitoring data collected and analyzed during each quartering sampling event. The purpose of the quarterly report is to present data rather than provide thorough interpretation of the data. Quarterly samples are taken so that the seasonal variability such as precipitation, temperature, and human impact (i.e., base activity) can be measured and characterized. The quarterly reports emphasize factual data presented as clearly and concretely as possible using maps of well locations, numbers of wells, sampling dates, contour maps, hydrographs, and tables of water levels and results. Appendices in the quarterly report will include all sample data and results as well as a detailed, comprehensive, assessment of the quality control results and data usability.

The data presented in the quarterly report will have been validated and qualified for usability in accordance with the Basewide Quality Assurance Project Plan (HGL, 1997). Also included will be a discussion of how the Data Quality Objectives, including completeness, have been met. Data gaps induced by deviations and unattained DQOs will be identified and evaluated in each quarterly report.

6.1.2 Annual Report

The annual report allows all of the quarterly monitoring events to be viewed and understood within the context of a longer time span. The emphasis in such a report is to compile, compare, and contrast the year's data; an example would be to determine if groundwater levels or flows have varied from season to season. Data interpretation will be based on review of concentration distribution maps for contaminants (with supporting data tables), comparison graphs of inorganic contaminants against background levels, and organic contaminants above PQL, water table contour maps, isopleth maps of natural attenuation parameters, locations of monitoring wells, hydrographs, and selected time series plots.

6.2 GROUNDWATER SAMPLING AND ANALYSIS PLAN UPDATES

The following paragraphs describes the procedures for program evaluation and updates to the GSAP.

6.2.1 Groundwater Sampling and Analysis Program Evaluations

Data will be evaluated after every quarterly sampling event for consistency, representativeness, and relevance to the objectives of monitoring groundwater flow and transportation of contaminants. Ongoing data evaluation will also be performed to allow determination of the appropriateness of the wells sampled and analyses performed so that adjustments can be recommended, if necessary, to minimize unnecessary sampling.

The annual data synthesis will provide a comprehensive assessment of groundwater conditions. The GSAP will be revised or updated after the annual evaluation unless special circumstances warrant more frequent corrections. Three conditions warrant revisions to the GSAP: (1) if data collected to date indicate a change in conditions that would prevent or interfere with attaining the GSAP's objectives, (2) if data gaps in groundwater flow directions, contaminant concentrations, or migration patterns have been filled, or (3) if it is necessary to meet monitoring requirements of a removal or remedial action not already covered by the existing plan. The criteria and procedures for determining data sufficiency and revising the GSAP are summarized in Section 6.2.2. When the GSAP is updated, the rationale for the revised strategy will be described, and additions or modifications for water level measurements and chemical analyses will be documented to provide clear and complete guidance for those implementing the plan in the future.

6.2.2 Data Sufficiency Determination

Data will be considered sufficient to meet the GSAP objectives if they provide a representative picture of current conditions. Representativeness will be evaluated qualitatively by comparing the current data with recent (past quarter) and historical data, and by taking into consideration other ongoing activities, such as remediations or base construction, that might influence flow direction and contaminant concentrations.

The quarterly data evaluation will be directed toward identifying data gaps that limit the interpretation of groundwater flow, contaminant occurrence, or trends in concentrations at the base boundary and downgradient from known areas of contamination. This evaluation occurs after reviewing the analytical data for compliance with quality control (QC) criteria and after verifying the accuracy of the water level measurements. Quarterly evaluation of water level measurements involves preparing water table contour maps for the current quarter's measurements and comparing the current map with the past quarter to determine whether there are unexplained differences in levels and flow directions that could indicate data quality problems or data gaps.

Chemical indicator parameters, TCE, BTEX, and metals, for the current quarter will be evaluated by comparing the results for each well with those for the most recent results collected from the well and nearby wells. If there are changes in concentrations or contaminant occurrence greater than analytical and seasonal variability might suggest, the data will be further evaluated to identify the source of these discrepancies. If large data gaps are identified through this process, they will be reported along with recommendations for modifications during the next quarterly sampling event. Recommendations could include selecting additional or different wells for water level measurements or choosing different wells or analytical parameters for chemical measurements.

The annual data evaluation will be the primary mechanism for determining data sufficiency and the need to revise the groundwater monitoring plan. Historical data and data collected during the past year will be used to conduct a comprehensive evaluation of the data and groundwater conditions relative to program objectives and past conditions. The water level and chemical data should be reviewed in conjunction with each other to support interpretation of both types of results. (For example, determine if changing flow directions are causing a change in contaminant occurrence in the new downgradient direction.)

Water level data will be evaluated using some or all of the following techniques to determine whether data gaps have been filled and groundwater flow directions can be defined.

- Compare contour maps from the recent monitoring events with selected historical maps (from different seasons, years, etc.). Flow directions should be discernible from the maps based on knowledge of the hydrologic conditions related to both lithology and ongoing remediation or construction activities that influence flow.

- Determine if over-sampling has occurred by mapping subsets of wells to evaluate whether the water level contours change using fewer monitoring points. If the same logical contours are produced using fewer wells, then a recommendation to reduce the number of wells monitored during future sampling events may be made.

- Statistically evaluate data for seasonal trends to support interpretation of contaminant concentrations. This will only be possible after a minimum of four to six measurements are available.

If data gaps are still apparent and flow cannot be clearly defined, monitoring additional wells may be recommended. Conversely, if there are more wells than necessary to define flow in a particular area, eliminating selected wells from future sampling events will be recommended.

Contaminant concentrations will be evaluated using some or all of the following techniques to identify data gaps, changing trends in concentration, or to meet other defined data use objectives.

- Prepare contour plots of indicator contaminants (TCE, BTEX, etc.) when possible. Because areal coverage for some contaminants may be limited, contouring may not always be possible; in those cases, the concentrations will be posted on the maps and evaluated for well- or area-specific trends without imposing contours. These maps will be the primary means for evaluating whether there are sufficient chemical measurements to assess conditions in downgradient or base boundary areas. Concurrent evaluation with water level maps is necessary to decide whether this objective has been met.

- Graph data for selected wells in time-series plots if more than four samples have been collected since the well was installed. These plots can be used to identify any obvious concentration trends. Multiple wells in an area may be plotted together to provide a more comprehensive picture.

- Perform statistical analysis for seasonal or other trends if there are enough data points (usually at least four) to satisfy the statistical procedure requirements.

- Perform statistical analysis for comparison of contaminants concentrations to background levels.

- Investigate contaminant concentrations by depth, utilizing well screen interval and pump placement evaluation.

Modifications in sampling frequency, analytical methods, and wells should be made based on this evaluation.

6.3 CONTINGENCY NOTIFICATION

If any imminent physical or health hazards are encountered by personnel employed by the contractor or their representative during field investigation activities, the AFCEE Team Chief and NAS Fort Worth JRB Point of Contact (POC) will be contacted immediately by telephone. Written notification of the situation, including supporting documentation, will be made within three days after telephone notification.

TAB

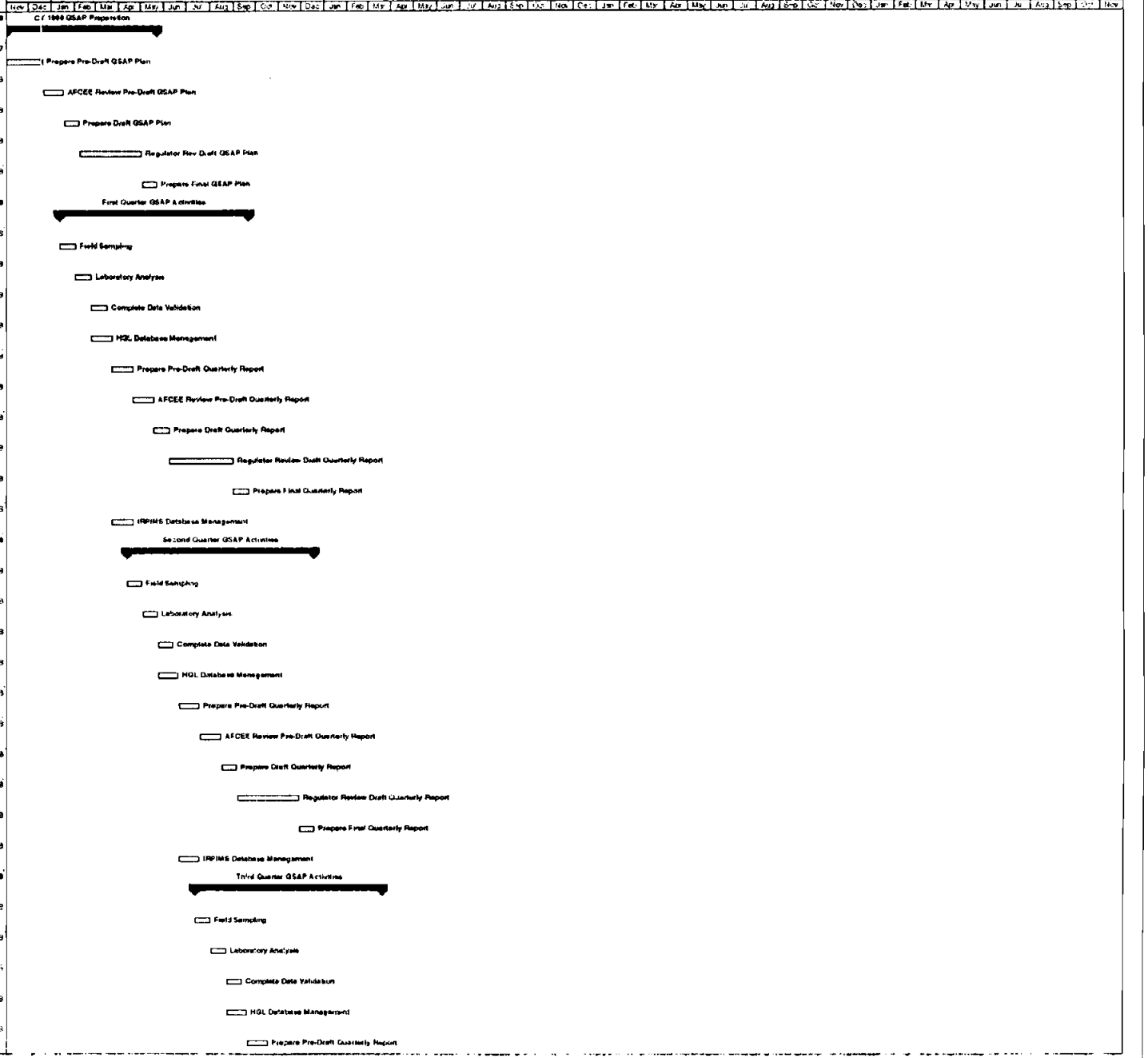
7.0

7.0 PROJECT SCHEDULE

A schedule for completion of tasks for each quarterly sampling event as well as preparations for the next year's GSAP is presented in Figure 7.1. This schedule includes GSAP preparations, field sampling, laboratory analyses, data validation, database management, quarterly reports, and the annual report. The schedule for technical report preparation includes a review of a pre-draft documentation by AFCEE and a TNRCC review of the revised draft documentation. Responses to the review comments will be prepared along with revision to the pre-draft and the revised draft documents, resulting in a final document that incorporates AFCEE and TNRCC input.

Figure 7-1
Proposed Project Schedule
QSAP NAS Fort Worth JRB, Texas

ID	Task Name	Start	Duration	Finish
1	CY 1998 QSAP Preparation	11/3/97	185d	5/22/98
2	Prepare Pre-Draft QSAP Plan	11/3/97	35d	12/18/97
3	AFCEE Review Pre-Draft QSAP Plan	12/22/97	20d	1/16/98
4	Prepare Draft QSAP Plan	1/16/98	15d	2/5/98
5	Regulator Rev Draft QSAP Plan	2/5/98	60d	5/1/98
6	Prepare Final QSAP Plan	5/4/98	15d	5/22/98
7	First Quarter QSAP Activities	1/13/99	180d	9/21/99
8	Field Sampling	1/13/99	15d	2/2/99
9	Laboratory Analysis	2/3/99	15d	2/23/99
10	Complete Data Validation	2/24/99	15d	3/10/99
11	HGL Database Management	2/24/99	20d	3/23/99
12	Prepare Pre-Draft Quarterly Report	3/24/99	20d	4/20/99
13	AFCEE Review Pre-Draft Quarterly Report	4/21/99	20d	5/18/99
14	Prepare Draft Quarterly Report	5/18/99	15d	6/8/99
15	Regulator Review Draft Quarterly Report	6/9/99	60d	8/31/99
16	Prepare Final Quarterly Report	8/7/99	15d	9/21/99
17	IRPIMS Database Management	3/24/99	20d	4/20/99
18	Second Quarter QSAP Activities	4/13/99	180d	12/8/99
19	Field Sampling	4/13/99	15d	5/3/99
20	Laboratory Analysis	5/4/99	15d	5/23/99
21	Complete Data Validation	5/25/99	15d	6/12/99
22	HGL Database Management	5/25/99	20d	6/18/99
23	Prepare Pre-Draft Quarterly Report	6/22/99	20d	7/13/99
24	AFCEE Review Pre-Draft Quarterly Report	7/20/99	20d	8/14/99
25	Prepare Draft Quarterly Report	8/17/99	15d	9/4/99
26	Regulator Review Draft Quarterly Report	9/7/99	60d	11/27/99
27	Prepare Final Quarterly Report	11/30/99	15d	12/18/99
28	IRPIMS Database Management	6/22/99	20d	7/17/99
29	Third Quarter QSAP Activities	7/13/99	180d	3/10/00
30	Field Sampling	7/13/99	15d	7/31/99
31	Laboratory Analysis	8/1/99	15d	8/21/99
32	Complete Data Validation	8/24/99	15d	9/11/99
33	HGL Database Management	8/24/99	20d	9/18/99
34	Prepare Pre-Draft Quarterly Report	9/21/99	20d	10/16/99



