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FINAL 2001 BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN NAS FORT WORTH TX

5/1/2001

HYDROGEOLOGIC

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NAVAL AIR STATION
FORT WORTH JRB
CARSWELL FIELD
TEXAS

ADMINISTRATIVE RECORD
COVER SHEET

AR File Number 631

HydroGeoLogic INC.

FINAL
2001 BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN NAS FORT WORTH JRB, TEXAS

Prepared for

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

Contract Number F41624-95-D-8005-0033

May 2001

HydroGeoLogic, Inc
12343 Hymeadow Drive, Suite 3B
Austin, TX 78750
(512) 336-1170

HYDRO GeoLogic INC.

FEDERAL EXPRESS

May 18, 2001

Mr. Don Ficklen
HQ AFCEE/ERD
3207 North Road
Brooks AFB, Texas 78235-5363

Re: Final 2001 Basewide Groundwater Sampling and Analysis Plan
NAS Fort Worth JRB, Texas
F41624-95-D-8005-0033

Dear Mr. Ficklen:

HydroGeoLogic, Inc. is pleased to submit the Final 2001 Basewide Groundwater Sampling and Analysis Plan for NAS Fort Worth JRB, Texas. This report presents the monitoring objectives and activities for the groundwater sampling and analysis program to be followed at NAS Fort Worth JRB, Texas for the April and October semi-annual sampling events scheduled for 2001.
Under Air Force Center for Environmental Excellence cover letter, HydroGeoLogic will also submit copies of the Final 2001 Basewide Groundwater Sampling and Analysis Plan to the Texas Natural Resource Conservation Commission and U.S. Environmental Protection Agency Region VI.

Please call me at (512) 336-1170 should you have any questions or comments concerning this document.

Sincerely,

Todd Harrah

Todd C. Harrah
Project Manager

Enclosure

cc: Mr. Michael Dodyk, P.E. (1 copy)
AFCEE/ERD
Building 1619, Intersection of Doolittle and Carswell Ave.
NAS Fort Worth JRB, Texas 76127

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Wright Patterson AFB, OH 45433

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2100 Bypass Road
Building 580
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DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AIR FORCE BASE TEXAS

18 May, 2001

MEMORANDUM FOR RAY RISNER (TNRCC)

FROM: Michael Dodyk, P.E.
HQ AFCEE/ERD
P.O. BOX 27008
Ft Worth, TX 76127-0008

SUBJECT: Final 2001 Groundwater Sampling and Analysis Plan,
NAS Fort Worth JRB, Texas
Facility ID 0009696

Dear Mr. Risner,

Two (2) copies of the Final 2001 Groundwater Sampling and Analysis Plan, NAS Fort Worth JRB, Texas, are enclosed for your records. This report describes the monitoring objectives and activities for the groundwater sampling and analysis program to be followed at NAS Fort Worth JRB, Texas for the April and October semi-annual sampling events scheduled for 2001. The data obtained during these sampling events represent a voluntary monitoring program being conducted by the Air Force to help facilitate the investigation of solid waste management units and areas of concern basewide. As such, this report is not submitted to meet a specific corrective action requirement under the base Resource Conservation and Recovery Act (RCRA) Permit (HW-50289). This document is provided for use as a resource of basewide groundwater quality, as well as for your records.

Should you have any questions regarding this report, please contact me at (817) 782-7167

Sincerely,

Michael R. Dodyk, P.E.
Restoration Team Chief
ERA Restoration Division

Enclosures
cc:

Mr. Gary Miller (1 copy)
US EPA Region VI
1445 Ross Ave., Ste. 1200
Dallas, TX 78202

Mr. Tim Sewell (1 copy)
TNRCC Region VI
1101 E. Arkansas Lane
Arlington, TX 76010

Mr. Don Ficklen (1 copy)
HQ AFCEE/ERD
3207 North Road
Brooks AFB, TX 78235

Ms. Audrie Medina (1 copy)
UNITEC
2100 Bypass Rd., Building 580
Brooks AFB, TX 78235

RESPONSES TO COMMENTS:
DRAFT FINAL
2001 BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN
NAS FORT WORTH JRB, TEXAS
MAY 2001

Responses to UNITEC's Comments

Comment 1 *Page 2-9, Section 2.3.1, Paragraph 3, last sentence, Figure 2.6: Monitoring wells WHGLPA002 and WHGLPA004 have the same location in Figure 2.6. Please clarify.*

Response **HydroGeoLogic will modify figure to reflect well symbols for both monitoring wells. Please note the monitoring well locids WHGLPA001 through WHGLPA004 have been modified to reflect a more accurate description of the well. (i.e., WHGLPA001, WHGLPA003, and WHGLPA004 are now labeled WHGLPU001, WHGLPU003, and WHGLPU004, respectively.) WHGLPA002 is now labeled WHGLWN002.**

Comment 2 *Page 2-9, Section 2.3.1, Paragraph 3, Sentence 1 · According to this section, "Flow between aquifers is restricted by the Goodland/Walnut; therefore the Terrace Alluvium groundwater has no significant hydraulic connection to the underlying aquifers at NAS Fort Worth JRB "*

This sentence contradicts Section 2.3.1, fourth paragraph, last sentence, "These early observations and analytical results suggest a degree of hydraulic connection between the Terrace Alluvium groundwater and the underlying aquifer.... ".

In addition, this also appears to contradict Section 2.3.2, second paragraph, first sentence, page 2-13 "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. Please clarify.

Response **HydroGeoLogic recognizes that this issue may be prematurely addressed using the initial data obtained from the installation and sampling of the Paluxy wells. Additional groundwater monitoring and aquifer testing must be obtained prior to drawing a conclusion. The last sentence in the fourth paragraph of Section 2.3.1 will be removed.**

The statement appearing in Section 2.3.2, regarding the "window area" will remain as stated, due to the "window area" being the only confirmed/known exception to the integrity of the Goodland/Walnut Aquitard.

Comment 3 *Page 3-9, Section 3.2.1, Paragraph 2, sixth sentence. The vinyl chloride concentration of 200 µg/L detected in monitoring well LF05-01 during the October 2000 sampling is not on Table A.1 of Appendix A. Please clarify.*

Response **The vinyl chloride concentration for LF05-01 was included in the Draft 2001 Basewide GSAP and can be found on Page A-4 of Appendix A, Table A.1.**

Comment 4 *Page 3-9, Section 3.2.1, Paragraph 2, last sentence: Please identify and include the three wells with vinyl chloride concentrations detected at or above the RRS 2 value.*

Response **HydroGeoLogic will identify the three wells containing vinyl chloride concentrations exceeding the RRS 2 (i.e., LF05-01, LF05-5G, and WITCTA024).**

Comment 5 *Page 3-9, Section 3.3, Paragraph 2, First Sentence· The concentration of arsenic detected during the October 2000 sampling for WITCTA010 is not included on Table A.1 in Appendix A as stated in the text. Please revise.*

Response **HydroGeoLogic will incorporate the arsenic result from October 2000 into Appendix A, Table A.1.**

Comment 6 *Appendix B, Please include monitoring well data.*

Response **The title sheet containing Appendix B, Monitoring Well Data prefaces the information contained in Appendix B.1 through Appendix B.4, therefore the requested data is currently included.**

FINAL
2001 BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN NAS FORT WORTH JRB, TEXAS

Prepared for

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

Contract Number F41624-95-D-8005-0033

Prepared by

HydroGeoLogic, Inc.
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May 2001

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NAS Fort Worth JRB, Texas

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6 AUTHOR(S)
HydroGeoLogic, Inc

7 PERFORMANCE ORGANIZATION NAMES(S) AND ADDRESS(S)

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Herndon, VA 20170

8 PERFORMANCE ORGANIZATION REPORT NUMBER

AFC001

9 SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(S)

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13 ABSTRACT (Maximum 200 words)

The Final 2001 Basewide Groundwater Sampling and Analysis Plan (GSAP) describes the monitoring objectives and activities for the groundwater sampling and analysis program to be followed at NAS Fort Worth JRB, Texas for the April and October semi-annual sampling events scheduled for 2001.

14 SUBJECT TERMS

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PREFACE

The 2001 Final 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 2001 at the Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB), Carswell Field, Texas. This plan was prepared under Contract Number F41624-95-D-8005, Delivery Order 33 issued to HydroGeoLogic, Inc. (HydroGeoLogic). Activities to be included in this contract were specified in the Statement of Work dated March 2000. The AFCEE Contracting Officer's Representative (COR) is Mr. Don Ficklen. HydroGeoLogic's Project Manager is Mr. Todd Harrah.

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

Page

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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LIST OF ACRONYMS/ABBREVIATIONS

AFCEE	Air Force Center for Environmental Excellence
AFP 4	Air Force Plant 4
AOC	Area of Concern
BRAC	Base Realignment and Closure
BTEX	benzene, toluene, ethylbenzene, and xylenes
CADD	computer-aided drafting and design
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	*cis*-1,2-dichloroethene
cm/s	centimeter per second
COR	contracting officer's representative
°F	degrees Fahrenheit
DO	dissolved oxygen
DPT	direct push technology
DQO	Data Quality Objective
EC	electrical conductance
EDD	electronic data deliverable
EDF	electronic data file
Eh	oxidation-reduction potential
EPA	Environmental Protection Agency
ERA	Environmental Restoration Account
ERPIMS	Environmental Restoration Program Information Management System
ESE	Environmental Science and Engineering
FFA	Federal Facilities Agreement
ft/d	feet per day
GIS	geographic information system
gpd/ft	gallons per day per foot
gpd/ft^2	gallons per day per square foot
GSAP	groundwater sampling and analysis plan
HydroGeoLogic	HydroGeoLogic, Inc.
IRA	Interim Remedial Action
IRP	Installation Restoration Program
Jacobs	Jacobs Engineering Group, Inc.

LIST OF ACRONYMS/ABBREVIATIONS (continued)

LNAPL	light non-aqueous phase liquid
LPST	Leaking Petroleum Storage Tank
LTM	long-term monitoring
µg/L	micrograms per liter
MDL	method detection limit
mg/L	milligrams per liter
MOU	memorandum of understanding
MQL	Method Quantitation Limit
MSC	Medium Specific Concentration
mya	million years ago
NAS Fort Worth JRB	Naval Air Station Fort Worth Joint Reserve Base
NCP	National Contingency Plan
NFA	no further action
NGVD	national geodetic vertical datum
NPL	National Priority List
OPR	office of primary responsibility
OWS	oil/water separator
Parsons	Parsons Engineering Science, Inc.
PCE	tetrachloroethylene
POL	petroleum, oil, and lubricant
PQL	practical quantitation limit
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
Radian	Radian International
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RRS	Risk Reduction Standard
SI	site investigation
SQL	sample quantitation limit
SVOC	semi volatile organic compound
SWMU	Solid Waste Management Unit

LIST OF ACRONYMS/ABBREVIATIONS (continued)

TAC	Texas Administrative Code
TCE	trichloroethene
TI	Tolerance Interval
TM	Technical Memorandum
TNRCC	Texas Natural Resource Conservation Commission
TOC	total organic carbon
TWC	Texas Water Commission
trans-1,2-DCE	*trans*-1,2-dichloroethene
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UST	underground storage tank
UTL	upper tolerance limit
VC	vinyl chloride
VOC	volatile organic compound
WAA	waste accumulation area

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TAB

SECTION 1.0

FINAL
2001 BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN NAS FORT WORTH JRB, TEXAS

1.0 INTRODUCTION

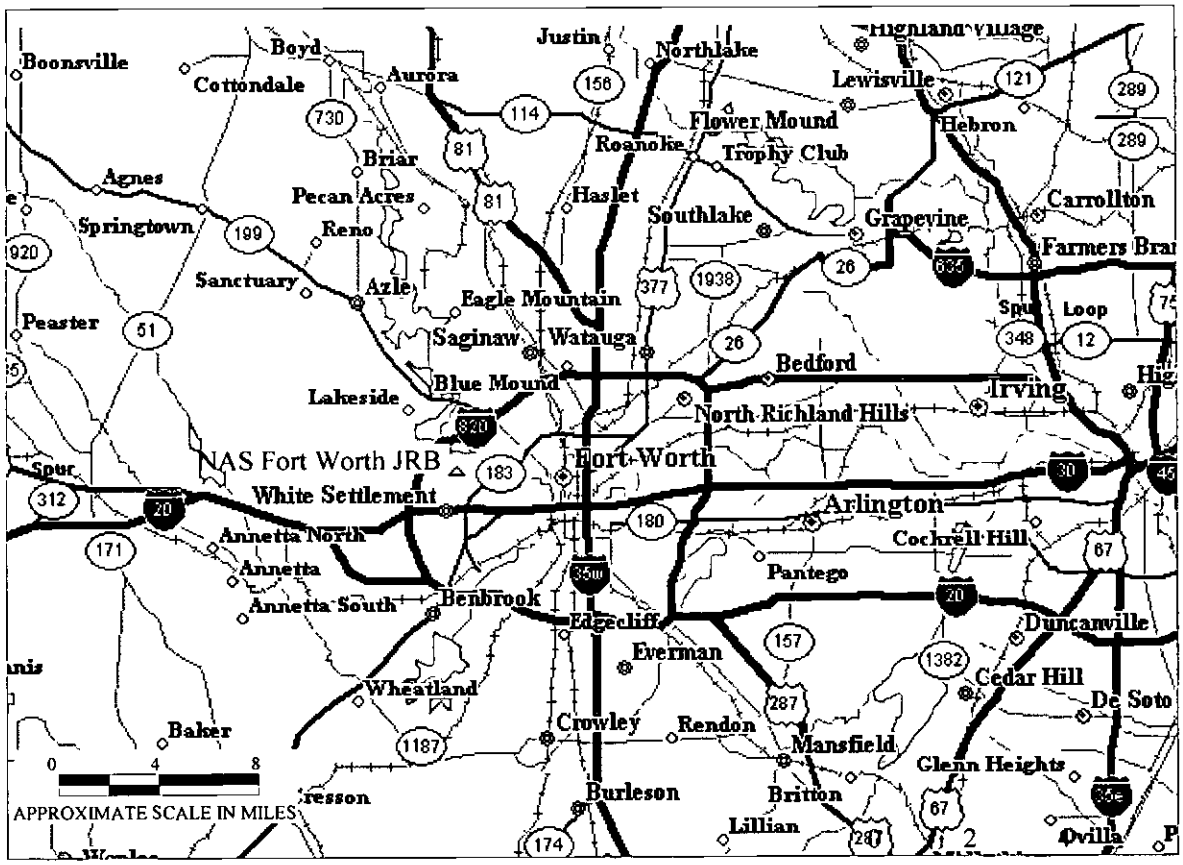
This report sets forth the groundwater sampling and analysis plan (GSAP) for the semi-annual groundwater monitoring activities to be conducted in 2001 at the Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), Formerly Carswell Field (Figure 1.1). As part of the U.S. Air Force Installation Restoration Program (IRP), this GSAP fulfills both short-term and long-term groundwater monitoring objectives. The fulfillment of these objectives is not presently a regulatory requirement, except for units that currently have long-term monitoring (LTM) requirements as part of approved or proposed closure plans. Consequently, the proposed GSAP is a voluntary action on the part of the U.S. Air Force to conduct basewide monitoring of the groundwater flow and quality. This introductory section includes: (1) a discussion of the GSAP objectives and approach, (2) an overview of the IRP program and its objectives, and (3) a site description and identification of the units of concern.

1.1 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 Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) identified on the base. Nineteen rounds of quarterly sampling have been implemented to date: April 1995, July 1995, October 1995, January 1996, January 1997, April 1997, July 1997, October 1997, January 1998, April 1998, July 1998, October 1998, January 1999, April 1999, July 1999, October 1999, April 2000, July 2000, and October 2000. This GSAP has been developed based on the results of the three quarterly sampling rounds conducted as part of the 2000 program, as well as other available data. The GSAP presents the program approach for the 2001 sampling program. Monitoring objectives for the 2001 program have been established to ensure that adequate data are collected for the evaluation of the critical exposure pathways involving groundwater.

Below are the 2001 GSAP monitoring objectives, which are based on the findings of previous investigations, and the current understanding of the remediation/assessment plans anticipated in the coming year. These objectives 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 objectives.

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



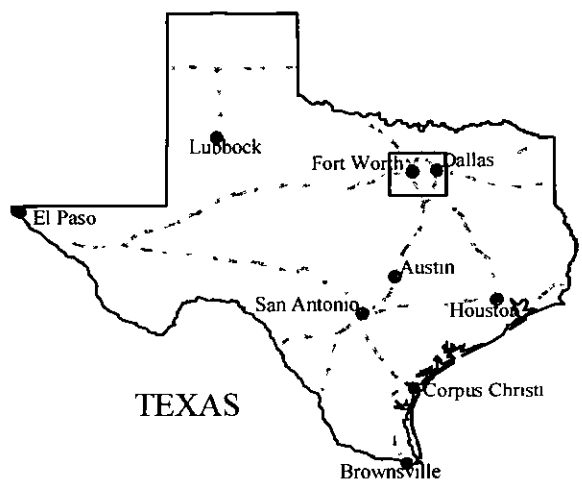


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Figure 1.1

Site Location Map
NAS Fort Worth JRB, Texas

- 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; and

- Natural Attenuation Monitoring - collect data to demonstrate the extent that natural attenuation of trichloroethene (TCE) is occurring.

1.2 GSAP APPROACH

This GSAP has been developed to provide a framework to achieve the objectives described above, and presents in detail, the approach for the current program. This document includes the approach and methodology for the following components:

- Collection of water level measurements;
- Removal of light non-aqueous phase liquids (LNAPL) if necessary;
- Collection and analysis of groundwater quality samples;
- Methods for water quality analyses;
- Well inspection and maintenance;
- Procedures for management and transfer of analytical and field data; and
- Format and objectives of reporting documents.

This framework includes sampling existing wells, recommendations for sampling wells proposed for near future installation, and recommendations for chemical parameters to be included in the analytical program. The framework is based on a current understanding of the restoration plans for the SWMUs and AOCs at the base. Details for subsequent monitoring rounds will be tailored based on results of the previous sampling event and the overall remediation/monitoring strategy for NAS Fort Worth JRB.

1.3 NAS FORT WORTH JRB INSTALLATION RESTORATION PROGRAM

The objectives of the U.S. Air Force IRP are 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.

Environmental contamination was identified at U.S. Air Force Plant No. 4 (AFP 4) through site investigations conducted during the 1980s. As a result, AFP 4 was placed on the National Priority List (NPL) in August 1990. A Federal Facilities Agreement (FFA) was entered into between the Texas Natural Resource Conservation Commission (TNRCC), the U.S. Environmental Protection Agency (EPA) Region VI, and the U.S. Air Force. Investigation, remediation, and monitoring information can be located in Environmental Science and Engineering, Inc. 1994; Rust Geotech, 1995a and 1995b; HydroGeoLogic, Inc. (HydroGeoLogic), 2001b; and Jacobs, 2001.

Although the Air Force developed the IRP in response to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), NAS Fort Worth JRB is not listed on the NPL and as such, is not subject to corrective action under CERCLA. The primary regulatory

programs that govern the investigation, remediation, and closure of NAS Fort Worth JRB sites is the Resource Conservation and Recovery Act (RCRA) and TNRCC Risk Reduction Rules Program (RRR). The TNRCC is the lead regulatory agency for activities to be conducted at the subject sites.

On February 7, 1991 the former Carswell AFB was issued a RCRA hazardous waste permit (HW-50289) by the TNRCC. This permit requires a RCRA facility investigation of all 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.

A Memorandum of Understanding (MOU) was signed by the acting Secretaries of the Air Force and Navy on June 8 and 9, 1993. The MOU outlined the general terms under which the Air Force would transfer responsibility for portions of the former Carswell AFB to the Navy. The MOU established a final target date of September 20, 1994 for the transfer of host responsibilities from the Air Force to the Navy. On September 23, 1994, the Navy and Air Force executed another MOU to amend the previous MOU. The Navy assumed "host responsibilities" for NAS Fort Worth JRB, on October 1, 1994, but did not assume several key environmental program responsibilities.

In a letter dated February 26, 1996, the Air Force Deputy Assistant Secretary interpreted and amended the original MOU. This amendment confirmed the Air Force's acceptance of funding and management responsibilities for the final remediation of all environmental restoration requirements attributed to former Carswell AFB operations that occurred prior to October 1, 1994. In an MOU dated June 19, 1996, the parties reached agreement regarding the cleanup of NAS Fort Worth JRB (Air Force, 1997).

The primary emphasis of all site investigations is to meet the requirements of Permit Provision VIII of the NAS Fort Worth JRB HW-50289 permit. However, as the IRP, TNRCC RRRs, and RCRA rely heavily on guidance documents prepared under CERCLA, this GSAP has been prepared using guidance documents from all four programs.

1.4 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 for off-base recycling or disposal. Since 1984, many of these sites (which include landfills, fire training areas, oil/water separators (OWS), and evidence of spills at waste accumulation areas) have been investigated. A total of 68 SWMUs are identified at the base. Many were addressed as part of a RCRA Facility Assessment (RFA) conducted for what was then Carswell AFB (A.T. Kearney, 1989), with additional SWMUs added later via letters from the TNRCC. Additionally, 19 AOCs were identified in either Permit HW-50289 or by subsequent individual letters from the TNRCC. A number of the SWMUs and AOCs identified have been determined to require no further action (NFA) and are currently considered closed by the TNRCC (TNRCC, 1995). All SWMUs and AOCs are listed on Table 1.1 and Table 1.2 respectively, and the locations of SWMUs and AOCs are shown on Figure 1.2.

Table 1.1
Solid Waste Management Units at NAS Fort Worth JRB, Texas

SWMU	Description	OPR
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 1627 Waste Accumulation Area for Building 1628	ERA
6	Building 1628 Wash Rack and Drain	ERA
7	Building 1628 Oil/Water Separator (NFA)	ERA
8	Building 1628 Sludge Collection Tank (NFA)	ERA
9	Building 1628 Work Station Waste Accumulation Area (NFA)	ERA
10	Building 1617 Work Station Waste Accumulation Area (NFA)	ERA
11	Building 1618 Waste Accumulation Area for Buildings 1617 and 1619	ERA
12	Building 1602 Former Waste Accumulation Area	ERA
13	Building 1710 Visual Information Center Work Station Former Waste Accumulation Areas (NFA)	ERA
14	Building 1060 Bead Blaster Collection Tray (NFA)	BRAC
15	Building 1060 Paint Booth Vault (NFA)	BRAC
16	Building 1059 Waste Accumulation Area (NFA)	ERA
17	Landfill No 7	ERA
18	Fire Training Area No. 1 (NFA)	ERA
19	Fire Training Area No. 2	ERA
20	Waste Fuel Storage Tank	ERA
21	Waste Oil Tank	ERA
22	Landfill No. 4	BRAC
23	Landfill No. 5	ERA
24	Waste Burial Area	ERA
25	Landfill No. 8	ERA
26	Landfill No. 3	ERA
27	Landfill No. 10 (NFA)	ERA
28	Landfill No. 1	ERA
29	Landfill No. 2	ERA
30	Landfill No. 9	ERA
31	Building 1050 Former Waste Accumulation Area	ERA
32	Building 1415 Waste Accumulation Area for Building 1410	ERA
33	Building 1436 Waste Accumulation Area for Building 1420 (NFA)	ERA
34	Building 1194 Former Waste Accumulation Area (NFA)	ERA
35	Vehicle Refueling Shop (Building 1194) Oil/Water Separation System	ERA
36	Building 1191 Former Waste Accumulation Area	ERA
37	Vehicle Maintenance Shop (Building 1191) Oil/Water Separation System	ERA
38	Building 1269 Polychlorinated Biphenyl Transformers Building (NFA)	BRAC

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

SWMU	Description	OPR
39	Building 1643 Former Waste Accumulation Area (NFA)	ERA
40	Building 1643 Oil/Water Separation System	ERA
41	Building 1414 Oil/Water Separation System, Field Maintenance Squadron Aerospace Ground Equipment	ERA
42	Building 1414 Former Waste Accumulation Area (NFA)	ERA
43	Building 1414 Non Destructive Inspection Waste Accumulation Point (NFA)	ERA
44	Building 1027 Oil/Water Separation System at the Aircraft Washing Hangar	ERA
45	Building 1027 Waste Oil Tank Vault	ERA
46	Building 1027 Waste Accumulation Area (NFA)	ERA
47	Building 1015 Jet Engine Test Cell Oil/Water Separator	ERA
48	Building 1048 Fuel Systems Shop Floor Drains (NFA)	ERA
49	Aircraft Washing Area No. 1	ERA
50	Aircraft Washing Area No 2	ERA
51	Central Waste Holding Area/Waste Accumulation Areas 1187 and 1189	ERA
52	Building 1190 Oil/Water Separation System	ERA
53	Storm Water Drainage System	ERA
54	Storm Water Interceptors	ERA
55	East Gate Oil/Water Separator	ERA
56	Building 1405 Waste Accumulation Area (NFA)	ERA
57	Buildings 1432/1434 Waste Accumulation Area (NFA)	ERA
58	Pesticide Rinse Area (NFA)	BRAC
59	Building 8503 Weapons Storage Area Waste Accumulation Area	BRAC
60	Building 8503 Radioactive Waste Burial Site	BRAC
61	Building 1319 Waste Accumulation Area for Building 1320	ERA
62	Landfill No. 6	ERA
63	Entomology Dry Well (NFA)	ERA
64	French Underdrain System	ERA
65	Weapons Storage Area Disposal Site (NFA)	BRAC
66	Sanitary Sewer System	BRAC
67	Building 1340 Oil/Water Separator	ERA
68	POL Tank Farm	ERA

Notes
OPR - Office of Primary Responsibility
BRAC - Base Realignment and Closure
ERA - Environmental Restoration Account
NFA - No further action
POL - Petroleum, oil, and lubricant

Table 1.2
Areas of Concern at NAS Fort Worth JRB, Texas

AOC	Description	OPR
1	Former Base Service Station/ Former Base Gas Station	ERA
2	Airfield Groundwater Plume	ERA
3	Waste Oil Dump (NFA)	ERA
4	Fuel Hydrant System	ERA
5	Grounds Maintenance Yard	ERA
6	RV Storage Area (NFA)	ERA
7	Former Base Refueling Area	ERA
8	Aerospace Museum	BRAC
9	Golf Course Maintenance Yard (NFA)	BRAC
10	Building 1064 Oil/Water Separator	ERA
11	Building 1060 Oil/Water Separator	ERA
12	Building 4210 Oil/Water Separator	ERA
13	Building 1145 Oil/Water Separator	ERA
14	Unnamed Stream	ERA
15	Storage Shed Building 1190 (NFA)	ERA
16	Family Camp (NFA)	BRAC
17	Suspected Former Landfill	ERA
18	Suspected Former Fire Training Area A	ERA
19	Suspected Former Fire Training Area B	ERA

Notes:
OPR - Office of Primary Responsibility
BRAC - Base Realignment and Closure
ERA - Environmental Restoration Account
NFA - No further action

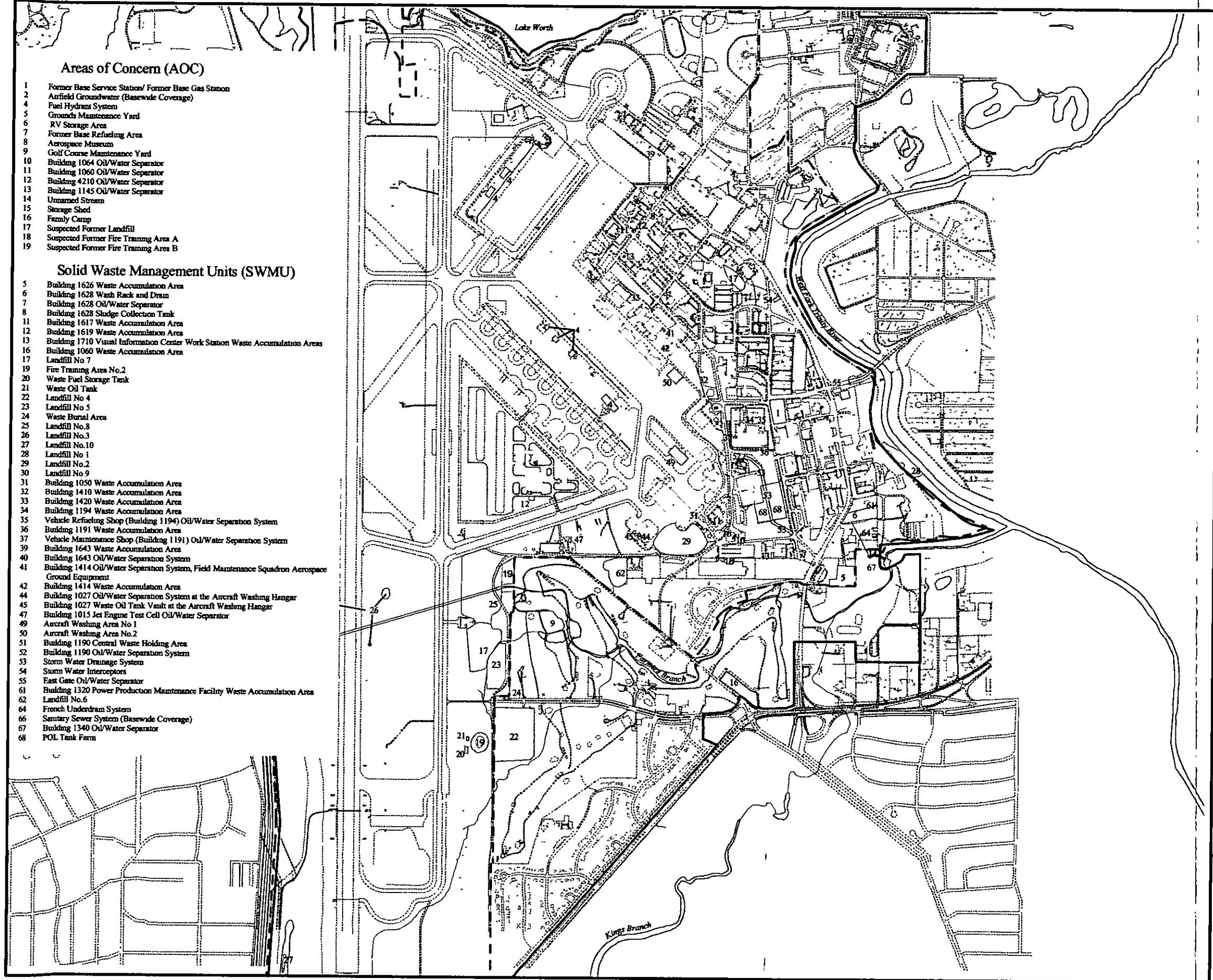
Portions of the facility are subject to Air Force Base Realignment and Closure (BRAC) management, while other portions are managed by AFCEE under the Environmental Restoration Account (ERA). These management responsibilities are included on Table 1.1 and Table 1.2.

1.5 OVERVIEW OF 2000 BASEWIDE GROUNDWATER MONITORING ACTIVITIES AND PROPOSED ACTIVITIES FOR 2001

Since the publication of the 2000 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. Table 1.3 also provides a brief description of the anticipated monitoring activities to be conducted in 2001 as part of the ongoing and/or proposed remediation/assessment efforts, and the analytical data they will generate. This GSAP has been developed based on the understanding of these ongoing and anticipated efforts. 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.

1.6 REPORT ORGANIZATION

Section 2.0 of this GSAP includes a site description, while Section 3.0 provides a characterization of the nature and extent of groundwater contamination as delineated by the results of the previous sampling events. The data quality objective (DQO) statements and processes are described in Section 4.0. Section 5.0 of this report describes the proposed monitoring activities for 2001; the inspection procedures; the rationale and selection of monitoring wells for water level measurements; and the rationale and selection of monitoring wells for analytical sampling, sampling frequency, and testing methods. Data management and data quality evaluation procedures are presented in Section 6.0, which includes an outline of the procedures for updating the GSAP. Report requirements are provided in Section 7.0. Section 8.0 presents the schedule for sampling and reporting, and Section 9.0 lists references. Appendix A presents detected analytical results from the 2000 basewide sampling program. Appendix B provides a list of water table elevations for NAS Fort Worth JRB, monitoring well construction information, guidelines and procedures for well closure, and the TNRCC rules for well abandonment. Field sampling procedures and field measurement and documentation forms are contained in Appendix C. Appendix D contains the Health and Safety Plan. The geostatistical methodology used to support 2001 well selection is provided in Appendix E.



Areas 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 Building 1064 Oil/Water Separator
11 Building 1060 Oil/Water Separator
12 Building 4210 Oil/Water Separator
13 Building 1145 Oil/Water Separator
14 Unnamed Stream
15 Storage Shed
16 Firmly Camp
17 Suspected Former Landfill
18 Suspected Former Fire Training Area A
19 Suspected Former Fire Training Area B

Solid Waste Management Units (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
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

HydroGeoLogic, Inc.
2001 Basewide Groundwater Sampling and Analysis Plan
NAS Fort Worth JRB, Texas

Figure 1.2

SWMU/AOC Location Map

U.S. Air Force Center for Environmental Excellence

Legend

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

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Map Source Jacobs, 1996

HYDRO GeoLogic Inc.

Table 1.3

Summary of Recent and Anticipated Groundwater Monitoring Activities at NAS Fort Worth JRB, Texas

Documentation of Project/Activities	Description of Project/Activity	Contractor	2000 Groundwater-Related Activities	Anticipated 2001 Groundwater-Related Activities
Final Remedial Action Plan for the Risk-Based Remediation of SWMU 68 and AOC 7 (POL Tank Farm) [Parsons, 1997]	Semi-annual long-term monitoring.	HydroGeoLogic	Final Site Assessment Report was submitted to the TNRCC in August 2000. Semi-annual groundwater sampling of 9 wells for VOCs performed in 2000.	Submit a 2000 Annual Report to AFCEE including a Closure Report. No additional sampling planned.
Corrective Action Plans for AOC 1 (Base Service Station and Base Gas Station) [IT Corporation, 1997a; 1997b]	Semi-annual long-term monitoring.	HydroGeoLogic	Semi-annual groundwater sampling of 9 wells for VOCs performed in 2000.	Quarterly sampling of the 9 selected wells for VOCs.
NAS Fort Worth JRB Basewide Sampling and Analysis Plan [HydroGeoLogic, 2000a]	Continued monitoring of wells basewide.	HydroGeoLogic	Quarterly sampling events conducted in April, July, and October for approximately 17 wells.	Submit a 2000 Annual Report to AFCEE. Semi-annual sampling events will be conducted in April and October 2001 for approximately 44 wells.
AFP 4 Basewide Sampling [Jacobs, 2001]	Continued monitoring of groundwater contamination at AFP 4.	Jacobs	Semi-Annual Monitoring of 10 monitoring wells at NAS Fort Worth JRB and 16 monitoring wells at AFP 4 in April and October 2000.	Continue semi-annual monitoring of approximately 8 monitoring wells at NAS Fort Worth JRB and 16 monitoring wells at AFP 4 in April and October 2001.

Table 1.3 (continued)
Summary of Recent and Anticipated Groundwater Monitoring Activities at NAS Fort Worth JRB, Texas

Documentation of Project/Activities	Description of Project/Activity	Contractor	2000 Groundwater-Related Activities	Anticipated 2001 Groundwater-Related Activities
RCRA Facility Investigation of Landfills 1, 2, 3, 6, 7, and 9 (SWMUs 28, 29, 26, 62, 17, and 30, respectively). [HydroGeoLogic, 2001a]	Determine nature and extent of landfill related contaminants in groundwater for six landfills.	HydroGeoLogic	Phase III investigation of each Landfill was completed in June 2000.	Landfill RFI reports will be submitted to AFCEE next year, pending additional delineation activities. Additional groundwater sampling activities may be performed.
Final Monitoring Well Abandonment and Repair Letter Report [HydroGeoLogic, 2000k]	Abandonment of damaged and/or unnecessary wells and repair of damaged wells at AFP 4 and NAS Fort Worth JRB.	HydroGeoLogic	Determined the number of wells requiring abandonment and repair. Abandonment of 15 wells at NAS Fort Worth JRB and 41 wells at AFP 4. Repair of 4 wells located at NAS Fort Worth JRB.	Review well reconnaissance data in Spring 2001 to develop a new list of wells to be abandoned or repaired at NAS Fort Worth JRB and AFP 4.
AOC 4 Site Investigation [HydroGeoLogic, 2000f]	Monitor contamination associated with the abandoned fuel hydrant system located at the Navy Ramp and Alert Apron.	HydroGeoLogic	Semi-annual groundwater sampling of 7 wells for VOCs performed in 2000.	Submit a 2000 Annual Report to AFCEE including a Closure Report. No additional sampling planned.
Phase II RFI of AOC 13 (Building 1145 - Automotive Hobby Shop) [HydroGeoLogic, 2000e]	Removal, disposal, and investigation of Hobby Shop OWS and waste oil tank.	HydroGeoLogic	May and June 2000, the OWS and UST was removed and replaced with a new OWS. Delineation/confirmation groundwater sampling occurred with October Quarterly sampling.	RFI Report planned for submission in April 2001. No additional sampling planned.

Table 1.3 (continued)
Summary of Recent and Anticipated Groundwater Monitoring Activities at NAS Fort Worth JRB, Texas

Documentation of Project/Activities	Description of Project/Activity	Contractor	2000 Groundwater-Related Activities	Anticipated 2001 Groundwater-Related Activities
Site Investigation of 12 Underground Storage Tanks [HydroGeoLogic, 1999b]	Review data gaps for 12 USTs and recommend additional sampling activities necessary for closure.	HydroGeoLogic	Sampled two monitoring wells at Building 1411 and one well at Building 1191.	No additional groundwater sampling planned.
RCRA Facility Investigation of Waste Accumulation Areas [HydroGeoLogic, 2000c]	Review of existing data on 16 waste accumulation areas (WAAs). Recommend additional investigation	HydroGeoLogic	7 of 16 WAAs approved for closure in November 2000. Phase II of RFI completed in October 2000.	Additional groundwater delineation to be performed in 2001.
RCRA Facility Investigation of SWMUs 19, 20, 21, and 53; and Site Investigation of AOCs 17, 18, and 19 [HydroGeoLogic, 2000d]	Conduct SI at one former landfill and two former fire training areas to determine if a release occurred. Conduct RFI to determine nature and extent of contamination related to the former Fire Training Area No. 2 and the Stormwater Drainage System.	HydroGeoLogic	None	Installation of monitoring wells with three rounds of sampling approximately two months apart. The first round using analyses for Appendix IX compounds, with 2 subsequent rounds of Appendix IX VOCs, SVOCs, and metals.
RCRA Facility Investigation at SWMU 50, (Former Aircraft Washrack) [HydroGeoLogic, 2000i]	Conduct investigation of washracks to determine extent of contamination.	HydroGeoLogic	None	Groundwater investigations may occur depending on results of soil investigations performed in late 2000.
RCRA Facility Investigation at SWMU 54 and 55 (Storm Water Interceptors and East Gate OWS) [HydroGeoLogic, 2000h]	Investigation of potential contamination associated with stormwater interceptors and East Gate OWS.	HydroGeoLogic	None	Groundwater investigations may occur depending on results of soil investigations performed in late 2000.

Table 1.3 (continued)
Summary of Recent and Anticipated Groundwater Monitoring Activities at NAS Fort Worth JRB, Texas

Documentation of Project/Activities	Description of Project/Activity	Contractor	2000 Groundwater-Related Activities	Anticipated 2001 Groundwater-Related Activities
Focused Feasibility Study of the Southern Plume Lobe (additional Terrace and Paluxy Wells) [HydroGeoLogic, 2000g]	Feasibility Study for remediation of Southern Lobe of TCE Plume in the area of the golf course.	HydroGeoLogic	Installation and two rounds of sampling at five Terrace Alluvium wells and four Paluxy wells.	No additional sampling planned under this project.

Notes:

AFCEE - Air Force Center for Environmental Excellence
AFP - Air Force Plant
AOC - Area of Concern
NAS Fort Worth JRB - Naval Air Station Fort Worth Joint Reserve Base
RCRA - Resource Conservation and Recovery Act
RFI - RCRA Facility Investigation
SI - site investigation
SVOC - semivolatile organic compound
SWMU - solid waste management unit
TCE - trichloroethene
UST - underground storage tank
VOC - volatile organic compound

TAB

SECTION 2.0

2.0 SITE DESCRIPTION

On October 1, 1994, the Air Force transferred the majority of the property that constituted Carswell AFB to the U.S. Navy to become NAS Fort Worth JRB. NAS Fort Worth JRB is located on 2,264 acres of land in Tarrant County, Texas, 8 miles west of downtown Fort Worth. The base is bordered by Lake Worth to the north; the West Fork 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 AFP 4 to the west (Figure 2.1). 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).

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. The Central Lowlands Physiographic Province 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, which is characterized by rolling topography and a heavy growth of post and blackjack oaks (Radian, 1989). Surface elevations for this region range from about 620 feet above national geodetic vertical datum (NGVD) along the southwestern side of the base, to approximately 529 feet above NGVD, along the eastern side of the base. Figure 2.1 is a portion of the Lake Worth and Benbrook Texas, U.S. Geological Survey (USGS) topographic maps showing the relief of the NAS Fort Worth JRB Area.

2.2 REGIONAL GEOLOGY

The major 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 geologic 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 following five hydrogeologic units, listed from the shallowest to the deepest, located in the NAS Fort Worth JRB area include (Figure 2.5): (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 with interbedded fine-grained clay and shale layers of the Goodland and Walnut Formations, (3) an aquifer in the sandstone of the Paluxy Formation,

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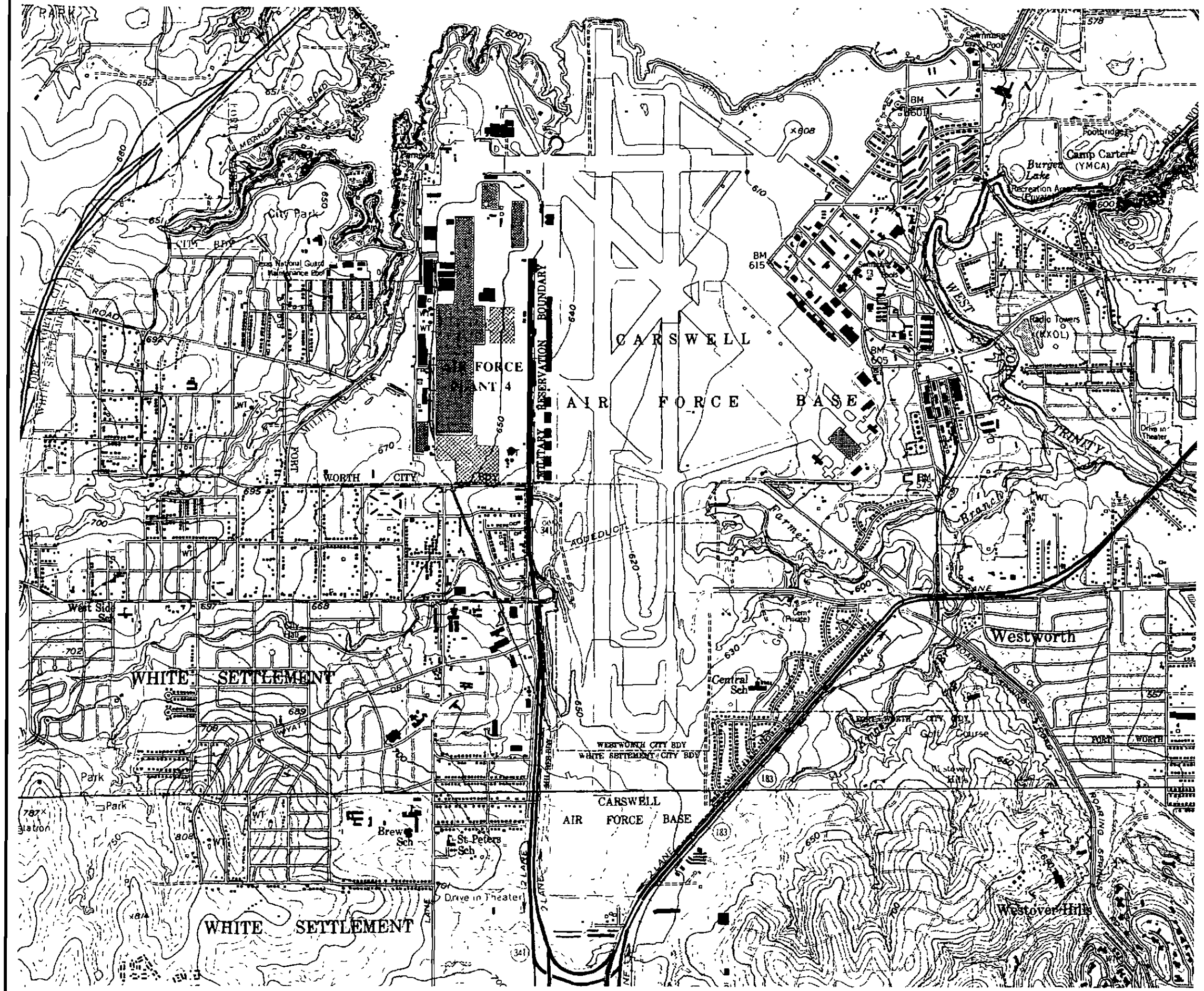
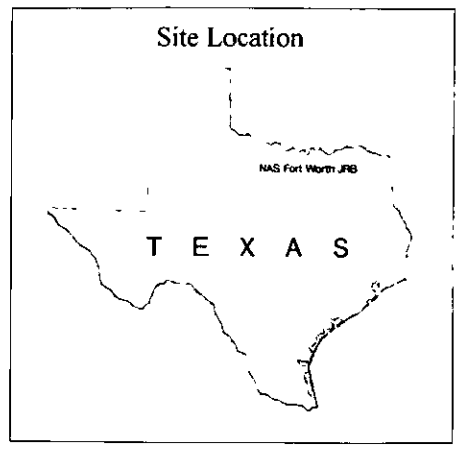
Figure 2.1

NAS Fort Worth JRB
Regional Topographic Map

Air Force Center for Environmental Excellence



Site Location



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Revised 02/27/01 jb
Maps Lake Worth and Benbrook TX
Dates Photorevised 1981, 1982

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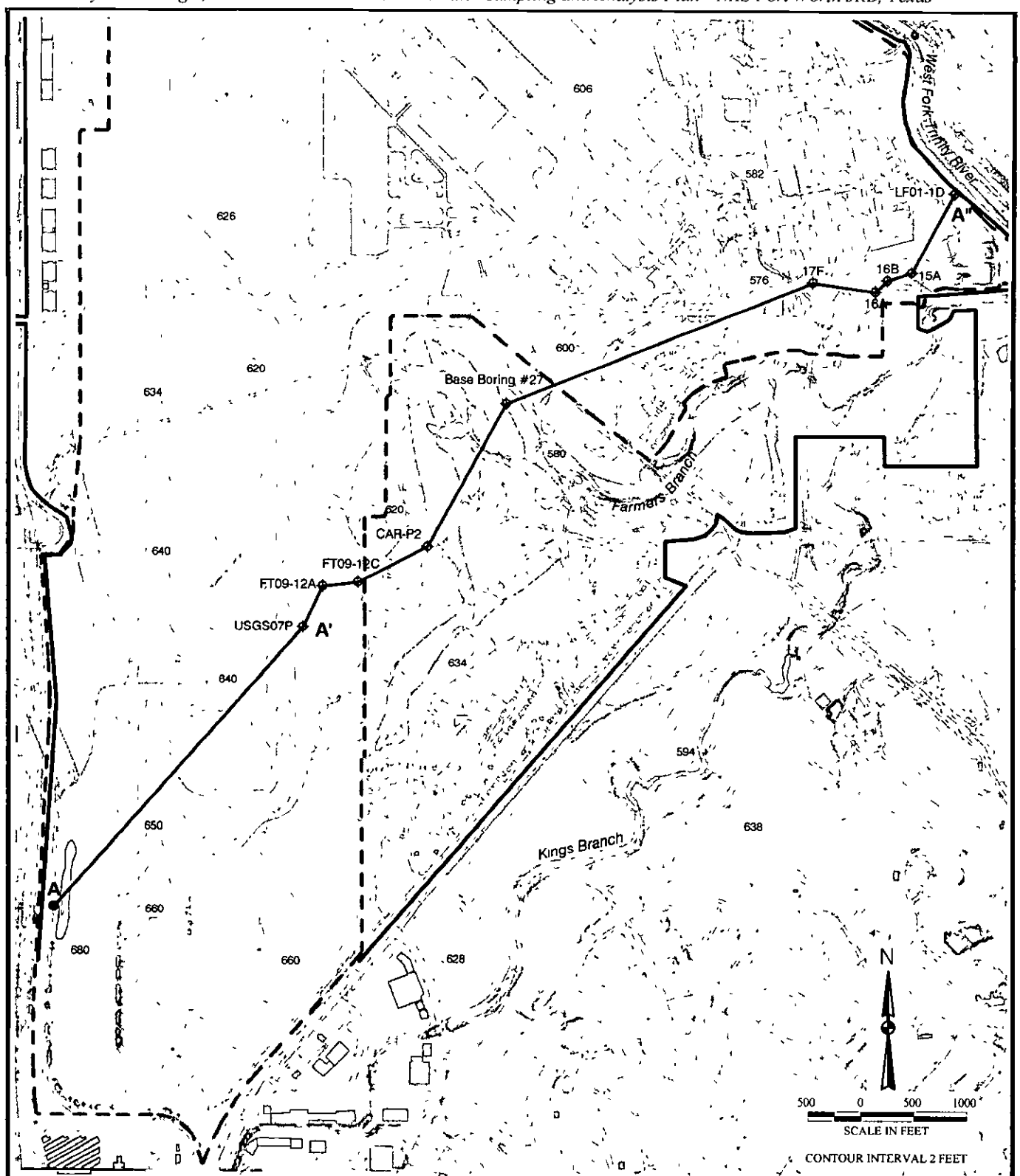

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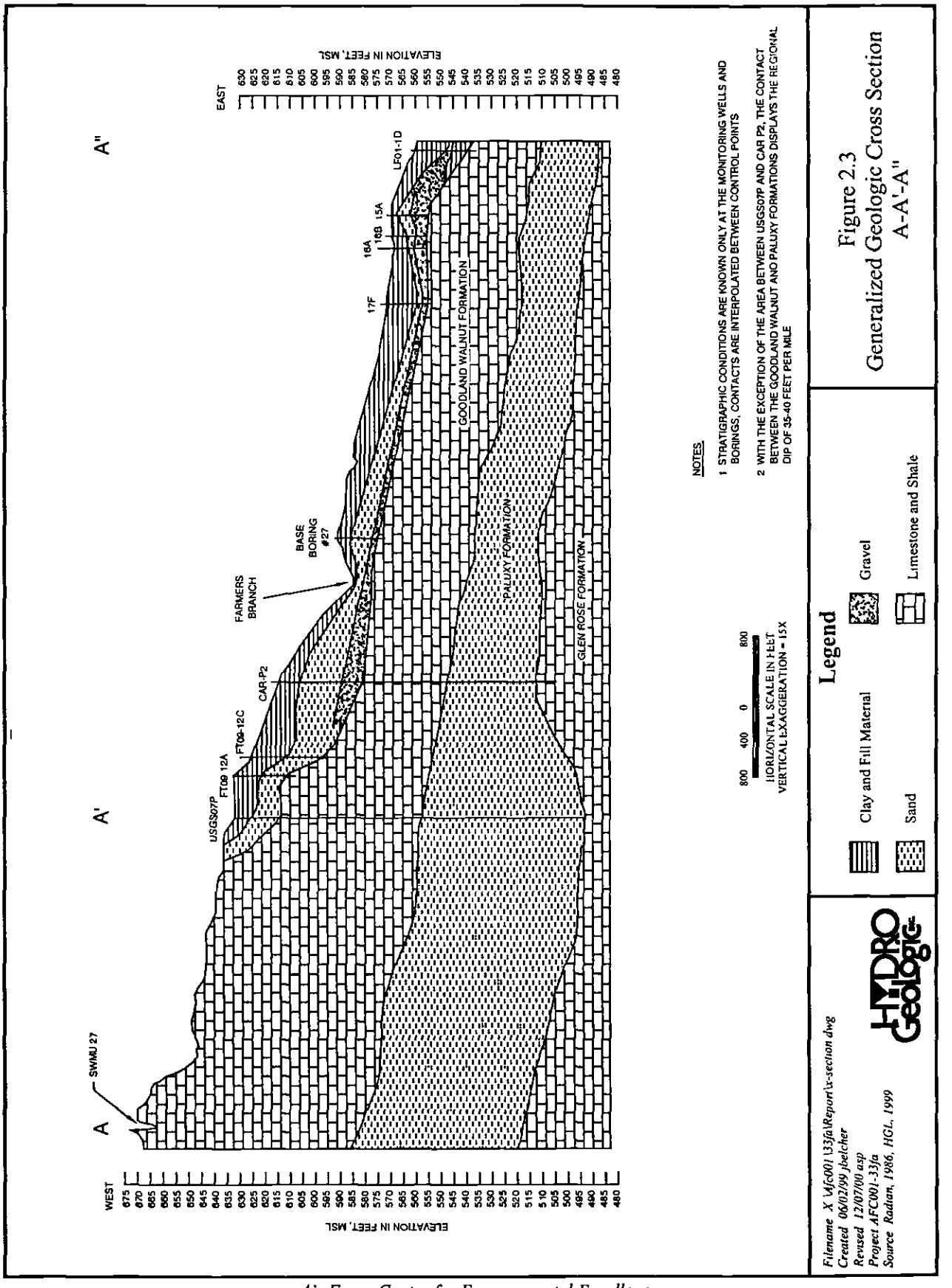
Source HydroGeoLogic, Inc—GIS Database

HYDRO GeoLogic

Legend

- NAS Fort Worth JRB Boundary
- Former Carswell AFB Boundary
- SWMU 27 Location
- 660 Topographic Contour

Figure 2.2
Cross Section Location
A-A'-A"


A
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WEST
EAST
ELEVATION IN FEET, MSL
SWMU 27
USGS07P
FT09 12A
FT09-12C
CAR-P2
FARMERS BRANCH
BASE BORING #27
17F
16A
16B
15A
LF01-1D
GOODLAND WALNUT FORMATION
PALUXY FORMATION
GLEN ROSE FORMATION
NOTES
1 STRATIGRAPHIC CONDITIONS ARE KNOWN ONLY AT THE MONITORING WELLS AND BORINGS, CONTACTS ARE INTERPOLATED BETWEEN CONTROL POINTS
2 WITH THE EXCEPTION OF THE AREA BETWEEN USGS07P AND CAR P2, THE CONTACT BETWEEN THE GOODLAND WALNUT AND PALUXY FORMATIONS DISPLAYS THE REGIONAL DIP OF 35-40 FEET PER MILE
800 400 0 800
HORIZONTAL SCALE IN FEET
VERTICAL EXAGGERATION = 15X
Legend
Clay and Fill Material
Gravel
Sand
Limestone and Shale
Figure 2.3
Generalized Geologic Cross Section
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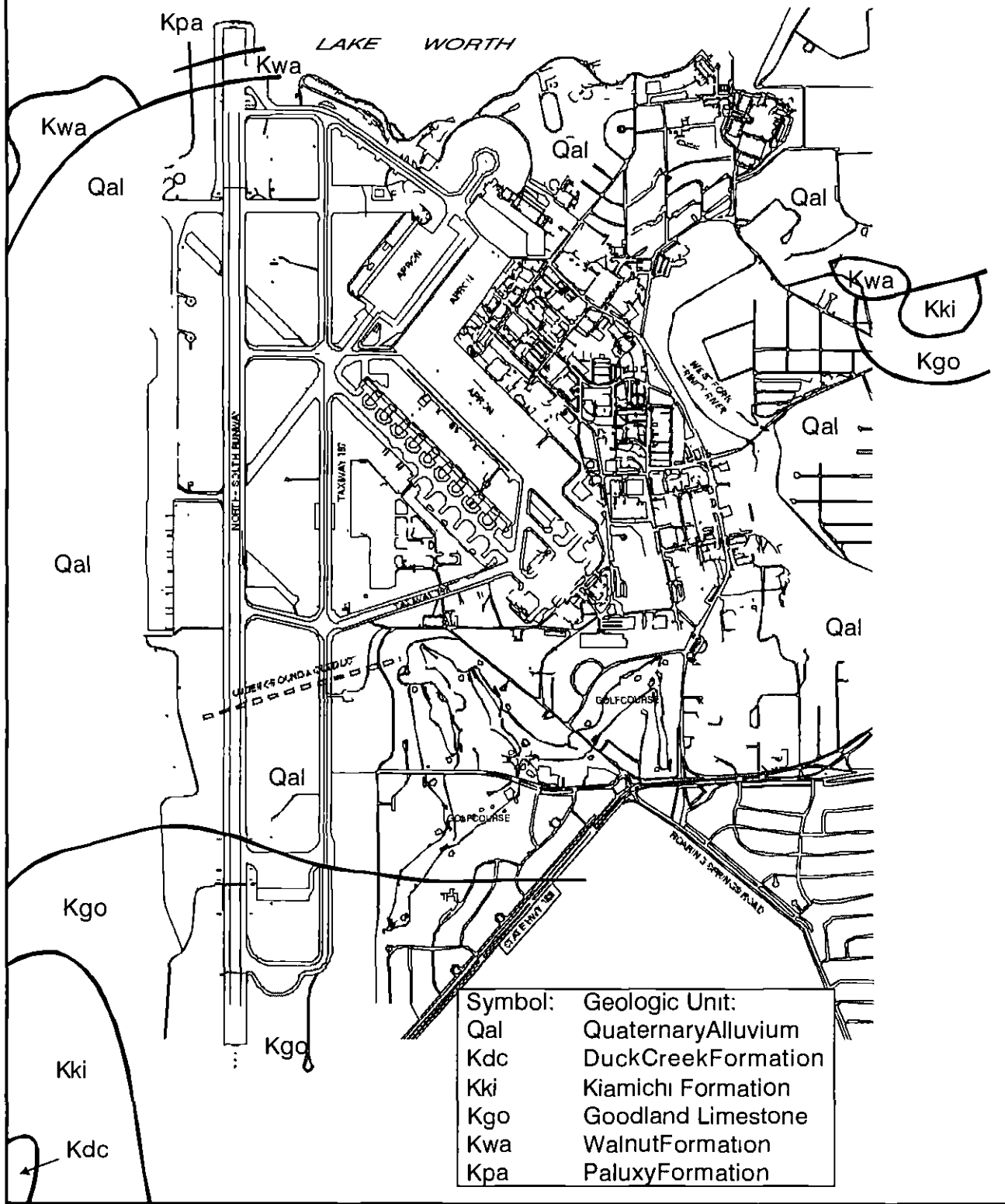

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Figure2.4
Areal Distribution of Geologic Units

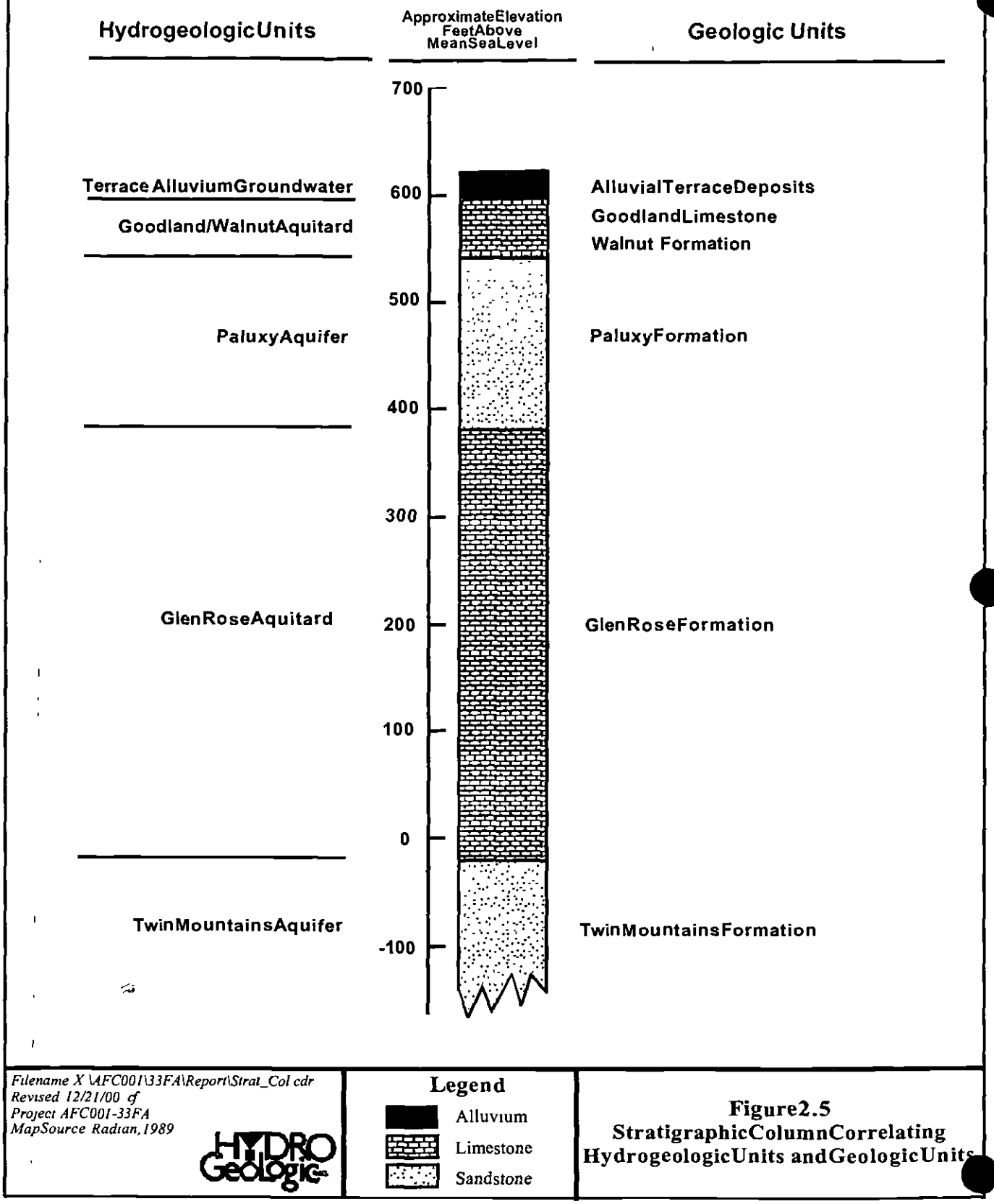


Figure2.5
StratigraphicColumnCorrelating HydrogeologicUnits andGeologicUnits

(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. Each of the major lithologic units beneath NAS Fort Worth JRB is examined in more detail in the following paragraphs.

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 is not often used as a source of potable water due to its limited distribution, poor yield, and susceptibility to surface/storm-water pollution (USGS, 1996). No potable water supply monitoring wells are completed in the Terrace Alluvium within 0.5 miles of NAS Fort Worth JRB.

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 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 Terrace Alluvium groundwater is 4.57 gallons per day per square foot (gpd/ft^2) (Radian, 1989).

Theoretically, 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. However, during a Risk Assessment/Focused Feasibility Study conducted on Former Carswell AFB, the Goodland/Walnut formation was observed to be fractured and appeared to have higher hydraulic conductivities than the Upper Paluxy. (HydroGeoLogic, 2000g). As part of the investigations, three monitoring wells were installed and screened in the paluxy upper sands (WHGLPU001, WHGLPU003, and WHGLPU004). An additional monitoring well (WHGLWN002) was installed on-base in the Walnut Limestone formation in order to characterize the unit. The locations of these wells are presented on Figure 2.6.

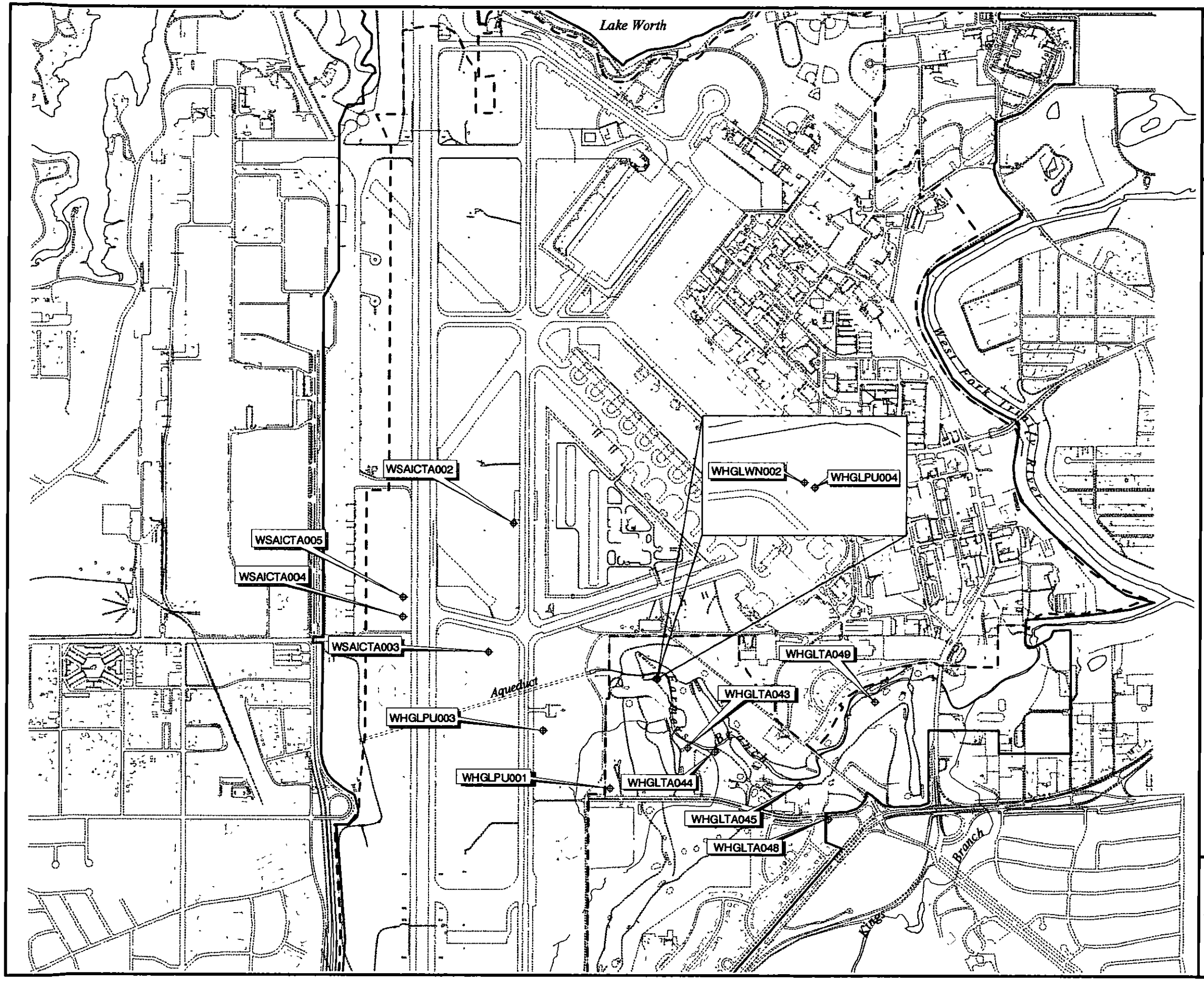
The initial sample collected from WHGLPU001 in October 2000 displayed TCE concentrations of 4 micrograms per liter ($\mu g/L$), which is below the Risk Reduction Standard 2 (RRS 2) value of 5 $\mu g/L$. Also detected was *cis*-1,2-dichloroethene (DCE), methylene chloride, bromochloromethane, and chloroform. Samples collected from the three other Paluxy wells contained no VOCs above the laboratory detection limits. A second round of sampling was conducted in December 2000 and preliminary laboratory results indicated that WHGLPU001 had a TCE concentration of 5 $\mu g/L$ and no other VOCs were detected. The remaining three Paluxy wells contained no VOCs.

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	Permeability varies; gravels and sands permeable
		Pleistocene	Terrace alluvial deposits	0-60	Gravel, sand, silt, clay	Permeability varies; gravels and sands permeable
Mesozoic	Cretaceous (65 to 140 mya)	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 an 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

Notes:
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, as cited 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 as cited in USGS 1996.
4 This stratigraphic name does not conform to the usage of the USGS.

mya - million years ago



HydroGeoLogic, Inc.
2001 Basewide Groundwater Sampling and Analysis Plan
NAS Fort Worth JRB, Texas

Figure 2.6

Newly Installed Paluxy and Terrace Alluvium Wells Installed October 2000

U.S. Air Force Center For Environmental Excellence

Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- Paleochannel Well
- Paluxy Well
- Southern Plume Delineation Well

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Map Source HydroGeoLogic, Inc GIS Database, Jacobs Engineering

HYDRO GeoLogic INC.

The primary flow direction of water in the Terrace Alluvium is generally eastward toward the West Fork 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. Groundwater discharge occurs into surface water on-site, specifically Farmers Branch Creek.

Potentiometric maps of NAS Fort Worth JRB Terrace Alluvium groundwater developed from data obtained in July 2000 are presented in Figure 2.7. The July 2000 gauging event shows an easterly trend in groundwater flow across the base toward the West Fork 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 1.2×10^{-09} centimeters per second (cm/s) to 7.3×10^{-11} cm/s for the NAS Fort Worth JRB and AFP 4 area. This corresponds to a vertical advective velocity rate that ranges between 1.16×10^{-03} feet per day (ft/d) to 5.22×10^{-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 monitoring wells and borings have been advanced on NAS Fort Worth JRB, and no evidence has been found indicating that a similar window exists on the base property.

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, obtain 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 use 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 and 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 1,263 to 13,808 gallons per day per foot (gpd/ft), respectively.