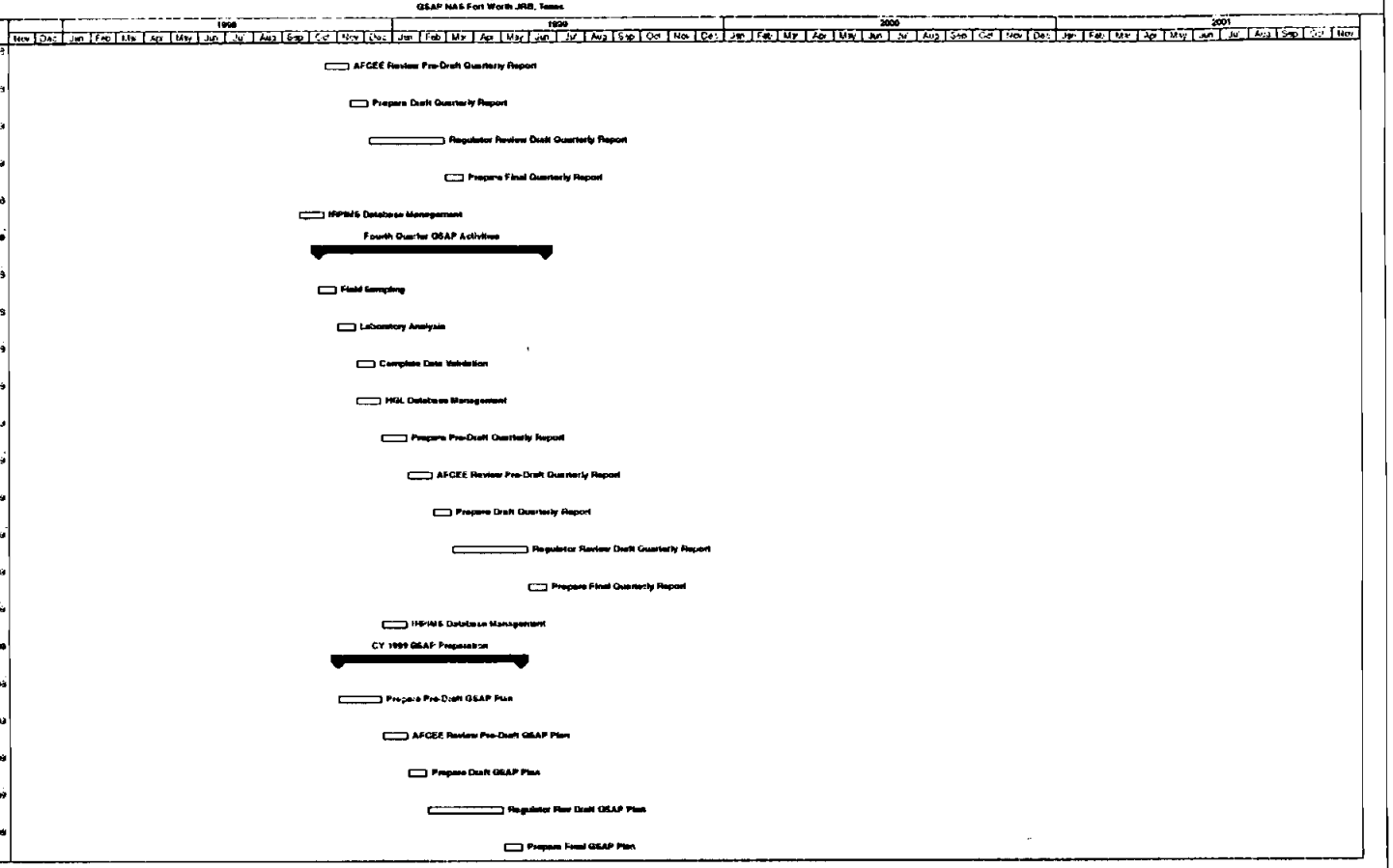
Project: QSAP Schedule
Date: 12/18/97

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

Page 1

Figure 7-1
Proposed Project Schedule
GSAP NAS Fort Worth JRB, Texas

ID	Task Name	Start	Duration	Finish
35	AFCEE Review Pre-Draft Quarterly Report	10/1/98	20d	11/3/98
36	Prepare Draft Quarterly Report	11/6/98	15d	12/4/98
37	Regulator Review Draft Quarterly Report	12/7/98	60d	2/26/99
38	Prepare Final Quarterly Report	3/1/99	15d	3/18/99
39	IRPIMS Database Management	9/21/99	20d	10/18/99
40	Fourth Quarter GSAP Activities	10/12/99	180d	4/10/00
41	Field Sampling	10/12/99	15d	10/30/99
42	Laboratory Analysis	11/2/99	15d	11/20/99
43	Complete Data Validation	11/23/99	15d	12/11/99
44	HGL Database Management	11/23/99	20d	12/18/99
45	Prepare Pre-Draft Quarterly Report	12/21/99	20d	1/15/00
46	AFCEE Review Pre-Draft Quarterly Report	1/18/00	20d	2/12/00
47	Prepare Draft Quarterly Report	2/15/00	15d	3/3/00
48	Regulator Review Draft Quarterly Report	3/6/00	60d	5/26/00
49	Prepare Final Quarterly Report	5/31/00	15d	6/18/00
50	IRPIMS Database Management	12/21/99	20d	1/15/00
51	CY 1999 GSAP Preparation	11/2/99	145d	6/21/00
52	Prepare Pre-Draft GSAP Plan	11/2/99	35d	12/18/99
53	AFCEE Review Pre-Draft GSAP Plan	12/21/99	20d	1/15/00
54	Prepare Draft GSAP Plan	1/18/00	15d	2/5/00
55	Regulator Rev Draft GSAP Plan	2/8/00	60d	4/30/00
56	Prepare Final GSAP Plan	5/3/00	15d	5/21/00



Project: GSAP Schedule
Date: 12/18/97

Task | Progress | Milestone | Summary | Rolled Up Task | Rolled Up Milestone | Rolled Up Progress

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8.0

8.0 REFERENCES

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TAB

Appendix A

Appendix A.1
Well Coordinates

Area	Location	Coordinates		Top of Casing
		Easting	Northing	Elevation
Flightline	GMI-22-01M	2297688.4	6965108.03	606.62
	GMI-22-02M	2296186.804	6966618.856	619.129
	GMI-22-03M	2298538.703	6966206.079	608.034
	GMI-22-04M	2297339.007	6967235.898	610.702
	GMI-22-05M	2299431.878	6966926.352	584.28
	GMI-22-06M	2298186.199	6966990.687	606.842
	GMI-22-07M	2298321.676	6969004.353	605.66
	GMI-22-08M	2298970.215	6970309.355	606.942
	HM-116	2294283.721	6966412.381	634.06
	HM-117	2294274.322	6967356.25	633.318
	HM-118	2294780.422	6968036.082	626.234
	HM-119	2294271.689	6968727.198	625.043
	HM-120	2295343.029	6969490.055	616.838
	HM-121	2295279.205	6967391.16	627.663
	HM-124	2295223.46	6963958.786	623.258
	HM-125	2295220.292	6965893.458	629.366
	LSA1628-1	2297802.1	6967936.2	602.1
	LSA1628-2	2297846.5	6967943.3	602.7
	LSA1628-3	2297791.257	6967993.079	601.732
	MW-11A	2297057.278	6965810.342	612.171
	MW-18	2295389.85	6963519.14	NA
	MW-19	2295368.85	6963512.61	NA
	MW-1A	2301542.45	6970397.32	NA
	MW-36	2299356.658	6965034.802	NA
	MW-38	2298153.077	6965981.092	604.109
	MW-39	2298171.115	6965999.012	NA
	MW-40	2298224.978	6966053.097	NA
	MW-41	2298204.568	6966088.853	NA
	MW-42	2298144.896	6966031.035	NA
	MW-48	2295643.543	6968478.952	619.326
	MW-49	2295623.167	6968470.498	NA
	MW-50	2295621.7	6968528.648	NA
	MW-51	2295639.958	6968536.471	NA
	MW-52	2296182.561	6964355.172	NA
	MW-53	2296200.241	6964378.184	616.75
	MW-56	2296055.932	6968789.529	614.321
	MW-57	2297112.98	6967217.16	613.368
	MW-57B	2296034.177	6968836.004	613.776
	MW-58	2297175.216	6966950.884	NA
	MW-59	2297160.82	6966970.471	NA
	MWMTAC-001	2296520.35	6959115.8	645.04
	SPOT-35-3	2296850.617	6966108.748	NA
	SPOT-35-6	2296634.627	6966234.614	NA

Appendix A.1
Well Coordinates

Area	Location	Coordinates		Top of Casing
		Easting	Northing	Elevation
Flightline	SPOT35-1	2296878.532	6966202.395	613.59
	SPOT35-2	2296854.203	6966175.289	613.635
	SPOT35-4	2296777.882	6966174.924	612.739
	SPOT35-5	2296846.726	6966020.036	614.09
	SPOT35-7	2296508.592	6966534.791	616.408
	USGS01P	2297664.372	6970387.26	604.83
	USGS01T	2297660.422	6970383.919	604.785
	USGS02T	2300335.041	6970326.57	604.206
	USGS03T	2300608.98	6968690.536	575.015
	USGS04T	2299177.629	6968758.861	604.923
	W-153	2294096.507	6965107.145	631.568
	WCHMHTA001	2293702.384	6966632.501	639.08
	WCHMHTA002	2294818.468	6967545.100	631.32
	WCHMHTA003	2295039.039	6967958.333	631.00
	WCHMHTA004	2295041.059	6967949.303	631.25
	WCHMHTA005	2295662.842	6967495.679	626.95
	WCHMHTA006	2295671.903	6967494.615	626.73
	WCHMHTA007	2295910.42	6967910.326	623.93
	WCHMHTA008	2295862.693	6968694.421	622.85
	WCHMHTA009	2296663.993	6968444.685	615.55
	WCHMHTA010	2296660.061	6968440.059	615.35
	WCHMHTA011	2297328.375	6969295.196	605.8
	WCHMHTA012	2297691.142	6968645.437	605.85
	WCHMHTA013	2300051.586	6967055.521	578.26
	WCHMHTA014	2294337.637	6971208.882	619.11
	WITCTA001	2296446.73	6969591.007	610.85
	WITCTA002	2296135.475	6969258.49	613.36
	WITCTA003	2297405.052	6969111.3	607.58
	WITCTA004	2297490.47	6968938.831	606.62
	WITCTA005	2298166.787	6968458.461	602.81
	WITCTA006	2298261.857	6968425.939	602.76
	WITCTA007	2298432.068	6968309.561	603.03
	WITCTA008	2298030.119	6967939.663	600.62
	WITCTA009	2298232.895	6967860.597	597.15
	WITCTA010	2298752.182	6967693.534	600.31
	WITCTA011	2297357.309	6967455.258	610.27
	WITCTA012	2298224.392	6967348.773	599.93
	WITCTA013	2297750.979	6967015.62	605.39
	WITCTA014	2297417.505	6966903.565	611.74
	WITCTA015	2298395.024	6966332.667	606.84
	WITCTA016	2298061.326	6966238.285	607.85
	WITCTA017	2299305.778	6967298.148	592.94
	WITCTA020	2296316.788	6963895.317	616.78
	WITCTA024	2298956.02	6965971.777	604.86
	WITCTA025	2299534.282	6966004.916	595.2

Appendix A.1
Well Coordinates

Area	Location	Coordinates		Top of Casing Elevation
		Easting	Northing	
East	15B	2301032.08	6963338.735	567.589
	17I	2299626.674	6963642.662	578.129
	17J	2299584.431	6963780.053	579.943
	17K	2299799.209	6963578.343	575.469
	17L	2299741.167	6963812.735	577.321
	17M	2300037.62	6963761.95	574.28
	BGSMW01	2299511	6964916.44	578.64
	BGSMW02	2299618.19	6965006.79	577.57
	BGSMW03	2299690.06	6965067.5	576.72
	BGSMW04	2299589.5	6965084.53	578.49
	BGSMW05	2299961.23	6965150.67	571.66
	BGSMW06	2299910.09	6964981.31	576.51
	BGSMW07	2299737.83	6964990.68	574.88
	BSS-A	2300115.431	6965491.098	566.493
	BSS-B	2300085.914	6965811.954	569.405
	ITMW-01T	2298967.14	6961062.05	NA
	LF01-1A	2301249.8	6964466.4	570.27
	LF01-1B	2301057.006	6964700.806	560.182
	LF01-1C	2301376.05	6964438.037	562.148
	LF01-1D	2301412.716	6964288.176	563.909
	LF01-1E	2301174.3	6964606.025	562.113
	MW-1	2300345.606	6965853.592	560.635
	MW-10	2300541.575	6965836.203	558.846
	MW-11	2300791.955	6965706.661	558.167
	MW-12	2300142.021	6966149.318	559.621
	MW-2	2300555.919	6965704.96	557.55
	MW-20	2296878.439	6963365.698	611.38
	MW-21	2296841.863	6963382.211	NA
	MW-3	2299750.342	6965242.674	576.475
	MW-37	2299384.988	6965061.349	590.529
	MW-4	2300090.055	6965802.687	NA
	MW-5	2300138.608	6965803.452	563.687
	MW-6	2300173.696	6965734.917	562.873
	MW-7	2300055.237	6965967.108	567.37
	MW-8	2300491.789	6965584.178	557.036
	MW-9	2300329.174	6966001.958	559.538
	MW1-16	2300066.63	6963755.16	NA
	OT-15C	2300947.512	6963316.339	564.251
	P5	2299737.38	6965287.56	NA
	PI-U9	2300053.58	6965632.91	NA
	SAV-1	2300298.887	6965776.357	NA
	SAV-2	2300280.415	6965807.583	NA
	SD13-01	2300621.423	6963391.743	573.089
	SD13-02	2300753.03	6963487.702	573.279
	SD13-03	2300699.63	6963362.921	571.414
	SD13-04	2300770.955	6963361.521	569.078