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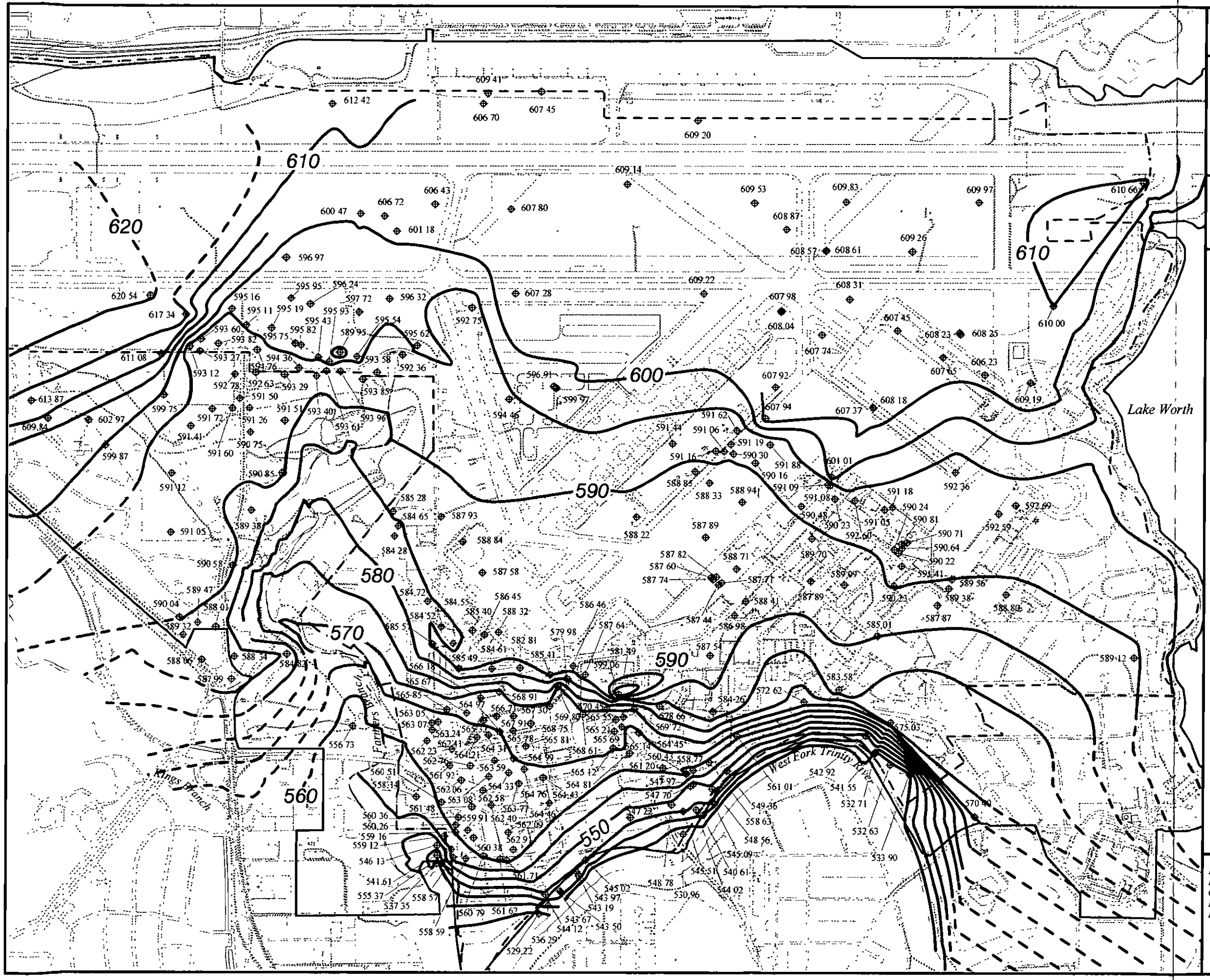

HydroGeoLogic, Inc
2001 Basewide Groundwater Sampling & Analysis Plan
NAS Fort Worth JRB, Texas

Figure 2.7

Water Level Elevations
Terrace Alluvium
July 2000

U.S. Air Force Center For Environmental Excellence

Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- –600– Groundwater Elevation Contour (ft msl)
- Monitoring Well
- 533 76 Groundwater Elevation (ft msl)

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Project AFC001-33FB
Created 01/22/00 jbelcher
Revised 05/17/01 jb
Map Source HydroGeoLogic, Inc GIS Database

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

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

Storm water, which enters the NAS Fort Worth storm water drainage system, is discharged directly into Lake Worth. The outfall is permitted under the National Pollutant Discharge Elimination System, and monitoring results document compliance with permit discharge limitations (IT Corporation, 1997c).

Storm water which does not enter the drainage system, drains east towards the West Fork Trinity River. A portion of the base is drained by Farmers Branch Creek, a tributary to the West Fork Trinity River. Farmers Branch Creek begins within the community of White Settlement and flows

eastward. Most of the flow in the creek is due to surface runoff, with some groundwater recharge from the Terrace Alluvium groundwater. 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. Another unnamed stream (approximately 200 feet long) is located in the SD13 area and discharges to Farmers Branch Creek as well. Most of the base drainage is intercepted by a series of storm drains and culverts, directed to OWSs, and discharged to the West Fork 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 sub-humid 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. Mean annual precipitation recorded at the base is approximately 33.70 inches. The wettest months are May and October, with a secondary maximum in April. 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 2 to 3 days per year. The maximum precipitation recorded in a 24-hour period is 1.49 inches. On the average, measurable snowfall occurs 2 days per year.

During 2000, the average annual temperature in the area was 65.6 degrees Fahrenheit (°F), and monthly mean temperatures varied from 43.4°F in January to 85.3°F in July. The average daily minimum temperature in January was 32.7°F, and the lowest recorded temperature was 32°F. The average daily maximum temperature and highest temperature recorded at the base during 2000 were both in July was 96.5°F, and the highest temperature ever recorded at the base was 98°F in the month of July. Freezing temperatures occur at NAS Fort Worth JRB an average of 30 days per year. (National Weather Service, 2001).

TAB

SECTION 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 at the base. The background and regulatory values used in evaluating levels of contamination determined from analytical sampling are discussed in the next section. The groundwater sampling results are then discussed using the following contaminant subheadings:

- TCE and degradation compounds and
- Metals

The discussion of contaminants are divided first by the investigations in which the data was collected, then by the geographic area on the base. The final section discusses additional potential sources of contamination which are currently being investigated.

3.1 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. The results of metals analyses were compared to established basewide background concentrations (Jacobs, 1998), and the results of the organic analyses were compared to practical quantitation limits (PQLs). These comparisons identified locations where contamination is possible, and monitoring should be continued to provide further characterization. In addition, all data, both inorganic and organic constituent concentrations, were compared to the TNRCC RRS 2 values. Comparison of contaminant concentrations to their respective RRS 2 value provides a basis for risk assessment. Concentrations of contaminants that exceed their respective RRS 2 values indicate areas where continued monitoring or remedial action may be necessary.

3.1.1 Background Concentrations

Background concentrations were determined for 24 inorganic constituents at NAS Fort Worth JRB (Jacobs, 1998) in December 1996. A single groundwater sample was collected from 12 background monitoring wells 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 monitoring wells known to contain volatile organic compounds (VOCs) and semi-volatile organic compounds (SVOCs). Locations of the twelve background wells sampled are shown in Figure 3.1.

The tolerance interval (TI) method provided by the EPA (USEPA, 1989, 1992) was used to estimate background concentrations for the 24 inorganic constituents for comparison to compliance monitoring wells. TIs are useful for groundwater data analysis because it is important to ensure that, at most, a small fraction of the compliance monitoring wells sampled exceed a specific concentration level (USEPA, 1992). Two coefficients are associated with any tolerance interval. One is the proportion of the population 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

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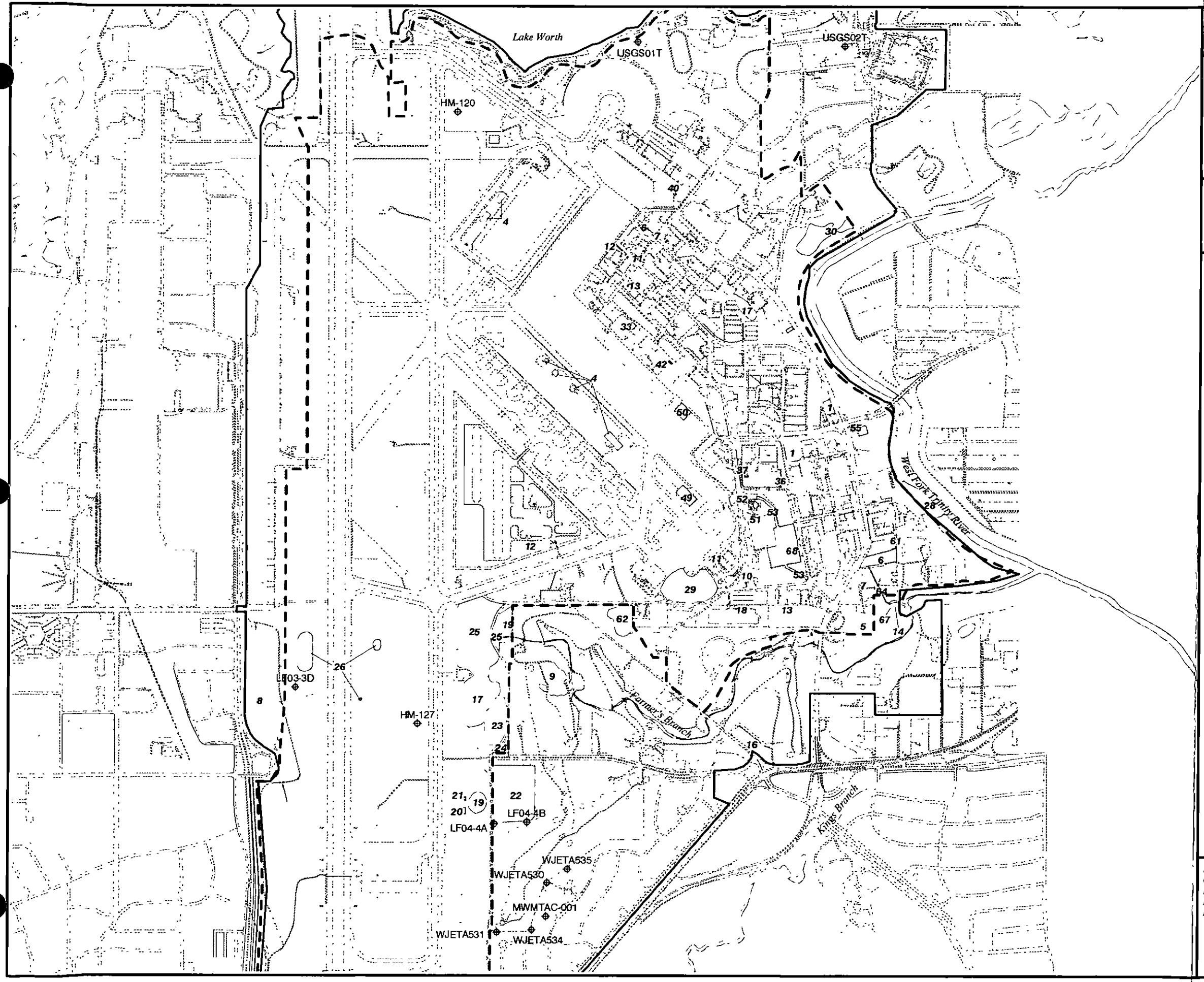

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NAS Fort Worth JRB, Texas

Figure 3.1

Background Wells
NAS Fort Worth JRB

U.S. Air Force Center For Environmental Excellence

Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- HM-127 — Background Monitoring Well Locations Jacobs Engineering
- Solid Waste Management Unit (SWMU)
- Area of Concern (AOC)

N

600 0 600 1200

SCALE IN FEET

Filename X:\Afc001\33fa\Report\background wells.apr
Created 12/20/99 jbelcher
Revised 01/26/00 jb
Project AFC001-331A
Map Source HydroGeoLogic, Inc GIS Database, Jacobs Engineering

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by Jacobs as the background concentration for comparison to contaminant concentrations. These values are provided in Table 3.1.

3.1.2 Detection and Quantitation Limits

A PQL is the lowest analytical result level that can reasonably be achieved within specified limits of precision and accuracy during routine laboratory conditions. Each PQL value is higher than the associated method detection limit (MDL), which is the minimum concentration of a substance that can be measured and reported with 99-percent confidence the analyte concentration is greater than zero. Both MDLs and PQLs are adjusted for sample-specific conditions such as moisture, subsample mass, and dilution. Sample concentrations falling between the sample-specific MDL and sample-specific PQL are assigned an "F" qualifier indicating the variability of the result (HydroGeoLogic, 2000b). In July 1998, the TNRCC issued an Interoffice Consistency Memorandum (TNRCC, 1998a), followed in September 1998 by an Erratum Sheet (TNRCC, 1998b). The Consistency Memorandum defined a method quantitation limit (MQL) as the demonstrated lower limit of the linear range for a particular analyte. As defined, an analyte's MQL is analogous to the PQL reported by the laboratory without adjustment for sample-specific conditions. The Erratum Sheet also defined an analyte sample quantitation limit (SQL) as an analyte's MDL adjusted for sample-specific conditions. Because a background concentration for organic compounds is not appropriate, the MQL is used for background comparison purposes.

3.1.3 Risk Reduction Standard 2

RRS 2 values are chemical-specific risk-based cleanup levels for remediation of groundwater contaminated by a release(s) from a SWMU or AOC. These values are established from health-based standards and criteria (Texas and/or Federal) pursuant to TNRCC Regulations, 30 Texas Administrative Code (TAC) 335.551-335.569. If the MQL or background concentration for a given chemical is greater than the RRS 2 level, either the MQL or the background value, whichever is greater, 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., MSCs for RRS 2). RRS 2 values for inorganic and organic compounds are provided in Table 3.1 and Table 3.2, respectively. Any changes to the RRS 2 values are updated each quarter.

3.2 TCE AND DEGRADATION COMPOUNDS

TCE contamination in groundwater at NAS Fort Worth JRB is generally described as one plume. The portion of the TCE plume that is migrating west to east in the flightline area, or northern portion of the base, is referred to as the northern lobe; the portion migrating west to east in the landfill area, or southern portion of the base, is referred to as the southern lobe. Although the major contaminant in the groundwater plume is TCE, TCE-related compounds, mainly *cis*-1,2-dichloroethene (*cis*-1,2-DCE), but including *trans*-1,2-dichloroethene (*trans*-1,2-DCE), tetrachloroethene, and vinyl chloride, are also presented in groundwater beneath the base. Figure

Table 3.1
Background and Risk Reduction Standard 2
Values for Inorganic Constituents in Groundwater

Metal	Background Value (µg/L)	RRS 2 Value (µg/L)	RRS 2 Value Source[1]
Aluminum	1,332	100,000	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	226,300	--	Essential Nutrient[2]
Chromium	6	100	TNRCC
Cobalt	8.9	6,100	Derived
Copper	2 8	1,300	Derived
Iron	224	300	Derived
Lead	1.6	15	TNRCC
Magnesium	37,800	--	Essential Nutrient[2]
Manganese	175	14,000	Derived
Mercury	0.1	2	TNRCC
Molybdenum	14.4	510	Derived
Nickel	20.4	2000	TNRCC
Potassium	15,030	--	Essential Nutrient[2]
Selenium	7.7	50	TNRCC
Silver	0.2	510	TNRCC
Sodium	167,000	--	Essential Nutrient[2]
Thallium	63.2	2	Derived
Tin[3]	--	61,000	Derived
Vanadium	12	720	Derived
Zinc	118	31,000	Derived

Notes:

[1] Source of all values was TNRCC RRS 2 (30 TAC 335). Those noted as "Derived" were derived based on procedures presented in the regulations.

[2] Essential Nutrient - no risk values available.

[3] Tin was not included in the background study.

-- No value.

Table 3.2
Risk Reduction Standard 2 Values
for Volatile Organic Compounds in Groundwater

VOCs	RRS 2 Value (µg/L)	RRS 2 Value Source[1]
1,1-Dichloroethane	10,000	TNRCC
1,1-Dichloroethene	7	TNRCC
2-Methylnaphthalene	4,100	TNRCC
Benzene	5	TNRCC
Bis(2-Ethylhexyl)phthalate	6	TNRCC
Chlorobenzene	100	TNRCC
Chloroform	100	TNRCC
cis-1,2-Dichloroethene	70	TNRCC
Ethylbenzene	700	TNRCC
Isopropylbenzene (cumene)	10,000	TNRCC
m-Xylene & *p*-Xylene	10,000	Derived
Methyl *tert*-butyl ether	1,000	TNRCC
n-Butylbenzene	1,000	Derived
n-Propylbenzene	10,000	Derived
Naphthalene	2,000	TNRCC
o-Xylene	10,000	TNRCC
Isopropylbenzene	10,000	TNRCC
p-Isopropyltoluene (*p*-cymene)	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	31,000	TNRCC
1,2,4-Trimethylbenzene	5,100	Derived
1,3,5-Trimethylbenzene	5,100	Derived
Vinyl chloride	2	TNRCC

Notes:
[1] Source of all values was TNRCC RRS 2 (30 TAC 335). Those noted as "Derived" were derived based on procedures presented in the regulations.

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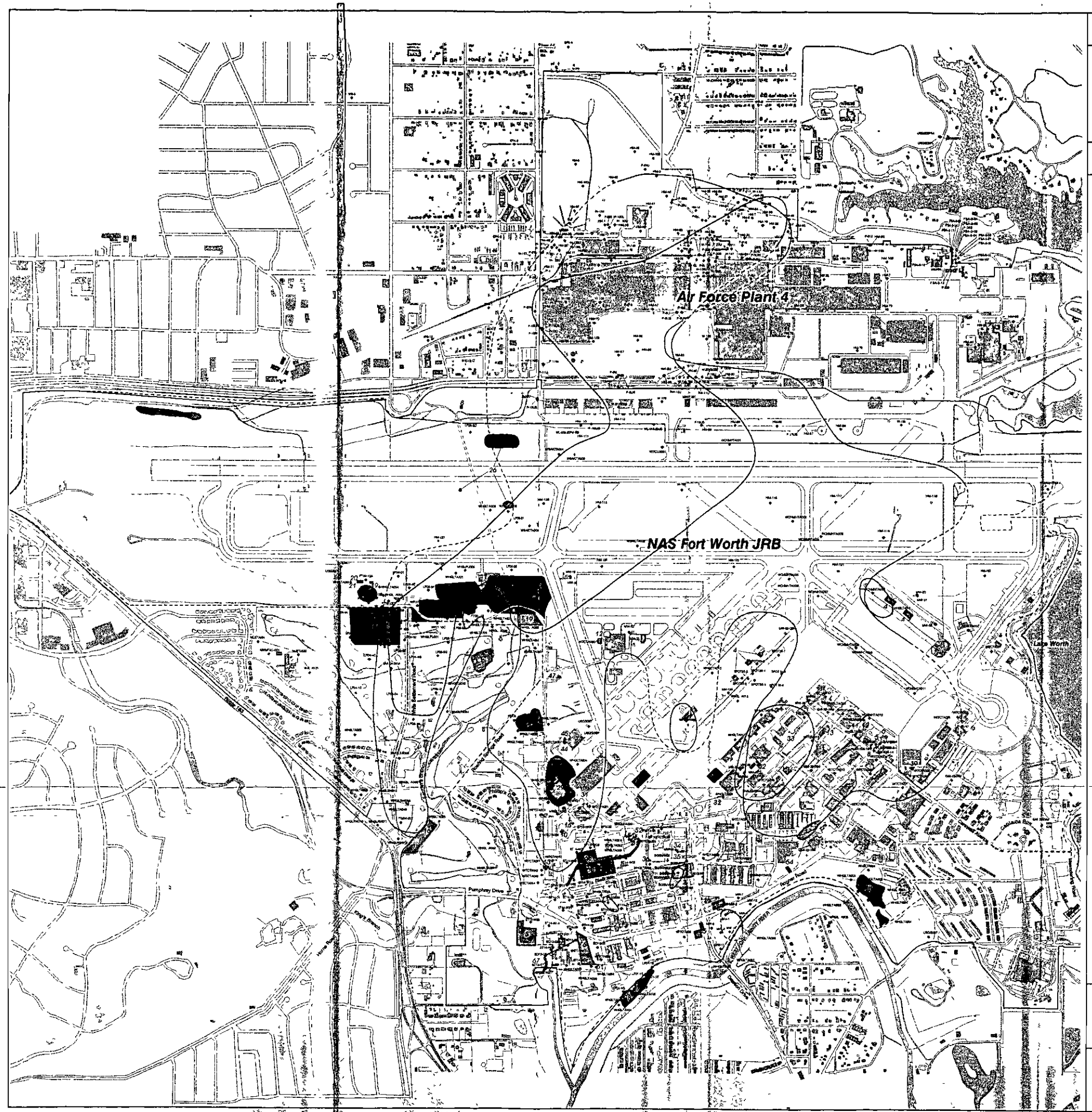
NAS Fort Worth JRB Texas

Figure 3-2

Proposed Groundwater Sampling Locations

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



Legend

- NAS Fort Worth JRB (Carswell Field)
- Former Carswell Air Force Base
- Trichloroethene Plume Boundary set at MCL (5 µg/L)
- cis-1,2-Dichloroethene Plume Boundary set at MCL (70 µg/L)
- Benzene Plume Boundary set at MCL (5 µg/L)
- Semi-Annual Plume Monitoring Wells (April & October)
- AOC 1 Monitoring Wells
- Paluxy Well
- AFP 4 Semi-Annual Monitoring Wells
- Other Monitoring Wells

Notes
1. Dashed contour indicates interpreted plume boundary
2. WHGLTA029 and WITCTA003 are only sampled in April 2001
3. Concentration data was collected during October 2000 at NAS Fort Worth and AFP 4
4. The following wells are sampled annually and not semi-annually HM-93 HM-120, HM-127 LH-04-10 and GMI-22-02M Other Jacobs wells are sampled annually

Area of Concern (AOC)

1. Former Base Service Station/Former Base Gas Station
2. Airfield Groundwater (Basewide Coverage)
4. Fuel Hydrant System
6. 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. Unvented Sewer
15. Storage Shed
16. Family Camp
17. Former Landfill
18. Suspected Former Fire Training Area A
19. Suspected Former Fire Training Area B

Solid Waste Management Unit (SWMU)

5. Building 1626 Waste Accumulation Area
6. Building 1626 Wash Rack and Drain
7. Building 1626 Oil/Water Separator
8. Building 1626 Sludge Collection Tank
11. Building 1617 Waste Accumulation Area
12. Building 1618 Waste Accumulation Area
13. Building 1710 Waste Accumulation Area
16. Building 1090 Waste Accumulation Area
17. Landfill No 1
19. Fire Training Area No 2
20. Water Fuel Storage Tank
21. Waste Oil Tank
22. Landfill No 4
23. Landfill No 5
24. Waste Burial Area
25. Landfill No 8
28. Landfill No 3
27. Landfill No 10
28. Landfill No 1
29. Landfill No 7
30. Landfill No 9
31. Building 1090 Waste Accumulation Area
32. Building 1419 Waste Accumulation Area
33. Building 1430 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 1121) 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 Squadron Aerospace Ground Equipment
42. Building 1414 Waste Accumulation Area
44. Building 1697 Oil/Water Separation System at the Aircraft Washing Hangar
45. Building 1697 Waste Oil Tank Vault at the Aircraft Washing Hangar
47. Bldg. 1618, Jet Engine Test Cell Oil/Water Separator
48. Aircraft Washing Area No 1
50. Aircraft Washing Area No 2
51. Building 1180 Central Waste Holding Area
52. Building 1180 Oil/Water Separator System
53. Storm Water Drainage System
54. Storm Water Interceptors
55. East Gate Oil/Water Separator
61. Building 1320 Power Production Maintenance Facility Waste Accumulation Area
80. Landfill No 6
84. French Limbergram System
86. Sanitary Sewer Systems (Basewide Coverage)
87. Building 1340 Oil/Water Separator
88. POL Tank Farm

N

500 0 500 1000
SCALE IN FEET

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Filename: X:\AFC001331a\Report proposed gw samps.apr
Created by: jbelcher 06/26/99
Revised: 05/14/01 asp
Project: AFC.001.331A
Map Source: HydroGeoLogic GIS Database 2001
Jacobs Engineering, 1999

3.2 provides the approximate extent of the TCE and *cis*-1,2-DCE plumes, where the contours reflect the RRS 2 values for each compound.

The RRS 2 values for TCE and *cis*-1,2-DCE are 5 μg/L and 70 μg/L, respectively. The extent of the plumes depicted is based on the combined October 2000 Quarterly groundwater sampling event data collected by HydroGeoLogic at NAS Fort Worth JRB and by Jacobs at AFP 4.

3.2.1 NAS Fort Worth JRB Basewide Groundwater Sampling 2000

During 2000, three rounds of quarterly groundwater sampling were performed by HydroGeoLogic as part of the basewide groundwater sampling program. Appendix A, Table A.1 provides all detections above the MDL from all wells sampled during 2000 for this program. Some wells were not sampled during the quarters due to low water levels or free product in the well.

In October 2000, TCE was detected in 10 of the 16 plume monitoring wells sampled as part of this program at concentrations ranging from 4 μg/L (WHGLTA025) to 2,700 μg/L (HM-123). Eight monitoring wells had concentrations above the RRS 2 value of 5 μg/L for TCE. *Cis*-1,2-DCE was detected in 11 monitoring wells sampled at concentrations ranging from 0.6 μg/L (WITCTA010) to 550 μg/L (HM-123). Four of these monitoring wells exceeded the RRS 2 value for *cis*-1,2-DCE of 70 μg/L. Tetrachloroethene (PCE) was detected in three of the monitoring wells sampled, with only HM-116 exceeding the RRS 2 value of 5 μg/L. In addition, vinyl chloride, a degradation product of TCE, was detected in four monitoring wells sampled at concentrations ranging from 1 μg/L (HM-123) to 200 μg/L (LF05-01). Three of the four monitoring wells (LF05-01, LF05-5G, and WITCTA024) had vinyl chloride at concentrations at or above the RRS 2 value of 2 μg/L.

3.2.2 AFP 4 Basewide Groundwater Sampling 2000

A semi-annual basewide sampling program was conducted by Jacobs Engineering at AFP 4 during April and October 2000. Twenty-four monitoring wells were sampled in October 2000 by Jacobs as part of the AFP 4 LTM. Of the 24 monitoring wells, 16 are located at AFP 4 and 8 are located at NAS Fort Worth JRB. The sampling protocol for AFP 4 LTM is included in the February 1998 LTM Plan (Jacobs, 2001).

During the October 2000 sampling event, 13 of these wells contained TCE at concentrations ranging from 17 μg/L to 820,000 μg/L, all above the RRS 2 value for TCE (5 μg/L). Appendix A, Table A.2 provides a summary of all detected analytical results for 2000 at AFP 4.

3.3 METALS

During 2000, three rounds of quarterly groundwater sampling were performed by HydroGeoLogic as part of the basewide groundwater sampling program (HydroGeoLogic, 2000a). Iron was detected above the RRS 2 value of 300 μg/L at monitoring wells USGS07T in July, and WITCTA010 in April and October.

The following metals were detected in October 2000 above background levels in the wells indicated: manganese (ITMW-01T and WITCTA010), iron (WITCTA010), arsenic (WITCTA010), and chromium (HM-116). The concentrations of these metals for each quarter in which they exceeded background values are listed in Appendix A, Table A.1.

3.4 OTHER POTENTIAL SOURCE AREAS

While a number of SWMUs and AOCs compose the primary potential sources of contamination in the three primary contamination plumes, other SWMUs and AOCs located within and between the primary potential sources may also impact groundwater quality. This section identifies these potential sources of contamination and describes, where possible, current and future planned investigations in each area. Some of this data was obtained and used during the 2000 GSAP, to better define the plume.

3.4.1 Waste Accumulation Areas

The Waste Accumulation Areas (WAAs) at NAS Fort Worth JRB provide on-site storage of aircraft, vehicle, and general machinery maintenance-related wastes prior to disposal or off-site shipment. Seven of these WAAs, SWMUs 9, 10, 14, 43, 46, 56, and 57, have been designated for NFA by the TNRCC in a letter dated March 2, 1995 (TNRCC, 1995). One additional WAA, SWMU 13, received an NFA designation by the TNRCC in 1999 (HydroGeoLogic, 1999a). An additional 16 WAAs are currently under investigation and/or remediation.

An RFI of 16 WAAs was conducted in order to obtain closure of the units under the TNRCC RRS Program. The three primary objectives of this RFI were as follows: fill data gaps with respect to the hydrogeological regime at several of the sites; determine if a release from a WAA had occurred; and, if contamination was encountered, characterize the nature and extent of the contamination by defining the vertical and lateral extent of chemicals that exceed background or RRS 1. Data used to complete this RFI was collected through soil boring installation, monitoring well installation, and groundwater sampling from new and existing monitoring wells (HydroGeoLogic, 1999d).

The 16 WAAs included in this RFI were SWMUs 5, 6, 11, 12, 16, 31, 32, 33, 34, 36, 39, 42, 51, and 61, and AOCs 6 and 15 (HydroGeoLogic, 1999d). Seven of the 16 WAAs were approved for closure by the TNRCC in November 2000. The nine remaining units include SWMUs 5, 6, 11, 12, 31, 32, 36, 51, and 61. In October 2000, the second phase of sampling was completed and the results will be evaluated for consideration of proposing site closure in 2001.

3.4.2 Oil/Water Separators

A total of 23 oil/water separators (OWSs) located at 21 buildings on NAS Fort Worth JRB have been investigated to determine if releases of regulated substances into the environment have occurred and the potential impact on human health and the environment. All of the OWSs investigated were, or are, connected to the sanitary sewer system, which is also known as SWMU 66. It should be noted that 6 of the 23 OWSs are actually grit/oil interceptors, but are commonly referred to as OWSs for simplicity. The 23 OWSs are associated with the following 21 buildings:

1015, 1027, 1060, 1064, 1101, 1145, 1190, 1191(2), 1194, 1320, 1414, 1423, 1602, 1628, 1643(2), 1655, 1656, 3358, 4146, 4160, and 4210 (IT Corporation, 1998).

Previous OWS investigations have included collection of near surface soils (0 to 2 feet bgs) and subsurface soils to determine the nature and extent of contamination near the OWS. The soils were analyzed for VOCs, SVOCs, pesticides/polychlorinated biphenyls, and metals. In addition, monitoring wells were installed at each OWS and groundwater analyzed for VOCs, SVOCs, and metals. Monitoring well borings installed at Buildings 1015 and 1194 were found to be dry. These borings were subsequently abandoned. Soil and groundwater contaminants were compared to TNRCC RRSs (IT Corporation, 1998). Additional delineation of OWSs was performed in 2000.

As a result of the previous OWS investigations completed in 1998, an interim remedial action (IRA) was conducted at AOC 13. AOC 13, also known as the Automotive Hobby Shop OWS consisted of the Building 1145 OWS and its associated underground storage tank (UST). Results of the site investigations revealed and delineated a small petroleum LNAPL plume beneath the OWS system. The OWS and UST were removed in June 2000 to eliminate the source of the contamination and to expedite closure of AOC 13. Following the removal, a new OWS system was installed. In December 2000, additional soil and groundwater samples were collected to confirm and/or delineate the excavation area, in order to submit for site closure.

In addition to the IRA at AOC 13, a Draft Technical Memorandum (TM) was submitted for a request of closure at SWMU 7 and SWMU 8. SWMU 7 is the Building 1628 OWS and SWMU 8 is its associated UST. The TM provided descriptions of the wastes handled, and summaries of the initial assessments and investigations focused on recognizing any potential contamination resulting from the sites. SWMU 7 and SWMU 8 were recommended for NFA based on the conclusion that a release of hazardous constituents from either site did not occur. Previous assessments and investigations showed no evidence of contamination of the soil or groundwater from either SWMU. All wastes handled at SWMU 7 and SWMU 8 were considered to have been well managed prior to their disposal, and proper release controls were in place (HydroGeoLogic 1999e). The TNRCC approved SWMUs 7 and 8 for closure in a letter dated July 19, 2000.

3.4.3 Underground Storage Tanks

One hundred thirty-one USTs have been identified as having potentially existed at NAS Fort Worth JRB. An evaluation of the records pertaining to the 131 USTs concluded that only 20 of the USTs required some form of action under the U.S. Air Force IRP to achieve closure from the TNRCC and transfer of the regulatory responsibility for compliance, where appropriate, to the Navy. These actions have included either a submittal of previously collected site characterization data for TNRCC review or an investigation of current site conditions.

A Final Release Determination Report form was submitted to the TNRCC/PST Division for the former UST 1427-1 located at Building 1427. This form was submitted to inform the TNRCC of a confirmed release due to the operation of the former UST which was discovered during a UST field investigation in 1999.

A Final Investigation Summary was submitted to the TNRCC/PST Division for five UST sites which were determined to have not caused a release. The five USTs included 1040-1, 4115-1, 4136-1, GCA-1, and GCA-2. The goal for this submission was to request a 'no LPST' letter from the TNRCC stating that they require no further action to investigate the UST sites.

In response to a request made by the TNRCC/PST Division, three off site wells were installed along the West Fork Trinity River at AOC 1. The new off site wells and several existing on-base wells were sampled and analyzed for VOCs on a semiannual basis during 2000 to monitor plume stability and to determine the down gradient extent of contaminants originating from AOC 1. In addition three surface water samples were collected from the West Fork Trinity River to monitor for any indication of seepage along the bank. Continued groundwater monitoring will be required in 2001.

A Final AOC 4 1999 Groundwater Report was submitted to the TNRCC/PST Division as part of the efforts to proceed toward site closure. In addition, semiannual groundwater sampling was performed to monitor groundwater plume stabilization at the site during 2000. Free product was monitored on a weekly to monthly basis at SPOT35-3 and SPOT35-6. Regulatory requirements for continued groundwater sampling will not continue in 2001.

A Final Site Assessment Report form (TNRCC-0562) was submitted to the TNRCC/PST Division for SWMU 68/AOC 7. In addition, semiannual groundwater sampling was performed to monitor groundwater plume stabilization at the site. Free product was monitored on a weekly to monthly basis at SD13-07 and WHGLTA007. Regulatory requirements for continued groundwater sampling will not continue in 2001.

3.4.4 Landfill Investigations

Eleven landfill areas are known to have operated at NAS Fort Worth JRB between 1942 and 1975. These landfills were used for the disposal of municipal waste, cadmium batteries, drums of waste paints, thinners, oils, PD-680, medical waste, construction debris (in the form of concrete, asphalt, wood, and trees), and potentially small amounts of undocumented hazardous materials. Five of the former landfills were listed as SWMUs in the RCRA hazardous waste permit (HW-50289) to the former Carswell Air Force Base (CAFB), Fort Worth, Texas issued by the TNRCC in February 1991. These five landfills were designated SWMU 22 (Landfill 4), SWMU 23 (Landfill 5), SWMU 24 (Waste Pile 7), and SWMU 28 (Landfill 1). The HW-50289 permit was subsequently amended by the TNRCC in a letter dated March 2, 1995 to include additional SWMUs and Areas of Concern (AOCs). The landfills added to the HW-50289 permit included SWMU 17 (Landfill 7), SWMU 25 (Landfill 8), SWMU 26 (Landfill 3), SWMU 27 (Landfill 10), SWMU 29 (Landfill 2), SWMU 30 (Landfill 9), and SWMU 62 (Landfill 6).

An RFI of each of the landfills was performed for the purpose of determining the nature and extent of soil contamination at each of the subject SWMUs in accordance with the requirements outlined in the TNRCC RRS Program. Specifically, the RFI was conducted to characterize the nature of the landfills, define landfill boundaries, and to determine if a release to the environment of the constituents listed in Title 40, Code of Federal Regulations (40 CFR) Part 264 Appendix IX occurred at one or more of the four landfills.

Field activities performed to characterize landfill soils included: (1) geophysical surveys to assess the nature and limits of the landfills; (2) test pits to examine and confirm the nature of wastes buried at the landfills (SWMUs 22, 23, and 25 only); (3) continuous core direct push technology (DPT) soil borings used to further investigate the nature of landfill debris, determine the lithology of native soils, and to support soil sample collection for laboratory analyses; and (4) the installation of monitoring wells using hollow stem augers (HSAs) to support groundwater sample collection for laboratory analyses.

The RFI report for SWMU 27 was completed in March 1999 (HydroGeoLogic 1999c). SWMU 27 was subsequently approved for no further action (NFA) by the TNRCC in accordance with RRS 1 in April 2000. The Draft RFI report for SWMUs 22, 23, 24, and 25 was submitted to the TNRCC in September 2000 (HydroGeoLogic 2000j) with a recommendation of NFA for SWMUs 22, 23, 24, and 25 in accordance with RRS 2. The remaining units currently under investigation consist of SWMUs 17, 26, 28, 29, 30, and 62. In February 2001, the third phase of sampling was completed at SWMU 28 and the fourth phase of sampling was completed at SWMUs 17, 26, 29, 30, and 62. Results from this sampling event will be evaluated for consideration of proposing site closures in 2001. Additional groundwater sampling for these SWMUs may occur in 2001.

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TAB

SECTION 4.0

4.0 DATA QUALITY OBJECTIVES

DQO statements are qualitative and quantitative methods of communicating planned sampling and analysis activities that prescribe the data needs, intended data uses, and the means to achieve acceptable data quality. DQO statements also specify acceptable levels of data uncertainty with respect to precision, accuracy, representativeness, completeness, and comparability. DQOs are developed in order to ensure that specific project objectives are achieved in accordance with applicable client and regulatory agency requirements and guidelines. The development of DQOs will assist in identifying the required type, quality, and quantity of data needed to support environmental site evaluations and which are both scientifically and legally defensible (USACE, 1995). Sections 4.0, 6.0, and 7.0, of the Final 2000 Basewide QAPP (HydroGeoLogic, 2000b), provide a detailed discussion on definitive and screening data as they relate to DQOs.

The DQO process involves seven steps, the output of each step influences the choices that are made later in the DQO process. This process is iterative since the outputs of one step may lead to reconsideration of previous steps. The seven steps of the DQO process include the following:

- Step 1 - State the Problem
- Step 2 - Identify the Decision
- Step 3 - Identify the Inputs to the Decision
- Step 4 - Define the Study Boundaries
- Step 5 - Develop a Decision Rule
- Step 6 - Specify Tolerable Limits on Decision Errors
- Step 7 - Optimize the Design

DQOs are derived from the outputs of the first six steps of the DQO Process. The outputs of these steps provide the following information:

- Clarify the study objective
- Define the most appropriate type of data to collect
- Determine the most appropriate conditions from which to collect the data
- Specify tolerable limits on decision errors which will be used as the basis for establishing the quantity and quality of data needed to support the decision

The complexity and applicability for each of the seven steps varies from one project to another depending on site conditions, purpose of the sampling events, availability of the information, and regulatory considerations. As stated in the EPA DQO guidance document, every step of the DQO guidance may not be applicable to data collection activities where specific decisions cannot be identified, such as studies that are exploratory in nature (USEPA, 1994). The following subsections identify and describe the steps of the DQO process performed for sampling activities proposed in the GSAP.

4.1 STUDY OBJECTIVE

The first step in the DQO process involves clearly defining the problem so that the focus of the study will be unambiguous. This step requires the following information to be provided:

identification of the project decision makers, a concise description of the problem, and a summary of available resources and relevant deadlines for the project.

The AFCEE Contracting Officer's Representative (COR) and HydroGeoLogic's Project Manager are identified in the Preface to this report. In addition, a list of Office of Primary Responsibility (OPR) is provided in Table 1.1 for SWMUs and Table 1.2 for AOCs. A concise description of the project background is provided in Section 1.3, Section 1.4, and Table 1.3 The descriptions provided in Sections 1.3 and 1.4 include background descriptions of the regulatory programs guiding the work that is being conducted.

The second step of the DQO process is to identify the decisions. The goal of this step is to define the question that the study will attempt to resolve and identify the alternative actions that may be taken based on the outcome of the study. The objectives of this project, listed below, are provided in Section 1.1, GSAP Objectives.

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

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

- Natural Attenuation Monitoring - collect data to determine the extent that natural attenuation of TCE is occurring.

4.1.1 Selection of Monitoring Wells and Analytes to be Sampled

The third step of the DQO process is to identify the information inputs that will be required to resolve the decision statement. This step involves identifying data that should be collected, identifying the information that is needed to establish the action level, and to confirm that appropriate measurement methods exist to provide the necessary data.

The discussion provided in Section 5.3 provides the approach that was taken to propose sampling locations and analytes for the GSAP. A sampling matrix for each of the selected wells is provided in Table 5.3. The analytical methods proposed for each well reflects the monitoring objective(s) that it supports.

The information that is needed to establish the action level for the data is discussed in Section 3.1 In order to confirm that appropriate measurement methods exist to provide the necessary data, PQLs were compared to background values, RRS 2 values, and PST Action Levels. This comparison indicated that the proposed analyses provide representative data within the range of the appropriate action levels.

4.1.2 Data Collection Conditions

The fourth step of the DQO process is to define the spatial and temporal boundaries of the project. This step is performed for each project and has been documented in project specific reports. The reader should refer to the documents listed under each activity in Table 1.3 for additional information on the specific monitoring objectives and boundaries of each project.

4.1.3 Decision Rules and Tolerable Limits for Decision Errors

The fifth step in the DQO process is to develop a decision rule. The purpose of this step is to define the parameter of interest, specify the action level, and describe a logical basis for choosing among alternative actions. Step 6 in the DQO process is to specify tolerable limits on decision errors. Both Step 5 and Step 6 are addressed thoroughly in the Final 2000 Basewide QAPP (HydroGeoLogic, 2000b). The Final 2000 Basewide QAPP is applicable to all areas of investigation being conducted by HydroGeoLogic at NAS Fort Worth JRB.

Two descriptive data quality categories are implemented to describe the analytical approach to achieve the desired level of data quality for the intended data use. The two data quality categories are (1) screening data with definitive confirmation and (2) definitive data. These two categories are associated with specific Quality Assurance/Quality Control (QA/QC) requirements generated using a wide range of analytical methods with varying degrees of data accuracy and precision. The Final 2000 Basewide QAPP, Section 6.0 and Section 7.0 provide a detailed discussion of the tolerable limits on decision errors which will be used as the basis for establishing the quantity and quality of data needed to support the decision. Section 8.0 includes brief descriptions of the methods and QC required for screening procedures commonly used to collect field samples.

4.1.4 Project Optimization

The seventh and final step of the DQO process is to optimize the design for obtaining data. The purpose of this step is to identify a resource-effective data collection design for generating data that are expected to satisfy the DQOs. HydroGeoLogic acknowledges that the DQOs may require modification to accommodate new data resulting from ongoing future investigations/remedial actions at NAS Fort Worth JRB. The 2001 GSAP will be amended to reflect modifications to the objectives. The following items demonstrate that project optimization is actively being incorporated into the 2001 GSAP:

- multiple monitoring objectives are streamlined into each sampling event, allowing wells to be sampled for parameters based on the monitoring objective(s) that each well supports; and

- a statistical package optimized the number of locations of wells to be sampled;

4.2 PROJECT SPECIFIC DATA QUALITY OBJECTIVES

The groundwater monitoring to be conducted during the year 2001 at NAS Fort Worth JRB encompasses three main areas of investigation: (1) TCE plume monitoring; (2) natural attenuation

monitoring; and (3) long-term monitoring at AOC 1. In addition, groundwater sampling requirements that arise during 2001 may be added to the GSAP as addendums. Each of these areas of investigation are discussed below, including the relevant chemicals of concern and the DQOs.

4.2.1 TCE Plume Monitoring

The TCE plume monitoring objectives are established in the AFP 4 Record of Decision (ROD) and require monitoring the down gradient extent of the regional TCE plume, particularly at the Department of Defense boundaries along Route 183, the West Fork Trinity River, and Lake Worth (Rust-Geotech, 1996). The TCE plume monitoring DQO corresponds to the critical groundwater exposure pathways evaluation objectives listed for the project. The DQO is to collect data to assess (1) potential exposure to groundwater sources used for drinking water; and (2) on-site and off-site exposure to surface water bodies. The chemicals of concern for TCE plume monitoring include TCE and TCE-related compounds, mainly *cis*-1,2-DCE, but including *trans*-1,2-DCE, tetrachloroethene, and vinyl chloride. The method for selection of wells for sampling is detailed in Section 5.3. There are 46 wells selected for TCE plume monitoring during April and 44 wells selected during October 2001.

4.2.2 Natural Attenuation Monitoring

As summarized in Section 5.3.4, historic natural attenuation monitoring at NAS Fort Worth JRB has indicated that while some reductive dechlorination has occurred with the TCE plume, as evidenced by the large extent of *cis*-1,2-DCE, the effectiveness of the reductive dechlorination as a remedy for TCE groundwater contamination is limited. As a result, the number of wells recommended for sampling of natural attenuation parameters was drastically reduced in the year 2000 GSAP and the 2001 GSAP continues to contain a low number of wells compared to the 1999 GSAP. However, in order to fulfill the DQO, to determine the significance of natural attention of chlorinated solvents, five wells are recommended to be sampled for natural attenuation parameters to provide on-going baseline data. The chemicals of concern which are sampled as natural attenuation parameters include common anions, methane, ethane, ethene, alkalinity, and TOC. Several standard field parameters are also collected, including dissolved oxygen (DO), oxidation-reduction potential (Eh), pH, temperature, and specific conductivity (EC).

4.2.3 Long-term Monitoring at AOC 1

Long-term monitoring is being performed at AOC 1 as a result of a previous SI conducted at the site (IT Corporation, 1997d). The DQO applicable to AOC 1 sampling is additional source and plume delineation to monitor the stability of groundwater contaminant plume associated with miscellaneous hot spots. Nine monitoring wells have been selected to be sampled for VOCs on a quarterly basis.

TAB

SECTION 5.0

5.0 PROPOSED MONITORING ACTIVITIES FOR 2001

This section describes the proposed monitoring activities to be conducted in 2001 for the semi-annual basewide groundwater sampling and analysis program at NAS Fort Worth JRB. These activities include well inspection and maintenance, water level measurements, and analytical sampling. A description of field sampling procedures is included as Appendix C. The results and observations generated from these monitoring activities will be evaluated and adjusted, if needed, after each sampling event to ensure that all monitoring objectives are continuously being satisfied.

5.1 SELECTION OF MONITORING WELLS FOR INSPECTION

In preparing the 2000 GSAP, 275 wells were considered for sampling and gauged. Since the start of the 2000 quarterly sampling events, the following 56 monitoring wells have been added to the Base well inventory for a total of 331 wells. Table 5.1 provides a summary of the well inventory described below.

- 13 wells installed by HydroGeoLogic in support of an RFI at Landfill 7, 8, and 9;
- 10 wells installed by HydroGeoLogic as part of an RFI for WAAs;
- 2 well installed by HydroGeoLogic as part of an RFI of Building 1427;
- 3 wells installed by HydroGeoLogic as part of the LTM at AOC 1;
- 2 wells installed by HydroGeoLogic for a pump test (one monitoring well and one extraction well);
- 9 wells installed by HydroGeoLogic for a southern plume lobe data gap investigation (4 Paluxy wells and 5 Terrace Alluvium monitoring wells);
- 4 wells installed by IT Corporation, south and west of Building 1191;
- 2 wells installed by IT Corporation, near Waste Pile 7;
- 7 wells installed by HydroGeoLogic in January 2001, in SWMUs 19, 20, and 21 and AOC 19; and
- 4 wells installed by SAIC in the paleochannel, near the flightline area.

There were 17 monitoring wells abandoned in accordance with state and local regulations during 2000 (HydroGeoLogic, 2000k). These 17 wells were removed from the base well inventory list for 2001 (Table 5.2). An additional four monitoring wells (MW-13, MW-18, MW-58, and MW-59) were discovered to be damaged during the July 2000 quarterly groundwater monitoring and therefore were removed from the 2001 base well inventory list. Two additional monitoring wells were abandoned by the U.S. Navy and were subsequently removed from the 2001 base well inventory list. Table 5.1 provides a list of monitoring wells which were added or removed from

Table 5.1
2001 GSAP Base Well Inventory Database
NAS Fort Worth JRB, Texas

Number of Wells	Description of Wells
275	**Total Number of Wells Considered in the 2000 GSAP**
	Wells Added to the Base Well Inventory
13	Wells installed as part of various Landfill RFI Investigations
10	Wells installed as part of the WAA RFI Investigation
2	Well installed as part of the RFI of the UST at Building 1427
3	Wells installed for the LTM at AOC 1
4	Wells installed for the Paluxy Focused Feasibility Study
5	Wells installed as part of the Data Gap Investigation
2	Wells installed as part of a Pump Test
4	Wells installed by IT, south and west of Building 1191
2	Wells installed by IT, near Waste Pile 7
4	Wells installed by SAIC, near the flightline area
7	Wells installed by HydroGeoLogic, at SWMUs 19, 20, and 21 and AOC 19
	Wells Removed from the Base Well Inventory
17	Wells abandoned in accordance with state and local regulations
4	Wells presumed destroyed
2	Wells abandoned by the Navy.
1	Wells scheduled for abandonment in 2001
307	**Total Number of Wells Selected for 2001 GSAP Inspection**

the Base well inventory database. Table 5.2 contains a list of the monitoring wells abandoned during the year 2000. Appendix B, Table B.1 lists the monitoring well identification numbers, survey coordinates, and top of casing elevations for all of the wells addressed by the GSAP. A summary of the well construction information is provided in Appendix B, Table B.2. The monitoring wells are plotted on the NAS Fort Worth JRB base map shown in Figure 3.2.

5.2 SELECTION OF WELLS FOR WATER LEVEL MEASUREMENTS

The purpose of monitoring the water level measurements is to characterize the groundwater flow direction 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

Table 5.2
2000 Well Abandonment List
NAS Fort Worth JRB, Texas

Well Condition	Monitoring Well	
Monitoring Wells Abandoned in 2000	HM-122	MW-48
	LF04-4H	MW-49
	LF05-5D	MW-57B
	LF05-5F	SPOT25-2
	MW1-16	ST14-14
	MW-12A	ST14-26
	MW-20	WITCTA036
	MW-21	WJETA531
	MW-41	
Monitoring Wells Abandoned by the U.S. Navy	BSS-B	
	MW-4	
Monitoring Wells Presumed Destroyed	MW-13	MW-58
	MW-18	MW-59
Monitoring Wells Scheduled to be Abandoned in 2001	MW-11	

between April 1995 and October 1996 (CH2M HILL, 1996) and semi-annually (i.e., January and July) in 1997 through 2000, with the exception of January 2000. A review of these water level elevations shows little seasonal or annual fluctuation indicating a steady trend in groundwater flow direction from generally west to east across the site.

Water level elevations for all of the wells listed in Appendix B, Table B.1 will be measured during the April and October 2001 sampling events (i.e., 307 wells). If accurate water level measurements cannot be obtained from a well or the well no longer exists, it will be removed from subsequent water level measurements. In addition, monitoring wells installed over the course of 2001 will be incorporated into the list of water level measurement wells.

5.3 MONITORING WELL SAMPLING SELECTION

Components considered in developing the water quality sampling approach included 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 5.3). The analytical methods proposed for a selected well reflects the monitoring objective(s) that it supports. For example, when a selected well supports both the plume delineation objective as well as the natural attenuation objective, the list of analytical tests reflects the analysis needed to fulfill both objectives (e.g., VOCs and natural attenuation parameters). A statistical package aided in the selection of the wells used to monitor the TCE plume, as described in Section 5.3.3. Following the statistical analysis, the decision flow chart given in Figure 5.1 was used to finalize the selection process.

Table 5.3
Monitoring Wells Selected for April/October 2001 Basewide Sampling

Area	Well	Sample Parameters[1]		
		VOCs	Metals	Natural Attenuation[2]
Plume Monitoring Wells	GMI-22-06M	X		
	GMI-22-07M	X		
	HM-114	X		
	HM-116	X	X	
	HM-123	X		X
	HM-126	X		
	ITMW-01T[4]	X	X	X
	LF03-3D[4]	X	X[5]	
	LF04-02	X		
	LF05-01	X		
	LF05-02	X		
	LF05-19	X		
	LF05-5G	X		X
	MW-53	X		
	SPOT35-5	X		
	ST14-03	X		
	USGS04T	X		
	USGS07T	X	X	X
	W-153	X		X
	WCHMHTA006	X		
	WCHMHTA008	X		
	WCHMHTA009	X		
	WHGLRW016	X		
	WHGLRW017	X		
	WHGLTA004	X		
	WHGLTA009[4]	X		
	WHGLTA012	X		
	WHGLTA025	X		
	WHGLTA029[3]	X		
	WHGLTA043	X		
	WHGLTA044	X		
	WHGLTA045	X		
	WHGLTA049	X		
	WHGLTA051	X		
	WHGLTA603	X		
	WHGLTA704	X		
	WITCTA003[3]	X		
	WITCTA004	X		
	WITCTA010	X	X	

Table 5.3 (continued)
Monitoring Wells Selected for April/October 2001 Basewide Sampling

Area	Well	Sample Parameters[1]		
		VOCs	Metals	Natural Attenuation[2]
Plume Monitoring Wells (cont.)	WITCTA019	X		
	WITCTA024	X		X
	WITCTA040	X		
	WITCTA041	X		
	WITCTA043	X		
AOC 1 Monitoring Wells[6]	BGSMW03	X		
	BGSMW05	X		
	BGSMW06	X		
	MW-6	X		
	MW-10	X		
	SAV-2	X		
	WHGLTA036	X		
	WHGLTA037	X		
	WHGLTA038	X		
Paluxy Well	WHGLPU001	X		

Notes:

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

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

[3] These monitoring wells are only to be sampled in April 2001.

[4] Monitoring wells sampled for Jacobs.

[5] This well will be sampled for chromium only.

[6] AOC 1 Monitoring wells will only be sampled in April and July 2001.

VOCs - Volatile organic compounds (EPA Method SW8260B)
Metals - Total Metals plus mercury (EPA Method SW6010B/SW7470)
Natural Attenuation - sulfate, nitrate, chloride (SW9056); TOC (SW9060); alkalinity (E310.1), methane, ethane, ethene (Method RSK-175).

5.3.1 Current Regulatory Requirements

The first step in selecting wells for the 2001 GSAP was to determine which wells were previously proposed or selected for compliance with a regulatory requirement. One site at NAS Fort Worth currently has instituted quarterly monitoring requirements in 2001.

A long-term monitoring program was proposed for AOC 1, Former Base Service Station/Former Base Gas Station, prior to the 1999 GSAP. Following the interpretation of the data from 2000, a fourth year of quarterly sampling was requested by the TNRCC. Each of the 9 wells is to be sampled for VOCs (SW8260B) during April and July 2001. These wells are colored blue in Figure 3.2.

5.3.2 Other Long-Term Monitoring Programs

Jacobs Engineering performs semi-annual and annual groundwater monitoring as part of the AFP 4 basewide sampling program. Concluding the October 2000 AFP 4 sampling program, an evaluation of the monitoring frequencies and durations was performed. During 2001, Jacobs modified the sampling frequency for some of the monitoring wells. In 2000, 10 monitoring wells located on NAS Fort Worth JRB and/or Former Carswell AFB were sampled semi-annually; however during 2001, Jacobs will continue to sample 5 of the 10 semi-annually and the other 5 will be sampled annually. In addition, one monitoring well (WHGLTA048) was added to the 2001 sampling program. All data collected during 2001 will be incorporated into this GSAP program to avoid duplication of efforts.

AFP 4 monitoring objectives are to track any possible off-site migration of TCE, DCE, vinyl chloride or chromium. The 11 monitoring wells (GMI-22-02M, GMI-22-03M, GMI-22-05M, HM-93, HM-112, HM-119, HM-120, HM-127, LF04-10, USGS06T, and WHGLTA048) are located, for the most part, on perimeters of the TCE plume, and at the boundary between AFP 4 and NAS Fort Worth JRB. These wells are colored yellow in Figure 3.2.

5.3.3 TCE Plume Monitoring

There is a significant amount of ongoing and planned feasibility study work occurring at the base focusing on the regional trichloroethylene plume in the Terrace Alluvium aquifer. Accordingly, the Air Force has expressed an increased interest in reducing uncertainty associated with plume delineation using the well selection process for the 2001 GSAP. In response, HydroGeoLogic used a combination of site knowledge, a review of several years of quarterly sampling data, and geo-statistical analysis to develop a list of proposed wells for the 2001 GSAP. In addition, the well selection flow chart present in Figure 5.1 was considered as part of this process.

A geo-statistical analysis was performed to determine the potential reduction in estimation uncertainty by the addition of sampling locations where samples were not collected in 2000, or in recent years. This analysis considered all TCE quarterly and additional TCE monitoring data available, that was collected from October through December 2000. Independently from the geo-statistical analysis, a preliminary proposed well list was developed based on site and project knowledge and several years of historical groundwater data. This preliminary well list was then

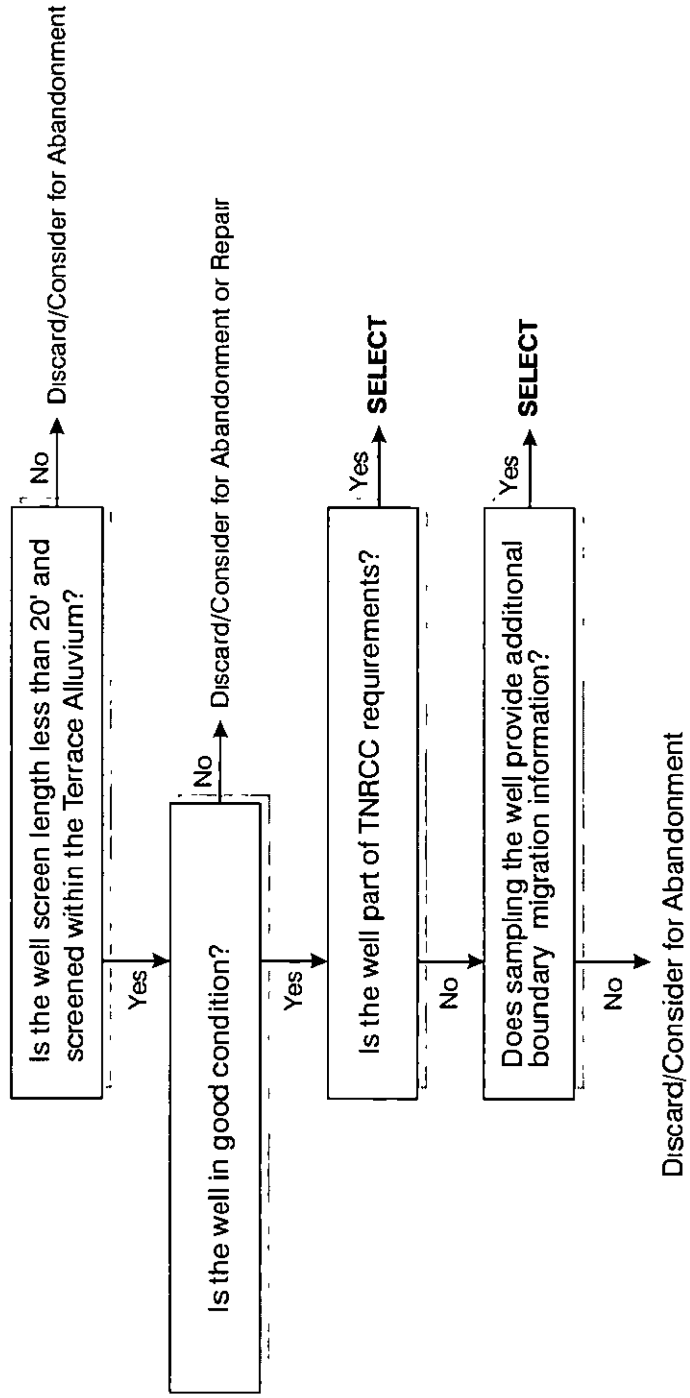

Figure 5.1
NAS Fort Worth JRB
Well Selection Flow Chart

Filename X:AFC001\33fa\Report\Figure_5-1 cdr
Project AFC001-33fa
Created 04/10/98 cfarmer
Revised 03/06/01 jb

superimposed over the above described uncertainty contours to support evaluating candidate additional well locations. Based on this review, which encompassed several iterations, some wells were removed from consideration, while others were added to arrive at the proposed well list for plume monitoring in the 2001 GSAP. Details of the geo-statistical well selection methodology are provided in Appendix E.

Monitoring wells listed under a regulatory requirement (i.e., AOC 1) are included in the GSAP regardless of the outcome of their statistical uncertainty analysis. Also included are the Jacobs' AFP 4 wells, regardless of statistical importance. Table 5.3 provides a list of the wells to be sampled for the April and October 2001 sampling events.

5.3.4 Natural Attenuation Monitoring

TCE can be present in groundwater either as a original component of a release or as a reductive dechlorination product of PCE. At NAS Fort Worth JRB and AFP 4, the TCE appears to be primarily an original component rather than a dechlorination product, although some PCE has been detected at the sites. TCE undergoes sequential reductive dechlorination initially forming the DCE isomers (mainly *cis*-1,2-DCE), then vinyl chloride (VC), and finally ethene and ethane. The completeness of the sequential dechlorination of TCE to less chlorinated compounds is dependent on the redox conditions in the aquifer (Environmental Science Center, 1997).

Since 1995, natural attenuation parameters have been collected at the site on a regular basis (semi-annually prior to July 1997, and quarterly since July 1997). These parameters include common anions (EPA Method SW9056); methane, ethane, ethene (Method RSK-175); total organic carbon (TOC) (EPA Method SW9060); and alkalinity (EPA Method 310.1), as well as several of the standard field stabilization parameters collected at every well. During that same time period, CH2MHILL also conducted an RFI at AOC 2 (CH2M HILL, 1999). Data evaluations from both the AOC 2 RFI report and from the quarterly natural attenuation data have virtually the same conclusions: while some reductive dechlorination has occurred with the TCE plume at NAS Fort Worth JRB, as evidenced by the large extent of *cis*-1,2-DCE, is limited in extent. The percentage of *cis*-1,2-DCE compared to *trans*-1,2-DCE is approximately 70 percent based on DCE data collected in 1999. This ratio is a strong indicator that the DCE is present from the dechlorination rather than from a direct source.

The following data supports the lack of evidence for complete TCE degradation:

- Sampling data indicate virtually no presence of ethene or ethane, the ultimate products of TCE degradation (assuming complete reductive dechlorination). Only 16 wells out of 66 sampled over the past 3 years have displayed any concentration of ethene. The highest concentrations of ethene and ethane were 14.57 μg/L and 79.91 μg/L, respectively.

- Some nitrate and high sulfate concentrations exist at the site. These preferred electron acceptors compete with the TCE. The areas of high sulfate and nitrate concentrations occur in the areas of highest TCE contamination in the southern TCE plume near the landfill area, most likely inhibiting the degradation of the TCE.

- TOC concentrations are extremely low at the site, averaging less than 7 mg/L over 66 wells sampled. The wells with the lowest TOC concentrations correlate with the areas of highest TCE concentration, indicating that the carbon source has been virtually depleted. TOC concentrations of 20 mg/L or more are considered a significant level of organic carbon source (CH2M HILL, 1999). Carbon acts as an electron donor and is considered one of the more important factors in order for degradation to occur.

- Sampling data from 1998 through 2000 indicate only 15 of 56 monitoring wells have shown any concentrations of VC, the first degradation product of DCE. Concentrations of VC ranged from non-detect in many wells to 490 μg/L in LF05-01 (January 1999).

- DCE concentrations are substantially lower than TCE concentrations, showing that TCE is still the dominant contaminant, resisting degradation.

5.3.4.1 Natural Attenuation Scoring

In addition to the evidence above, the AFCEE and EPA protocol (AFCEE, 1996) for "scoring" the potential for natural attenuation of chlorinated solvents was applied to the 1999 quarterly data at the site. CH2MHILL also applied the scoring criteria in their AOC 2 report, although it was only applied to two monitoring wells, while the criteria calls for at least six. According to the guidelines the following conclusions can be made for the scores below:

- 0 to 5 = Inadequate evidence for biodegradation of chlorinated organics
- 6 to 14 = Limited evidence for biodegradation of chlorinated organics
- 15 to 20 = Adequate evidence for biodegradation of chlorinated organics
- >20 = Strong evidence for biodegradation of chlorinated organics

The two evaluations are summarized in the following sections.

HydroGeoLogic GSAP Scoring

The sampling data for January through October 1999 were evaluated using the scoring protocol. All wells sampled for natural attenuation parameters and VOCs (on average 27 wells) were included in this evaluation. Only two wells, LF05-01 and FT09-12C, demonstrated a score greater than 20, which is a score that indicates strong evidence for biodegradation of chlorinated organics. Six wells scored between 15 to 20 at least once during the four quarters. This score indicates adequate evidence for biodegradation of chlorinated organics. Twenty-two wells scored between 6 to 14 at least once during the four quarters. Twenty-one wells scored 0 to 5 at least once during the four quarters. These scoring ranges indicate inadequate evidence for biodegradation of chlorinated organics. For scoring data, refer to Appendix F, Table F.7 of the Final 2000 Basewide Groundwater Sampling and Analysis Plan (HydroGeoLogic, 2000a).

AOC 2 RFI Report Scoring

The scoring calculation performed in the AOC 2 RFI report, was only applied to two monitoring wells' sampling data (WCHMHTA012 and LSA1628-3) collected during December 1997 and

April 1998. These wells were selected based on availability of supporting data and the presence of significant concentrations of TCE. The evaluation resulted in a score of 11 and 6, respectively for the two wells analyzed. According to the protocol, scores in this range have limited evidence for biodegradation of chlorinated solvents.

Natural Attenuation Conclusions

As summarized above, the evidence to support natural attenuation of the TCE is minimal. It is recommended that the natural attenuation sampling remain limited to six monitoring wells. The monitoring wells selected are located in the areas containing high TCE concentrations (W-153), several hundred feet downgradient from that well (HM-123 and LF05-5G), and in the most downgradient well ITMW-01T. Two wells along the perimeter will also be sampled for "background" conditions (WITCTA024 and USGS07T).

5.4 ANALYSIS, SAMPLING, AND REPORTING PROCEDURES

Analytical specifications for all sampling rounds will be conducted in accordance with the Final 2000 Basewide QAPP (HydroGeoLogic, 2000b). 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 C.

TAB

SECTION 6.0

6.0 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.

6.1 DATA EVALUATION

Data evaluation will be conducted as described in the Final 2000 Basewide QAPP (HydroGeoLogic, 2000b). 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 Environmental Restoration Program Information Management System (ERPIMS) submittals are prepared.

6.2 DATA MANAGEMENT

Data management activities will include compiling sample information such as field measurements and analytical results in a structured database design. The database design 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. QA procedures for database security and integrity will also be established to ensure that the data collected are complete, accurate, and scientifically defensible.

6.3 DATA TRANSFER

Electronic Data Deliverable (EDD) transfer is a critical data management contractor responsibility. Data must be easily transferred to data users, among contractors, and to the ERPIMS. 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 electronic data file (EDF) transfer to AFCEE and other contractors will be the ERPIMS format because this format is a standard that most contractors support. ERPIMS 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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TAB

SECTION 7.0

7.0 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 technical reports. This section provides a description of the requirements for the technical reports and GSAP updates. Also addressed are notification requirements if hazards are encountered during performance of the work.

7.1 TECHNICAL REPORTS

In November 2000, AFCEE requested that HydroGeoLogic modify the Quarterly LTM groundwater sampling program to a semi-annual program for the 2001 GSAP. The 2001 groundwater sampling events will occur during April and October 2001.

7.1.1 Semi-Annual - April Report

This report will tabulate and graphically represent all monitoring data collected and analyzed during the April sampling event. The April report will present the data rather than provide a thorough interpretation of the data. This report will emphasize factual data presented as clearly and concretely as possible using maps of well locations, numbers of wells, sampling dates, contour maps, and tables of water levels and results. The Appendices will include all sample data and results as well as a detailed, comprehensive, assessment of the QC results and data usability.

The data presented in this report will have been validated and qualified for usability in accordance with the Final 2000 Basewide QAPP (HydroGeoLogic, 2000b). Also included will be a discussion of how the DQOs, including completeness, have been met. Data gaps induced by deviations and unattained DQOs will be identified and evaluated.

7.1.2 Annual - October Report

The annual report allows all of the April and October 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 MQL, water table contour maps, isopleth maps of natural attenuation parameters, locations of monitoring wells, and hydrographs.

7.2 GROUNDWATER SAMPLING AND ANALYSIS PLAN UPDATES

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

7.2.1 Groundwater Sampling and Analysis Program Evaluations

Data will be evaluated after both the April and October 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.

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 7.2.2. 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.

7.2.2 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 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 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 QC criteria and after verifying the accuracy of the water level measurements. Semi-annual evaluation of water level measurements involves preparing water table contour maps for the measurements and comparing the current map with the previous water level data 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 sampling event 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 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-gauging 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. The temporal analysis consists of an examination of data at each location to identify underlying relationships over time and to quantify an interval of confidence in the predictive quality of the data. The relationships derived will be used to estimate contaminant levels and their associated uncertainties in the future at each sample location. In the final step of the analysis, future contaminant distributions will be estimated using the spatial and temporal relationships. In addition, the estimation uncertainty in both space and time will be quantified.

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.

- Determine if over-sampling or under-sampling has occurred by mapping subsets of wells to evaluate whether the concentration 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.

- 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.

7.3 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 will be contacted immediately by telephone. Written notification of the situation, including supporting documentation, will be made within three days after telephone notification.

TAB

SECTION 8.0

8.0 PROJECT SCHEDULE

A schedule for completion of tasks for each sampling event as well as preparations for the next year's GSAP is presented in Figure 8.1. 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 draft document by AFCEE. Responses to the review comments will be prepared along with revision to draft documents, resulting in a final document that incorporates AFCEE input for the 2002 program.