Appendix A.1
Well Coordinates

Area	Location	Coordinates		Top of Casing
		Easting	Northing	Elevation
East	SD13-05	2300775.292	6963904.275	571.535
	SD13-06	2300907.827	6963164.35	557.677
	SD13-07	2301009.342	6963167.041	560.436
	ST14-01	2300089.327	6963307.935	575.945
	ST14-02	2300089.486	6963524.076	575.513
	ST14-03	2299888.427	6964091.765	576.679
	ST14-04	2300342.951	6963656.498	575.607
	ST14-14	2299735.22	6964309.76	NA
	ST14-24	2299084.2	6964017.889	594.136
	ST14-25	2299065.36	6964563.76	NA
	ST14-26	2299557.04	6964593.25	NA
	ST14-27	2300212.35	6964257.94	NA
	ST14-28	2300495.99	6963728.32	NA
	ST14-29	2300512.775	6963527.787	571.446
	ST14-30	2300466.182	6963211.534	566.872
	ST14-W05	2299093.85	6963726.062	593.632
	ST14-W06	2299330.792	6963806.563	581.417
	ST14-W07	2299393.809	6963614.609	579.96
	ST14-W08	2299479.591	6964323.981	580.535
	ST14-W09	2299550.097	6963471.685	575.54
	ST14-W10	2299730.125	6963949.34	573.985
	ST14-W11	2299657.972	6964128.603	576.308
	ST14-W12	2299581.062	6963953.266	575.517
	ST14-W13	2299776.442	6963695.163	574.487
	ST14-W15	2299923.113	6963315.787	573.474
	ST14-W16	2300128.304	6964064.608	573.62
	ST14-W18	2300162.474	6963906.725	573.789
	ST14-W19	2300203.607	6963699.799	573.312
	ST14-W20	2300275.355	6964009.08	573.48
	ST14-W21	2300242.02	6963417.822	572.884
	ST14-W22	2301016.385	6963649.635	571.301
	ST14-W23	2300410.368	6962949.056	565.601
	ST14-W31	2300830.861	6963549.672	571.234
	ST14-W32	2300815.069	6963239.017	NA
	USGS05P	2299736.772	6965287.814	576.77
	USGS06P	2297557.582	6963772.044	606.713
	USGS06T	2297542.147	6963763.468	606.673
	WITCTA019	2298838.013	6963107.247	600.82
	WITCTA021	2298718.156	6963794.398	604.19
	WITCTA022	2298742.854	6963649.916	604.17
	WITCTA026	2299480.089	6965456.85	584.37
	WITCTA027	2299510.856	6965193.741	581.44
	WITCTA028	2300621.253	6965160.619	558.11
	WITCTA031	2299152.204	6964689.931	592.1
	WITCTA032	2299195.636	6964500.665	587.37
	WITCTA033	2300475.241	6964323.666	574.63

Appendix A.1
Well Coordinates

Area	Location	Coordinates		Top of Casing
		Easting	Northing	Elevation
	WITCTA034	2300951.486	6963956.683	571.95
	WITCTA035	2299093.681	6963387.121	599.37
	WITCTA036	2299629.281	6963181.649	578.57
	WITCTA037	2297784.441	6963424.036	604.19
Landfill	FT08-11A	2295877.824	6962320.529	608.153
	FT08-11B	2295930.494	6962033.727	608.047
	FT09-12A	2295444.952	6960550.799	635.384
	FT09-12B	2295702.537	6960711.211	627.364
	FT09-12C	2295776.808	6960592.732	627.863
	FT09-12D	2295747.783	6960889.736	627.26
	FT09-12E	2295826.279	6960703.506	627.338
	GMI-04-01M	2296728.134	6960931.26	613.788
	HM-111	2293265.658	6963623.549	636.494
	HM-114	2294352.05	6963913.38	NA
	HM-122	2295260.535	6962891.108	619.441
	HM-123	2295273.071	6961639.474	624.852
	HM-126	2294300.504	6963121.979	622.988
	HM-127	2294853.212	6961589.394	624.038
	LF03-3D	2293269.12	6962056.65	625.25
	LF04-01	2295382.891	6961027.715	629.164
	LF04-02	2296313.704	6961116.666	623.441
	LF04-03	2296310.26	6961069.03	623.25
	LF04-04	2297169.758	6960947.279	611.954
	LF04-10	2297084.938	6960417.453	626.472
	LF04-4A	2295852.984	6960300.484	625.84
	LF04-4B	2296274.338	6960323.911	619.953
	LF04-4C	2296593.501	6960604.002	612.962
	LF04-4D	2296416.385	6960831.587	615.126
	LF04-4E	2296410.998	6961036.036	618.489
	LF04-4F	2296058.767	6961061.85	625.28
	LF04-4G	2296658.929	6961224.127	619.754
	LF04-4H	2296721.26	6960928.75	613.43
	LF05-01	2294577.894	6962727.628	621.884
	LF05-02	2295279.205	6962654.333	622.612
	LF05-14	2296543.61	6961562.305	611.791
	LF05-18	2297077.935	6961560.048	611.708
	LF05-19	2297465.123	6961246.474	606.05
	LF05-5A	2295580.898	6961438.557	622.999
	LF05-5B	2296078.248	6961901.555	597.174
	LF05-5C	2295993.73	6961720.051	608.561
	LF05-5D	2295757.035	6961740.466	611.397
	LF05-5E	2295550.36	6961177.867	626.703
	LF05-5F	2296336.36	6961288.64	618.95
	LF05-5G	2296536.324	6961581.317	615.279
	LF05-5H	2296343.797	6961735.963	610.612
	MW-12A	2295756.2	6961041.92	NA

Appendix A.1
Well Coordinates

Area	Location	Coordinates		Top of Casing
		Easting	Northing	Elevation
Landfill	MW-13	2295736.39	6961035.09	NA
	MW-IT-02T	2292616.01	6965366.41	NA
	RW-1	2296721.472	6960929.874	NA
	TREE	2296603	6960772.688	NA
	TREE	2296542	6960604	NA
	USGS07P	2295251.112	6960150.607	632.1
	USGS07T	2295245.824	6960168.163	632.426
	WHGLTA002	2296111.39	6962377.91	608.52
	WHGLTA003	2298029.84	6961043.88	614.22
	WHGLTA004	2295760.62	6962943.38	614.35
	WITCTA039	2295415.407	6962339.771	619.47
	WJETA530	2296533.87	6959546.93	639.39
	WJETA531	2295893.78	6958908.59	644.17
	WJETA534	2296341.54	6958941.15	647.38
	WJETA535	2296794.44	6959722.27	634.61
	WP07-10A	2295811.284	6961292.961	626.5
	WP07-10B	2296044.506	6961280.516	624.223
	WP07-10C	2296065.422	6961578.291	617.179

Notes:
NA = Data not available.