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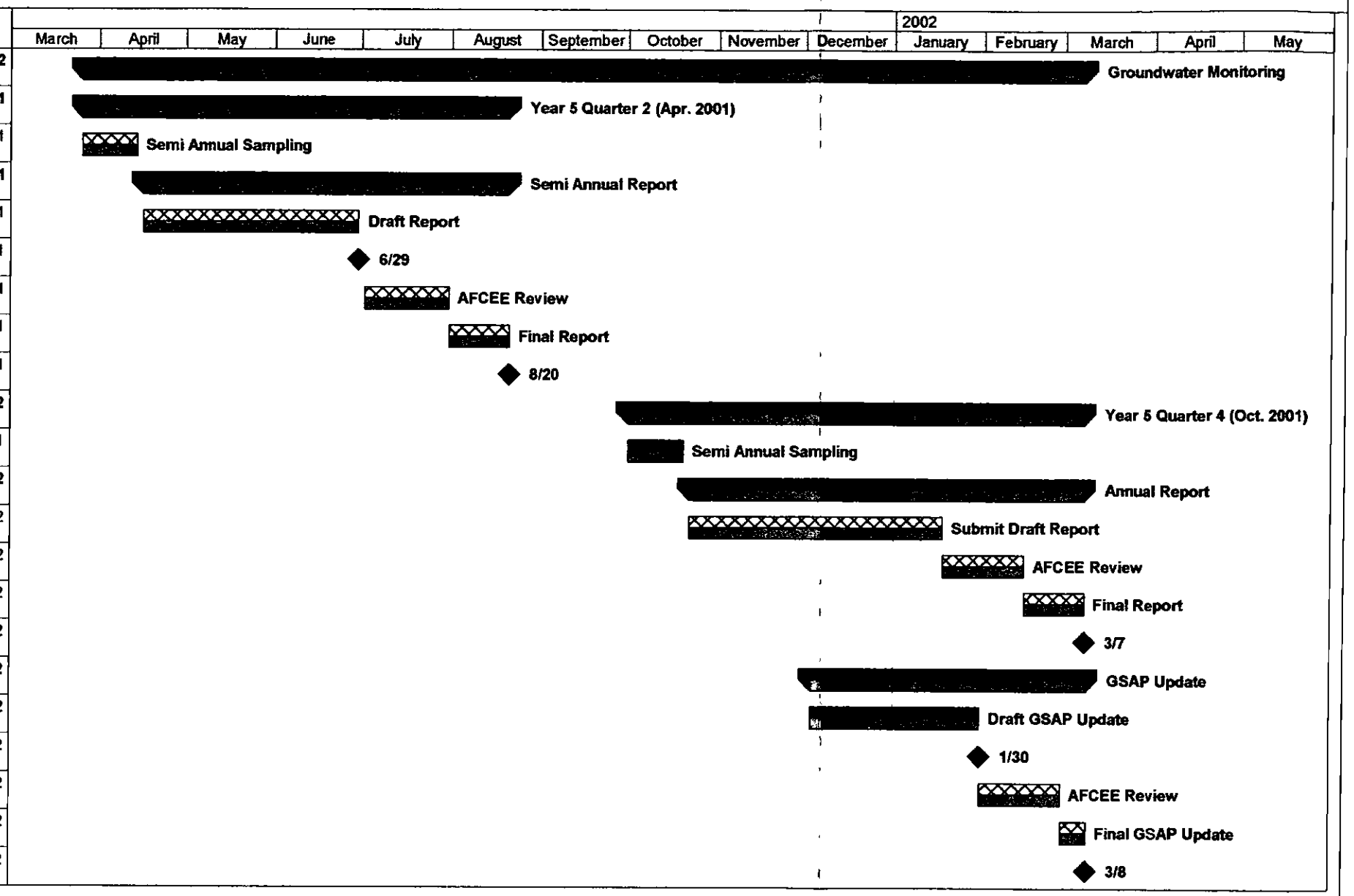
Figure 8.1
Master Integrated Project Schedule
Groundwater Sampling and Analysis Plan

ID	Task Name	Duration	Start	Finish
1	**Groundwater Monitoring**	**242 days**	**Mon 3/26/01**	**Thu 3/7/02**
2	**Year 5 Quarter 2 (Apr. 2001)**	**104 days**	**Mon 3/26/01**	**Mon 8/20/01**
3	Semi Annual Sampling	15 days	Mon 3/26/01	Fri 4/13/01
4	**Semi Annual Report**	**89 days**	**Mon 4/16/01**	**Mon 8/20/01**
5	Draft Report	54 days	Mon 4/16/01	Fri 6/29/01
6	Submit Draft Report	0 days	Fri 6/29/01	Fri 6/29/01
7	AFCEE Review	20 days	Mon 7/2/01	Mon 7/30/01
8	Final Report	15 days	Tue 7/31/01	Mon 8/20/01
9	Submit Final Report	0 days	Mon 8/20/01	Mon 8/20/01
10	**Year 5 Quarter 4 (Oct. 2001)**	**110 days**	**Mon 10/1/01**	**Thu 3/7/02**
11	Semi Annual Sampling	14 days	Mon 10/1/01	Fri 10/19/01
12	**Annual Report**	**96 days**	**Mon 10/22/01**	**Thu 3/7/02**
13	Submit Draft Report	61 days	Mon 10/22/01	Thu 1/17/02
14	AFCEE Review	20 days	Fri 1/18/02	Thu 2/14/02
15	Final Report	15 days	Fri 2/15/02	Thu 3/7/02
16	Submit Final Report	0 days	Thu 3/7/02	Thu 3/7/02
17	**GSAP Update**	**69 days**	**Mon 12/3/01**	**Fri 3/8/02**
18	Draft GSAP Update	42 days	Mon 12/3/01	Wed 1/30/02
19	Submit Draft GSAP Update	0 days	Wed 1/30/02	Wed 1/30/02
20	AFCEE Review	20 days	Thu 1/31/02	Wed 2/27/02
21	Final GSAP Update	7 days	Thu 2/28/02	Fri 3/8/02
22	Submit Final GSAP Update	0 days	Fri 3/8/02	Fri 3/8/02



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Summary Task Progress Milestone Split Baseline

TAB

SECTION 9.0

9.0 REFERENCES

Air Force, 1997, Memorandum of Understanding for Environmental Compliance at Naval Air Station Fort Worth, JRB, Carswell Field.

Air Force Center for Environmental Excellence (AFCEE), 1996, Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater.

A.T. Kearney, 1989, RCRA Facility Assessment, Preliminary Review/Visual Site Inspection, Carswell AFB, Texas. March 1989.

CH2M HILL, 1984, Installation Restoration Program Records Search, Carswell AFB, Texas, February 1984.

CH2M HILL, 1996, Draft, GSAP for HQ AFCEE, Ft. Worth, August 1996.

CH2M HILL, 1999, Draft RCRA Facility Investigation, Area of Concern 2, January 1999.

Environmental Science and Engineering, Inc. (ESE), 1994. Final Report Summary of Remediation Projects at Air Force Plant 4 and Carswell AFB, Volume 1, July 1994.

Environmental Science Center, 1997, Draft Final Report, Anaerobic Biodegradation of Organic Chemicals in Groundwater: A summary of Field and Laboratory Studies.

HydroGeoLogic, Inc., 1999a. Draft Technical Memorandum, Recommendation for No Further Action at SWMU 13, Visual Information Center Work Station Waste Accumulation Areas, NAS Fort Worth JRB, Texas. February 1999.

HydroGeoLogic, Inc., 1999b. Draft Work Plans for Site Investigation of 12 Underground Storage Tanks, NAS Fort Worth JRB, Texas. February 1999.

HydroGeoLogic, Inc., 1999c. Site Assessment Report RCRA Facility Investigation - SWMU 27 (Landfill No. 10), NAS Fort Worth JRB, Texas. March 1999.

HydroGeoLogic, Inc., 1999d. Revised Final Work Plan RCRA Facility Investigation of Waste Accumulation Areas, NAS Fort Worth JRB, Texas. October 2000.

HydroGeoLogic, Inc., 1999e. Draft Technical Memorandum, Recommendation for No Further Action at SWMU 7 and SWMU 8, NAS Fort Worth JRB, Texas. August 1999.

HydroGeoLogic, Inc., 2000a. Final 2000 Basewide Groundwater Sampling and Analysis Plan, NAS Fort Worth JRB, Texas. March 2000.

HydroGeoLogic, Inc., 2000b. Final 2000 Basewide Quality and Assurance Project Plan, NAS Fort Worth JRB, Texas. March 2000.

HydroGeoLogic, Inc., 2000c. Final Phase II RCRA Facility Investigation of WAAs Work Plan Addendum, NAS Fort Worth JRB, Texas. April 2000.

HydroGeoLogic, Inc., 2000d. Final Work Plans, RCRA Facility Investigation of SWMUs 19, 20, 21 and 53; and Site Investigations of AOCs 17, 18, and 19 at NAS Fort Worth JRB, Texas. April 2000.

HydroGeoLogic, Inc., 2000e. Draft Phase II RFI Work Plan, Area of Concern 13, NAS Fort Worth JRB, Texas. May 2000.

HydroGeoLogic, Inc., 2000f. Final Area of Concern 4, 1999 Annual Groundwater Report, NAS Fort Worth JRB, Texas. July 2000.

HydroGeoLogic, Inc., 2000g. Final Work Plan Data Gap Investigation of the Southern Lobe TCE Plume, NAS Fort Worth JRB, Texas. August 2000.

HydroGeoLogic, Inc., 2000h. Final Work Plan Addendum Limited RCRA Facility Investigation of SWMUs 45, 54, and 55, NAS Fort Worth JRB, Texas. September 2000.

HydroGeoLogic, Inc., 2000i. Final Work Plan Addendum Limited RCRA Facility Investigation of SWMU 50, Former Aircraft Wash Rack, NAS Fort Worth JRB, Texas. September 2000.

HydroGeoLogic, Inc., 2000j. Draft RCRA Facility Investigation Solid Waste Management Units 22, 23, 24, and 25, NAS Fort Worth JRB, Texas. September 2000.

HydroGeoLogic, Inc., 2000k. Final Work Plan for Monitoring Well Abandonment and Repair Letter Report, Air Force Plant 4 and NAS Fort Worth JRB, Texas. October 2000.

HydroGeoLogic, Inc., 2001a. Final Phase III Work Plan Addendum, RCRA Facility Investigation of SWMUs 17, 26, 29, 30, and 62, NAS Fort Worth JRB, Texas. January 2001.

HydroGeoLogic, Inc., 2001b. Final Basewide Groundwater Sampling and Analysis Program 2000 Annual Report, NAS Fort Worth JRB, Texas. March 2001.

IT Corporation, 1997a, Final Attachment 20 Corrective Action Plan Submittal, TNRCC Assessment Report Form, Base Gas Station, NAS Fort Worth JRB, Carswell Field, Fort Worth, Texas. June 1997.

IT Corporation, 1997b, Final Attachment 20 Corrective Action Plan Submittal, TNRCC Assessment Report Form, Base Service Station, NAS Fort Worth JRB, Carswell Field, Fort Worth, Texas. June 1997.

IT Corporation, 1997c, Draft RCRA Facility Investigation of Sanitary Sewer, Volume 1, NAS Fort Worth JRB, Texas. September 1997.

IT Corporation, 1997d, AOC 1 Assessment Report Form, NAS Fort Worth JRB, Texas. December 1997.

IT Corporation, 1998, Draft Oil/Water Separator (OWS) RCRA Facility Investigation, Addendum Report, NAS Fort Worth JRB, Texas. July 1998.

Jacobs Engineering Group, Inc. (Jacobs), 1998, Final Basewide Background Study, Volume 1, NAS Fort Worth JRB, Texas. September 1998.

Jacobs Engineering Group, Inc. (Jacobs), 2001, Long Term Monitoring Sampling and Analysis Air Force Plant 4, Fort Worth, Texas. January 2001.

National Weather Service, 2001. www.nws.noaa.gov

Parsons Engineering Science, Inc., 1997, Remedial Action Plan for Risk-Based Remediation of Site ST14(SWMU68), LPST ID 104819; the Former Base Refueling Area (AOC7), Carswell AFB, NAS Fort Worth JRB, Texas. July 1997.

Radian Corporation, 1989, Installation Restoration Program RI/FS, Stage 2, Draft Final, Volume 2: Appendices A-E, Technical Report, Carswell AFB, Texas. April 1989.

Rust-Geotech, 1995a, AFP 4 Feasibility Study, Volume 1 & 2, Fort Worth. September 1995.

Rust-Geotech, 1995b, Remedial Investigation & Preliminary Assessment/Site Investigation Report, Volume 1, AFP 4, Fort Worth. September 1995.

Rust-Geotech, 1996, Final Record of Decision, Air Force Plant 4.

Texas Natural Resource Conservation Commission (TNRCC), 1995, Letter from Paul Lewis, TNRCC to Ohlen Long, AFBDA, "Determination of a Need for an RFI and Current Condition Report," March 2.

Texas Natural Resource Conservation Commission (TNRCC), 1998a, Interoffice Memorandum Implementation of the Existing Risk Reduction Rule. July 1998.

Texas Natural Resource Conservation Commission (TNRCC), 1998b, Erratum Sheet to the July 23, 1998 Memorandum. September 1998.

Texas Water Commission (TWC), 1991, RCRA Hazardous Waste Permit Part B (HW-50289).

U.S. Army Corp of Engineers (USACE), 1995, Technical Project Planning Guidance for HTRW Data Design, Engineering Manual EM200-12.

U.S. Environmental Protection Agency (USEPA), 1989, Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Interim Final Guidance, Office of Solid Waste, Permits and State Programs Division, Washington, DC. EPA/530-SW-89-026.

U.S. Environmental Protection Agency (USEPA), 1992, Statistical Analysis of Ground-Water Monitoring Data at RCRA Facilities: Addendum to Interim Final Guidance, Office of Solid Waste, Permits and State Programs Division, Washington, DC. July 1992.

U.S. Environmental Protection Agency (USEPA), 1994, Guidance for the Data Quality Objectives.

U.S. Environmental Protection Agency (USEPA), 1996, Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.

United States Geological Survey (USGS), 1996, Hydrogeology at Air Force Plant 4 and Vicinity and Water Quality of the Paluxy Aquifer, Fort Worth JRB, Texas. Water Resources Investigations Report 96-4091. January 1996.

TAB

APPENDIX A

APPENDIX A

POSITIVE ANALYTICAL RESULTS FROM 2000 SAMPLING AT NAS FORT WORTH AND AFP 4

TABLE A.1

DETECTED ANALYTICAL RESULTS FROM 2000 QUARTERLY SAMPLING

Table A.1
Detected Analytical Results From 2000 Quarterly Sampling
NAS For Worth JRB

Analytical Method/Analyte	Reporting Limit	GMI-22-04M April 2000	GMI-22-04M July 2000	GMI-22-04M October 2000
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
Chloroform	0 3	0.4	--	0.4
cis-1,2-Dichloroethene	0.5	84 [1]	--	66
trans-1,2-Dichloroethene	0 5	5	--	4
Tetrachloroethene (PCE)	0.5	1	--	1
Trichloroethene (TCE)	0.5	500 [1]	--	360
Trichlorofluoromethane	0 5	0.8 J [2]	--	0.7
Analytical Method/Analyte	**Reporting Limit**	**GMI-22-06M April 2000**	**GMI-22-06M July 2000**	**GMI-22-06M October 2000**
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
1,1-Dichloroethene	0.5	--	0 5	--
Chloroform	0 3	--	0.6	--
cis-1,2-Dichloroethene	0 5	--	91 [1]	--
trans-1,2-Dichloroethene	0.5	--	6	--
Tetrachloroethene (PCE)	0.5	--	1	--
Trichloroethene (TCE)	0.5	--	540 [1]	--
Analytical Method/Analyte	**Reporting Limit**	**HM-112 April 2000**	**HM-112 July 2000**	**HM-112 October 2000**
Alkalinity - E310.1 (mg/L)				
Alkalinity, Total (as CaCO3)	5	294 S	--	--
Methane, Ethane, and Ethene - RSK-175 (µg/L)				
Ethane	0.5	0.37 F	--	--
Ethene	0.5	0.68	--	--
Methane	0 5	290 [1]	--	--
Chromium (SW6010B) - (µg/L)				
Chromium (total)	5	--	--	25 [3]
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
1,1-Dichloroethane	0.4	2	--	--
1,1-Dichloroethene	0.5	4	--	--
cis-1,2-Dichloroethene	0.5	200 [1]	--	220 [3]
trans-1,2-Dichloroethene	0.5	5	--	--
Bromodichloromethane	0.5	0.7	--	--
Chlorobenzene	0 4	0 6	--	--
Chloroform	0.3	1	--	--
Tetrachloroethene (PCE)	0.5	2	--	--
Trichloroethene (TCE)	0.5	7400 [1]	--	6900 J [3]
Common Anions - SW9056 (mg/L)				
Chloride (as Cl)	0.2	27 1	--	--
Nitrogen, Nitrate (as N)	0.1	7.6	--	--
Sulfate (as SO4)	0.2	83.5	--	--

Table A.1 (continued)
Detected Analytical Results From 2000 Quarterly Sampling
NAS For Worth JRB

Analytical Method/Analyte	Reporting Limit	HM-116 April 2000	HM-116 July 2000	HM-116 October 2000
Chromium (AA Furnace Technique) - SW7191 (µg/L)				
Chromium (total)	5	29 8	--	32.8
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
Chloroform	0.3	0.3	--	0.5
1,1-Dichloroethene	0.5	1	--	1
cis-1,2-Dichloroethene	0.5	32 [1]	--	38
trans-1,2-Dichloroethene	0 5	0.9	--	0.9
Tetrachloroethene (PCE)	0 5	7 J	--	8
Trichloroethene (TCE)	0 5	370 [1]	--	300
Trichlorofluoromethane	0 5	1	--	2
Analytical Method/Analyte	**Reporting Limit**	**HM-123 April 2000**	**HM-123 July 2000**	**HM-123 October 2000**
Alkalinity - E310.1 (mg/L)				
Alkalinity, Total (as CaCO3)	5	334 S	--	305 S
Methane, Ethane, and Ethene - RSK-175 (µg/L)				
Ethane	0.5	0.83	--	0.65
Ethene	0.5	0.15 F	--	ND
Methane	0.5	110 [1]	--	70
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
1,1-Dichloroethane	0.4	0 9	1	0.9
1,1-Dichloroethene	0.5	3	3	2
Chloroform	0.3	0.6	0 7	0.6
cis-1,2-Dichloroethene	0.5	540 [1]	550 [1]	550
trans-1,2-Dichloroethene	0 5	14	14	10
Tetrachloroethene (PCE)	0 5	0.7	0 7	0.6
Trichloroethene (TCE)	0 5	3100 [1]	3000 [1]	2700
Trichlorofluoromethane	0 5	ND	0.6	ND
Vinyl chloride	0.5	3	2	1
Common Anions - SW9056 (mg/L)				
Chloride (as Cl)	0.2	18.7	--	18.6 [1]
Nitrogen, Nitrate (as N)	0.1	2.8	--	3
Sulfate (as SO4)	0.2	59.8	--	62.8 [1]
Total Organic Carbon - SW9060 (mg/L)				
Total Organic Carbon	1	ND	--	1.7

Table A.1 (continued)
Detected Analytical Results From 2000 Quarterly Sampling
NAS For Worth JRB

Analytical Method/Analyte	Reporting Limit	HM-126 April 2000	HM-126 July 2000	HM-126 October 2000
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
Chloroform	0 3	--	0.6	--
1,1-Dichloroethane	0.4	--	0.4	--
1,1-Dichloroethene	0.5	--	1	--
cis-1,2-Dichloroethene	0.5	--	70 [1]	--
trans-1,2-Dichloroethene	0 5	--	3	--
Tetrachloroethene (PCE)	0.5	--	1	--
Trichloroethene (TCE)	0.5	--	1500 [1]	--
Analytical Method/Analyte	**Reporting Limit**	**ITMW-01T April 2000**	**ITMW-01T July 2000**	**ITMW-01T October 2000**
Alkalinity - E310.1 (mg/L)				
Alkalinity, Total (as CaCO3)	5	400 S	--	391 S
Methane, Ethane, and Ethene - RSK-175 (µg/L)				
Methane	0.5	3.4	--	1.7
Trace Elements (Metals) by ICP - SW6010B (µg/L)				
Barium	200	98 6 F	98.3 F	93.8 F
Calcium	500	167000	172000	157000
Magneseum	500	10900	10900	10000
Manganese	20	227	228	184
Molybdenum	10	2.3 F	2.9 F	ND
Potassium	5000	1540 F	1610 F	1680 F
Sodium	1000	41900	37500	42100
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
cis-1,2-Dichloroethene	0 5	3	5	10
trans-1,2-Dichloroethene	0.5	ND	ND	0 6
m- & *p*-Xylene (sum of isomers)	0.5	ND	0.2 F	ND
Trichloroethene (TCE)	0.5	8	13	22
Common Anions - SW9056 (mg/L)				
Chloride (as Cl)	0.2	39.4 [1]	--	37.8
Nitrogen, Nitrate (as N)	0.1	0.94	--	0.72 [1]
Sulfate (as SO4)	0 2	104 [1]	--	92 [1]
Total Organic Carbon - SW9060 (mg/L)				
Total Organic Carbon	1	1.1 S	--	1.1 S

Table A.1 (continued)
Detected Analytical Results From 2000 Quarterly Sampling
NAS For Worth JRB

Analytical Method/Analyte	Reporting Limit	LF03-3D April 2000	LF03-3D July 2000	LF03-3D October 2000
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
Methyl *tert*-butyl ether	0.5	R	2	--
Analytical Method/Analyte	**Reporting Limit**	**LF05-01 April 2000**	**LF05-01 July 2000**	**LF05-01 October 2000**
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
1,1-Dichloroethane	0.4	0 7	0.5	ND
1,1-Dichloroethene	0.5	0.7	ND	4 F
1,2-Dichlorobenzene	0 3	0 3	ND	2 F
Benzene	0.4	0.4	ND	ND
cis-1,2-Dichloroethene	0.5	180 J[1]	60 [1]	140
trans-1,2-Dichloroethene	0.5	9	4	4
Trichloroethene (TCE)	0.5	4 J	6	5
Vinyl chloride	0 5	200 J[1]	79 [1]	200
Analytical Method/Analyte	**Reporting Limit**	**LF05-5G April 2000**	**LF05-5G July 2000**	**LF05-5G October 2000**
Alkalinity - E310.1 (mg/L)				
Alkalinity, Total (as CaCO3)	5	410 S[2]	--	387 S
Methane, Ethane, and Ethene - RSK-175 (µg/L)				
Ethane	0.5	0.39 F	--	0 59
Ethene	0 5	0.66	--	0 54
Methane	0.5	310 J[1]	--	440 [1]
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
1,1-Dichloroethane	0.4	0.4	0 4	ND
1,1-Dichloroethene	0.5	6	5 J[2]	5 J
1,4-Dichlorobenzene	0.3	2	2	1
Benzene	0.4	0.4	ND	3 F
Chlorobenzene	0.4	2 [2]	1	2 J
cis-1,2-Dichloroethene	0.5	220 [1,2]	280 [1,2]	300
trans-1,2-Dichloroethene	0.5	28 [2]	28 [2]	37 [2]
Trichloroethene (TCE)	0.5	880 [1,2]	790 [1,2]	920
Vinyl chloride	0.5	16 [2]	19 J[2]	16
Common Anions - SW9056 (mg/L)				
Chloride (as Cl)	0.2	46.5 [1,2]	--	51.6 [1]
Sulfate (as SO4)	0.2	47.6 [1,2]	--	70 6 [1,2]
Total Organic Carbon - SW9060 (mg/L)				
Total Organic Carbon	1	4 6 S[2]	--	3 S

Table A.1 (continued)
Detected Analytical Results From 2000 Quarterly Sampling
NAS For Worth JRB

Analytical Method/Analyte	Reporting Limit	MW-53 April 2000	MW-53 July 2000	MW-53 October 2000
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
Chloroform	0.3	ND	ND	0.4
cis-1,2-Dichloroethene	0.5	0 8	ND	9
Trichloroethene (TCE)	0.5	10	5	50
Methyl *tert*-butyl ether	0.5	ND	1	--
Analytical Method/Analyte	**Reporting Limit**	**SPOT35-5 April 2000**	**SPOT35-5 July 2000**	**SPOT35-5 October 2000**
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
Isopropylbenzene (cumene)	0.5	--	28	--
Naphthalene	0.5	--	44 [1]	--
n-Propylbenzene	0.4	--	36	--
sec-Butylbenzene	0.5	--	9	--
tert-Butylbenzene	0.5	--	2	--
Analytical Method/Analyte	**Reporting Limit**	**USGS07T April 2000**	**USGS07T July 2000**	**USGS07T October 2000**
Trace Elements (Metals) by ICP - SW6010B (µg/L)				
Aluminum	500	--	1440 J	--
Barium	200	--	88 F	--
Calcium	500	--	106000	--
Iron	70	--	976	--
Magneseum	500	--	4830	--
Manganese	20	--	35 3	--
Potassium	5000	--	1000 F	--
Sodium	1000	--	29600	--
Chromium (SW7191) - (µg/L)				
Chromium (total)	5	--	1 8 F	--
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
Tetrachloroethene (PCE)	0.5	--	1	--
Analytical Method/Analyte	**Reporting Limit**	**W-153 April 2000**	**W-153 July 2000**	**W-153 October 2000**
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
1,1-Dichloroethane	0.4	0.5	0.4	ND
1,1-Dichloroethene	0.5	2	2 J	2
Chloroform	0 3	0.6	0 6	0.7
cis-1,2-Dichloroethene	0 5	100 [1]	110 [1]	87 [1,2]
trans-1,2-Dichloroethene	0.5	2	1	2
Tetrachloroethene (PCE)	0.5	5 J	5	5
Trichloroethene (TCE)	0.5	700 [1]	730 [1]	530 [1,2]
Trichlorofluoromethane	0 5	4	3	3

Table A.1 (continued)
Detected Analytical Results From 2000 Quarterly Sampling
NAS For Worth JRB

Analytical Method/Analyte	Reporting Limit	WHGLRW015 April 2000	WHGLRW015 July 2000	WHGLRW015 October 2000
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
cis-1,2-Dichloroethene	0.5	8	10	17
trans-1,2-Dichloroethene	0 5	ND	ND	0.6
Trichloroethene (TCE)	0.5	22	26	36
Analytical Method/Analyte	**Reporting Limit**	**WHGLRW017 April 2000**	**WHGLRW017 July 2000**	**WHGLRW017 October 2000**
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
Vinyl acetate	2	--	--	3
Analytical Method/Analyte	**Reporting Limit**	**WHGLTA011 April 2000**	**WHGLTA011 July 2000**	**WHGLTA011 October 2000**
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
Trichloroethene (TCE)	0.5	--	8	--
Analytical Method/Analyte	**Reporting Limit**	**WHGLTA025 April 2000**	**WHGLTA025 July 2000**	**WHGLTA025 October 2000**
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
cis-1,2-Dichloroethene	0 5	4	2	0.8
Trichloroethene (TCE)	0.5	14	7	4
Analytical Method/Analyte	**Reporting Limit**	**WITCTA004 April 2000**	**WITCTA004 July 2000**	**WITCTA004 October 2000**
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
1,1-Dichloroethene	0.5	--	1 J	--
cis-1,2-Dichloroethene	0.5	--	19	--
trans-1,2-Dichloroethene	0.5	--	0.8 J	--
Tetrachloroethene (PCE)	0.5	--	0.6	--
Trichloroethene (TCE)	0.5	--	180 [1]	--
Analytical Method/Analyte	**Reporting Limit**	**WITCTA010 April 2000**	**WITCTA010 July 2000**	**WITCTA010 October 2000**
Trace Elements (Metals) by ICP - SW6010B (µg/L)				
Arsenic	500	17.5 F	--	6.7 F
Barium	200	151 F	--	117 F
Calcium	500	93000	--	80600
Iron	70	9330	--	3040
Magneseum	500	11400	--	9570
Manganese	20	2070	--	865
Molybdenum	10	2.9 F	--	5.2 F
Potassium	5000	4380 F	--	5490
Sodium	1000	39700	--	31200

Table A.1 (continued)
Detected Analytical Results From 2000 Quarterly Sampling
NAS For Worth JRB

Analytical Method/Analyte	Reporting Limit	WITCTA010 April 2000	WITCTA010 July 2000	WITCTA010 October 2000
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
cis-1,2-Dichloroethene	0.5	2	1	0.6
Isopropylbenzene (cumene)	0.5	ND	0.6	1
trans-1,2-Dichloroethene	0.5	2	0 6	ND
Vinyl chloride	0.5	1	2	ND
n-proplybenzene	0.5	--	--	1
sec-Butylbenzene	0.5	--	--	0.8
n-Butlybenzene	0.5	--	--	1
Analytical Method/Analyte	**Reporting Limit**	**WITCTA017 April 2000**	**WITCTA017 July 2000**	**WITCTA017 October 2000**
Trace Elements (Metals) by ICP - SW6010B (µg/L)				
Barium	200	--	74.7 F	--
Calcium	500	--	122000	--
Iron	70	--	39 F	--
Magneseum	500	--	14600	--
Molybdenum	10	--	2.3 F	--
Potassium	5000	--	5060	--
Sodium	1000	--	35200	--
Analytical Method/Analyte	**Reporting Limit**	**WITCTA024 April 2000**	**WITCTA024 July 2000**	**WITCTA024 October 2000**
Alkalinity - E310.1 (mg/L)				
Alkalinity, Total (as CaCO3)	5	349	--	338
Methane, Ethane, and Ethene - RSK-175 (µg/L)				
Ethane	0.5	1.3	--	0.59
Ethene	0 5	0.51	--	0.65
Methane	0.5	590 [1]	--	1500 [1]
Volatile Organic Compounds by GC/MS - SW8260B (µg/L)				
tert-Butylbenzene	0.5	2	2	2
Vinyl chloride	0 5	2	3	4
Common Anions - SW9056 (mg/L)				
Chloride (as Cl)	0.2	122 J[1]	--	137 [1]
Sulfate (as SO4)	0.2	2.1 [1]	--	2.5
Total Organic Carbon - SW9060 (mg/L)				
Total Organic Carbon	1	2.4 [1]	--	2.4 [1]

Table A.1 (continued)
Detected Analytical Results From 2000 Quarterly Sampling
NAS For Worth JRB

Analytical Method/Analyte	Reporting Limit	WJETA535 April 2000	WJETA535 July 2000	WJETA535 October 2000
Alkalinity - E310.1 (mg/L)				
Alkalinity, Total (as CaCO3)	5	349 S	--	364 S
Methane, Ethane, and Ethene – RSK-175 (µg/L)				
Methane	0.5	ND	--	0.099 F
Trace Elements (Metals) by ICP - SW6010B (µg/L)				
Barium	200	--	129 F	--
Calcium	500	--	155000	--
Magneseum	500	--	6930	--
Potassium	5000	--	593 F	--
Sodium	1000	--	23300	--
Mercury in Liquid Waste - SW7470 (µg/L)				
Mercury	0.2	--	0.51	--
Common Anions - SW9056 (mg/L)				
Chloride (as Cl)	0.2	17.1	--	16.3 [1]
Nitrogen, Nitrate (as N)	0.1	2.3	--	2.3
Sulfate (as SO4)	0.2	46.4	--	45.2 [1]

Notes:
[1] Analytical results were taken from the reanalysis of this sample
[2] Field duplicate result of the parent sample was used
[3] Source. Jacobs

F - The analyte was positively identified, but the associated numerical value is below the PQL
J - The analyte was positively identified, the quantitation is an estimate
S - Screening analytical method
R - The datum was unusable due to serious deficiencies in the ability to meet QC criteria
ND - Not detected above the PQL
-- - Not analyzed

TABLE A.2

DETECTED ANALYTICAL RESULTS FROM 2000 SEMI-ANNUAL AFP 4 SAMPLING

Table A.2
Detected Analytical Results From 2000 Semi-Annual AFP 4 Sampling

Area	Well Identification	Date	Method	Analyte	Result (µg/L)
Air Force Plant 4 Terrace Alluvium Wells	F-218	April	SW6010	Chromium, Total	19
			SW8260B	*cis*-1,2-Dichloroethene	3,000
				Trichloroethene	19,000 J
		October	SW8260B	*cis*-1,2-Dichloroethene	2,000
				Trichloroethene	13,000
	HM-31	April	SW8260B	*cis*-1,2-Dichloroethene	99
				Trichloroethene	340 J
		October	SW8260B	*cis*-1,2-Dichloroethene	170
				trans-1,2-Dichloroethene	14
				Trichloroethene	500
	HM-36	April	SW8260B	*cis*-1,2-Dichloroethene	54
				trans-1,2-Dichloroethene	3.8
				Trichloroethene	31
		October	SW8260B	*cis*-1,2-Dichloroethene	55
				trans-1,2-Dichloroethene	4.5
				Trichloroethene	38 J
	HM-50	April	SW8260B	*cis*-1,2-Dichloroethene	130
				Trichloroethene	36
				Vinyl Chloride	21
		October	SW8260B	*cis*-1,2-Dichloroethene	780 [2]
				Trichloroethene	59 J [2]
				Vinyl Chloride	140
	HM-65	April	SW8260B	Trichloroethene	1 4 J
	HM-88	April	SW6010B	Chromium, Total	32
			SW8260B	*cis*-1,2-Dichloroethene	280 [1]
				trans-1,2-Dichloroethene	3 5
				Trichloroethene	7,200 [1]
		October	SW6010B	Chromium, Total	34
			SW8260B	*cis*-1,2-Dichloroethene	440
				Trichloroethene	5900
	HM-95	April	SW6010B	Chromium, Total	37
			SW8260B	*cis*-1,2-Dichloroethene	49
				Trichloroethene	260 [1]
		October	SW8260B	*cis*-1,2-Dichloroethene	150
				Trichloroethene	610 J
	HM-102	April	SW8260B	Trichloroethene	3 7 J

Table A.2 (continued)
Detected Analytical Results From 2000 Semi-Annual AFP 4 Sampling

Area	Well Identification	Date	Method	Analyte	Result (µg/L)
Air Force Plant 4 Terrace Alluvium Wells (con't)	HM-112	April	SW6010B	Chromium, Total	30
			SW8260B	*cis*-1,2-Dichloroethene	230
				Trichloroethene	4,600J
		October	SW6010B	Chromium, Total	25
			SW8260B	*cis*-1,2-Dichloroethene	220
				Trichloroethene	6900 J
	MW-5	April	SW8260B	Trichloroethene	550,000 J [1]
		October	SW8260B	Trichloroethene	820,000
	W-149	April	SW6010B	Chromium, Total	436
			SW8260B	*cis*-1,2-Dichloroethene	1,000
				trans-1,2-Dichloroethene	5 3
				Trichloroethene	11,000 [1]
	W-157	April	SW7471	Lead	101
NAS Fort Worth JRB Terrace Alluvium Wells	GMI-22-03M	April	SW8260B	*cis*-1,2-Dichloroethene	91
				trans-1,2-Dichloroethene	49
				Trichloroethene	98
		October	SW8260B	*cis*-1,2-Dichloroethene	150
				trans-1,2-Dichloroethene	99 [2]
				Trichloroethene	180
	HM-119	April	SW8260B	*cis*-1,2-Dichloroethene	1
				Trichloroethene	29 J
		October	SW8260B	Trichloroethene	20
	USGS06T	April	SW8260B	Trichloroethene	12 J
		October	SW8260B	Trichloroethene	17

Notes:
[1] Analytical results were taken from the reanalysis of this sample.
[2] Analytical results were taken from the associated field duplicate.

J - The analyte was positively identified, the quantitation is an estimate.
Analytical results were obtained from Jacobs Engineering Group, Inc.

TAB

APPENDIX B

APPENDIX B

MONITORING WELL DATA

TABLE B.1

GROUNDWATER ELEVATIONS FOR JULY 2000

Table B.1
Groundwater Elevations for July 2000

Monitoring Well	Coordinates		Top of Casing Elevation (ft. above msl)	Groundwater Elevation (ft. above msl)
	Easting	Northing		
15B	2301032.08	6963338.74	567.59	558.57
17I	2299626 67	6963642.66	578.13	565 32
17J	2299584.43	6963780.05	579.94	566.71
17K	2299799.21	6963578.34	575.47	564.21
17L	2299741.17	6963812.74	577.32	564 97
17M	2300037 62	6963761.95	574.28	563.59
BGSMW01	2299511.00	6964916.44	578.64	570.45
BGSMW02	2299618 19	6965006 79	577.57	565.21
BGSMW03	2299690.06	6965067.50	576.72	565.14
BGSMW04	2299589.50	6965084.53	578 49	565 55
BGSMW05	2299961.23	6965150 67	571.66	564.81
BGSMW06	2299910.09	6964981.31	576.51	565.12
BGSMW07	2299737.83	6964990.68	574.88	565.69
BSS-A	2300115.43	6965491 10	566.49	561.20
BLDG1040-1	2298699.62	6963528 01	604 27	585 40
FT08-11A	2295876.40	6962318 10	608.15	595.54
FT08-11B	2295928 50	6962030 90	608.05	595.93
FT09-12A	2295439.20	6960549.80	635.38	617.34
FT09-12B	2295697.40	6960709 30	627 36	593 60
FT09-12C	2295771 50	6960590 30	627.86	593.12
FT09-12D	2295743.4	6960887.6	627 26	593 82
FT09-12E	2295821.2	6960701.1	627.34	593.27
GMI-04-01M	2296728.53	6960930.74	613 71	--[1]
GMI-22-02M	2296187.40	6966632.90	619.13	607.92
GMI-22-03M	2298539 40	6966219.90	608.03	586.98
GMI-22-04M	2297340.50	6967250.50	610 70	590.23
GMI-22-05M	2299432.10	6966940.30	584.28	572.62
GMI-22-06M	2298186 60	6967004 50	606.84	587.89
GMI-22-07M	2298322 50	6969018 70	605 66	588.80
GMI-22-08M	2298971.50	6970323.60	606.94	589.12
HM-110	2293163 20	6963667 50	637.33	609.41
HM-111	2293265.66	6963623.55	636 49	606.70
HM-112	2293141.65	6964217 56	638.06	607.45
HM-114	2294352.00	6963912.10	627.77	607 80
HM-116	2294283.70	6966411.40	634.06	609 53
HM-117	2294274.30	6967355.40	633.32	609.83
HM-118	2294780.50	6968035.20	626.23	609 26
HM-119	2294271.80	6968726 00	625 04	609.97

Table B.1 (continued)
Groundwater Elevations for July 2000

Monitoring Well	Coordinates		Top of Casing Elevation (ft. above msl)	Groundwater Elevation (ft. above msl)
	Easting	Northing		
HM-120	2295343.20	6969489.00	616.84	610.00
HM-121	2295279.20	6967390.20	627.66	608 31
HM-123	2295272 60	6961638 50	624.85	595 95
HM-124	2295223.30	6963957 80	623.26	607.28
HM-125	2295220.29	6965893.46	629 37	609.22
HM-126	2294300.20	6963121.00	622 99	606.43
HM-127	2294853 30	6961588.50	624.04	596.97
ITMW-01T	2298967.14	6961062.05	602.77	588 34
LF01-1B	2301057.01	6964700.81	560.18	545 02
LF01-1D	2301412 72	6964288.18	563.91	544.12
LF01-1E	2301174.30	6964606 03	562.11	543.97
LF01-1F	2301376 05	6964438 04	562 26	543.67
LF03-3D	2293269.12	6962056 65	625.25	612 42
LF04-01	2295382 89	6961027.72	629.16	595.16
LF04-02	2296309.10	6961113 10	623.44	591 50
LF04-04	2297170.07	6960946 90	612.13	--[2]
LF04-10	2297078.90	6960411.80	626.47	591.12
LF04-4A	2295852.98	6960300 48	625.84	611 08
LF04-4B	2296274.34	6960323.91	619.95	599 75
LF04-4C	2296593.50	6960604.00	612.96	591.41
LF04-4D	2296416.39	6960831.59	615.13	591.72
LF04-4E	2296411.00	6961036 04	618 49	591 60
LF04-4F	2296058.77	6961061 85	625.28	592.78
LF04-4G	2296658.93	6961224.13	619.75	590.75
LF05-01	2294577.80	6962728 30	621.88	601.18
LF05-02	2295278.90	6962653.10	622.61	596.32
LF05-18	2297075.40	6961555.60	611.71	590 85
LF05-19	2297461.40	6961239.90	606.05	589 38
LF05-5A	2295580.90	6961438.56	623.00	595.19
LF05-5B	2296078.25	6961901.56	600.40	593.40
LF05-5C	2295993.73	6961720.05	608.56	594.36
LF05-5E	2295550.36	6961177.87	626.70	595 11
LF05-5G	2296536 32	6961581 32	615.28	591.51
LF05-5H	2296343.46	6961735 72	610.54	--[1]
LSA1628-1	2297802.10	6967936.20	601.67	590.81
LSA1628-2	2297846.50	6967943.30	601 93	590.64
LSA1628-3	2297791 26	6967993.08	601 73	590.71
LSA1628-14	2297896 92	6967908.30	601 60	590.22
LSA1628-15	2297860.79	6967862.87	601.35	590 24

Table B.1 (continued)
Groundwater Elevations for July 2000

Monitoring Well	Coordinates		Top of Casing Elevation (ft. above msl)	Groundwater Elevation (ft. above msl)
	Easting	Northing		
MW-10	2300541.58	6965836.20	558.85	544.02
MW-11	2300791.96	6965706 66	558.17	530.96
MW-11A	2297057.28	6965810 34	612.17	588.85
MW-12	2300142.02	6966149.32	559 62	549.36
MW-13	2295736.39	6961035.09	620 83	--[2]
MW-18	2295389 85	6963519.14	621 19	--[2]
MW-19	2295368.85	6963512.61	611.28	592.75
MW-2	2300555.92	6965704.96	557.55	545 51
MW-3	2299750.34	6965242.67	576 48	564.45
MW-36	2299356.66	6965034.80	604.11	599.06
MW-37	2299384.99	6965061.35	590.53	581.49
MW-38	2298153.08	6965981.09	604.11	587.60
MW-39	2298171 12	6965999.01	604 12	587.74
MW-40	2298224.98	6966053.10	604.16	587 44
MW-42	2298144.90	6966031 04	604.60	587 82
MW-5	2300138.61	6965803.45	563.69	558.77
MW-50	2295621.70	6968528 65	619.27	608.23
MW-51	2295639 96	6968536.47	619 36	608 25
MW-52	2296182.56	6964355.17	616.29	596.91
MW-53	2296200.24	6964378 18	616.75	599.97
MW-56	2296055 93	6968789.53	614.32	606 23
MW-57	2297112.98	6967217.16	613.37	601.01
MW-58	2297175.22	6966950.88	612 94	--[2]
MW-59	2297160.82	6966970.47	613.37	--[2]
MW-6	2300173.70	6965734.92	562.87	560.43
MW-7	2300055.24	6965967.11	567.37	558.63
MW-8	2300491.79	6965584.18	557.04	548 78
MW-9	2300329 17	6966001.96	559.54	548.56
MWMTAC-001	2296520.35	6959115.80	645.04	609.84
OT-15C	2300947.51	6963316.34	564.25	555.37
SAV-1	2300298 89	6965776.36	560 15	547 70
SAV-2	2300280.42	6965807.58	560.07	547.97
SD13-01	2300621.42	6963391.74	573.09	560.36
SD13-02	2300753.03	6963487 70	573.28	559.91
SD13-03	2300699.63	6963362.92	571.41	560 26
SD13-04	2300770.96	6963361 52	569.08	559 16
SD13-05	2300775 29	6963904.28	571 54	562.09
SD13-06	2300907.83	6963164.35	557.90	546.13
SD13-07	2301009.34	6963167.04	560.30	541.61

Table B.1 (continued)
Groundwater Elevations for July 2000

Monitoring Well	Coordinates		Top of Casing Elevation (ft. above msl)	Groundwater Elevation (ft. above msl)
	Easting	Northing		
SPOT35-1	2296878 53	6966202.40	613.59	590.30
SPOT35-3	2296850.62	6966108.75	612.02	591.06
SPOT35-4	2296777.88	6966174.92	612 74	591.19
SPOT35-5	2296846.73	6966020.04	614.09	591.16
SPOT35-6	2296634 63	6966234.61	615.68	591.62
SPOT35-7	2296508 59	6966534.79	616.41	607 94
SPOT35-8	2296970 16	6966428.55	613.55	590.16
SPOT35-9	2296780.62	6966581.53	614.96	591.88
ST14-01	2300090.80	6963295.30	575.95	561.92
ST14-02	2300091.70	6963511.60	575 51	562.76
ST14-03	2299891.60	6964080.00	576.68	565.81
ST14-04	2300345 30	6963642.70	575.61	562.58
ST14-24	2299084.20	6964017 89	594.14	582 81
ST14-25	2299065.36	6964563.76	592 94	586 46
ST14-27	2300212 35	6964257 94	573.85	564.43
ST14-28	2300495.99	6963728.32	574 45	562 40
ST14-29	2300512.78	6963527.79	571.45	561.48
ST14-30	2300466.18	6963211.53	566.87	560.51
ST14-W05	2299093.85	6963726 06	593.63	584 61
ST14-W06	2299330.79	6963806.56	581.42	568.91
ST14-W07	2299393 81	6963614 61	579.96	566.18
ST14-W08	2299479 59	6964323 98	580.54	568.75
ST14-W09	2299550.10	6963471.69	575.54	565.67
ST14-W10	2299730.13	6963949.34	573.99	565 78
ST14-W11	2299657 97	6964128 60	576.31	567.30
ST14-W12	2299581.06	6963953 27	575.52	567 91
ST14-W13	2299776.44	6963695 16	574 49	564.31
ST14-W15	2299923.11	6963315.79	573.47	562.41
ST14-W16	2300128.30	6964064.61	573.62	564.76
ST14-W18	2300162 47	6963906 73	573.79	564 33
ST14-W19	2300203 61	6963699.80	573 31	563 08
ST14-W20	2300275.36	6964009.08	573.48	563.77
ST14-W21	2300242.02	6963417.82	572 88	562.06
ST14-W22	2301016.39	6963649.64	571.30	560 79
ST14-W23	2300410.37	6962949.06	565.60	558.14
ST14-W31	2300830.86	6963549.67	571.23	560.38
ST14-W32	2300815.07	6963239.02	564.15	559.12
USGS03T	2300610.00	6968704.70	575.02	570.40
USGS04T	2299177.61	6968758.34	604.97	--[2]

Table B.1 (continued)
Groundwater Elevations for July 2000

Monitoring Well	Coordinates		Top of Casing Elevation (ft. above msl)	Groundwater Elevation (ft. above msl)
	Easting	Northing		
USGS06T	2297542 16	6963763.04	606 61	--[3]
USGS07T	2295246.50	6960182 50	632.43	620.54
W-153	2294096.20	6965106.30	631.57	609.14
WCHMHTA001	2293437.60	696528.17	639.08	609.20
WCHMHTA002	2294553 41	6966740.53	631.32	608.87
WCHMHTA003	2294774.14	6967153.88	631.00	608.57
WCHMHTA004	2294776.10	6967144.61	631 25	608 61
WCHMHTA005	2295397.82	6966691.19	626 95	608.04
WCHMHTA006	2295406.97	6966690.11	626.73	607 98
WCHMHTA007	2295645.39	6967105.89	623.93	607.74
WCHMHTA008	2295597.48	6967889 89	622 85	607.45
WCHMHTA009	2296395.01	6967635.29	615.55	607.37
WCHMHTA010	2296398.80	6967640 08	615.35	608.18
WCHMHTA011	2297063.01	6968490.51	605.80	592.36
WCHMHTA012	2297425.82	6967840.86	605 85	591.18
WCHMHTA013	2299786.18	6966251.26	578.26	561.01
WCHMHTA014	2294072 81	6970403.90	619.11	610 66
WHGLPU001	2296096.76	6961282.67	620 44	--[5]
WHGLWN002	2296645 31	6962607.06	591.74	--[5]
WHGLPU003	2295286.48	6961976 31	622.61	--[5]
WHGLPU004	2296655.89	6962601.66	591.41	--[5]
WHGLRW015	2298662.64	6960871.43	604.71	589.01
WHGLRW016	2299201.47	6961034.95	602 47	587.99
WHGLRW017	2299000 59	6960727.11	604.66	588 06
WHGLRW018	2298744 63	6960532.93	608 03	589.32
WHGLRW019	2298620.19	6960684 23	605.34	589.47
WHGLTA002	2296111.39	6962377.91	608.52	593.85
WHGLTA003	2298029.84	6961043.88	614.22	590.58
WHGLTA004	2295760.62	6962943.38	614.35	595.62
WHGLTA005	2301043.78	6963469.85	570.56	558 59
WHGLTA007	2301093.17	6963162.46	552 88	537.35
WHGLTA008	2300016 84	6963955 17	572 37	564.99
WHGLTA009	2297528.70	6965211.65	612.09	588.22
WHGLTA010	2296770.93	6965580.03	618.13	591 44
WHGLTA011	2295873.87	6968356.67	619.71	607.65
WHGLTA012	2297740.00	6965920.84	606.64	587 89
WHGLTA013	2297177.07	6965957.77	611.13	588.33
WHGLTA014	2297373 92	6966295 34	610.26	588.94
WHGLTA020	2299684.95	6962285 83	568.83	556.73

Table B.1 (continued)
Groundwater Elevations for July 2000

Monitoring Well	Coordinates		Top of Casing Elevation (ft. above msl)	Groundwater Elevation (ft. above msl)
	Easting	Northing		
WHGLTA022	2297691.54	6960401.65	614.95	591.05
WHGLTA023	2298565.43	6960492.16	608.42	590.04
WHGLTA025	2298942.63	6961608.26	601.37	584.82
WHGLTA026	2297200.73	6967204 01	612.14	591.08
WHGLTA027	6967173.21	2297196.85	612.00	591 05
WHGLTA028	2297450.94	6967760.51	605.76	591.47
WHGLTA029	2298574 35	6965736.08	603.13	--[2]
WHGLTA030	2299155.33	6964327.76	589.07	585.90
WHGLTA031	2299198.98	6964366.12	592.78	585.89
WHGLTA033	2295656 05	6964665.24	581.23	568 61
WHGLTA034	2301060.21	6963889.66	571.42	561 71
WHGLTA035	2301048 39	6963823 75	571.43	561.62
WHGLTA036	2300458 39	6966001.70	555 45	545.09
WHGLTA037	2300596.51	6965905.87	556.08	540.61
WHGLTA038	2300726.46	6965829.45	556.29	--[1]
WHGLTA039	2299277.71	6964408.76	590 21	569 80
WHGLTA040	2297196.85	6967173.21	611.96	--[5]
WHGLTA043	2297021.32	6961771.99	602.17	--[5]
WHGLTA044	2297347 37	6961721 40	582.93	--[5]
WHGLTA045	2298368.80	6961321.90	598.52	--[5]
WHGLTA046	2296089.68	6961298 49	620.04	--[5]
WHGLTA047	2296103.20	6961250.47	621.04	--[5]
WHGLTA048	2298714.83	6960916.20	604.89	--[5]
WHGLTA049	2299269 36	6962329 24	574.26	--[5]
WHGLTA050	2296420.09	6963013.36	599.08	--[5]
WHGLTA051	2296247.12	6962894.90	598 30	--[5]
WHGLTA052	2296098 07	6962769 45	597.00	--[5]
WHGLTA053	2295473.82	6960333.99	636.02	--[5]
WHGLTA054	2295541 09	6960748 26	631.26	--[5]
WHGLTA055	2295662.85	6960809.82	628.49	--[5]
WHGLTA056	2295827.62	6960787.36	627.48	--[5]
WHGLTA101	2301220.30	6964633.49	559 35	543 19
WHGLTA102	2301388.56	6964448.94	559.86	543.50
WHGLTA103	2301522.24	6964314.53	559 77	536.29
WHGLTA104	2301608.27	6964225.38	560.34	529 22
WHGLTA201	2298660.88	6963198.14	603.21	584.52
WHGLTA202	2298832 59	6963326.21	603.45	584.55
WHGLTA203	2298400.38	6963058.53	600.98	584.72

Table B.1 (continued)
Groundwater Elevations for July 2000

Monitoring Well	Coordinates		Top of Casing Elevation (ft. above msl)	Groundwater Elevation (ft. above msl)
	Easting	Northing		
WHGLTA204	2298104.66	6963625 62	605.57	587.58
WHGLTA302	2294422.27	6962602 64	621.70	606.72
WHGLTA303	2294400 77	6962351.21	622.77	600.47
WHGLTA601	2297473.69	6962697.81	599.92	585.28
WHGLTA602	2297625.01	6962752 66	600.00	584.65
WHGLTA603	2297727.19	6962713.38	600.92	584.28
WHGLTA604	2297530 02	6963195 39	607 43	587.93
WHGLTA701	2295332.86	6961835.73	623.08	596 24
WHGLTA702	2295882.07	6961920 16	609 41	595 43
WHGLTA703	2295741.23	6961680.70	615.07	595.75
WHGLTA704	2295831.51	6962141.07	602.54	589.95
WHGLTA705	2296026.58	6962002 86	599.32	593.61
WHGLTA706	2296030.82	6962146.24	607.65	593.96
WHGLTA707	2295592.35	6962188 16	620.61	--[5]
WHGLTA708	2295647.18	6962019.93	620.22	--[5]
WHGLTA709	2295750.93	6961934.71	619 54	--[5]
WHGLTA801	2295857.80	6962790.06	601.85	593 73
WHGLTA803	2296040.83	6962524.15	602.54	593.99
WHGLTA901	2299642.88	6967831 58	584.97	575.03
WHGLTA902	2299952 24	6967670 51	558.90	541.55
WHGLTA903	2300086 28	6967830 13	559.37	532.49
WHGLTA904	2300173.98	6968031 10	563.27	532.28
WHGLTA905	2299782.00	6967573.60	562.52	542.92
WHGLTA952	2299956 02	6967676 53	558.90	532.71
WHGLTA953	2300078 45	6967825 90	559.48	532.63
WHGLTA954	2300179.00	6968032 47	563 21	533.90
WITCTA001	2296447 95	6969591.17	609.82	--[4]
WITCTA002	2296135.48	6969258.49	613.36	609.19
WITCTA003	2297405.05	6969111 30	607.58	592.69
WITCTA004	2297490.47	6968938.83	606 62	592 59
WITCTA005	2298166.79	6968458 46	602.81	589.56
WITCTA006	2298261 86	6968425 94	602 76	589 38
WITCTA007	2298432.07	6968309.56	603.03	587.87
WITCTA008	2298030.12	6967939.66	600.62	591.41
WITCTA009	2298232.90	6967860 60	597.15	590.23
WITCTA010	2298752.18	6967693.53	600.31	585 01
WITCTA011	2297357.31	6967455.26	610.27	592 60
WITCTA012	2298224.39	6967348 77	599.93	589.09
WITCTA013	2297750 98	6967015 62	605.39	589.70

Table B.1 (continued)
Groundwater Elevations for July 2000

Monitoring Well	Coordinates		Top of Casing Elevation (ft. above msl)	Groundwater Elevation (ft. above msl)
	Easting	Northing		
WITCTA014	2297417.51	6966903.57	611.74	590.48
WITCTA015	2298395.02	6966332.67	606.84	588.41
WITCTA016	2298061 33	6966238.29	607 85	588.71
WITCTA017	2299305.78	6967298.15	592.94	583 58
WITCTA019	2298838 01	6963107.25	600.82	585.57
WITCTA020	2296316 79	6963895.32	616.78	594.46
WITCTA021	2298718.16	6963794.40	604.19	588.32
WITCTA022	2298742 85	6963649.92	604.17	586.45
WITCTA024	2298956.02	6965971.78	604 86	587.54
WITCTA025	2299534.28	6966004.92	595 20	584.26
WITCTA026	2299480.09	6965456 85	584.37	578.66
WITCTA027	2299510 86	6965193.74	581.44	569.72
WITCTA028	2300621.25	6965160.62	558.11	547.22
WITCTA031	2299152.20	6964689.93	592 10	587 64
WITCTA032	2299195 64	6964500.67	587 37	579.98
WITCTA033	2300475 24	6964323 67	574.06	564.46
WITCTA034	2300951 49	6963956.68	571.95	562.91
WITCTA035	2299093 68	6963387.12	599.37	585.49
WITCTA037	2297784.44	6963424.04	604.19	588.84
WITCTA039	2295415.41	6962339.77	619 47	597.72
WITCTA040	2299514 54	6963259 78	579.03	565 85
WITCTA041	2299642.10	6963168.75	577.97	563.24
WITCTA042	2299653 16	6963108.38	576.76	563.05
WITCTA043	2299724.86	6963110.05	576.72	563.07
WITCTA044	2299836.00	6963055.72	575.76	562 23
WITCTA045	2299047 02	6964832.18	590.24	--[5]
WITCTA046	2299062.19	6964719.30	590.07	586.30
WITCTA047	2299169.98	6964663.98	589.39	--[5]
WITCTA048	2299238.69	6964668.05	589.50	585.82
WITCTA057	2295952.51	6961308.78	624.74	594 46
WITCTA058	2296005.60	6961311 99	624.12	--[5]
WJETA530	2296533.87	6959546 93	639.39	602.97
WJETA534	2296341.54	6958941.15	647.38	613.87
WJETA535	2296794 44	6959722.27	634.61	599 87
WP07-10A	2295807.30	6961290.00	626.50	594.76
WP07-10B	2296040.40	6961277.50	624.22	592.63
WP07-10C	2296062.40	6961575.60	617.18	593 29
WSAICTA002	2294921.60	6964473.10	624.79	--[5]
WSAICTA003	2294630.40	6962921.10	621.14	--[5]

Table B.1 (continued)
Groundwater Elevations for July 2000

Monitoring Well	Coordinates		Top of Casing Elevation (ft. above msl)	Groundwater Elevation (ft. above msl)
	Easting	Northing		
WSAICTA004	2293586.30	6963343.80	628.40	--[5]
WSAICTA005	2293587.30	6963578.00	629.55	--[5]

Notes.
[1] Monitoring well is dry.
[2] Monitoring well was not found
[3] Groundwater elevation could not be measured; monitoring wells contains Jacobs dedicated pump.
[4] Monitoring well was damaged.
[5] Monitoring wells were installed after July 2000, and the data is unavailable

Elevations are reported in feet above mean sea level (ft above msl)
-- Groundwater Elevation could not be determined.

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TABLE B.2

WELL CONSTRUCTION INFORMATION

Table B.2
Well Construction Information

Monitoring Well	Well Stickup (ft.)	Total Depth (ft. bgs)	Total Depth (ft. below TOC)	Depth to Bedrock (ft. bgs)	Screened Interval (ft. TOC)	Filter Pack Interval (ft. bgs)	Seal Interval (ft. bgs)	Well Inside Diameter (in)
15B	3.95	7.43	11.38	9.00	5 95 - 10.95	3.0 - 9.0	2 0 - 3.0	2
17I	2.99	17.50	20.49	20 00	7 74 - 19.49	4.0 - 17.5	2 0 - 4 0	2
17J	2.79	20.20	22.99	20 50	10.24 - 21 99	5.5 - 20 2	3.5 - 5 5	2
17K	1 54	18 70	20.24	18 00	10.24 - 19 24	6.0 - 18 7	4.0 - 6.0	2
17L	2.87	20.20	23 07	20.00	10.32 - 22.07	5.5 - 20 2	3.5 - 5.5	2
17M	1.68	15.90	17.58	16.00	7.58 - 16.58	4.0 - 15.9	2.0 - 4.0	2
BGSMW01	-0.29	23.50	23.21	-	9 31 - 13.0	6.71 - 23 5	4.71 - 6.71	4
BGSMW02	-0.48	22.50	22.02	-	7 52 - 17.7	5.52 - 22.5	3.52 - 5.52	4
BGSMW03	-0.44	22 00	21.56	-	10 06 - 20.06	8.06 - 22.0	6 06 - 8 06	4
BGSMW04	-0.62	24 00	23.68	-	9.58 - 22.08	7.58 - 24 0	5.58 - 7.58	4
BGSMW05	-0.32	14.00	13.68	-	7 28 - 12.18	5.28 - 14 0	3.28 - 5 28	4
BGSMW06	-0.48	20.22	19.74	-	6 92 - 16.92	4 92 - 20.22	2 92 - 4.92	4
BGSMW07	-0 26	20.00	19.74	-	7 24 - 17.24	5.24 - 20.0	3 24 - 5.24	4
Bldg1040-1	-0.50	19 66	19.16	-	-	-	-	2
BSS-A	-0.38	11 00	10.62	10 50	5.0 - 10 0	4.0 - 11.0	2.0 - 4.0	2
FT08-11A	3.50	14 50	17.62	13 50	7.5 - 17 5	3.5 - 14.5	2.0 - 3.5	2
FT08-11B	4.55	15 00	19.34	14 00	3.5 - 13.5	3.0 - 15.0	2.0 - 3.0	2
FT09-12A	3 90	25 00	27.78	19.0	16.9 - 26 9	10.5 - 25.0	8 0 - 10.5	2
FT09-12B	2 03	40.00	41.95	38.5	29.53 - 39 43	26 0 - 40.0	24.0 - 26.0	2
FT09-12C	2.63	38.00	40.55	30.5	30 13 - 40 13	25.0 - 38 0	23.0 - 25.0	2
FT09-12D	2.65	35 40	38.05	NE	24.05 - 37.05	-	-	2
FT09-12E	2.98	38 50	41.48	40.0	24.0 - 27.5	-	-	2
GMI-04-01M	2.62	19 70	22.32	22.0	13.0 -23 0	11.0 - 23.3	9.5 - 11.0	2
GMI-22-02M	2.70	27 80	30.5	30.0	15.0 - 30 0	3.0 - 30.5	1.0 - 3 0	2
GMI-22-03M	2.37	32 50	34 87	19.0	14.37 - 34.37	10.5 - 32.5	8 5 - 10.5	2
GMI-22-04M	2.28	23.30	25 58	22.0	15 28 - 25 28	11.0 - 23 3	9 5 - 11 0	2
GMI-22-05M	2.78	11 00	13 78	11 0	8 28 - 13 28	3.5 - 11 0	2.0 - 3.5	2
GMI-22-06M	2.55	24 00	26.55	23 0	16.05 - 26 05	11.5 - 24 0	9.5 - 11.5	2
GMI-22-07M	2.75	20.50	23 25	19 0	12.75 - 22.75	8.5 - 20 5	6.5 - 8.5	2
GMI-22-08M	2.67	22.50	25.17	22 5	12.67 - 25.17	7.0 - 22.5	5.0 - 7.0	2
HM-110	-0.57	37.00	36.43	-	27.43 - 36.43	21.0 - 37 0	-	4
HM-111	-0.40	47 8	51.79	-	31 79 - 51.79	31.0 - 53 0	-	4
HM-112	-0 44	50 5	50 06	-	20 06 - 50.06	18.5 - 50 5	-	4
HM-114	-0 23	36 5	36.27	-	16 27 - 36.27	14.5 - 36.5	-	4
HM-116	-0 43	33	32 57	-	22 57 - 32 57	20 0 - 33 0	-	4
HM-117	-0.40	39.5	39 10	-	19 1 - 39 1	17.5 - 39.5	-	4

Table B.2 (continued)
Well Construction Information

Monitoring Well	Well Stickup (ft.)	Total Depth (ft. bgs)	Total Depth (ft. below TOC)	Depth to Bedrock (ft. bgs)	Screened Interval (ft. TOC)	Filter Pack Interval (ft. bgs)	Seal Interval (ft. bgs)	Well Inside Diameter (in)
HM-118	-0.30	27 03	27.00	-	7.0 - 27.0	7.0 - 27.0	-	4
HM-119	-0.24	32	31.76	-	11.76 - 31.76	10.0 - 32.0	-	4
HM-120	-0.54	18	17.46	-	7.46 - 17.46	7.0 - 18 0	-	4
HM-121	-0.33	31.37	31.04	-	11.17 - 31.17	9.5 - 31 5	-	4
HM-123	-1.21	40.5	40.09	-	20.09 - 40.09	36.5 - 40 5	-	4
HM-124	-0.22	25	24.78	-	9.78 - 24 78	7.0 - 25.0	-	4
HM-125	-0.35	33	32.65	-	12 65 - 32.65	11 0 - 33.0	-	4
HM-126	-0.49	37	36.51	-	16 51 - 36.51	12.0 - 37.0	-	4
HM-127	-0.32	38.5	38 18	-	18.18 - 38 18	34.5 - 38.5	-	4
ITMW-01T	-0.30	21.87	21 57	-	-	-	-	4
LF01-1B	-0 45	20 00	19.55	NE	9 0 - 19.0	8.0 - 20 0	5.5 - 8 0	2
LF01-1D	3.60	23.30	26.73	23.0	20.0 - 24.7	12 0 - 23.3	10.0 - 12.0	2
LF01-1E	2.85	29.60	32.45	NE	19.6 - 31 35	12.0 - 29.5	10.0 - 12.0	2
LF01-1F	-0.43	33.10	32.67	33.0	22.27 - 32.27	20.0 - 33.1	17.2 - 20.0	2
LF03-3D	3.65	15.40	19 05	15.5	11.15 - 18.05	5.5 - 15.5	3.5 - 5 5	2
LF04-01	2.74	40 00	42.74	40 0	32.69 - 42.44	28.0 - 40 10	26.0 - 28.0	2
LF04-02	2.68	37 65	40.33	37.0	25.78 - 40.13	20 9 - 37 7	18.9 - 20.9	2
LF04-04	2.72	25.20	27.92	25.0	17.87 - 27 6	13 2 - 25.2	11.2 - 13 2	2
LF04-10	-0 36	49.50	49.14	49 0	38 86 - 48.59	30.0 - 49.5	25.8 - 30.0	2
LF04-4A	1.19	24.00	25.19	18 0	15 19 - 25.19	10.5 - 24.0	8.0 - 10 5	2
LF04-4B	1.33	24 00	25.33	18 0	14.33 - 24.33	12.0 - 24 0	9.0 - 12.0	2
LF04-4C	2.30	29 50	31.80	28.0	20.8 - 30.8	16.0 - 29.5	14.0 - 16.0	2
LF04-4D	2.25	30 50	32.75	30.0	20.25 - 30.25	16.5 - 30.5	14.5 - 16.5	2
LF04-4E	1.10	35.00	36 10	33.7	16.1 - 36 1	23.9 - 35 0	21.0 - 23.9	2
LF04-4F	2.56	35.00	37.56	35.5	22.56 - 36.56	15.5 - 35 0	13.5 - 15.5	2
LF04-4G	0.92	36.00	36 92	39.5	21.92 - 35.92	19.0 - 36.0	17.0 - 19.0	2
LF05-01	2.66	25.00	27.66	25.0	17.61 - 27.36	11.8 - 25.2	9.8 - 11.8	2
LF05-02	2.39	27 00	29.39	27.0	19 34 - 29.09	15.0 - 27.2	14.95 - 16.95	2
LF05-18	-0.26	23 95	23.69	23.0	13.9 - 23.64	11.2 - 23.95	9.6 - 11.6	2
LF05-19	-0.22	20.75	20 53	20.0	10 03 - 19.78	8 15 - 20.75	5.60 - 8.15	3
LF05-5A	3.80	32 00	35.80	31.0	21.8 - 31.8	16.0 - 32.0	14.0 - 16.0	2
LF05-5B	3 30	9.00	12.30	8.0	7.3 - 12.3	3.5 - 9.0	2 0 - 3.5	2
LF05-5C	2.10	22.00	24.10	20 0	9 1 - 24.1	6 0 - 22.0	4.0 - 6 0	2
LF05-5E	2.99	39.10	42.09	NE	27.09 - 41 09	21.5 - 39 1	19.5 - 21.5	2
LF05-5G	3.39	27.00	30.39	29.0	17.64 - 29 39	11.0 - 27.0	9 0 - 11.0	2
LF05-5H	2.03	25.60	27 63	25.0	15.07 - 25.82	8.0 - 25 6	6.0 - 8.0	2
LSA1628-1	-0.76	20.00	19 24	16.0	7.9 - 17.9	6.66 - 20.0	4.66 - 6.66	4

Table B.2 (continued)
Well Construction Information

Monitoring Well	Well Stickup (ft.)	Total Depth (ft. bgs)	Total Depth (ft. below TOC)	Depth to Bedrock (ft. bgs)	Screened Interval (ft. TOC)	Filter Pack Interval (ft. bgs)	Seal Interval (ft. bgs)	Well Inside Diameter (in)
LSA1628-2	-0.33	20.00	19.67	18.0	9.67 - 19.67	8.0 - 20.0	6.0 - 8.0	4
LSA1628-3	-0.92	18.50	17.58	16.5	7.58 - 17.58	6.5 - 18.5	4.5 - 6.5	4
LSA 1628-14	-0.25	15 85	15.60	NE	6 0 - 16.5	4.0 - 17.0	1.0 - 4.0	2
LSA 1628-15	-0.25	16.90	16.65	NE	6 0 - 16.5	5.0 - 17.0	1.0 - 5.0	2
MW-10	-0.68	32.00	31.32	NE	11.32 - 31.32	10.0 - 36.6	8 0 - 10.0	4
MW-11	-0.73	38 00	37.27	NE	12.2 - 32.2	11.0 - 32 6	9.0 - 11.0	4
MW-11A	-0.15	26.2	26.05	-	-	-	-	4
MW-12	-0.76	28 00	27.24	NE	6.94 - 26.94	5 5 - 28.0	3.5 - 5.5	4
MW-13	-0 35	19.79	19.44	-	-	-	-	4
MW-18	-0 70	20 36	19.66	-	-	-	-	4
MW-19	-0.6	20.2	19.6	-	-	-	-	4
MW-2	-0.49	49.39	48 90	48.0				4
MW-3	-0.20	20.02	19.82	20.0	9.8 - 19.8	7.0 - 20.5	4.5 - 7.0	4
MW-36	-0.29	19.99	19.7	-	-	-	-	4
MW-37	-0.33	20 06	19.73	-	-	-	-	4
MW-38	-0.30	19 88	19.58	-	-	-	-	4
MW-39	-0.35	19.40	19.05	-	-	-	-	4
MW-40	-0.20	19.75	19.55	-	-	-	-	4
MW-42	-0.30	19.66	19.36	-	-	-	-	4
MW-5	1.58	6.42	8.00	-	3.5 - 11.0	2.0 - 11.0	1 0 - 2.0	4
MW-50	-0.30	14.69	14.39	-	-	-	-	4
MW-51	-0.35	15.45	15.1	-	-	-	-	4
MW-52	-0.35	19.65	19.3	-	-	-	-	4
MW-53	-0.50	20.04	19 54	-	-	-	-	4
MW-56	-0.24	19.51	19 27	-	-	-	-	4
MW-57	-0.45	14.75	14 30	-	-	-	-	4
MW-58	-0 60	20.27	19 67	-	-	-	-	4
MW-59	-0 45	20.05	19 60	-	-	-	-	4
MW-6	-0.42	10.36	9.94	-	-	-	-	4
MW-7	-0.41	17.00	16 59	11.0	6 13 - 16.13	4.0 - 17.0	2 0 - 4 0	4
MW-8	-0.79	27.00	26 21	NE	6 0 - 26 0	4.0 - 27.0	2.0 - 4.0	4
MW-9	-0 14	29.00	28 86	NE	8 1 - 28.1	6.0 - 29.0	4.0 - 6.0	4
MWMTAC-001	-0.11	43.95	43.84	-	-	-	-	2
OT-15C	3.70	12.00	15 78	9.0	8.7 - 13.7	4.5 - 12.0	3.0 - 4.5	2
SAV-1	-1 11	20.00	18.89	-	6 39 - 18.89	5.5 - 7.5	2.5 - 5.5	4
SAV-2	-1.15	20.00	18 85	-	5 85 - 18 35	5.0 - 7.0	2 0 - 5.0	4
SD13-01	2.94	14.50	17.44	14.5	10.06 - 17.26	5.0 - 14.6	2.9 - 5.0	2