Appendix A.2
Well Construction Information
NAS Fort Worth JRB, Texas

Site Name/ SWMU #/ IRP #	Well ID	Well Stickup Length (ft.)	Ground Elevation (ft.MSL)	TOC Elevation (ft.MSL)	TD (ft) when Installed (ft.BGS)	TD (ft) when Installed (ft. below TOC)	DTW when Inspected (ft. below TOC)	SWL (ft.MSL)	Depth to Bedrock (ft.BGS)	Screened Interval (ft.BGS)	Stratigraphic Unit	Casing Parameters when Inspected: Inside Diameter (in)	PVC? Y/N	pH	Bailer Down Well	HNu ppm	Product Present? (Y/N)	Well Casing Fittings	Filter Pack Interval (ft.BGS)	Seal Interval (ft.BGS)	Remarks
Landfill 01/	LF01-1A	3.77	566.50	570.27	7.75	-	-	-	7	2.8 - 7.8	AL	2	Y	-	-	-	-	-	2.6 - 9.0	1.5 - 2.6	Well in proximity to LF01-1F
SWMU 28/	LF01-1B	-0.25	560.50	560.25	19.10	19.87	14.97	545.28	NE	9.0-19.0	AL	2	Y	7.0	Plumb	4.0	N	T	8.0-20.0	5.5-8.0	Included in Jacobs groundwater study
IRP Site 1	LF01-1C	-0.30	560.30	560.00	33.10	32.54	18.80	541.20	33.0	22.7-32.7	AL	2	Y	7.0	Plumb	5.7	N	T	20.0-33.1	17.2-20.0	-
	LF01-1D	3.43	560.50	563.93	23.30	28.14	20.05	543.88	23.0	16.4-21.1	AL	2	Y	7.0	Plumb	16.1	N	T	12.0-23.3	10.0-12.0	Well located inside firing range
	LF01-1E	2.85	559.40	562.25	29.60	32.12	17.97	544.28	NE	19.60-30.35	AL	2	Y	7.0	Plumb	73.2	N	T	12.0-29.6	10.0-12.0	-
Landfill 03/SWMU 26/ IRP Site 3	LF03-3D	3.65	621.60	625.25	16.00	17.85	12.67	-	-	7.5 - 14.4	-	2	Y	-	-	-	-	-	5.5 - 15.5	3.5 - 5.5	-
Landfill 04/	LF04-4A	1.16	624.60	625.76	24.00	24.79	12.04	613.72	18.0	14.0-24.0	AL	2	Y	7.0	Plumb	ND	N	T	10.5-24.0	8.0-10.5	Well difficult to access due to snakes
SWMU 22/	LF04-4B	1.50	618.40	619.90	24.00	25.30	14.17	605.73	18.0	13.0-23.0	AL	2	Y	7.0	Plumb	ND	N	T	12.0-24.0	9.0-12.0	Well difficult to access due to thick brush
IRP Site 4	LF04-4C	2.14	610.90	613.04	29.50	28.00	19.74	593.30	28.0	18.5-28.5	AL	2	Y	7.0	Plumb	ND	N	T	16.0-29.5	14.0-16.0	Included in Jacobs groundwater study
	LF04-4D	2.25	613.10	615.35	30.50	27.69	21.47	593.88	30.0	18.0-28.0	AL	2	Y	7.0	Plumb	ND	N	T	16.5-30.5	14.5-16.5	-
	LF04-4E	1.04	617.50	618.54	35.00	30.76	24.93	593.61	33.7	24.3-35.0	AL	2	Y	7.0	Plumb	ND	N	T	23.9-35.0	21.0-23.9	-
	LF04-4F	2.56	622.80	625.36	35.00	37.26	30.31	595.05	35.5	21.0-34.0	AL	2	Y	7.0	Plumb	ND	N	T	15.5-35.0	13.5-15.5	-
	LF04-4G	0.92	619.10	620.02	36.00	33.20	27.22	592.80	39.5	22.0-35.0	AL	2	Y	7.0	Plumb	ND	N	T	19.0-36.0	17.0-19.0	Included in Jacobs groundwater study
	LF04-4H	2.93	610.50	613.43	28.00	18.33	None	None	27.0	14.0-27.0	AL	2	Y	-	Plumb	ND	N	T	10.0-28.0	8.0-10.0	Dry Well
	LF04-01	2.74	626.5	629.24	40.00	41.41	31.61	31.61	40.0	29.95 - 40.0	-	2	Y	7.0	Plumb	ND	N	T	28.0 - 40.0	26.0 - 28.0	WCDNA
	LF04-02	2.68	621.0	623.68	37.65	38.76	29.78	29.78	37.0	23.1 - 37.65	-	2	Y	7.0	Plumb	ND	N	T	20.9 - 3737	18.9 - 20.9	WCDNA
	LF04-03	561.20	62.05	623.25	25.20	-	-	-	37.0	22.4 - 37.42	-	2	Y	-	-	-	-	-	19.4 - 37.52	17.4 - 19.4	-
	LF04-04	2.67	609.4	612.07	49.50	26.90	19.68	19.68	25.0	15.2 - 25.2	-	2	Y	7.0	Plumb	36	N	T	13.2 - 25.2	11.2 - 13.2	Overgrown brush around well; WCDNA
	LF04-10	-0.36	626.9	626.54	-	-	-	-	49.0	39.22 - 49.1	-	2	Y	-	-	-	-	-	30.0 - 49.5	28.0 - 30.0	-
	MW-12A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MW-13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Downgradient Well	WHGLTA003	-0.25	614.47	614.22	30.00	[illegible]	[illegible]	[illegible]	30	20 - 31	AL	2	Y	[illegible]	[illegible]	[illegible]	N	[illegible]	18 - 20	16 - 18	[illegible]
Landfill 05/	LF05-5A	3.78	619.40	623.18	32.00	30.38	25.05	598.13	31.0	18 - 28	AL	2	Y	7.0	Plumb	ND	N	T	16.0- 32	14.0 - 16	Included in Jacobs Engineering groundwater study
SWMU 23/	LF05-5B	3.05	597.40	600.45	9.00	-	-	-	8.0	4.0 - 9.0	AL	2	Y	-	-	-	N	T	3.5 - 9.0	2.0 - 3.5	Unable to access well
IRP Site 5	LF05-5C	1.88	606.80	608.68	22.00	20.44	11.41	597.27	20.0	7.0 - 22.0	AL	2	Y	7.0	Plumb	ND	N	T	6.0 - 22.0	4.0 - 6.0	-
	LF05-5D	3.21	608.50	611.71	20.50	21.18	12.98	598.73	NE	10.5 - 19.5	AL	2	Y	7.0	Plumb	ND	N	T	8.0 - 20.5	6.0 - 8.0	Access to well difficult tdue to weeds
	LF05-5E	2.99	623.90	626.89	39.10	35.85	29.13	597.76	NE	25.1 - 38.1	AL	2	Y	7.0	Plumb	ND	N	T	21.5 - 39.1	19.5 - 21.5	Top 6" of well casing is cracked
	LF05-5F	-0.50	619.45	618.95	36.00	-	-	-	NE	21.0 - 35.0	-	2	Y	-	-	-	-	-	16.0 - 37.0	14.0 - 16.0	-
	LF05-5G	3.39	612.00	615.39	27.00	30.22	22.10	593.29	29.0	15.25 - 26	AL	2	Y	7.0	Plumb	ND	N	T	11.0 - 27.0	9.0 - 11.0	-
	LF05-5H	2.22	608.40	610.62	25.60	27.81	16.49	594.13	25.0	13.85 - 24.6	AL	2	Y	7.0	Plumb	ND	N	T	8.0 - 25.6	6.0 - 8.0	Roots/other organics retrieved in bailer
	LF05-01	2.66	619.30	621.96	25.00	27.47	19.71	-	25.0	14.95 - 25.0	-	2	Y	-	-	-	-	-	11.8 - 25.2	9.8 - 11.8	-
	LF05-02	2.39	620.30	622.69	27.00	29.98	24.34	-	27.0	16.95 - 27.0	AL	2	Y	7.0	Plumb	ND	N	T	16.95 - 27.2	14.95 - 16.95	WCDNA
	LF05-14	-0.22	603.20	602.98	13.15	12.54	9.70	-	13.0	5.12 - 13.15	-	2	Y	-	-	-	-	-	4.8 - 13.15	2.8 - 4.8	-
	LF05-18	-0.26	612.10	611.84	23.95	23.95	19.83	-	23.0	13.9 - 23.95	AL	2	Y	7.0	Plumb	11.4	N	T	11.6 - 23.95	9.6 - 11.6	WCDNA
	LF05-19	-0.22	606.30	606.08	20.75	[illegible]	[illegible]	-	20.0	[illegible]	[illegible]	[illegible]	Y	7.0	Plumb	[illegible]	N	T	[illegible]	[illegible]	WCDNA
	WHGLTA002	-0.20	608.72	608.52	20.00	-	-	-	20.0	10 - 20	AL	2	Y	7.0	-	-	N		8.0 - 21.0	6.0 - 8.0	-
FTA 01/ SWMU 18	FT08-11A	3.42	604.80	608.22	14.50	17.54	11.00	597.22	13.50	4.0 - 14.0	AL	2	Y	7.0	Plumb	ND	N	T	3.5 - 14.5	2.0 - 3.5	-
IRP Site 11	FT08-11B	4.34	603.80	608.14	15.00	17.06	8.92	599.22	14.00	3.5 - 13.5	AL	2	Y	7.0	Plumb	ND	N	T	3.0 - 15.0	2.0 - 3.0	-
FTA 01/	FT09-12A	3.66	632.00	635.66	25.00	27.85	13.85	621.81	19.0	13.0 - 23.0	AL	2	Y	7.0	Plumb	ND	N	T	10.5 -25.0	8.0 - 10.5	-
SWMU 19/	FT09-12B	1.95	625.60	627.55	40.00	37.66	31.67	595.88	38.5	27.5 - 37.4	AL	2	Y	7.0	Plumb	ND	N	T	26.0 - 40.0	24.0 - 26.0	-
IRP Site 12	FT09-12C	2.55	625.50	628.05	38.00	39.96	32.71	595.34	30.5	27.5 - 37.5	AL	2	Y	7.0	Plumb	ND	N	T	25.0 - 38.0	23.0 - 25.0	-
	FT09-12D	2.65	624.80	627.45	35.40	36.99	31.22	596.23	NE	21.4 - 34.4	AL	2	Y	7.0	Plumb	ND	N	T	-	-	Well located in close proximity to well FT12-12B
	FT09-12E	2.98	624.50	627.48	38.50	38.68	32.12	595.36	40.0	24.0 - 27.5	AL	2	Y	7.0	Plumb	ND	N	T	-	-	Well located in close proximity to well FT12-12C
Landfill 8/ SWMU25	WHGLTA004	0.20	614.55	614.35	23.50	[illegible]	[illegible]	[illegible]	24.0	13.5 - 23.5	AL	2	Y	[illegible]	[illegible]	[illegible]	N	T	11.5 - 24.0	9.5 - 11.5	[illegible]
POL Tank Farm/	17I	2.99	575.20	578.19	17.50	19.75	11.08	567.11	20.00	4.0 - 16.5	AL	2	Y	7.0	Plumb	9.80	N	T	6.0 - 17.5	4.0 - 6.0	Well located in close proximity to well ST14-W13
SWMU 68/	17J	1.19	577.00	578.19	20.20	-	-	-	18.00	8.45 - 19.2	AL	2	Y	-	-	-	N	T	5.5 - 20.2	3.5 - 5.5	Not inspected
IRP Site 17	17K	1.54	573.80	575.34	18.70	18.55	10.11	565.23	18.00	7.7 - 17.0	AL	2	Y	-	Plumb	2.00	N	T	6.0 - 18.7	4.0 - 6.0	Well located in close proximity to well ST14-W15
	17L	2.87	574.40	577.27	20.20	-	-	-	20.00	8.45 - 19.2	AL	2	Y	-	-	-	N	T	5.5 - 20.2	3.5 - 5.5	Unable to locate well
	17M	1.68	572.60	574.28	15.90	[illegible]	[illegible]	[illegible]	16.00	4.9 - 15.9	AL	2	Y	[illegible]	[illegible]	[illegible]	N	T	[illegible]	2.0 - 4.0	Not inspected
	ST14-01	2.69	573.20	575.89	18.40	18.55	13.86	562.03	18.20	8.45 - 18.2	AL	2	Y	7.0	Plumb	1.90	N	T	6.5 - 18.8	4.5 - 6.5	-
	ST14-02	2.94	572.70	575.64	17.10	19.48	[illegible]	563.48	[illegible]	[illegible]	AL	2	Y	[illegible]	Plumb	[illegible]	N	T	[illegible]	[illegible]	
	ST14-03	1.89	574.83	576.72	17.90	-	-	-	18.20	7.85 - 17.6	AL	2	Y	-	Plumb	-	N	T	5.8 - 18.3	3.5 - 5.8	Unselected at AFCEE's request
	ST14-04	2.84	572.90	575.74	16.50	-	-	-	16.50	6.45 - 16.2	AL	2	Y	-	Plumb	-	N	T	4.3 - 17.0	2.3 - 4.3	Not inspected
	ST14-14	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	ST14-24	-	594.14	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	ST14-25	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ST14-26	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	ST14-27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ST14-28	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	ST14-29	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	ST14-30	-	566.87	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ST14-W05	-	-	-	16.60	-	-	-	15.0	6.59 - 15.49	AL	2	Y	-	-	-	N	T	4.0 - 16.6	2.0 - 4.0	Not inspected
	ST14-W06	-	-	-	27.00	-	-	-	27.0	6.99 - 25.89	AL	2	Y	-	-	-	N	T	5.0 - 27.0	3.0 - 5.0	Not inspected
	ST14-W07	-	-	-	26.00	-	-	-	25.7	5.99 - 24.89	AL	2	Y	-	-	-	N	T	4.0 - 26.0	1.8 - 4.0	Not inspected

Site Name/ SWMU #/ IRP #	Well ID	Well Stickup Length (ft.)	Ground Elevation (ft.MSL)	TOC Elevation (ft.MSL)	TD (ft) when Installed (ft.BGS)	TD (ft) when Installed (ft. below TOC)	DTW when Inspected (ft. below TOC)	SWL (ft.MSL)	Depth to Bedrock (ft.BGS)	Screened Interval (ft.BGS)	Stratigraphic Unit	Casing Parameters when Inspected: Inside Diameter (in)	PVC? Y/N	pH	Bailer Down Well	HNu ppm	Product Present? (Y/N)	Well Casing Fittings	Filter Pack Interval (ft.BGS)	Seal Interval (ft.BGS)	Remarks
	ST14-W08	-	-	-	26.00	-	-	-	NE	8.19 - 24.89	AL	2	Y	-	-	-	N	T	6.0 - 26.0	4.0 - 6.0	Not inspected
	ST14-W09	-	-	-	22.00	-	-	-	NE	7.04 - 20.85	AL	2	Y	-	-	-	N	T	5.0 - 22.0	3.0 - 5.0	Not inspected
	ST14-W10	-	-	-	21.00	-	-	-	21.0	6.04 - 19.89	AL	2	Y	-	-	-	N	T	4.0 - 21.0	2.0 - 4.0	Unselected at AFCEE's request
	ST14-W11	-	-	-	21.00	-	-	-	21.0	6.04 - 19.89	AL	2	Y	-	-	-	N	T	4.0 - 21.0	2.0 - 4.0	Not inspected
	ST14-W12	-	-	-	19.00	-	-	-	19.0	6.19 - 17.89	AL	2	Y	-	-	-	N	T	4.0 - 19.0	2.0 - 4.0	Unselected at AFCEE's request
	ST14-W13	-	-	-	19.00	-	-	-	NE	6.19 - 17.89	AL	2	Y	-	-	-	N	T	4.0 - 19.0	1.8 - 4.0	Not inspected
	ST14-W15	-	-	-	19.40	-	-	-	19.0	6.19 - 17.89	AL	2	Y	-	-	-	N	T	4.0 - 19.4	2.0 - 4.0	Not inspected
	[redacted]																				
	ST14-W19	-	-	-	17.00	-	-	-	17.0	6.99 - 15.89	AL	2	Y	-	-	-	N	T	5.0 - 17.0	3.0 - 5.0	Not inspected
	ST14-W20	-	-	-	17.00	-	-	-	17.0	6.99 - 16.44	AL	2	Y	-	-	-	N	T	4.0 - 17.0	2.0 - 4.0	Not inspected
	[redacted]																				
	ST14-W22	-	-	-	15.40	-	-	-	15.0	7.59 - 14.44	AL	2	Y	-	-	-	N	T	5.0 - 15.4	3.0 - 5.0	Not inspected
	ST14-W23	-	-	-	10.50	-	-	-	NE	5.54 - 9.54	AL	2	Y	-	-	-	N	T	3.0 - 10.5	1.0 - 3.0	Not inspected
	[redacted]																				
	ST14-W32	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	MW1-16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fuel Island West of Bldg. 1430	MW-38	Flush	-	-	-	19.58	16.24	16.24	-	-	-	4	Y	7.0	Plumb	ND	N	T	-	-	WCDNA
	MW-39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MW-40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MW-41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MW-42	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fuel Maintenance	MW-36	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bldg. 1194	MW-37	Flush	-	-	-	19.73	8.57	8.57	-	-	-	4	Y	7.0	Plumb	ND	N	T	-	-	WCDNA
Bldg. 1427	MW-57	Flush	-	-	-	14.30	12.84	12.84	-	-	-	4	Y	7.0	Plumb	ND	1	T	-	-	WCDNA
	MW-58	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MW-59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Base Service Station	BSS-A	-0.52	566.90	566.38	11.00	1.03	4.65	561.73	10.5	5.0 - 10.0	AL	2	Y	7.0	Plumb	ND	N	T	4.0 - 11.0	2.0 - 4.0	-
	[redacted]																				
	P5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PI-U9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SAV-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	[redacted]																				
	MW-1	-0.20	561.06	560.86	-	-	14.06	546.80	48.5		AL	4	Y	7.0	Plumb	ND	N	T			
	MW-2	-0.49	558.30	557.81	-	-	-	-	48.0		AL	-	Y	-	-	-	N	T			-
	MW-3	-0.20	576.96	576.76	-	19.82	10.75	566.01	20.0	10.0 - 20.0	AL	4	Y	7.0	Plumb	5.00	Y	T	7.0 - 20.5	4.5 - 7.0	No lock on well. Sheen observed on water in casing
	MW-4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MW-5	2.54	561.36	563.9	-	8.08	3.35	560.55	-	3.5 - 11.0	AL	4	Y	7.0	Plumb	ND	N	T	2.0 - 11.0	1.0 - 2.0	Installed/sampled to cover BSS data gaps per AFCEE.
	MW-6	-0.42	563.53	563.11	-	9.94	2.10	561.01	-	-	-	4	Y	7.0	Plumb	ND	N	T	-	-	Well located on edge of road.
	MW-7	-0.03	567.91	567.88	17.00	-	-	-	11.0	6.13 - 16.13	AL	4	Y	7.0	Plumb	ND	N	T	4.0 - 17.0	2.0 - 4.0	-
	MW-8	0.18	556.73	556.91	27.00	-	-	-	NE	6.0 - 26.0	AL	4	Y	7.0	Plumb	ND	N	T	4.0 - 27.0	2.0 - 4.0	-
	MW-9	-0.14	560.44	560.30	29.00	27.90	11.31	548.99	NE	8.1 - 28.1	AL	4	Y	7.0	Plumb	ND	N	T	6.0 - 29.0	4.0 - 6.0	-
	[redacted]																				
	MW-11	0.02	558.88	558.90	38.00	32.43	25.61	533.29	NE	12.2 - 32.2	AL	4	Y	7.0	Plumb	ND	N	T	11.0 - 32.6	9.0 - 11.0	-
	MW-12	0.18	560.20	560.38	28.00	27.40	10.41	549.97	NE	7.7 - 27.7	AL	4	Y	7.0	Plumb	ND	N	T	5.5 - 28.0	3.5 - 5.5	Installed/sampled to cover BSS data gaps per AFCEE.
Various	GMI04-01M	-	-	-	32.00	34.77	20.96	20.96	27.5	16.5 - 31.5	AL	2	Y	7.0	Plumb	ND	N	T	15.0 - 32.0	13.0 - 15.0	-
	GMI22-01M	-	606.62	-	28.50	-	-	-	28.0	13.0 - 28.0	A	2	Y	-	-	-	N	T	11.0 - 28.5	9.0 - 11.0	Not Inspected
	[redacted]																				
	GMI22-08M	-	-	-	22.50	-	-	-	22.5	10.0 - 22.5	AL	2	Y	-	-	-	N	T	7.0 - 22.5	5.0 - 7.0	Not Inspected
	USGS01P	-	604.83	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	USGS01T	-	604.79	-	-	19.88	11.22	-	-	-	-	2	-	-	-	-	-	-	-	-	-
	USGS02T	-	604.21	-	-	30.10	18.94	-	-	-	-	2	-	-	-	-	-	-	-	-	Damaged as of July 1997
	USGS03T	-	575.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	[redacted]																				
	USGS05P	-	576.77	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	USGS06P	-	606.71	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	USGS06T	-	606.67	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	USGS07P	-	632.10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	[redacted]																				
	HM-111	-	-	-	-	47.51	25.20	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Site Name/ SWMU #/ IRP #	Well ID	Well Stickup Length (ft.)	Ground Elevation (ft.MSL)	TOC Elevation (ft.MSL)	TD (ft) when Installed (ft.BGS)	TD (ft) when Installed (ft. below TOC)	DTW when Inspected (ft. below TOC)	SWL (ft.MSL)	Depth to Bedrock (ft.BGS)	Screened Interval (ft.BGS)	Stratigraphic Unit	Casing Parameters when Inspected: Inside Diameter (in)	PVC? Y/N	pH	Bailer Down Well	HNu ppm	Product Present? (Y/N)	Well Casing Fittings	Filter Pack Interval (ft.BGS)	Seal Interval (ft.BGS)	Remarks
	HM-114	-	-	-	-	35.64	17.59	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	HM-116	-	634.06	-	-	31.37	21.90	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	HM-117	-	633.32	-	-	38.47	21.18	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	HM-118	-	626.23	-	-	26.29	15.11	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	HM-119	-	625.04	-	-	28.78	13.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	HM-120	-	616.84	-	-	17.41	4.65	-	-	-	-	4	-	-	-	-	-	-	-	-	-
	HM-121	-	627.66	-	-	30.29	17.23	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	HM-122	-	619.44	-	-	27.77	13.34	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	HM-123	-	624.85	-	-	38.38	26.48	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	HM-124	-	623.26	-	-	24.30	15.32	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	HM-125	-	629.37	-	-	33.01	17.39	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	HM-126	-	622.99	-	-	33.66	14.87	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	HM-127	-	624.04	-	-	37.70	25.36	-	-	-	-	4	-	-	-	-	-	-	-	-	-
	MW-18	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MW-19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MW-1A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	W-153	-	631.57	-	-	39.27	19.75	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	RW-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TREE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TREE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	ITMW-01T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MWTT02T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MWMTAC-001	-	645.04	-	-	44.50	33.97	-	-	-	-	2	-	-	-	-	-	-	-	-	-
Bldg. 1015	MW-20	Flush	-	-	-	19.70	19.57	19.57	-	-	-	4	Y	-	Plumb	3.20	N	T	-	-	Dry; WCDNA
	MW-21	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Cargo Area near Bldgs 4141/4145	MW-48	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	T	-	-	WCDNA
	MW-49	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MW-50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MW-51	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Cargo Area near	MW-52	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bldgs. 4215/4216	MW-53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	T	-	-	WCDNA
Hot Cargo Area near	MW-56	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	T	-	-	WCDNA
Bldgs. 4170/4171	MW-57	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	N	T	-	-	WCDNA
Spot 35	SPOT35-1	Flush	613.95	-	27.50	26.58	22.47	22.47	NE	-	-	2	Y	7.0	Plumb	104.00	N	T	10.0 - 27.5	8.0 - 10.0	Leak detection well
	SPOT35-2	Flush	612.70	-	25.00	26.26	20.83	20.83	NE	-	-	4	Y	7.0	Plumb	124.00	N	T	7.0 - 25.0	5.0 - 7.0	Leak detection well
	SPOT35-3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SPOT35-4	Flush	613.70	-	26.30	24.41	19.82	19.82	NE	14.3 - 24.3	-	4	Y	7.0	Plumb	94.00	N	T	12.5 - 26.3	8.7 - 12.5	Leak detection well
	SPOT35-5	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	SPOT35-6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SPOT35-7	-	616.41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	MW-11A	-	612.17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Waste Burial Area/ SWMU 24/ IRP Site 10	WP07-10A	0.00	626.70	626.70	39.00	-	-	-	NE	27.0 - 37.0	AL	2	Y	-	-	-	N	T	26.0 - 39.0	24.0 - 26.0	Not inspected due to hornets nest
	WP07-10B	3.36	621.10	624.46	36.00	34.50	28.78	595.68	34.5	23.0 - 33.0	AL	2	Y	7.0	Plumb	ND	N	T	18.0 - 36.0	15.5 - 18.0	-
	WP07-10C	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Entomology Dry Well/ SWMU 63/ IRP #15	OT15C	3.70	564.17	567.87	12.00	-	-	-	9.0	5.0 - 10.0	AL	2	Y	-	-	-	N	T	4.5 - 12.0	3.0 - 4.5	Not Inspected
Unnamed Stream/ SWMU #64/ IRP #16	15B	-	567.59	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	SD13-01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	SD13-02	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	SD13-03	2.94	568.60	571.54	14.10	-	-	-	13.5	7.08 - 13.85	AL	2	Y				N	T	5.0 - 14.1	2.7 - 5.0	Not Inspected
	SD13-04	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	SD13-05	-0.19	571.59	571.40	13.93	-	-	-	NE	3.86 - 13.53	AL	4	Y				N	T	1.73 - 13.93	0.41 - 1.73	Not Inspected
	SD13-06	1.92	555.74	557.66	11.36	-	-	-	6.9	6.17 - 10.83	AL, L	4	Y				N	T	2.37 - 11.36	0.15 - 2.37	Not Inspected
	SD13-07	1.88	554.42	556.30	19.13	-	-	-	13.0	18.69	AL, L	4	Y				N	T	19.13	6.97	Not Inspected
Bldg. 1628	LSA1628-1	-0.76	602.43	601.67	20.00	-	-	-	16.0	8.66 - 18.66	AL, L	4	Y	-	-	-	-	-	6.66 - 18.66	4.66 - 6.66	Not included in site survey
	LSA1628-2	-0.33	602.26	601.93	20.00	-	-	-	18.0	10.0 - 20.0	AL, L	4	Y	-	-	-	-	-	8.0 - 20.0	6.0 - 8.0	Not included in site survey
	LSA1628-3	-0.92	602.63	601.71	18.50	-	-	-	16.5	8.5 - 18.5	AL, L	4	Y	-	-	-	N	T	6.5 - 18.5	4.5 - 6.5	Not included in site survey
Background Wells	WJETA530	-0.23	639.62	639.39	43.76	43.63	38.52	-	44.5	34.11 - 43.76	AL	2	Y	-	-	-	N	T	32.0 - 34.11	29.2 - 32.0	-
	WJETA531	-0.29	644.46	644.17	34.00	33.15	26.24	-	34.0	24.35 - 34.0	AL	2	Y	-	-	-	N	T	22.0 - 24.35	19.7 - 22.0	-
	WJETA534	-0.36	647.74	647.38	40.00	39.50	31.15	-	40.0	25.14 - 40.0	AL	2	Y	-	-	-	N	T	23.0 - 25.14	21.0 - 23.0	-
	WJETA535	-0.21	634.82	634.61	43.00	42.57	34.36	-	43.0	33.35 - 43.0	AL	2	Y	-	-	-	N	T	28.7 - 33.35	18.5 - 28.7	-
Base Gas Station Wells	BGSMW01	-	-	578.64	-	-	9.08	569.56	-	-	-	4	Y	-	-	-	N	-	-	-	-
	BGSMW02	-	-	577.57	-	-	12.93	564.64	-	-	-	4	Y	-	-	-	N	-	-	-	-
	BGSMW03	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	BGSMW04	-	-	578.49	-	-	12.65	565.84	-	-	-	4	Y	-	-	-	N	-	-	-	-