631 133

Table B.2 (continued)
Well Construction Information

Monitoring Well	Well Stickup (ft.)	Total Depth (ft. bgs)	Total Depth (ft. below TOC)	Depth to Bedrock (ft. bgs)	Screened Interval (ft. TOC)	Filter Pack Interval (ft. bgs)	Seal Interval (ft. bgs)	Well Inside Diameter (in)
SD13-02	2.64	14.20	16.84	14 0	12.14 - 16.14	7.4 - 14 2	5.1 - 7.4	2
SD13-03	2.94	14.10	17.04	13.5	10.02 - 16.79	5.0 - 14.1	2.7 - 5.0	2
SD13-04	2.76	10.50	13.26	-	3.26 - 13.26	-	-	2
SD13-05	-0.19	13.93	13 74	NE	3.86 - 13.53	1.73 - 13.93	0.41 - 1.73	4
SD13-06	2.06	11.36	13.42	6 9	8.09 - 12.3	2.37 - 11.36	0.15 - 2.37	4
SD13-07	1.78	19.13	20.98	13.0	10.85 - 20.57	6.97 - 19.13	4.97 - 6 97	4
SPOT35-1	-0.92	27.50	26.58	NE	9.82 - 27.32	10 0 - 27.5	8.0 - 10 0	2
SPOT35-3	-0 66	25.00	24 44	NE	6 34 - 24.34	7 0 - 25.0	5.0 - 7.0	2
SPOT35-4	-0.96	26 30	25 34	NE	14.3 - 24.3	12.5 - 27.6	8.7 - 12 5	4
SPOT35-5	-0.15	27.50	27.35	28.3	16 45 - 26 45	13 0 - 28 3	10.0 - 13.0	4
SPOT35-6	-0.35	28 35	28	29.1	18.0 - 28.0	15.0 - 30.0	12.0 - 15.0	4
SPOT35-7	-0 04	20.6	20 3	28.2	5.0 - 20 0	4.0 - 22.0	2 0 - 4.0	4
SPOT35-8	-0.16	26.4	26 24	28 5	15 8 - 25.8	13 0 - 28.6	10.0 - 13 0	4
SPOT35-9	-0.40	28 9	28 50	29	18.3 - 28.3	14.5 - 30.0	11.5 - 14.5	4
ST14-01	2.69	18.40	21.09	18 20	11 14 - 20.89	6.5 - 18.8	4.5 - 6.5	2
ST14-02	2.94	17 10	20.04	17.10	9.99 - 19.74	5.0 - 17.5	2.7 - 5.0	2
ST14-03	1.85	17.90	19.78	18.20	9.7 - 19 5	5.8 - 18.3	3.5 - 5.8	2
ST14-04	2.71	16.50	19.22	16.50	9.16 - 18 86	4.3 - 17.0	2.3 - 4.3	2
ST14-24	-0.30	17 30	17 0	11 0	6.6 - 16.6	-	-	2
ST14-25	-0.65	17.00	16 35	15.0	6.35 - 17.35	-	-	2
ST14-27	-1.19	17.00	15.81	17.0	4.81 - 14.81	-	-	2
ST14-28	-0.44	17.00	16.66	16.0	7.0 - 17.0	-	-	2
ST14-29	-0.3	16.00	15.7	15.0	5.7 - 15 7	-	-	2
ST14-30	-0.44	14 50	14.06	12 5	7 0 - 14.0	-	-	2
ST14-W05	-0.14	16.60	16.46	15 0	6.59 - 15 49	4.0 - 16.6	2.0 - 4 0	2
ST14-W06	-0.26	27 00	26 74	27.0	6.99 - 25.89	5 0 - 27.0	3.0 - 5.0	2
ST14-W07	-0.07	26.00	25.93	25.7	5.99 - 24.89	4 0 - 26 0	1.8 - 4.0	2
ST14-W08	-0.30	26.00	25.70	NE	8 19 - 24.89	6.0 - 26 0	4.0 - 6 0	2
ST14-W09	-0.27	22.00	21.73	NE	7.04 - 20.85	5.0 - 22.0	3 0 - 5.0	2
ST14-W10	-0.04	21.00	20.96	21.0	6 04 - 19.89	4.0 - 21.0	2.0 - 4.0	2
ST14-W11	-0.09	21 00	20 91	21 0	6 04 - 19.89	4.0 - 21.0	2 0 - 4.0	2
ST14-W12	-0 17	19 00	18 83	19.0	6.19 - 17.89	4.0 - 19.0	2.0 - 4.0	2
ST14-W13	-0 16	19.00	18 84	NE	6.19 - 17 89	4.0 - 19.0	1.8 - 4.0	2
ST14-W15	-0 36	19.40	19.04	19.0	6.19 - 17 89	4.0 - 19.4	2 0 - 4.0	2
ST14-W16	-0.37	20 00	19 63	20 0	7.19 - 18.89	5 0 - 20 0	3.0 - 5.0	2
ST14-W18	-0.26	17 00	16.74	17.0	4.19 - 15.89	3 0 - 17 0	1.0 - 3.0	2
ST14-W19	-0.77	17.00	16.23	17.0	6.99 - 15.89	5 0 - 17 0	3.0 - 5.0	2

Table B.2 (continued)
Well Construction Information

Monitoring Well	Well Stickup (ft.)	Total Depth (ft. bgs)	Total Depth (ft. below TOC)	Depth to Bedrock (ft. bgs)	Screened Interval (ft. TOC)	Filter Pack Interval (ft. bgs)	Seal Interval (ft. bgs)	Well Inside Diameter (in)
ST14-W20	-0.032	17.00	16.68	17.0	6.99 - 16 44	4.0 - 17.0	2 0 - 4.0	2
ST14-W21	-0.15	18.00	17.85	18.0	7.99 - 16.89	6 0 - 18.0	4 0 - 6.0	2
ST14-W22	-0.25	15.40	15.15	15.0	7 59 - 14.44	5 0 - 15.4	3 0 - 5.0	2
ST14-W23	-0.14	10.50	10.36	NE	5.54 - 9 54	3.0 - 10.5	1.0 - 3.0	2
ST14-W31	-0.28	14.5	14.22	13 5	9.0 - 14.0	-	-	2
ST14-W32	2.74	9.50	12 24	5.3	5.74 - 11.74	-	-	2
USGS03T[1]	-0.77	8.5	7.73	8 0	4.73 - 7.23	6.5 - 8.5	2.0 - 4.0	2
USGS04T[1]	-0.24	26	25.76	26.5	15.5 - 25.5	14.0 - 26.0	10 0 - 12.0	2
USGS06T[1]	-0.40	22.5	22.10	21.0	14.88 - 24.88	8.5 - 22.5	6 0 - 8.0	2
USGS07T[1]	-1.34	16.5	15.16	16.0	10.16 - 15.16	6 5 - 16.5	4 0 - 6.0	2
W-153	-0.13	39.40	39.27	-	29.77 - 39.27	-	25.0 - 27.0	2
WCHMHTA001	-0.49	46.47	45.98	-	25.51 - 45.51	-	-	2
WCHMHTA002	-0.51	42 91	42.40	-	21.49 - 41.49	-	-	2
WCHMHTA003	-0.69	29 34	28.65	-	17.31 - 27.31	-	-	2
WCHMHTA004	-0.43	38.27	37.84	-	27.57 - 37.57	-	-	2
WCHMHTA005	-0.44	27.19	26.75	-	15.56 - 25.56	-	-	2
WCHMHTA006	-0.49	36 98	36 49	-	26.01 - 36.01	-	-	2
WCHMHTA007	-0.61	33.06	32 45	-	11.89 - 31.89	-	-	2
WCHMHTA008	-0.30	25.00	24.70	-	9.7 - 24 7	-	-	2
WCHMHTA009	-0.18	12.00	11.82	-	4.32 - 11.82	-	-	2
WCHMHTA010	-0.39	25.00	24.61	-	14.61 - 24 61	-	-	2
WCHMHTA011	-0.52	22.00	21.48	-	11.48 - 21 48	-	-	2
WCHMHTA012	-0.33	19.42	19.09	-	8.17 - 18.7	-	-	2
WCHMHTA013	-0.50	19.31	18.81	-	13 0 - 18 0	-	-	2
WCHMHTA014	-0.32	12.50	12.18	-	7.18 - 12.18	-	-	2
WHGLPU001	-0.07	90.5	90.43	135	74 2 - 89.2	70.8 - 90.5	69.0 - 70.8	2
WHGLWN002	-0.10	32.0	31.9	8	13.05 - 28.25	12.0 - 32.0	10.25 - 12.0	2
WHGLPU003	0.12	90.0	89.88	34 5	74.7 - 89.7	71.0 - 90.0	69.0 - 71.0	2
WHGLPU004	-0.17	51.0	50.83	51.0	35.0 - 50.0	32 0 - 51.0	30.0 - 32.0	2
WHGLRW015	-0.58	24.00	23.42	24	13.5 - 23.5	10.7 - 24.0	8.8 - 10.7	4
WHGLRW016	-0.50	23 00	22 50	23.7	12.5 - 22.5	10 0 - 23.0	8.0 - 10.0	4
WHGLRW017	-0.40	25.00	24 60	25	13.9 - 23.9	12 0 - 25.0	10.0 - 12.0	4
WHGLRW018	-0.20	28.00	27.80	28	12 5 - 27.5	10.0 - 28.0	8.0 - 10.0	4
WHGLRW019	-0.23	24.00	23.77	24	8.0 - 18.0	6.0 - 24 0	4 0 - 6.0	4
WHGLTA002	-0.20	20.00	19.80	20.0	9 8 - 19 8	8.0 - 21.0	6.0 - 8 0	2
WHGLTA003	-0.25	30.00	29.75	30	19.75 - 29 75	18.0 - 20.0	16.0 - 18.0	2
WHGLTA004	-0.20	23.50	23.30	24.0	13 3 - 23.3	11.5 - 24.0	9.5 - 11.5	2

Table B.2 (continued)
Well Construction Information

Monitoring Well	Well Stickup (ft.)	Total Depth (ft. bgs)	Total Depth (ft. below TOC)	Depth to Bedrock (ft. bgs)	Screened Interval (ft. TOC)	Filter Pack Interval (ft. bgs)	Seal Interval (ft. bgs)	Well Inside Diameter (in)
WHGLTA005	2.98	14.5	17.48	-	5 48 - 15 48	1 5 - 14 5	0.5 - 1.5	2
WHGLTA007	-0.40	31.00	30.60	-	15.0 - 30.0	10 5 - 31 0	8.5 - 10.5	2
WHGLTA008	-0.38	15.50	15.12	-	5.0 - 15.0	3.0 - 15.5	1.0 - 3.0	2
WHGLTA009	2.75	26.00	28 75	-	17.75 - 27.75	12.0 - 26.0	10.0 - 12.0	2
WHGLTA010	2.26	28.50	30 76	-	20.5 - 30.5	15 0 - 28.5	12.5 - 15.0	2
WHGLTA011	1.94	16.00	17 94	-	5.43 - 16.93	2.0 - 16 0	1.0 - 2 0	2
WHGLTA012	-0.60	25.00	24.40	-	13 1 - 23.1	12.0 - 25 0	3.0 - 12.0	2
WHGLTA013	-0.55	27.30	26 75	-	16.45 - 26.45	17.0 - 27.3	2.0 - 17.0	2
WHGLTA014	-0.20	26.00	25.80	-	14.8 - 24 8	13.0 - 26.0	4.0 - 13.0	2
WHGLTA020	-0.32	16 00	15.68	16	5 0 - 15.0	3.0 - 16.0	1.0 - 3.0	2
WHGLTA022	-0 24	32.00	31.76	32	16.5 - 26 5	15.0 - 32.0	13 0 - 15 0	2
WHGLTA023	-0.45	29.00	28.55	29	8.5 - 18.5	7 0 - 29.0	5.0 - 7.0	2
WHGLTA025	-0.34	21.00	20 66	20.4	10 5 - 20.5	8.5 - 21.0	6.0 - 8.5	2
WHGLTA026	-0.47	28.00	27 53	28	18 0 - 28.0	16.0 - 28.0	3.0 - 7 0	2
WHGLTA027	-0 33	18.50	18.17	18.5	8.5 - 18 5	6.5 - 18.5	4.5 - 6.5	2
WHGLTA028	-0.36	19 00	18.64	NE	9.0 - 19 0	7 - 19	5.0 - 7.0	2
WHGLTA029	-0.27	21.00	20.73	NE	11.0 - 21.0	9.0 - 21 0	7.0 - 9.0	2
WHGLTA030	-0.48	15.00	14 52	14	5.0 - 15.0	4.0 - 15.0	2 0 - 4.0	2
WHGLTA031	-0.52	11.00	10.48	13	6.0 -11 0	4.0 - 11.0	2 0 - 4.0	2
WHGLTA033	-0 52	28 00	27.48	13.5	13.0 - 28.0	11.0 - 28.0	9 0 - 11.0	2
WHGLTA034	-0.71	15.00	14.29	15	5.0 - 15.0	3.0 - 15.0	1.0 - 3.0	2
WHGLTA035	-0.39	15.00	14.61	15.3	5.0 - 15 0	3.0 - 15.0	1.0 - 3.0	2
WHGLTA036	-0 52	24.50	23 98	24	14 0 - 24.5	12.0 - 24.5	10.25 - 12.0	4
WHGLTA037	-0 43	24 50	24.07	24	14 0 - 24.0	12 0 - 25.0	10.25 - 12 0	4
WHGLTA038	-0.41	26 5	26.09	26.5	16.0 - 26.0	14.0 - 28.0	12.0 - 14 0	4
WHGLTA039	-0 53	25.5	24.97	25.5	15.5 - 25.5	13.5 - 25.5	11.5 - 13.5	2
WHGLTA040	-0 37	26.7	26.33	NE	16.7 – 26.7	14.2 – 26.8	12.0 – 14.2	2
WHGLTA043	-0.30	14.0	13.7	12 0	8.5 - 14 0	6.5 - 14.0	4.5 - 6.5	2
WHGLTA044	-0.06	9 0	8.94	8 1	3.5 - 8.5	2.5 - 9.0	0.0 - 2.5	2
WHGLTA045	-0.10	16.1	16.0	14.8	5.6 - 15 6	4.0 - 16.1	2.0 - 4.0	2
WHGLTA046	-0 18	36.0	35.82	36.7	20.5 – 35.5	19 0 – 36.7	17 - 19	4
WHGLTA047	-0.12	36 1	35.98	36 5	25.6 – 35.6	23.5 – 36.5	20.5 – 23 5	2
WHGLTA048	-0 26	25 3	25 04	25.3	15.0 - 25.0	13.0 - 25.5	10.5 - 13 0	2
WHGLTA049	-0.02	26.8	26 78	26.8	16 7 - 26 7	14.2 - 26 8	12.0 - 14.2	2
WHGLTA050	-0.11	7.0	6.89	7	2.0 – 7 0	1.5 – 7.2	0.5 – 1.5	2
WHGLTA051	-0.07	7.0	6.93	7	2.0 - 7 0	1.5 - 7.2	0.5 - 1.5	2
WHGLTA052	-0.12	7 0	6.88	7	2.0 – 7.0	1.5 – 7.2	0.5 – 1.5	2

Table B.2 (continued)
Well Construction Information

Monitoring Well	Well Stickup (ft.)	Total Depth (ft. bgs)	Total Depth (ft. below TOC)	Depth to Bedrock (ft. bgs)	Screened Interval (ft. TOC)	Filter Pack Interval (ft. bgs)	Seal Interval (ft. bgs)	Well Inside Diameter (in)
WHGLTA053	3.20	27.0	30.20	27.0	12.0 – 27 0	10 0 – 27.0	1.0 – 10.0	2
WHGLTA054	3.52	36.5	40.02	36.50	26.5 – 36 5	24 0 – 36.5	1.0 – 24.0	2
WHGLTA055	3.21	38.0	41.21	38.0	28.0 – 38 0	26.0 – 38.0	2 0 – 26.0	2
WHGLTA056	3.55	38.0	41 55	38.0	22.0 – 37.0	20.0 – 38 0	2.0 – 20.0	2
WHGLTA101	-0.40	35	34 6	35.0	20.0 – 35.0	18.0 - 50	4.0 - 18.0	4
WHGLTA102	-0.40	37	36.6	37 0	22.0 – 37.0	20 0 - 54	2.0 - 20.0	4
WHGLTA103	-0.40	45	44.6	45	24.7 - 44 7	23.0 -45.0	2.0 - 23.0	4
WHGLTA104	-0.45	44	43.55	NE	28 5 - 43.5	25.0 - 44.0	23.0 - 25.0	4
WHGLTA201	-0 30	22.5	22 2	-	7.2 - 22.2	4.0 - 22.5	2.0 - 4.0	2
WHGLTA202	-0.25	22	21.75	-	6 75 - 21.75	5.0 - 22 0	3.0 - 5.0	2
WHGLTA203	-0.40	18	17 6	-	7.6 - 17.6	6.0 - 18 0	4.0 - 6.0	2
WHGLTA204	-0.42	26.5	26.08	-	13.98 - 23.98	11.0 - 26.5	2 5 - 11 0	2
WHGLTA302	2.89	20	22.89	-	12.89 - 22.89	8.0 - 20.0	6 0 - 8.0	2
WHGLTA303	2.95	20	22.95	-	15.45 - 22.95	9.0 - 20.0	7.0 - 9.0	2
WHGLTA601	-0.24	18.2	17 96	-	7.76 - 17.76	50 - 19.0	3.0 - 5.0	2
WHGLTA602	-0.22	19	18.78	-	3.78 - 18.78	2.0 - 19 0	0 - 2.0	2
WHGLTA603	2 27	18	20 27	-	8 - 18	5 - 18	3 - 5	2
WHGLTA604	-0.22	24	23.78	-	9 0 - 24.0	6.0 - 24.0	4.0 - 6.0	2
WHGLTA701	-0.23	36	35.77	-	19 77 - 34 77	18.0 - 36.0	15.0 - 18.0	2
WHGLTA702	3.17	18.5	21.67	-	11.17 - 21.17	6 0 - 18 5	3.5 - 6.0	2
WHGLTA703	2.55	29.5	32.05	-	8.55 - 28.55	4.0 - 29.5	2.0 - 4.0	2
WHGLTA704	2.32	18.5	20.82	-	8.02 - 20.52	4.0 - 18.5	2.0 - 4.0	2
WHGLTA705	-0.53	11.2	10.67	NE	5.8 - 10.8	3.8 - 11.2	1.5 - 3.8	2
WHGLTA706	-0.56	18.5	17.94	18.5	8.5 - 18.5	6.5 - 18.5	4.5 - 6.5	2
WHGLTA707	3.13	27.0	30.13	27.0	17.0 – 27.0	15.5 – 27.0	2.0 – 15.5	2
WHGLTA708	2.90	34.0	36.90	34	17.0 – 27 0	15.0 – 34.0	3.0 – 15.0	2
WHGLTA709	3.44	28.0	31.44	28.0	17.0 – 27.0	14.0 – 28.0	3.0 – 14.0	2
WHGLTA801	0.02	14.5	14.52	14.5	4.0 - 14.0	3.5 - 14.0	2.0 - 3.5	2
WHGLTA803	0.11	12.0	12 11	10 5	7 0 - 12.0	5.0 - 12.5	3 0 - 5.0	2
WHGLTA901	3.30	17.5	20 80	6	7.5 - 17.5	6.0 - 20	4.0 - 6.0	2
WHGLTA902	3.15	30	33.15	NE	15.0 - 30 0	13.0 - 30 0	2 0 - 13.0	2
WHGLTA903	2 97	41	43.97	NE	20.7 - 40.7	18.0 - 41	2.0 - 18.0	2
WHGLTA904	2 98	35	37.98	-	19 7 - 34.7	18.0 - 35	2.0 - 18.0	2
WHGLTA905	2.97	29	31.97	26 5	11 5 - 26.5	10.0 - 29.0	7.0 - 10.0	2
WHGLTA952	3.12	55	58.12	NE	43.3 - 53 3	41.0 - 55.0	38 5 - 41.0	2
WHGLTA953	2.70	55	57 7	52.5	43.5 - 53 5	41 5 - 55 0	40.0 - 41.5	2
WHGLTA954	2.80	54	56.80	NE	33.7 - 53.7	2.0 - 31.0	2 0 - 31	2

Table B.2 (continued)
Well Construction Information

Monitoring Well	Well Stickup (ft.)	Total Depth (ft. bgs)	Total Depth (ft. below TOC)	Depth to Bedrock (ft. bgs)	Screened Interval (ft. TOC)	Filter Pack Interval (ft. bgs)	Seal Interval (ft. bgs)	Well Inside Diameter (in)
WITCTA001	-0.44	22.00	21.56	NE	9.23 - 21.48	7.5 - 22 0	5.5 - 7.5	2
WITCTA002	-0.47	8.00	7.53	7.0	2.53 - 7.28	2.5 - 8.0	1.0 - 2.5	2
WITCTA003	-0.53	24.00	23.47	NE	13.47 - 23.22	12.0 - 24.0	7.0 - 12 0	2
WITCTA004	-0 35	19.00	18.65	NE	10 95 - 18.2	9.5 - 18.8	7 5 - 9.5	2
WITCTA005	-0 34	19.40	19.06	NE	11 56 - 18.81	9.5 - 19 4	7.5 - 9.5	2
WITCTA006	-0 25	19.00	18.75	NE	11 05 - 18.3	9 5 - 18.8	7.5 - 9.5	2
WITCTA007	2.97	22.50	25.47	-	15 47 - 25.22	10 5 - 22.5	8.5 - 10.5	2
WITCTA008	2.16	14.24	16.40	NE	8.91 - 16.16	5 5 - 14.25	1.0 - 5.5	2
WITCTA009	-0.59	13 50	12.91	-	2.91 - 12 66	2.6 - 13.5	1.6 - 2.6	2
WITCTA010	-0.43	19.00	18.57	-	10.97 - 18.22	9.0 - 18.9	7.0 - 9.0	2
WITCTA011	-0.64	23.00	22.36	NE	12 36 - 22.11	11 0 - 23.0	9.0 - 11 0	2
WITCTA012	-0 62	17.70	17.08	-	7.08 - 16.83	5.7 - 17.7	3.7 - 5.7	2
WITCTA013	-0.55	22.00	21.45	-	11.45 - 21.2	10.0 - 22.0	8.0 - 10.0	2
WITCTA014	-0.18	25 00	24.82	NE	14.82 - 24.57	13.0 - 25.0	11.0 - 13.0	2
WITCTA015	-0.29	26.70	26.41	-	16.41 - 26.16	14.7 - 26 7	12 7 - 14.7	2
WITCTA016	-0.38	28 00	27 62	NE	12 62 - 27.37	11.0 - 28.0	9.0 - 11.0	2
WITCTA017	-0.10	14.00	13.90	-	6.5 - 13.75	5.0 - 14.0	3.0 - 5.0	2
WITCTA019	-0.21	19 90	19.69	NE	9.69 - 19.44	7.9 - 19.9	5 9 - 7.9	2
WITCTA020	-0.06	26.00	25.94	-	20.74 - 25.44	19 0 - 25.8	17.0 - 19.0	2
WITCTA021	-0.60	25.00	24.40	NE	14.0 - 23.75	12.6 - 24 6	10.6 - 12.6	2
WITCTA022	-0.88	24 40	23.52	22.8	13 52 - 23.27	11.5 - 24.4	9.5 - 11.5	2
WITCTA024	-0 47	23.70	23.23	-	12.76 - 22.51	11.7 - 23.7	9.7 - 11.7	2
WITCTA025	-1.51	12 00	10.49	-	5.49 - 10.24	5.0 - 12 0	3.0 - 5.0	2
WITCTA026	-0 15	10.00	9.85	-	4.85 - 9 6	4.0 - 10.0	2.0 - 4.0	2
WITCTA027	-0 30	23.00	22.70	NE	7.7 - 22.45	6.0 - 23.0	4.0 - 6 0	2
WITCTA028	-0.16	15 00	14.84	-	4.84 - 14.59	4 0 - 15.0	2.0 - 4.0	2
WITCTA031	-0.66	7 00	6.34	7.5	3.79 - 6.04	3 0 - 7.0	1 0 - 3.0	2
WITCTA032	-0 36	13.00	12.64	-	5.14 - 12.39	4.0 - 13 0	2.0 - 4.0	2
WITCTA033	-0.57	15 00	14.43	-	9 43 - 14.18	8.0 - 15.0	6 0 - 8.0	2
WITCTA034	-0 59	13.60	13 01	NE	8.01 - 12 76	6.5 - 13.6	4.5 - 6.5	2
WITCTA035	-0.78	19.40	18.62	NE	8 62 - 18.37	15.4 - 19.4	13 4 - 15.4	2
WITCTA037	-0.31	21.00	20.69	19.0	13.19 - 20.44	11 5 - 21.0	9.5 - 11.5	2
WITCTA039	-1 38	24.30	22..92	NE	12.92 - 22.67	12.5 - 24.3	10.5 - 12.5	2
WITCTA040	-0.39	24.00	23.61	-	13.11 - 23.11	11.5 - 24.0	9.0 - 11.5	2
WITCTA041	-0.46	22.00	21.54	-	6.5 - 21 5	4.5 - 22.0	2.0 - 4.5	2
WITCTA042	-0.08	22.00	21.92	-	11 42 - 16.17	9 5 - 22.0	6.5 - 9.5	2
WITCTA043	-0.11	20.00	19.89	-	9.5 - 19.5	7 0 - 20.0	4 0 - 7.0	2

Table B.2 (continued)
Well Construction Information

Monitoring Well	Well Stickup (ft.)	Total Depth (ft. bgs)	Total Depth (ft. below TOC)	Depth to Bedrock (ft. bgs)	Screened Interval (ft. TOC)	Filter Pack Interval (ft. bgs)	Seal Interval (ft. bgs)	Well Inside Diameter (in)
WITCTA044	-0.59	20.00	19.41	-	8 91 - 18.91	7.0 - 20.0	4 0 - 7.0	2
WITCTA045	-0.46	7.7	7 24	7.0	3.10 - 7.7	4 9 - 7 7	1.5 - 3.0	2
WITCTA046	-0 67	7.90	7.23	7.9	3 10 - 7.9	4.9 - 7.9	1 5 - 3.0	2
WITCTA047	-0.39	7.65	7.26	7.65	2.85 - 7.65	4.8 - 7.65	1.5 - 2 85	2
WITCTA048	-0.41	8.10	7.69	8.10	3.10 - 8.10	5.3 - 8.10	1.7 - 3.7	2
WITCTA057	2.69	42.20	44.89	39.5	21.0 - 41.0	22.20 - 42.20	17.0 - 18.0	2
WITCTA058	2.60	40	42.60	40	20.0 - 40.0	18 0 - 40.0	16.0 - 18.0	2
WJETA530	-0.23	43.76	43.53	44.5	33.88 - 42.88	32.0 - 44.0	29.7 - 32.0	2
WJETA534	-0.36	40.00	39.64	40.0	24.78 - 38.88	23 0 - 40.0	21 0 - 23.0	2
WJETA535	-0.21	43.00	42.79	43 0	33.14 - 42 14	28 7 - 43.0	18.5 - 28.7	2
WP07-10A	-0 20	39.00	38.80	NE	27 0 - 37.0	26.0 - 39.0	24.0 - 26.0	2
WP07-10B	3.12	36.00	39 12	34.5	23.0 - 33.0	18 0 - 36.0	15.5 - 18.0	2
WP07-10C	1.78	32.50	34.28	30.5	20.0 - 30.0	17.5 - 32.5	15.0 - 17.5	2
WSAICTA002	-0.27	26	25.73	25	15 0 - 25.0	13.0 - 26.0	11.0 - 13.0	2
WSAICTA003	-0.28	31	30.72	30.5	15.0 - 30.0	13.0 - 31.0	11.0 - 13.0	2
WSAICTA004	-0.59	42	41.41	42	21.0 - 41.0	19.0 - 42.0	17.0 - 19.0	2
WSAICTA005	-0.21	36	35.79	36	20 0 - 35.0	19.0 - 37	16.0 - 18.0	2

Notes:
[1] The USGS is responsible for the maintenance of these wells
bgs - below ground surface
ft. - feet
in - inch
NE - not encountered
TOC - top of casing

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ATTACHMENT B.3

REGULATORY GUIDELINES FOR MONITORING WELL ABANDONMENT

ATTACHMENT B.3
REGULATORY GUIDELINES
FOR MONITORING WELL ABANDONMENT

The abandonment of monitoring wells at NAS Fort Worth JRB will be conducted in accordance with the Texas Department of Licensing and Regulation (TDLR) Standards for Capping and Plugging of Wells and Plugging Wells that Penetrate Undesirable Water or Constituent Zones. These guidelines are provided in 16 Texas Administrative Code (TAC), §76.1004.

All monitoring well abandonment and repair activities shall conform with state and local regulations and will be supervised by a professional geologist or engineer registered in the state of Texas. HydroGeoLogic will obtain all permits, applications, and other requested documents, and subcontract a driller to perform the well abandonment. The well abandonment forms will be submitted to the TDLR upon completion of monitoring well abandonment, as required.

B.1 LICENSING AND REGISTRATION

Monitoring well abandonment will be conducted by a driller registered and licensed by the state of Texas. The licensing and registration requirements will be the responsibility of the driller.

B.2 REQUIREMENTS FOR MONITORING WELL ABANDONMENT

The three methods for well abandonment, as stated in 16 TAC §76.1004, are presented in the following paragraphs.

Method 1 If a well is abandoned or deteriorating, all removable casing shall be removed from the well and the entire well shall be pressure filled via a tremie pipe with cement from the bottom up to the land surface.

Method 2 In lieu of the above procedure, the well shall be pressure filled via a tremie pipe with bentonite grout of a minimum 9.1 pounds per gallon weight followed by a cement plug extending from land surface to a depth of not less than 2 feet, or if the well to be plugged has 100 feet or less of standing water the entire well may be filled with a solid column of 3/8 inch or larger granular sodium bentonite hydrated at frequent intervals while strictly adhering to the manufacturers recommended rate and method of application. If a bentonite grout is used, the entire well from not less than 2 feet below land surface may be filled with the bentonite grout. The top 2 feet above any bentonite grout or granular sodium bentonite shall be filled with cement as an atmospheric barrier.

Method 3 Undesirable water or constituents, or the fresh water zone(s), shall be isolated with cement plugs and the remainder of the wellbore filled with bentonite grout of a minimum 9.1

weight followed by a cement plug extending from land surface to a depth of not less than 2 feet.

Method 1 or Method 2 will be used to abandon the monitoring wells at NAS Fort Worth JRB. Method 3 would be used in the event that a well in the Paluxy Formation was to be abandoned. No monitoring well included for abandonment in this WP is completed in the Paluxy Formation.

All abandoned wells will be checked 24 to 48 hours after abandonment to determine whether proper curing has occurred. Additional curing specifications recommended by the manufacturer will be followed. If settling has occurred, a sufficient amount of cement will be added to fill the hole to the ground surface. Curing checks and any addition of cement will be recorded in the field logbook.

B.3 REQUIREMENTS FOR MONITORING WELL REPAIR

For flush-mounted completions, a new manhole assembly with a locking cover will be constructed over the casing. The manhole cover will be centered in a 3-foot square, 4-inch thick concrete pad that slopes away from the manhole assembly at ¼ inch per foot. The identity of the well will be permanently marked on the outside of the manhole assembly. Where heavy traffic may pass over the well, or for other reasons, the concrete pad and manhole/lid assembly will be constructed to meet the strength requirements of surrounding surfaces. A Monitoring Well Construction Form will be completed for each well (Attachment C).

B.4 ADDITIONAL FIELD WORK REQUIREMENTS

All aspects of field work not addressed in the above sections will be executed in accordance with the Field Sampling Plan and Health and Safety Plan from the Revised Final Resource Conservation and Recovery Act (RCRA) Facility Investigation of Waste Accumulation Areas, NAS Fort Worth JRB, Texas (HydroGeoLogic, 1999d). The field forms required for this field effort are included in Attachment C.

ATTACHMENT B.4

TNRCC RULES FOR WELL PLUGGING

SUBCHAPTER A : GENERAL PROVISIONS
§238.1 and §238.2

§238.1. Purpose of Rules.

These sections are adopted by the Texas Natural Resource Conservation Commission pursuant to Texas Water Code, §§32, 33, 26.003, 26.011, 26.128 and 28.030, and Texas Civil Statutes, Article 8905. The sections of the Texas Water Code referenced in this section direct the commission to establish the level of quality to be maintained, and to control and protect the quality of the underground water in this state and to promulgate procedures and standards for plugging wells.

Adopted November 20, 1996 Effective December 18, 1996

§238.2. Definitions.

The following words and terms, when used in this chapter, shall have the following meanings, unless the context clearly indicates otherwise.

Abandoned well - A well that has not been used for six consecutive months. A well is considered to be in use in the following cases:

(A) a non-deteriorated well which contains the casing, pump, and pump column in good condition; or

(B) a non-deteriorated well which has been capped.

Annular space - The space between the casing and borehole wall.

Atmospheric barrier - A section of cement placed from two feet below land surface to the land surface when using granular sodium bentonite as a casing sealant or plugging sealant in lieu of cement.

Bentonite - A sodium hydrous aluminum silicate clay mineral (montmorillonite) commercially available in powdered, granular, or pellet form which is mixed with potable water and used for a variety of purposes including the stabilization of borehole walls during drilling, the control potential or existing high fluid pressures encountered during drilling below a water table, and to provide a seal in the annular space between the well casing and borehole wall.

Bentonite grout - A fluid mixture of sodium bentonite and potable water mixed at manufacturer's specifications to a slurry consistency which can be pumped through a pipe directly into the annular space between the casing and the borehole wall. Its primary function is to seal the borehole in order to prevent the subsurface migration or communication of fluids.

Capped well - A well that is closed or capped with a covering capable of preventing surface pollutants from entering the well and sustaining weight of at least 400 pounds and constructed in such a way that the covering cannot be easily removed by hand.

Casing - A watertight pipe which is installed in an excavated or drilled hole, temporarily or permanently, to maintain the hole sidewalls against caving, advance the borehole, and in conjunction with cementing and/or bentonite grouting, to confine the ground waters to their respective zones of origin, and to prevent surface contaminant infiltration.

(A) Plastic casing - shall be National Sanitation Foundation (NSF) or American Society of Testing Material (ASTM) F-480 minimum SDR 26 approved water well casing.

(B) Steel Casing - shall be ASTM A-53 Grade B or better and have a minimum weight and thickness of American National Standards Institute (ANSI) schedule 10.

(C) Monitoring wells may use other materials, such as fluoropolymer (Teflon), glass-fiber-reinforced epoxy, or various stainless steel alloys.

Cement - A neat portland or construction cement mixture of not more than seven gallons of water per 94-pound sack of dry cement, or a cement slurry which contains cement along with bentonite, gypsum or other additives; the well driller will adhere to the manufacturer's recommended water content for the mix.

Chemigation - A process whereby pesticides, fertilizers or other chemicals, or effluent from animal wastes are added to irrigation water applied to land or crops, or both, through an irrigation distribution system

Completed Monitoring Well - A monitoring well which allows water from a single water-producing zone to enter the well bore, but isolates the single water-producing zone from the surface and from all other water-bearing zones by proper casing and/or cementing procedures. The single water-producing zone shall not include more than one continuous water-producing unit unless a qualified geologist or groundwater hydrologist has determined that all the units screened or sampled by the well are interconnected naturally.

Completed to Produce Undesirable Water - A completed monitoring well which is designed to extract water from a zone which contains undesirable water.

Completed Water Well - Sealing off access of undesirable water to the well bore by proper casing and/or cementing procedures.

Constituents - Elements, ions, compounds, or substances which may cause the degradation of the soil or ground water.

Council - Texas Water Well Drillers Advisory Council.

Dam - Any barrier across the bottom chord of the pipe which is of sufficient height to back water into the low-pressure drain outlet and prevent any flow (check valve seepage) back into the water supply.

Deteriorated well - A well, the condition of which will cause, or is likely to cause, pollution of any water in the state, including groundwater.

Dewatering well - An artificial excavation constructed to produce groundwater to cause a lowering of the water table or potentiometric surface. The term shall not include any dewatering well which is used for the production of, or to facilitate the production of, any mineral under a state regulatory program.

Dewatering well driller - A person, including an owner, operator, contractor, or drilling supervisor, who engages in the drilling, boring, coring, or construction of a dewatering well, but does not include a person who drills, bores, cores or constructs a dewatering well under the direct supervision of a licensed dewatering well driller and who is not primarily responsible for the drilling operation.

Driller - A water well driller, injection well driller, dewatering well driller, or monitoring well driller.

Dry Litter Poultry Facility - Fully enclosed poultry operation where wood shavings or similar material is used as litter.

Easy access - Access is not obstructed by other equipment and the fitting can be removed and replaced with a minimum of tools without risk of breakage of the attachment parts.

Edwards Aquifer Authority - A governmental agency and body politic and corporate of the State of Texas. The authority has all of the powers, rights, and privileges necessary to manage, conserve, preserve, and protect the Edwards Aquifer and to increase the recharge of, and prevent the waste or pollution of water in, the Edwards Aquifer.

Environmental soil borings - An artificial excavation constructed to measure or monitor the quality and quantity or movement of substances, elements, chemicals, or fluids beneath the surface of the ground. The term shall not include any well which is used in conjunction with the production of oil, gas, or any other minerals.

Examination fee - The non-refundable fee required of each applicant each time that applicant takes a commission examination.

Flapper - The clapper, closing, or checking device within the body of the check valve.

Foreign substance - Includes recirculated tailwater and may include instances where open-ditch water is treated when a pump discharge pipe is submerged in the ditch.

Freshwater - Water whose bacteriological, physical, and chemical properties are such that it is suitable and feasible for beneficial use.

Granular sodium bentonite - Sized, coarse ground, untreated, sodium based bentonite (montmorillonite) which has the specific characteristic of swelling in freshwater.