Site Name/ SWMU #/ IRP #	Well ID	Well Stickup Length (ft.)	Ground Elevation (ft.MSL)	TOC Elevation (ft.MSL)	TD (ft) when Installed (ft.BGS)	TD (ft) when Installed (ft. below TOC)	DTW when Inspected (ft. below TOC)	SWL (ft.MSL)	Depth to Bedrock (ft.BGS)	Screened Interval (ft.BGS)	Stratigraphic Unit	Casing Parameters when Inspected: Inside Diameter (in)	PVC? Y/N	pH	Bailer Down Well	HNu ppm	Product Present? (Y/N)	Well Casing Fittings	Filter Pack Interval (ft.BGS)	Seal Interval (ft.BGS)	Remarks
	BGSMW05	-	-	571.66	-	-	6.55	565.11	-	-	-	4	Y	-	-	-	N	-	-	-	-
	BGSMW06	-	-	576.51	-	-	11.09	565.42	-	-	-	4	Y	-	-	-	N	-	-	-	-
	BGSMW07	-	-	574.88	-	-	9.08	565.80	-	-	-	4	Y	-	-	-	N	-	-	-	-
Sanitary Sewer Wells	WITCTA001	0.27	610.58	610.85	22.00	22.27	14.85	596.00	-	9.5 - 21.75	-	2	Y	-	-	-	N	-	7.5 - 22.0	5.5 - 7.5	-
	WITCTA002	-0.47	613.83	613.36	8.00	7.53	3.52	609.84	-	3.0 - 7.75	-	2	Y	-	-	-	N	-	2.5 - 8.0	1.0 - 2.5	-
	WITCTA003	-0.53	608.11	607.58	24.00	23.47	13.19	594.39	-	14.0 - 23.75	-	2	Y	-	-	-	N	-	12.0 - 24.0	7.0 - 12.0	-
	WITCTA004	-0.35	606.97	606.62	19.00	18.65	12.55	594.07	-	11.3 - 18.55	-	2	Y	-	-	-	N	-	9.5 - 18.8	7.5 - 9.5	-
	WITCTA005	-0.34	603.15	602.81	19.40	19.06	10.88	591.93	-	11.9 - 19.15	-	2	Y	-	-	-	N	-	9.5 - 19.4	7.5 - 9.5	-
	WITCTA006	-0.25	603.01	602.76	19.00	18.75	11.43	591.33	-	11.3 - 18.55	-	2	Y	-	-	-	N	-	9.5 - 18.8	7.5 - 9.5	-
	WITCTA007	2.97	600.06	603.03	22.50	25.47	13.00	590.03	-	12.5 - 22.25	-	2	Y	-	-	-	N	-	10.5 - 22.5	8.5 - 10.5	-
	WITCTA008	-2.15	602.77	600.62	14.25	12.10	7.88	592.74	-	6.75 - 14.0	-	2	Y	-	-	-	N	-	5.5 - 14.25	1.0 - 5.5	-
	WITCTA009	-0.59	597.74	597.15	13.50	12.91	5.68	591.47	-	3.5 - 13.25	-	2	Y	-	-	-	N	-	2.6 - 13.5	1.6 - 2.6	-
	WITCTA010	-0.43	600.74	600.31	19.00	18.57	13.25	587.06	-	11.4 - 18.65	-	2	Y	-	-	-	N	-	9.0 - 18.9	7.0 - 9.0	-
	WITCTA011	-0.64	610.91	610.27	23.00	22.36	16.76	593.51	-	13.0 - 22.75	-	2	Y	-	-	-	N	-	11.0 - 23.0	9.0 - 11.0	-
	WITCTA012	-8.04	607.97	599.93	17.70	9.66	9.70	590.23	-	7.7 - 17.45	-	2	Y	-	-	-	N	-	5.7 - 17.7	3.7 - 5.7	-
	WITCTA013	-0.55	605.94	605.39	22.00	21.45	14.67	590.72	-	12.0 - 21.75	-	2	Y	-	-	-	N	-	10.0 - 22.0	8.0 - 10.0	-
	WITCTA014	-0.18	611.92	611.74	25.00	24.82	20.40	591.34	-	15.0 - 24.75	-	2	Y	-	-	-	N	-	13.0 - 25.0	11.0 - 13.0	-
	WITCTA015	-0.29	607.13	606.84	26.70	26.41	17.67	589.17	-	16.7 - 26.45	-	2	Y	-	-	-	N	-	14.7 - 26.7	12.7 - 14.7	-
	WITCTA016	-0.38	608.23	607.85	28.00	27.62	18.33	589.52	-	13.0 - 27.75	-	2	Y	-	-	-	N	-	11.0 - 28.0	9.0 - 11.0	-
	WITCTA017	-0.10	593.04	592.94	14.00	13.90	7.79	585.15	-	6.5 - 13.75	-	2	Y	-	-	-	N	-	5.0 - 14.0	3.0 - 5.0	-
	WITCTA019	-0.21	601.03	600.82	19.90	19.69	14.25	586.57	-	9.9 - 19.65	-	2	Y	-	-	-	N	-	7.9 - 19.9	5.9 - 7.9	-
	WITCTA020	-0.06	616.84	616.78	26.00	25.94	19.12	597.66	-	20.8 - 25.5	-	2	Y	-	-	-	N	-	19.0 - 25.8	17.0 - 19.0	-
	WITCTA021	-0.60	604.79	604.19	25.00	24.40	15.43	588.76	-	14.6 - 24.35	-	2	Y	-	-	-	N	-	12.6 - 24.6	10.6 - 12.6	-
	WITCTA022	-0.88	605.05	604.17	24.40	23.52	16.83	587.34	-	14.4 - 24.15	-	2	Y	-	-	-	N	-	11.5 - 24.4	9.5 - 11.5	-
	WITCTA024	-0.47	605.33	604.86	23.70	23.23	16.59	588.27	-	13.7 - 23.35	-	2	Y	-	-	-	N	-	11.7 - 23.7	9.7 - 11.7	-
	WITCTA025	-1.51	596.71	595.20	12.00	10.49	10.18	585.02	-	7.0 - 11.75	-	2	Y	-	-	-	N	-	5.0 - 12.0	3.0 - 5.0	-
	WITCTA026	-0.15	584.52	584.37	10.00	9.85	5.41	578.96	-	5.0 - 9.75	-	2	Y	-	-	-	N	-	4.0 - 10.0	2.0 - 4.0	-
	WITCTA027	-0.30	581.74	581.44	23.00	22.70	10.31	571.13	-	8.0 - 22.75	-	2	Y	-	-	-	N	-	6.0 - 23.0	4.0 - 6.0	-
	WITCTA028	-3.56	561.67	558.11	15.00	11.44	4.50	553.61	-	5.0 - 14.75	-	2	Y	-	-	-	N	-	4.0 - 15.0	2.0 - 4.0	-
	WITCTA031	-0.66	592.76	592.10	7.00	6.34	3.77	588.33	-	4.45 - 6.70	-	2	Y	-	-	-	N	-	3.0 - 6.95	1.0 - 3.0	-
	WITCTA032	-0.36	587.73	587.37	13.00	12.64	6.21	581.16	-	5.5 - 12.75	-	2	Y	-	-	-	N	-	4.0 - 13.0	2.0 - 4.0	-
	WITCTA033	-0.57	574.63	574.06	15.00	14.43	8.93	565.13	-	10.0 - 14.75	-	2	Y	-	-	-	N	-	8.0 - 15.0	6.0 - 8.0	-
	WITCTA034	-0.59	572.54	571.95	13.60	13.01	7.93	564.02	-	8.6 - 13.35	-	2	Y	-	-	-	N	-	6.5 - 13.6	4.5 - 6.5	-
	WITCTA035	-0.78	600.15	599.37	19.40	18.62	13.11	586.26	-	17.4 - 19.15	-	2	Y	-	-	-	N	-	15.4 - 19.4	13.4 - 15.4	-
	WITCTA036	-0.16	578.73	578.57	24.00	23.84	13.00	565.57	-	13.7 - 23.45	-	2	Y	-	-	-	N	-	12.0 - 23.7	10.0 - 12.0	-
	WITCTA037	-0.31	604.50	604.19	21.00	20.69	13.97	590.22	-	13.5 - 20.75	-	2	Y	-	-	-	N	-	11.5 - 21.0	9.5 - 11.5	-
	WITCTA039	0.00	619.47	619.47	26.00	26.00	17.4	602.07	-	14.3 - 24.05	-	2	Y	-	-	-	N	-	12.5 - 24.3	10.5 - 12.5	-
AOC 2 RFI	WCHMHTA001	-0.49	639.57	639.08	46.47	45.98	27.20	611.88	-	26-46	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA002	-0.51	631.83	631.32	42.91	42.40	20.18	611.14	-	22-42	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA003	-0.69	631.69	631.00	29.34	28.65	20.14	610.86	-	18-28	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA004	-0.43	631.68	631.25	38.27	37.84	20.36	610.89	-	28-38	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA005	-0.44	627.39	626.95	27.19	26.75	16.98	609.97	-	16-26	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA006	-0.49	627.22	626.73	36.98	36.49	16.81	609.92	-	26.5-36.5	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA007	-0.61	624.54	623.93	33.06	32.45	14.46	609.47	-	12.5-32.5	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA008	-0.30	623.15	622.85	24.94	24.64	13.45	609.40	-	10-25	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA009	-0.18	615.73	615.55	11.97	11.79	6.54	609.01	-	4.5-12	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA010	-0.39	615.74	615.35	24.57	24.18	6.35	609.00	-	15-25	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA011	-0.52	606.32	605.8	22.54	22.02	12.34	593.46	-	12-22	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA012	-0.33	606.18	605.85	19.42	19.09	13.70	592.15	-	8.5-18.5	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA013	-0.50	578.76	578.26	19.31	18.81	16.98	561.28	-	13.5-18.5	AL	-	-	-	-	-	-	-	-	-	-
	WCHMHTA014	-0.32	619.43	619.11	12.29	11.97	11.25	607.86	-	7.5-12.5	AL	-	-	-	-	-	-	-	-	-	-

TAB

Appendix B

APPENDIX B
SAMPLING PROCEDURES
NAS FORT WORTH JRB, TEXAS
BASEWIDE QUARTERLY GROUNDWATER SAMPLING PROGRAM 1998

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B.1.0 GROUNDWATER SAMPLING

The following section describes the procedures to be used for collection of groundwater samples and includes: (1) environmental sample collection procedures; (2) analytical methods; (3) sample handling; (4) sample custody; and (5) field quality control samples.

B.1.1 ENVIRONMENTAL SAMPLE COLLECTION PROCEDURES

All purging and sampling equipment will be decontaminated according to the specifications in Section B.4.2, prior to any sampling activities, and will be protected from contamination until ready for use.

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 Groundwater Field Data Sampling Sheets. Record-keeping procedures are specified in Section B.3.0.

Prior to groundwater sampling, 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 to have 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 Health and Safety Plan (HGL, 1997) 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 B.3.0, the following information will be recorded each time a well is purged and sampled: (1) depth to water before and after purging; (2) equivalent well volume calculation; (3) sounded total depth of the monitoring well; (4) the condition of each well, including visual (mirror) survey; (5) the thickness of any light or dense

nonaqueous 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* (USEPA, 1995) have been adapted where practical to augment current AFCEE procedures.

B.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 lowered slowly to the water level 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 groundwater level. The groundwater level will then be measured to the nearest 0.01 foot using an electric water level indicator. For wells which are suspected to contain 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 groundwater 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 recorded on the well sampling form. The initial water level depth will then 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.

B.1.1.2 Purging Prior to Sampling

Purging of monitoring 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 micropurge techniques. 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 to 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). This is 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 the stress to the system to the extent practical, 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 to 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 NTUs ± 1 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 as was used in purging. Field equipment will be calibrated in accordance with the Basewide QAPP (HGL, 1998).

In lieu of measuring all parameters (temperature, pH, EC, Turbidity, DO, and ORP), a minimum subset would include temperature, pH, EC, and Tubidity or DO as critical stabilization parameters. It should be noted that 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 (USEPA, 1995).

For wells known to have a less than 0.1 L/min flow rate, a low-flow (<0.1 L/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 (USEPA, 1995).

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 as described above and set in place a minimum of 48 hours prior to retrieval. Regulatory approval for sample volumes which are lower than required by

individual USEPA analytical methods would have to be obtained prior to using this procedure (USEPA, 1995).

If during low-flow purging the drawdown is greater than 0.33 feet using normal low-flow pumping rates, an attempt will be made to further lower the pumping rate. However, if this flow cannot be sustained by the pump or if overheating occurs (affecting temperature and volatilization of the sample), then the micropurge technique is assumed to be invalid and will be discontinued. This is because 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 now contains 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 equivalent well 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 equivalent well volumes have been removed and water quality parameters have stabilized for three consecutive readings, water samples will be collected when the water level has recovered to 80% of its static water level or 16 hours after completion of purging. Water samples will be collected using a low-flow pump.

If the parameters do not stabilize, then five equivalent well volumes will be removed and water samples will be collected when the water level has recovered to 80% of its static water level or 16 hours after completion of purging. 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 (USEPA, 1995). In this case, 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 investigative derived wastes is presented in Section B.4.3.

A maximum of five (5) equivalent well volumes may be removed from any well before it is sampled. An equivalent well volume is defined as the volume of submerged casing, screen, and filter pack. One equivalent well volume (E_V) can be calculated using the following equation:

$$E_V = (H \times (V_B - V_C) \times 0.3) + (H \times V_C)$$

where E_V = one equivalent well volume in gallons;
H = the difference between total depth of well (TD) and depth to water (DTW) in feet;
V_B = volume of one foot section of borehole (gallons);
V_C = volume of one foot section of well casing (gallons).

V_B can be calculated from the formula:

$$V_B = \Pi (D_B/2)^2 \times 7.48 \text{ gal/ft}^3$$

where D_B = the diameter of the well borehole (feet); and
$\Pi = 3.141593$.

V_C can be calculated from the formula:

$$V_C = \Pi (D_C/2)^2 \times 7.48 \text{ gal/ft}^3$$

where D_C = the diameter of the well casing (feet); and
$\Pi = 3.141593$.

B.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.

The first samples to be collected shall be VOCs. 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; dioxins/furans; metals; mercury; cyanide; 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 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

B.1.3 and Table B.1. Sampling equipment shall be decontaminated in accordance with Section B.4.2 upon completion of sampling activities.

B.1.2 ANALYTICAL METHODS

All analytical methods specified in the GSAP can be found in the Basewide QAPP (HGL, 1998), with the exception of the ferrous iron analysis. The ferrous iron method relies on HACH method (No. 8146) which is a calorimetric determination of ferrous iron content. Ferric iron may be reduced to ferrous iron as a result of oxidation of vinyl chloride or petroleum hydrocarbons, causing elevations in ferrous iron levels in groundwater. The procedure requires collection of 100 mL of water in a glass container, filtration, and a 10 mL aliquot for analysis. The MDL for this analysis method is 0.010 mg/L. The PQL is 0.024 mg/L.

B.1.3 SAMPLE HANDLING

The purpose of this section is to identify types of sample containers, sample volumes, methods of preservation, sample identification, sample holding times, sample packaging, and shipping method.

B.1.3.1 Sample Containers

Sample containers will be provided to field personnel precleaned and treated according to USEPA specifications for the methods. No sampling containers will be reused for these sampling events. 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.

B.1.3.2 Sample Volumes, Container Types, and Preservation Requirements

Sample volumes, container types, and preservation requirements for the analytical methods performed on the samples are listed in Table B.1.

Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. Holding times for methods required routinely for AFCEE work are specified in Table B.1.

B.1.3.3 Sample Identification

Each sample collected will be assigned a unique sample identification number. The unique IRPIMS well identification shall be used for each sample. Sample containers will be labeled with the sample number and will be entered on the chain-of-custody form (Appendix C). To eliminate any bias by the laboratory, the relationship between the unique sample identification number and the actual field sample number will be known only to the contractor.

Table B.1
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	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	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)
Total Organic Carbon	SW9060	one 250 m/L polyethylene	4°C; H_2SO_4 to pH < 2	250 mL	28 days
Methane	RSK-175	G, Teflon-lined septum, T	cool, 4°C, Hcl or H_2SO_4 to pH<2	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid
Ferrous Iron	HACH method #8146	100-ml glass vials	NA	NA	Field method-analyze immediately
Alkalinity	E310.1	One 500-mL polyethylene	4°C	250 mL	14 days
Common Anions	SW9056	one 1-L polyethylene	4°C	100 mL	28 days for Br^-, F^-, Cl^- and SO_4^{-2}: 48 hours for NO_3^-, NO_2^-, and PO_4^{-3}

Table B.1
Requirements for Containers, Preservation Techniques, Sample Volumes, and Holding Times (continued)

Name	Analytical Methods	Container[a]	Preservation[b,c]	Minimum Sample Volume or Weight	Maximum Holding Time
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.

B.1.4 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.

The contractor will maintain chain-of-custody records 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 case shall tape be used to seal sample containers. Samples will not be packaged with activated carbon.

The following minimum information concerning the sample shall be documented on the AFCEE chain of custody form:

- 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);
- 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; and
- 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. 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 volatile organics compound 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.

B.1.5 FIELD QUALITY CONTROL SAMPLES

Field quality control samples to be collected include blanks and duplicates, as described in the following sections.

B.1.5.1 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 , BTEX, or methane samples are taken and are analyzed only for those 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) to the samples during sample collection. Ambient blanks will be collected downwind of possible VOC sources. One ambient blank will be taken during each sampling round.

B.1.5.2 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. One equipment blank will be taken by each sampling team on each day of sampling that decontamination activities occur. 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.

B.1.5.3 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 as 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, BTEX, and methane samples are taken and are analyzed only for those 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 samples sent to the laboratory for analysis of VOCs, BTEX, or methane.

B.1.5.4 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 such 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. One field duplicate sample will be collected for each environmental sample.

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B.2.0 FIELD MEASUREMENTS

The purpose of this section is to identify: (1) all the parameters to be measured in the field; and (2) the equipment that will be used for the measurements.

B.2.1 EQUIPMENT CALIBRATION AND QUALITY CONTROL

All equipment will be calibrated according to manufacturers' instructions procedures outlined in the Basewide QAPP (HGL, 1998;Table 6.2-1). Calibration of all instruments will be recorded in the field log book. Specific calibration procedures are outlined below.

- Measurement of pH will be performed in the field with a pH meter. The instrument will be field-calibrated with two buffer solutions at the beginning of each day's use. Accuracy of the measurement is maintained by selecting a standard buffer with a pH close to that of the sample (preferably within three pH units). The pH of the buffers used will be dependent upon the pH of the sample, but in each case will "bracket" the range of measurement. The stability of the calibration will be verified through the analysis of one standard periodically throughout the day as deemed necessary by the Field Investigation Task Manager, but at least once every 5 hours.

- Temperature and specific conductivity will be measured with a portable meter. Calibration of the instrument is periodically performed at the factory as part of an internal QA program. The instrument probe will be rinsed with ASTM Type II reagent grade water between each use and the calibration of the specific conductivity probe will be checked at the beginning and middle of each day using a potassium chloride (KCl) solution with known conductance values.

- The hand-held portable organic vapor analyzer (OVA) with a photoionization detector (PID) is used to screen the air vapors when the well casing cap is removed. It will be calibrated daily with a 100-ppm level of isobutylene. The battery power supply will be recharged each evening prior to the next day's field activities.

- The hand-held portable atmospheric monitor used to screen the breathing zone for explosive conditions and H_2S will be calibrated daily, as described in the manufacturer's manual.

- Turbidity will be measured with a nephelometer (also known as a turbidimeter). Calibration of the instrument is periodically performed at the factory as part of routine maintenance. The stability of the calibration will be verified through the analysis of one standard periodically throughout the day as deemed necessary by the Task Leader, but at least once every 5 days.

- Dissolved Oxygen (DO) content will be measured using a portable hand held DO meter. The meter will calibrated each morning prior to use using a two-point calibration following

the manufacturers' recommended criteria. The DO meter will also be calibrated each day after sampling to ensure that the calibration remained valid over the course of the day.

B.2.2 FIELD MEASUREMENT EQUIPMENT MAINTENANCE AND DECONTAMINATION

B.2.2.1 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 Task Leader. The Task Leader 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.

B.2.2.2 Field Instruments Decontamination

Decontamination of field instruments will be instrument-specific. The probes of the pH, temperature, DO, and specific conductivity meters will be rinsed with ASTM Type II 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.

B.2.3 FIELD MONITORING MEASUREMENTS

Field monitoring will include groundwater level measurements, measurement of any non-aqueous phase liquids, and tracking of purge volumes. All field monitoring devices will be decontaminated in accordance with procedures in Section B.4.2.

B.2.3.1 Groundwater Level Measurements

Water level measurements shall 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. Groundwater level shall 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, allow time prior to measurement for equilibration of

pressures after the cap is removed. Repeat measurements until water level is stabilized.

B.2.3.2 Hydrocarbon Measurements

The thickness of hydrocarbons floating (LNAPLs) 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. If sinking hydrocarbons (DNAPLs) are suspected, a weighted cotton string will be lowered into the well to determine if such hydrocarbons are present and a measurement attempted if DNAPL is visible on the string.

B.2.3.3 LNAPL Removal Procedures

If the measured LNAPL thickness is greater than 0.05 feet, an attempt will be made to remove the product. This thickness represents a practical lower limit for potential recovery, beyond which thickness measurements are less reliable and recovery not feasible. The preliminary removal technique used will depend on the thickness of LNAPL and the relative permeability of LNAPL saturated sediments. Initial recovery attempts will use a bottom loading bailer that is slowly lowered in the well. If this method is not successful, an absorbent sock consisting of ooliphatic membrane will be tethered and lowered into the well. Any LNAPL or wastes containing LNAPL that are generated during this process will be handled and disposed in a manner consistent with the procedures described in Section B.4.3. A description of the LNAPL removal technique used will be summarized in both quarterly and annual groundwater monitoring reports and recommendations included to potentially improve LNAPL recovery efforts.

B.2.3.4 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 the guidelines specified in the Water Measurement Manual (Bureau of Reclamation, 1967). Measurement devices will be calibrated using containers of known volume.

B.2.4 FIELD PERFORMANCE AND SYSTEM AUDITS

The Task Leader 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 project-specific work plan, or as directed by the Task Leader. The informal document control audit will consist of checking each document for completeness, including items such as signatures, dates, and project numbers.
A systems audit of field operations may be required by the project-specific work plan and will be used to review the total data generation, which includes 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 Task Leader (TL) during the first week of sampling if deemed necessary by the PM, TL, Project Chemist, or client. The audit may focus on verifying that proper procedures are being followed so that subsequent sample data will be valid. Before the audit, a checklist will be prepared by the PM and TL that will serve as a guide for the performance audit. The audit may verify whether or not:

- Collection of samples follows the available written procedures
- Chain of custody procedures are followed for traceability of samples origin
- Appropriate QC checks are being made in the field and documented in the field logbook
- Specified equipment is available, calibrated, and working properly
- Sampling crews are adequately trained
- Record-keeping procedures are being followed and appropriate documentation is maintained
- Corrective action procedures are followed

An audit report summarizing the results and corrections will be prepared and filed in the project files.

B.3.0 RECORD KEEPING

Field records sufficient to recreate all sampling and measurement activities and to meet all IRPIMS data loading requirements will be maintained. The requirements listed in this section apply to all measuring and sampling activities. Requirements specific to individual activities are listed in the section that addresses each activity. The information will be recorded with indelible ink in a permanently bound notebook with sequentially numbered pages. These records will be archived in an easily accessible form and made available to the COR or authorized representative 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). AFCEE approved forms that will be used during field sampling are included in Appendix C.

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B.4.0 FIELD OPERATIONS

The following sections describe the procedures to be used during field operations. Included are sections describing standards for site reconnaissance and restoration, equipment decontamination, and waste handling.

B.4.1 SITE RECONNAISSANCE, PREPARATION, AND RESTORATION PROCEDURES

Prior to the first groundwater sampling event, a site reconnaissance will be performed to check each well location for accessibility to finalize the sampling sequence and identify a field office and storage areas for equipment and investigative derived wastes. Vehicle access routes to well locations will be determined at this time, and maps prepared for field sampling personnel.

Liquid waste shall be accumulated in 55-gallon drums and subsequently transported to a waste storage area designated by the Air Force. Decontamination areas for personnel and portable equipment will be set up at each well location. These locations will include basins or tubs to capture decontamination fluids, which will be transferred to a large accumulation drum as necessary.

A field office site will also be designated for centralization of sample tracking, packaging, and preparation for shipping.

Each sampling location will be returned to its original condition when possible. Efforts will be made to minimize impacts to 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 will be removed. Decontamination and/or purge water will be transported to the designated locations.

B.4.2 EQUIPMENT DECONTAMINATION

All equipment that may directly or indirectly contact samples will be decontaminated in the designated decontamination area. This includes sampling devices and instruments, such as slugs and sounders. In addition, the sample will be prevented 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 sampling devices, such as bailers or sampling pumps, that can be hand-manipulated. The equipment will be scrubbed with a solution of potable water and Alconox, or equivalent laboratory-grade detergent. For sampling pumps, the solution will be circulated through the pump. The equipment will then be rinsed with copious quantities of potable water followed by a ASTM Type II grade water. For sampling pumps, the potable rinse water and ASTM Type II grade water will also be circulated through the pump. High pressure liquid chromatograph-grade water and distilled water purchased in stores are not acceptable substitutes for ASTM Type II grade water. Then the equipment will be rinsed with

pesticide-grade methanol followed by with pesticide-grade hexane. The equipment will be air-dried on a clean surface or rack, such as Teflon, stainless steel, or oil-free aluminum elevated at least two 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.

ASTM Type II reagent grade 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. It is the contractor's responsibility to assure these materials remain free of contaminants. If any question of purity exists, new materials will be used.

B.4.3 WASTE HANDLING

All purge water from on-site monitor wells will be containerized for disposition either on- or off-site, as appropriate. Final plans for purge water disposition based on the availability of the AFP 4/IT Corporation treatment system. If this option is not available, other treatment and disposal options will be identified. The following sections describe procedures for handling investigative and noninvestigative wastes.

Waste handling will be dealt with on a site-by-site basis. Waste may be classified as noninvestigative waste or investigative waste.

Noninvestigative 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.

Investigation-derived waste 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. Liquid waste will be containerized in sealed, U.S. Department of Transportation (DOT)-approved steel 55-gallon drums and solid waste, such as tape, PPE, paper, or plastic sheeting, shall be containerized in small dumping bins with lids. The containers will be transported in such a manner to prevent spillage. To facilitate handling, the containers will be no more than half full when moved.

B.5.0 REFERENCES

HydroGeoLogic, Inc. (HGL), 1997. Draft Health and Safety Plan, Groundwater Sampling, NAS Fort Worth JRB, Texas, July 1997.

HydroGeoLogic, Inc. (HGL), 1998. Final Basewide Quality Assurance Project Plan (QAPP), NAS Fort Worth JRB, Texas, February 1998.

U.S. Environmental Protection Agency (USEPA), 1995. Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures, EPA/540/S-95/504.

Urquhart, L.C., 1962, Civil Engineering Handbook 4th Edition, Water Measurement Manual, Bureau of Reclamation, EPA/540/9-93/071.

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TAB

Appendix C

GROUNDWATER MEASUREMENT AND MONITORING WELL INSPECTION FORM

WELL	DTW	TD	DATE	TIME	MP HEIGHT ABOVE/ BELOW GR	CASING DIA.	OVM BG	OVM BZ	OVM TOC	ID PLATE	PAD CONDITION	LOCK	CAP	MANHOLE GASKET	BOLTS	LOG BOOK ENTRY	SAMPLER NAME(S)	COMMENTS	QC
15B																			
17I																			
17J																			
17K																			
17L																			
17M																			
BGSMW01																			
BGSMW02																			
BGSMW03																			
BGSMW04																			
BGSMW05																			
BGSMW06																			
BGSMW07																			
BSS-A																			
BSS-B																			
FT08-11A																			
FT08-11B																			
FT09-12A																			
FT09-12B																			
FT09-12C																			
FT09-12D																			
FT09-12E																			
GMI-04-01M																			
GMI-22-01M																			
GMI-22-02M																			
GMI-22-03M																			
GMI-22-04M																			
GMI-22-05M																			
GMI-22-06M																			
GMI-22-07M																			
GMI-22-08M																			
HM-111																			
HM-114																			
HM-116																			
HM-117																			
HM-118																			
HM-119																			
HM-120																			
HM-121																			
HM-122																			
HM-123																			
HM-124																			
HM-125																			
HM-126																			
HM-127																			
ITMW-01T																			
LF01-1A																			
LF01-1B																			
LF01-1C																			
LF01-1D																			
LF01-1E																			
LF03-3D																			
LF04-01																			
LF04-02																			
LF04-03																			
LF04-04																			
LF04-10																			
LF04-4A																			
LF04-4B																			
LF04-4C																			
LF04-4D																			
LF04-4E																			

GROUNDWATER MEASUREMENT AND MONITORING WELL INSPECTION FORM

WELL	DTW	TD	DATE	TIME	MP HEIGHT ABOVE/ BELOW GR.	CASING DIA	OVM BG	OVM BZ	OVM TOC	ID PLATE	PAD CONDITION	LOCK	CAP	MANHOLE GASKET	BOLTS	LOG BOOK ENTRY	SAMPLER NAME(S)	COMMENTS	OC
LF04-4F																			
LF04-4G																			
LF04-4H																			
LF05-01																			
LF05-02																			
LF05-14																			
LF05-18																			
LF05-19																			
LF05-5A																			
LF05-5B																			
LF05-5C																			
LF05-5D																			
LF05-5E																			
LF05-5F																			
LF05-5G																			
LF05-5H																			
LSA1628-1																			
LSA1628-2																			
LSA1628-3																			
MW-1																			
MW-10																			
MW-11																			
MW-11A																			
MW-12																			
MW-12A																			
MW-13																			
MW-18																			
MW-19																			
MW-1A																			
MW-2																			
MW-20																			
MW-21																			
MW-3																			
MW-36																			
MW-37																			
MW-38																			
MW-39																			
MW-4																			
MW-40																			
MW-41																			
MW-42																			
MW-48																			
MW-49																			
MW-5																			
MW-50																			
MW-51																			
MW-52																			
MW-53																			
MW-56																			
MW-57																			
MW-57B																			
MW-58																			
MW-59																			
MW-6																			
MW-7																			
MW-8																			
MW-9																			
MW-IT-02T																			
MW1-16																			
MWMTAC-001																			
OT-15C																			
P5																			

GROUNDWATER MEASUREMENT AND MONITORING WELL INSPECTION FORM

WELL	DTW	TD	DATE	TIME	MP HEIGHT ABOVE/ BELOW GR	CASING DIA	OVM BG	OVM BZ	OVM TOC	ID PLATE	PAD CONDITION	LOCK	CAP	MANHOLE GASKET	BOLTS	LOG BOOK ENTRY	SAMPLER NAME(S)	COMMENTS	QC
PI-U9																			
RW-1																			
SAV-1																			
SAV-2																			
SD13-01																			
SD13-02																			
SD13-03																			
SD13-04																			
SD13-05																			
SD13-06																			
SD13-07																			
SPOT35-1																			
SPOT35-2																			
SPOT35-3																			
SPOT35-4																			
SPOT35-5																			
SPOT35-6																			
SPOT35-7																			
ST14-01																			
ST14-02																			
ST14-03																			
ST14-04																			
ST14-14																			
ST14-24																			
ST14-25																			
ST14-26																			
ST14-27																			
ST14-28																			

HYDRO GeoLogic INC

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

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: _____

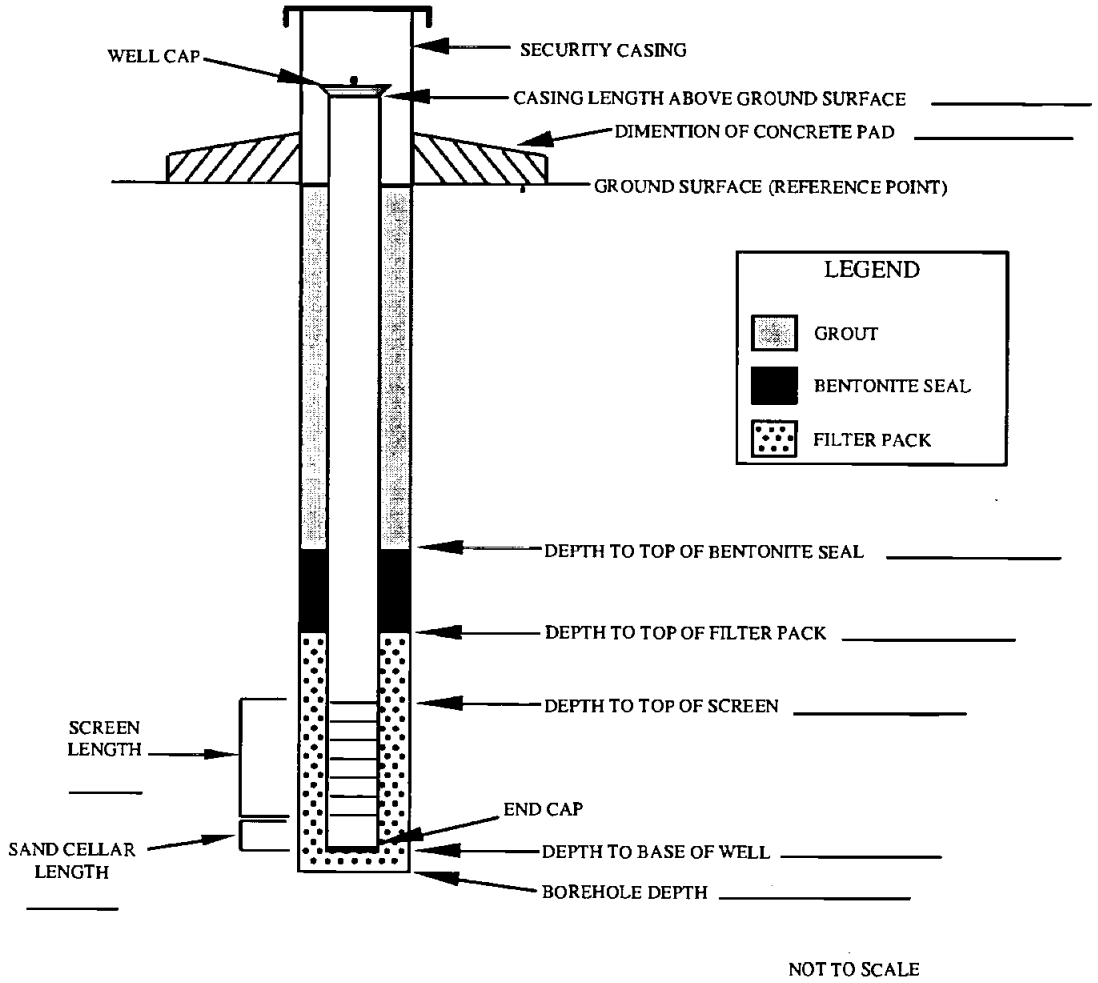
TYPE OF CEMENT: _____
AMOUNT CEMENT USED: _____
GROUT MATERIALS USED: _____

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 CONSTRUCTION DETAILS AND ABANDONMENT FORM

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: _____

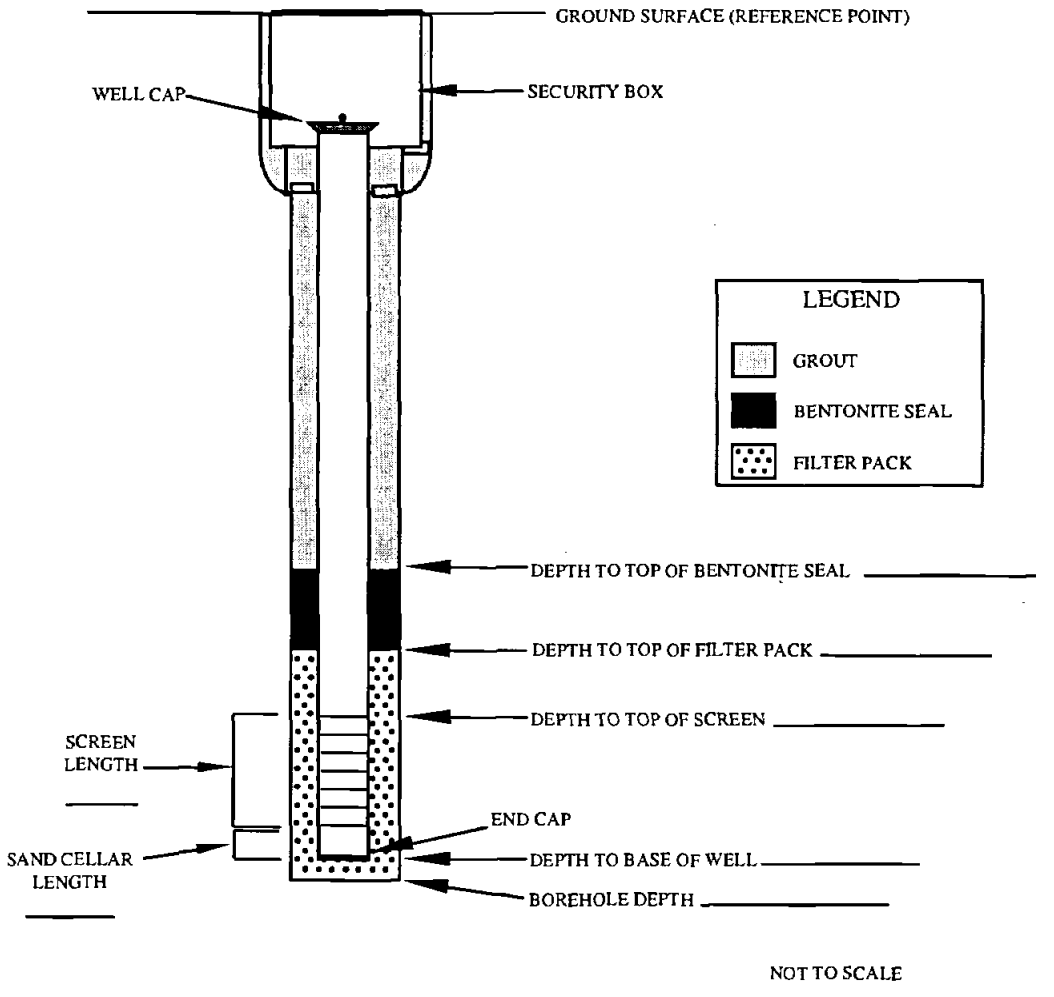
TYPE OF CEMENT: _____
AMOUNT CEMENT USED: _____
GROUT MATERIALS USED: _____

DIMENSIONS OF SECURITY BOX: _____

TYPE OF WELL CAP: _____
TYPE OF END CAP: _____

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



INSTALLED BY: _____ INSTALLATION OBSERVED BY: _____

DISCREPANCIES: _____

HYDRO GeoLogic Inc

WELL DEVELOPMENT RECORD

WELL/PIEZOMETER ID _____
SHEET _____ of _____

PROJECT NAME: _____ PROJECT NO. : _____ DATE: _____

LOCATION: _____ DATE INSTALLED: _____

TOTAL DEPTH (FTOC) _____ CASING DIAMETER _____

MEASURING POINT HEIGHT ABOVE/BELOW GROUND LEVEL _____

METHODS OF DEVELOPMENT

☐ Swabbing ☐ Bailing ☐ Pumping ☐ Describe _____

Equipment decontaminated 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:

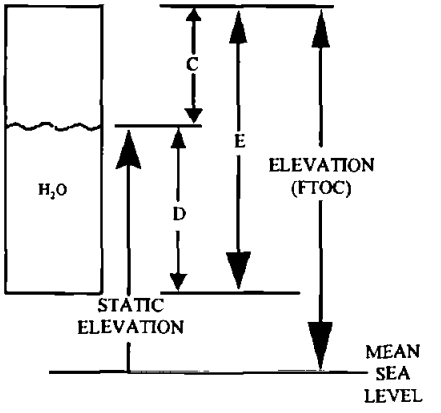
Measured Well Depth (B) _____ ft.

Measured Water Level Depth (C) _____ ft.

Length of Static Water Colume (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)	Type, Size, and Amount of Sediments Discharged During Purging

GROUNDWATER FIELD SAMPLING DATA SHEET

Well No.:		Site: NAS Fort Worth JRB	
Sampler(s):		Project No.:	
Well Depth:		Date:	Time:
DTW (ft):	DTP (ft):	Courier: ___FedEx ___UPS ___Hand ___Other	
MP Ht. Above/Below Ground Surface:		Sampling Method (G=grab, B=bailer, SP=submersible pump):	
Condition of Bottom of Well:		Type of Pump: Goundfos 2" submersible	
Screen Interval (ft):		Weather (sun/clear, overcast/rain, wind direction, ambient temperature):	
Well Diameter (in):			
Placement of Pump (ft):			

Field Parameters

Time	Depth to Water (ft)	Flow Rate (gpm)	Total Volume (gal)	pH	Temp. (C)	Cond. (umhos/cm)	ORP	D.O. (mg/L)	Turb. (N.T.U.)	Type, Size, and Amount of Sediment Discharged

Observations

Color: Clear Other (describe):

Odor: None Low Medium High Very strong H2S Fuel-like

Sample Parameters:

Notes:

Signed/Sampler(s):

HYDRO GeoLogic

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		PRESERVATIVE/ PREPARATION	EXTRACTION METHOD	ANALYTICAL METHOD	ANALYSIS
SIZE/TYPE	#				

NOTABLE OBSERVATIONS

PID READINGS	SAMPLE CHARACTERISTICS	MISCELLANEOUS
1st	COLOR:	
2nd	ODOR:	
	OTHER:	

pH _____ Temperature _____ Dissolved oxygen _____ Specific Conductivity_____

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

[redacted]

IRPIMS
Chain of Custody

Quanterra Incorporated
5910 Breckenridge Parkway
Tampa, Florida, 33610
Phone Number: _____

Quanterra
Environmental Services

QUA-4150

Air Force ID	PO Number	Project Manager

Sample Description	Lab ID	SBD	SED	Date	Time	SA	MC	Analysis									Remarks/ Special Instructions

	Signature	Print Name	Company/Title	Date	Time
Relinquished by					
Received by					
Relinquished by					
Received by					

Comments

Air Force ID: From IRPIMS Handbook
Lab ID: Quanterra Project Number
PO Number: Purchase Order Number
Sample Description: Client ID

SBD: Sample Beginning Depth
SED: Sample Ending Depth
Date: Collection Date
Time: Collection Time

Sample Aliquot (SA) Table

EB: Equipment Blank
FD: Field Duplicate
AB: Ambient Blank
FB: Field Blank
TB: Trip Blank
XX: Sample X

Matrix Code (MC) Table

WG: Ground Water
WW: Waste Water
WQ: Water QC
WS: Surface Water
SD: Sediment
SO: Soil

RECRA LabNet Use Only

Custody Transfer Record/Lab Work Request

RECRA LabNet

Client _____

Est. Final Proj. Sampling Date _____

Project # _____

Project Contact/Phone # _____

RECRA Project Manager _____

QC _____ Del _____ TAT _____

Date Rec'd _____ Date Due _____

Account # _____

Refrigerator #		
#/Type Container	Liquid	
	Solid	
Volume	Liquid	
	Solid	
Preservatives		

ANALYSES REQUESTED →

ORGANIC				INORG	
VOA	BNA	Pest/PCB	Herb	Metal	CN

RECRA LabNet Use Only

MATRIX CODES:
S - Soil
SE - Sediment
SO - Solid
SL - Sludge
W - Water
O - Oil
A - Air
DS - Drum Solids
DL - Drum Liquids
L - EP/TCLP Leachate
WI - Wipe
X - Other
F - Fish

Lab ID	Client ID/Description	Matrix QC Chosen (✓) MS	MSD	Matrix	Date Collected	Time Collected																	

FIELD PERSONNEL: COMPLETE ONLY SHADED AREAS

Special Instructions:

DATE/REVISIONS:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

RECRA LabNet Use Only

Samples were:
1) Shipped ___ or Hand Delivered ___
Airbill # _____
2) Ambient or Chilled
3) Received in Good Condition Y or N
4) Labels Indicate Properly Preserved Y or N
5) Received Within Holding Times Y or N

COC Tape was:
1) Present on Outer Package Y or N
2) Unbroken on Outer Package Y or N
3) Present on Sample Y or N
4) Unbroken on Sample Y or N

COC Record Present Upon Sample Rec'd Y or N

Discrepancies Between Samples Labels and COC Record? Y or N
NOTES:

Relinquished by	Received by	Date	Time	Relinquished by	Received by	Date	Time

423175

FINAL PAGE

ADMINISTRATIVE RECORD FILE

FINAL PAGE

423176

FINAL PAGE

ADMINISTRATIVE RECORD FILE

FINAL PAGE