Groundwater Conservation District - Any district or authority created under Article III, Section 52, or Article XVI, Section 59 of the Constitution or under the provisions of Chapters 35 and 36, Texas Water Code that has the authority to regulate the spacing or production from water wells.

Injection well - Includes:

(A) an air conditioning return flow well used to return water used for heating or cooling in a heat pump to the aquifer that supplied the water;

(B) a cooling water return flow well used to inject water previously used for cooling;

(C) a drainage well used to drain surface fluid into a subsurface formation;

(D) a recharge well used to replenish the water in an aquifer;

(E) a saltwater intrusion barrier well used to inject water into a freshwater aquifer to prevent the intrusion of salt water into the freshwater;

(F) a sand backfill well used to inject a mixture of water and sand, mill tailings, or other solids into subsurface mines;

(G) a subsidence control well used to inject fluids into a non-oil or gas producing zone to reduce or eliminate subsidence associated with the overdraft of fresh water; and

(H) a closed system geothermal well used to circulate water, other fluids, or gases through the earth as a heat source or heat sink.

Installer - An individual who installs or repairs water well pumps and equipment for hire or compensation. This term excludes the following from testing and licensing:

(A) A person who owns or is in control of property or the person's employee or a person not hired or compensated while acting on the person's behalf on the property the person owns or controls for the person's own use.

(B) Pump manufacturers and sellers of new and used pumps and/or pump equipment including pump distributors and pump dealers who do not install pumps and/or pump equipment.

Irrigation distribution system - A device or combination of devices having a hose, pipe. or other conduit which connects directly to any water well or reservoir connected to the well, through which

water or a mixture of water and chemicals is drawn and applied to land. The term does not include any hand held hose sprayer or other similar device which is constructed so that an interruption in water flow automatically prevents any backflow to the water source.

License fee - The fee to be paid by a successful applicant to become a licensed well driller and/or water well pump installer.

Licensed driller - Any person who holds a license issued by the State of Texas pursuant to the provisions of Chapter 32 of the Texas Water Code.

Licensed installer - A person who holds a license issued by the commission under Chapter 33 of the Texas Water Code.

Monitoring well - An artificial excavation constructed to measure or monitor the quality and/or quantity or movement of substances, elements, chemicals, or fluids beneath the surface of the ground. Included within this definition are environmental soil borings, piezometer wells, observation wells, and recovery wells. The term shall not include any well which is used in conjunction with the production of oil, gas, coal, lignite, or any other minerals.

Monitoring well driller - A person, including an owner, operator, contractor, or drilling supervisor, who engages in the drilling, boring, coring, or construction of a monitoring well.

Mud - A relatively homogenous; viscous fluid produced by the suspension of clay-size particles in water.

Person - An individual, firm, partnership, association, corporation, government, governmental subdivision, agency. or any other private legal entity.

Piezometer - A device so constructed and sealed as to measure hydraulic head at a point in the subsurface.

Piezometer well - A well of a temporary nature constructed to monitor well standards for the purpose of measuring water levels or used for the installation of piezometers resulting in the determination of locations and depths of permanent monitor wells.

Plugging - An absolute sealing of the well bore.

Pollution - The alteration of the physical, thermal, chemical, or biological quality of, or the contamination of, any water in the state that renders the water harmful, detrimental, or injurious to humans, animal life, vegetation, or property, or to public health, safety, or welfare, or impairs the usefulness or the public enjoyment of the water for any lawful or reasonable purpose.

Public water system - A system supplying water to a number of connections or individuals, as defined by current rules and regulations of the Texas Natural Resource Conservation Commission, Chapter 290.

Pump installation - The procedures employed in the placement, and preparation for operation, of equipment and materials used to obtain water from a well, including construction involved in establishing seals and safeguards as necessary to protect the water from contamination. The term includes repairs to an existing pump.

Qualified Groundwater Scientist - A scientist or engineer who has received a baccalaureate or post-graduate degree in the natural sciences or engineering and has sufficient training and experience in ground water hydrology and related fields as may be demonstrated by state registration, professional certifications, or completion of accredited university programs that enable that individual to make sound professional judgements regarding ground water monitoring, contaminant fate and transport, and corrective action.

Recovery Well - A well constructed for the purpose of recovering undesirable groundwater for treatment or removal of contamination.

Renewal fee - The annual fee paid by a previously registered well driller, or pump installer.

Sanitary well seal - A water tight device to maintain a junction between the casing and the pump column.

Subsidence district - Any district or authority created under Article III, Section 52, or Article XVI, Section 59, of the Texas Constitution that has the authority to regulate the spacing of or production from water wells solely for the purpose of controlling subsidence caused by withdrawal of water from underground water reservoirs or their subdivisions.

Undesirable water - Water that is injurious to human health and the environment or water that can cause pollution to land or the waters in the state.

Water or waters in the state - Groundwater, percolating or otherwise, lakes, bays, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Gulf of Mexico inside the territorial limits of the state, and all other bodies of surface water, natural or artificial, inland or coastal, fresh or salt, navigable or nonnavigable, and including the beds and banks of all watercourses and bodies of surface water, that are wholly or partially inside or bordering the state or inside the jurisdiction of the state.

Water well - Any excavation constructed for the purpose of exploring for or producing groundwater. The term, however, shall not include any test or blast holes in quarries or mines, or any well or excavation for the purpose of exploring for, or producing oil, gas, or any other minerals unless the holes are used to produce groundwater. The term shall not include any injection water source well regulated by the Railroad Commission of Texas pursuant to the Natural Resources Code, §91.101.

Water well driller - Any person (including an owner, operator, contractor, or drilling supervisor) who engages in the drilling, boring, coring, or construction of any water well in this state. The term, however, shall not include any person who drills, bores, cores, or constructs a water well on his or her own property for his or her own use or a person who assists in the construction of a water well under the direct supervision of a licensed driller and is not primarily responsible for the drilling operations.

Water Well Drillers Advisory Council - An advisory council consisting of nine members appointed by the commissioners of the Texas Natural Resource Conservation Commission.

Well - A water well, injection well, dewatering well, monitoring well, piezometer well, observation well, or recovery well.

Well Report - A log recorded on forms prescribed by the commission, at the time of drilling showing the depth, thickness, character of the different strata penetrated, location of water-bearing strata, depth, size, and character of casing installed, together with any other data or information required by the commission. Each copy of a Well Report, other than a commission copy, shall include the name, mailing address, and telephone number of the commission.

Well pumps and equipment - Equipment and materials used to obtain water from a well, including the seals and safeguards necessary to protect the water from contamination.

SUBCHAPTER B : STATE WELL REPORTS AND REPORTING UNDESIRABLE WATER §238.31 and §238.32

§238.31. State Well Reports.

(a) Every licensed well driller who drills, deepens, or otherwise alters a well, within this state shall cause to be made and kept a legible and accurate State Well Report on forms supplied by the executive director. In areas under the jurisdiction of a local groundwater conservation district, the forms supplied by the district can be used instead.

(b) Every licensed well driller shall deliver or transmit by certified mail the original of the State Well Report to the commission, and shall deliver or send by first-class mail a photocopy to the local groundwater conservation district and a copy to the owner or person for whom the well was drilled, within 60 days from the completion or cessation of drilling, deepening, or otherwise altering a well.

(c) Every licensed well driller shall inform the owner or person having the well drilled, deepened, or otherwise altered that he or she may submit a written request both to the commission by certified mail and to the local groundwater conservation district in person or by first-class mail that the State Well Report be kept confidential and exempt from disclosure as a public record.

Adopted November 20, 1996 Effective December 18, 1996

§238.32. Reporting Undesirable Water or Constituents.

(a) Each licensed well driller shall inform, within 24 hours, the landowner or person having a well drilled, deepened, or otherwise altered or their agent when undesirable water or constituents have been encountered.

(b) The well driller shall submit to the executive director, to the local groundwater conservation district if required by the local authority, and to the landowner or person having the well drilled, deepened, or otherwise altered, on forms supplied by the executive director or by a local groundwater conservation district having jurisdiction, a statement signed by the well driller indicating that the landowner or person having the well drilled, deepened, or otherwise altered, has been informed that undesirable water or constituents have been encountered.

(c) The statement indicated in subsection (b) of this section must be submitted within 30 days after encountering undesirable water or constituents.

Adopted November 20, 1996 Effective December 18, 1996

SUBCHAPTER C : WELL DRILLING, COMPLETION, CAPPING AND PLUGGING §§238.41-238.51

§238.41. Responsibility.

(a) All well drillers and persons having a well drilled, deepened, or otherwise altered shall adhere to the provisions of this chapter prescribing the location of wells and proper drilling, completion, capping, and plugging.

(b) Where a landowner, or person having the well drilled, deepened, or otherwise altered, denies a licensed well driller access to the well to complete the well to established standards and thereby precludes the driller from performing his or her duties under the Texas Water Code and this chapter, the well driller shall file a statement within five days with the commission as prescribed in §§238.80-238.83 of this title (relating to Miscellaneous Provisions). The landowner or person authorizing the well work must complete the well to established standards within ten days of notification by the executive director.

Adopted November 20, 1996 December 18, 1996

§238.42. Standards of Completion for Public Water System Wells.

Wells supplying a public water system shall be completed according to presubmitted plans approved by the commission under Chapter 290 of this title (relating to Water Hygiene).

(1) The water well driller shall to the best of his or her ability ascertain whether a well which is to be drilled, deepened, or otherwise altered is intended for use as part of a public water system and shall comply with all applicable rules and regulations of the commission under Chapter 290 of this title and any other local or regional regulations.

(2) By way of the State Well Report, the water well driller shall inform the commission of the well's intended use.

(3) The person having the well drilled, deepened, or otherwise altered is responsible for ascertaining that a well intended for use as a part of a public water system meets the current rules and regulations of the commission under Chapter 290 of this title and any other local or regional regulations.

(4) The executive director may file a complaint against a water well driller if the driller drills a well intended for part of a public water system that does not meet the existing rules and regulations of Chapter 290 of this title and any other local or regional regulations.

Adopted November 20, 1996 Effective December 18, 1996

§238.43. Location of New Wells.

(a) Water wells located within public well system sanitary easements must be constructed to public well standards.

(b) A well shall be located a minimum horizontal distance of 50 feet from any water-tight sewage and liquid-waste collection facility, except in the case of monitoring, dewatering, piezometer, and recovery wells which may be located where necessity dictates.

(c) Except as noted in §238.44(1) and §238.61 of this title, (relating to Standards of Completion for Wells and Chemical Injection, Chemigation and Foreign Substance Systems), a well shall be located a minimum horizontal distance of 150 feet from any concentrated sources of potential contamination such as, but not limited to, existing or proposed livestock or poultry yards, cemeteries, pesticide mixing/loading facilities, spray irrigation heads, and privies, except in the case of monitoring dewatering, piezometer, and recovery wells which may be located where necessity dictates. A well shall be located a minimum horizontal distance of 100 ft. from a septic system absorption field, a dry litter poultry facility and 50 feet from any property line provided the well is located at the minimum horizontal distance from the sources of potential contamination in this subsection.

(d) A well shall be located at a site not generally subject to flooding; provided, however, that if a well must be placed in a flood prone area, it shall be completed with a watertight sanitary well seal and steel casing extending a minimum of 36 inches above ground level.

Adopted November 20, 1996 Effective December 18, 1996

§238.44. Standards of Completion for Wells.

Wells shall be completed in accordance with the following specifications and in compliance with local groundwater conservation district or incorporated city ordinances:

(1) The annular space to a minimum of ten feet shall be three inches larger in diameter than the casing and filled from ground level to a depth of not less than ten feet below the land surface or well head with cement slurry or eight feet solid column of granular sodium bentonite topped with a two feet cement atmospheric barrier, except in the case of monitoring, dewatering, piezometer, and recovery wells when the water to be monitored, recovered, or dewatered is located at a more shallow depth. In that situation, the cement slurry or bentonite column shall only extend down to the level immediately above the monitoring, recovery, or dewatering level. Unless the well is drilled within the Edwards Aquifer or is set back in reference to spray irrigation heads, the distances given for separation of wells from sources of potential contamination in §238.43 (c) of this title (relating to Location of New Wells) may be decreased to a minimum of 50 feet provided the annular space is three inches larger than the casing and the cement slurry or bentonite column is emplaced under pressure to a minimum depth of 100 feet to surface. For wells less than 100 feet deep, the cement slurry or bentonite column shall be placed to the top of the producing layer. A well cemented to 100 feet or to the top of the producing layer may be located no closer than ten feet from a property line provided it remains at least 50 feet from any of the potential sources of contamination listed in §238.43 (c). In areas of shallow, unconfined groundwater aquifers, the cement or bentonite column need not be placed below the

static water level. In areas of shallow, confined groundwater aquifers having artesian head, the cement or bentonite column need not be placed below the top of the water-bearing strata.

(2) In all wells where plastic casing is used, except when a steel or polyvinyl chloride (PVC) sleeve or pitless adapter as described in paragraph (3) of this section, is used, a concrete slab or sealing block shall be placed above the cement slurry around the well at the ground surface.

(A) The slab or block shall extend at least two feet from the well in all directions and have a minimum thickness of four inches and should be separated from the well casing by a plastic or mastic coating or sleeve to prevent bonding of the slab to the casing.

(B) The surface of the slab shall be sloped to drain away from the well.

(C) The top of the casing shall extend a minimum of 12 inches above the land surface except in the case of monitoring wells when it is impractical or unreasonable to extend the casing above the ground. Monitoring wells shall be placed in a waterproof vault the rim of which extends two inches above the ground surface and a sloping cement slurry shall be placed 18 inches around and two feet below the base of the vault between the casing and the wall of the borehole so as to prevent surface pollutants from entering the monitoring well. The well casing shall have a locking cap that will prevent pollutants from entering the well. The annular space of the monitoring well shall be sealed with an impervious bentonite or similar material from the top of the interval to be tested to the cement slurry below the vault of the monitoring well.

(D) The well casing of a temporary monitoring well shall have a locking cap and the annular space shall be sealed 0 feet to 1 feet below ground level with an impervious bentonite or similar material; after 48 hours, the well must be completed or plugged in accordance with §238.44(2)(C) of this title (relating to Standards of Completion for Wells) and §238.48 of this title (relating to Well Plugging and Capping).

(E) The annular space of a closed loop injection well used to circulate water or other fluids shall be backfilled to the total depth with impervious bentonite or similar material.

(3) In wells where a steel or PVC sleeve is used:

(A) The steel sleeve shall be a minimum of 3/16 inches in thickness and/or the plastic sleeve shall be a minimum of Schedule 80 sun resistant and 24 inches in length, and shall extend 12 inches into the cement, except when steel casing or a pitless adapter as described in paragraph (2) of this section is used. The casing shall extend a minimum of 12 inches above the land surface, and the steel sleeve shall be two inches larger in diameter than the plastic casing being used; or

(B) A slab or block as described in paragraph (2)(A) of this section is required above the cement slurry except when a pitless adapter may be used. Pitless adapters may be used in such wells provided that:

(i) the adapter is welded to the casing or fitted with another suitably effective seal,

(ii) the annular space between the borehole and the casing is filled with cement to a depth not less than 20 feet below the adapter connection; and

(iii) in lieu of cement as described in clause (ii) of this subparagraph, the annular space may be filled with a solid column of granular sodium bentonite to a depth of not less than 20 feet below the adapter connection.

(4) All wells, especially those that are gravel packed, shall be completed so that aquifers or zones containing waters that differ in chemical quality are not allowed to commingle through the borehole-casing annulus or the gravel pack and cause quality degradation of any aquifer or zone.

(5) The well casing shall be capped or completed in a manner that will prevent pollutants from entering the well.

(6) Each licensed well driller drilling, deepening, or otherwise altering a well shall keep any drilling fluids, tailings, cuttings, or spoils contained in such a manner so as to prevent spillage onto adjacent property not under the jurisdiction or control of the well owner without the adjacent property owners written consent.

(7) Each licensed well driller drilling, deepening, or otherwise altering a well shall prevent the spillage of any drilling fluids, tailings, cuttings, or spoils into any body of surface water.

(8) Unless waived by written request from the landowner, a new, repaired, or reconditioned well or pump installation or repair on a well used to supply water for human consumption shall be properly disinfected. The well shall be properly disinfected with chlorine or other appropriate disinfecting agent under the circumstances. A disinfecting solution with a minimum concentration of 50 milligrams per liter (mg/l) (same as parts per million), shall be placed in the well as required by the American Water Works Association (AWWA), pursuant to ANST/AWWA C654-87 and the United States Environmental Protection Agency (EPA).

(9) Unless waived in writing by the landowner, after performing an installation or repair, the licensed installer shall disinfect the well by:

(A) treating the water in the well casing to provide an average disinfectant residual to the entire volume of water in the well casing of 50 mg/l. This may be accomplished by the addition of calcium hypochlorite tablets or sodium hypochlorite solution in the amounts shown in the attached Table 1 of ANSI/AWWA C654;

(B) circulating, to the extent possible, the disinfected water in the well casing and pump column; and

(C) pumping the well to remove disinfected water for a minimum of 15 minutes.

(D) If calcium hypochlorite (granules or tablets) is used, it is suggested that the installer dribble the tablets of approximately five-gram (g) size down the casing vent and wait at least 30 minutes for the tablets to fall through the water and dissolve. If sodium hypochlorite (liquid solution) is used, care should be taken that the solution reaches all parts of the well. It is suggested that a tube be used to pipe the solution through the well-casing vent so that it reaches the bottom of the well. The tube may then be withdrawn as the sodium hypochlorite solution is pumped through the tube. After the disinfectant has been applied, the installer should surge the well at least three times to improve the mixing and to induce contact of disinfected water with the adjacent aquifer. The installer should then allow the disinfected water to rest in the casing for at least twelve hours, but for not more than twenty-four hours. Where possible, the installer should pump the well for a minimum of 15 minutes after completing the disinfection procedures set forth above until a zero disinfectant residual is obtained. In wells where bacteriological contamination is suspected, the installer should inform the well or property owner that bacteriological testing may be necessary or desirable.

Adopted November 20, 1996 Effective December 18, 1996

§238.45. Standards of Completion for Water Wells Encountering Undesirable Water or Constituents.

(a) If a water well driller encounters undesirable water or constituents and the well is not plugged or made into a completed monitoring well, the licensed well driller shall see that the well drilled, deepened, or otherwise altered is forthwith completed in accordance with the following:

(1) When undesirable water or constituents are encountered in a water well, the undesirable water or constituents shall be sealed off and confined to the zone(s) of origin.

(2) When undesirable water or constituents are encountered in a zone overlying fresh water, the driller shall case the water well from an adequate depth below the undesirable water or constituent zone to the land surface to ensure the protection of water quality.

(3) The annular space between the casing and the wall of the borehole shall be cemented an adequate depth below the undesirable water or constituent zone to the land surface to ensure the protection of groundwater.

(4) When undesirable water or constituents are encountered in a zone underlying a fresh water zone, the part of the wellbore opposite the undesirable water or constituent zone shall be filled with cement to a height that will prevent the entrance of the undesirable water or constituents into the water well.

(b) The person who performs the well completion operation on a water well shall, within 30 days after completing the well, submit a well completion report to the executive director on forms supplied by the executive director and a copy of the report to the local groundwater conservation district.

Adopted November 20, 1996 Effective December 18, 1996

§238.46. Standards for Wells Producing Undesirable Water or Constituents.

(a) Wells completed to produce undesirable water or constituents shall be cased to prevent the mixing of water or constituent zones.

(b) The annular space between the casing and the wall of the borehole shall be cemented to the land surface.

(c) Wells producing undesirable water or constituents shall be completed in such a manner that will not allow undesirable fluids to flow onto the land surface except when appropriate state authorization is obtained.

Adopted November 20, 1996 Effective December 18, 1996

§238.47. Recompletions.

(a) The landowner shall have the continuing responsibility of insuring that a well does not allow the commingling of undesirable water or constituents and fresh water or the unwanted loss of water through the wellbore to other porous strata.

(b) If a well is allowing the commingling of undesirable water or constituents and fresh water or the unwanted loss of water, and the casing in the well cannot be removed and the well recompleted in accordance with the applicable rules, the casing in the well shall be perforated and squeeze cemented in a manner that will prevent the commingling or loss of water. If such a well has no casing then the well shall be cased and cemented, or plugged in a manner that will prevent such commingling or loss of water.

(c) The executive director or local groundwater conservation district may direct the landowner to take proper steps to prevent the commingling of undesirable water or constituents and fresh water, or the unwanted loss of water.

Adopted November 20, 1996 Effective December 18, 1996

§238.48. Well Plugging and Capping.

(a) It is the responsibility of the landowner or person having the well drilled, deepened, or otherwise altered, to cap or have capped, under standards set forth in §§238.44-238.51 of this title (relating to Well Drilling, Completion, Capping, and Plugging), any well which is open at the surface.

(b) It is the responsibility of the landowner or person having the well drilled, deepened, or otherwise altered to plug or have plugged a well which is abandoned under standards set forth in §238.49 of this title (relating to Standards for Plugging Wells).

(c) It shall be the responsibility of each licensed well driller to inform a landowner or person having a well drilled, deepened, or otherwise altered that the well must be plugged by the landowner, a licensed driller, or a licensed pump installer if it is abandoned under standards set forth in §238.49 of this title.

(d) It is the responsibility of the licensed well driller to see that any well which encounters undesirable water or constituents is plugged or is converted into a monitoring well under the standards set forth in §§238.41-238.51 of this title (relating to Well Drilling, Completion, Capping, and Plugging).

(e) The person that completes or plugs a well described in subsection (a), (b), or (d) of this section shall, within 30 days after completion or plugging is complete, submit a State Well Report or Plugging Report to the executive director on forms supplied by the executive director and a copy of the report mailed to the local groundwater conservation district.

(f) It shall be the responsibility of the driller of a newly drilled well or pump installer to place a cover over the boring or casing of any well that is to be left unattended with the pump removed. Well covers shall be capable of supporting a minimum of 400 pounds and constructed in such a way that they cannot be easily removed by hand.

Adopted November 20, 1996 Effective December 18, 1996

§238.49. Standards for Plugging Wells.

(a) If a well that does not contain any undesirable water or constituent zones is abandoned and deteriorating, all removable casing shall be removed from the well and the entire well pressure filled via a trimie pipe with cement from bottom up to the land surface.

(b) In lieu of the procedure in subsection (a) of this section, the well shall be pressure filled via a trimie tube with a bentonite grout (ten pounds per gallon mud or more with a marsh funnel viscosity of 50 seconds or equivalent) followed by a cement plug extending from land surface to a depth of not less than ten feet, or if the well to be plugged has 100 feet or less of standing water the entire well may be filled with a solid column of 3/8 inch or larger granular sodium bentonite hydrated at frequent intervals while strictly adhering to the manufacturers recommended rate and method of application. If a bentonite grout is used, the entire well from not less than two feet below land surface may be filled with the bentonite grout. The top two feet above any bentonite grout or granular sodium bentonite shall be filled with cement as an atmospheric barrier.

(c) Drillers may petition the executive director in writing for an alternative method of plugging a well. The petition should state in detail the alternative method proposed and all conditions applicable to the well that would make the alternative method preferable to those methods stated in subsection (a) and (b) of this section.

Adopted November 20, 1996 Effective December 18, 1996

§238.50. Standards for Plugging Wells That Penetrate Undesirable Water or Constituent Zones.

(a) If the use of a well that penetrates undesirable water or constituents is to be permanently discontinued, all removable casing shall be removed from the well and the entire well pressure filled with cement via a trimie tube from the bottom up to the land surface.

(b) In lieu of the procedure in subsection (a) of this section, either the zone(s) contributing undesirable water or constituents, or the fresh water zone(s) shall be isolated with cement plugs and the remainder of the wellbore filled with bentonite grout (ten pounds per gallon mud or more with a marsh funnel viscosity of 50 seconds or equivalent) to form a base for a cement plug extending from a depth of not less than two feet to the land surface, or if the section(s) of well bore to be filled with bentonite has 100 feet or less of standing water the section(s) may be filled with a solid column of 3/8 inch or larger granular sodium bentonite hydrated at frequent intervals while strictly adhering to the manufacturers recommended rate and method of application. If a bentonite grout is used, it should be set sufficiently to support the two-foot thick cement plug. The top two feet above any bentonite grout or granular sodium bentonite shall be filled with cement as an atmospheric barrier.

(c) Drillers may petition the executive director in writing for an alternative method of plugging a well. The petition should state in detail the alternative method proposed and all conditions applicable to the well that would make the alternative method preferable to those methods stated in subsections (a) and (b) of this section.

Adopted November 20, 1996 Effective December 18, 1996

§238.51. Standards For All Water Wells (drilled before June 1, 1983).

(a) Wells drilled prior to June 1, 1983, will be grandfathered without further modification unless the well is found to be a threat to public health and safety or to water quality. The following will be considered a threat to public health and safety or to groundwater quality:

(1) Annular space around the well casing is open at or near the land surface;

(2) An unprotected opening into the well casing that is above ground level;

(3) Top of well casing below known flood level and not appropriately sealed;

(4) Deteriorated well casing allowing commingling of aquifers or zones of water of different quality.

(b) If the annular space around the well casing is not adequately sealed as set forth in this section, it shall be the responsibility of each licensed driller or licensed pump installer to inform the landowner that the well is considered to be a deteriorated well and must be recompleted when repairs are made to the pump or well in accordance with this chapter, and the following specifications:

(1) The well casing shall be excavated to a minimum depth of four feet and the annular space shall be filled from ground level to a depth of not less than four feet below the land surface with cement. In areas of shallow, unconfined groundwater aquifers, the cement need not be placed below the static water level. In areas of shallow, confined groundwater aquifers having artesian head, the cement need not be placed below the top of the water bearing strata.

(2) A cement slab or sealing block shall be placed above the cement around the well at the ground surface except when a pitless adapter as described in §238.44(3)(B) of this title (relating to Standards of Completion for Wells) or a steel or plastic sleeve as described in §238.44(3)(A) of this title is used.

(A) The slab or block shall extend at least two feet from the well in all directions and have a minimum thickness of four inches.

(B) The surface of the slab shall be sloped to drain away from the well.

(C) The top of the casing shall extend a minimum of 16 inches above ground level or two feet above known flood level and unprotected openings into the well casing that are above ground shall be sealed water tight.

(3) If deteriorated well casing is allowing commingling of aquifers or zones of water of different quality and causing degradation of any water in the state including groundwater, the well shall be plugged according to §238.48 of this title (relating to Well Plugging and Capping) or repaired. Procedures for repairs shall be submitted to the executive director for approval prior to implementation.

(c) If a licensed well driller or pump installer finds any of the procedures described by this section to be inapplicable, unworkable, or inadequate, altemative procedures may be employed provided that the proposed altemative procedures will prevent injury and pollution and that the procedures shall be submitted to the executive director for approval prior to their implementation.

Adopted November 20, 1996 Effective December 18, 1996

SUBCHAPTER D : WATER DISTRIBUTION AND DELIVERY SYSTEMS AND CHEMICAL INJECTION, CHEMIGATION, AND FOREIGN SUBSTANCE SYSTEM §238.60 and §238.61

§238.60. Water Distribution and Delivery Systems.

(a) The well driller or pump installer shall inform the land owner and well owner that the land owner and well owner are responsible for complying with the rules and regulations under the standards set forth in this section.

(b) A buried discharge line between the pump discharge and the pressure tank or pressure system in any installation, including a deep well turbine or a submersible pump, shall not be under negative pressure at any time. With the exception of jet pumps, a check valve or an air gap shall be installed in a water line between the well casing and the pressure tank. Either a check valve or an air gap, as applicable, shall be required on all irrigation well pumps whenever a pump is installed or repaired. All wells shall have either a check valve, or an air gap as applicable.

(c) Wells shall be vented with watertight joints except as provided by subsection (b) of this section.

(1) Watertight joints, where applicable pursuant to the provisions of this rule, shall terminate at least two feet above the regional flood level or one foot above the established ground surface or the floor of a pump room or well room, whichever is higher.

(2) The casing vent shall be screened and point downward.

(3) Vents may be offset provided they meet the provisions of this rule.

(4) Toxic or flammable gases, if present, shall be vented from the well. The vent shall extend to the outside atmosphere above the roof level at a point where the gases will not produce a hazard.

Adopted November 20, 1996 Effective December 18, 1996

§238.61. Chemical Injection, Chemigation, and Foreign Substance Systems.

(a) The well driller or pump installer is to inform the land owner and well owner that the land owner and well owner are responsible for complying with the rules and regulations under the standards set forth in this section.

(b) All irrigation distribution systems or water distribution systems into which any type of chemical (except disinfecting agents) or other foreign substances will be injected into the water pumped from water wells shall be equipped with an in-line, automatic quick-closing check valve capable of preventing pollution of the ground water. The required equipment shall be installed on all systems whenever a pump is installed or repaired or at the time of a chemical injection, chemigation or foreign substance unit is added to a water delivery system or not later than January 1, 2000, if the well has a chemical injection, chemigation, or foreign

substance unit in the delivery system. The type of check valve installed shall meet the following specifications:

(1) The body of the check valve shall be constructed of cast iron, stainless steel, cast aluminum, cast steel, or of a material and design that provides a sturdy integrity to the unit and is resistant to the foreign substance being injected. All materials shall be corrosion resistant or coated to prevent corrosion. The valve working pressure rating shall exceed the highest pressure to which the valve will be subjected.

(2) The check valve shall contain a suitable automatic, quick-closing and tight-sealing mechanism designed to close at the moment water ceases to flow in the downstream or output direction. The device shall, by a mechanical force greater than the weight of the closing device, provide drip-tight closure against reverse flow. Hydraulic back pressure from the system does not satisfy this requirement.

(3) The check valve construction should allow for easy access for internal and external inspection and maintenance. All internal parts shall be corrosion resistant. All moving parts shall be designed to operate without binding, distortion, or misalignment.

(4) The check valve shall be installed in accordance with the manufacturer's specifications and maintained in a working condition during all times in which any fertilizer, pesticide, chemical, animal waste, or other foreign substance is injected into the water system. The check valve shall be installed between the pump discharge and the point of chemical injection or foreign substance injection.

(5) A vacuum-relief device shall be installed between the pump discharge and the check valve in such a position and in such a manner that insects, animals, floodwater, or other pollutants cannot enter the well through the vacuum-relief device. The vacuum-relief device may be mounted on the inspection port as long as it does not interfere with the inspection of other anti-pollution devices.

(6) An automatic low pressure drain shall also be installed between the pump discharge and the check valve in such a position and in such a manner that any fluid which may seep toward the well around the flapper will automatically flow out of the pump discharge pipe. The drain must discharge away from rather than flow into the water supply. The drain must not collect on the ground surface or seep into the soil around the well casing.

(A) The drain shall be at least three-quarter inch in diameter and shall be located on the bottom of the horizontal pipe between the pump discharge and the check valve.

(B) The drain must be flush with the inside surface of the bottom of the pipe unless special provisions, such as a dam made downstream of the drain, forces seepage to flow into the drain.

(C) The outside opening of the drain shall be at least two inches above the grade.

(7) An easily-accessible inspection port shall be located between the pump discharge and the check valve, and situated so the automatic low pressure drain can be observed through the port and the flapper can be physically manipulated.

(A) The port shall allow for visual inspection to determine if leakage occurs past the flapper, seal, seat, and/or any other components of the checking device.

(B) The port shall have a minimum four-inch diameter orifice or viewing area. For irrigation distribution systems with pipe lines too small to install a four-inch diameter inspection port, the check valve and other anti-pollution devices shall be mounted with quick disconnects, flange fittings, dresser couplings, or other fittings that allow for easy removal of these devices.

(8) Any check valve not fully meeting the specifications set forth in this section may on request be considered for a variance as given in §339.6 of this title (relating to Variance of Rules) if demonstrated to the satisfaction of the commission.

Adopted November 20, 1996 Effective December 18, 1996

SUBCHAPTER E : PUMP INSTALLATION AND TEMPORARY WELL PROTECTION §238.70

§238.70. Pump Installation.

(a) During any repair or installation of a water well pump, the licensed installer shall make a reasonable effort to maintain the integrity of ground water as to prevent contamination by elevating the pump column and fittings, or by other means suitable under the circumstances.

(b) This section shall include every type of connection device, including but not limited to, flange connections, hose-clamp connections, and other flexible couplings. Except as otherwise provided by this chapter, a pump shall be constructed so that no unprotected openings into the interior of the pump or well casing exist.

(1) A hand pump, hand pump head, stand, or similar device shall have a spout, directed downward.

(2) A power driven pump shall be attached to the casing or approved suction or discharge line by a closed connection. For the purposes of this section a closed connection is defined to be a sealed connection.

(c) The provisions of this section relating to the requirement of closed connections shall not apply to the following types of pumps and pumping equipment:

(1) sucker rod pumps and windmills; and

(2) hand pumps.

(d) A new, repaired, or reconditioned well, or pump installation or repair on a well used to supply water for human consumption shall be properly disinfected. The landowner may waive the disinfection process by submitting a written request to the driller or pump installer in accordance with §238.44 (7) or (8) of this title (relating to Standards of Completion for Wells).

Adopted November 20, 1996 Effective December 18, 1996

SUBCHAPTER F : MISCELLANEOUS PROVISIONS
§§238.80 - 238.83

§238.80. Minimum Standards.

(a) If the party having the well drilled, deepened, or otherwise altered, the licensed well driller, or the party plugging the well, finds any of the procedures prescribed by §§238.41-238.51 of this title (relating to Well Drilling, Completion, Capping, and Plugging) inapplicable, unworkable, or inadequate, combinations of the prescribed procedures or alternative procedures may be employed, provided that the proposed alternative procedures will prevent injury and pollution.

(b) Proposals to use combinations of prescribed procedures or alternative procedures shall be submitted to the executive director for approval prior to their implementation.

Adopted November 20, 1996 Effective December 18, 1996

§238.81. Field Inspection.

The executive director may initiate field inspection and investigation of well drilling, capping, plugging, or completion operations.

Adopted November 20, 1996 Effective December 18, 1996

§238.82. Plugging Responsibility.

A licensed well driller is responsible for assuring that a well which encounters undesirable water or constituents is plugged or completed forthwith pursuant to the following:

(1) Where a person having the well drilled, deepened, or otherwise altered denies a licensed driller access to a well which requires plugging or completion or otherwise precludes the driller from plugging or completing a well which has encountered undesirable water or constituents, the driller shall immediately file a signed statement with the executive director and provide a copy of the statement to the local groundwater conservation district.

(2) The statement shall indicate that:

(A) The driller, or person under his or her supervision, encountered undesirable water or constituents while drilling the well;

(B) The driller has informed the person having the well drilled, deepened, or otherwise altered that undesirable water or constituents were encountered and that the well must be plugged or completed pursuant to this chapter;

(C) The person having the well drilled, deepened, or otherwise altered has denied the driller access to the well;

(D) The reason, if known, for which access has been denied; and,

(E) If known, whether the person having the well drilled, deepened, or otherwise altered intends to have the well plugged or completed

(3) Upon receipt of the statement described in paragraph (2) of this section:

(A) The executive director shall determine whether undesirable water or constituents have been encountered;

(B) If undesirable water or constituents were encountered, the executive director shall determine whether the person having the well drilled, deepened, or otherwise altered intends to have the well plugged or completed within 30 days;

(C) Where a person having the well drilled, deepened, or otherwise altered does not intend to have the well plugged or completed as required by commission rules, or where he or she does not have the well plugged or completed within the prescribed time period, the executive director shall file a complaint before the commission requesting that the person having the well drilled, deepened, or otherwise altered appear before the commission and show cause why the well should not be plugged or completed pursuant to commission rules.

Adopted November 20, 1996 Effective December 18, 1996

§238.83. Complaints.

The commission may assess an administrative penalty, reprimand a licensee, suspend or revoke a license, or take any appropriate action described in Chapters 70 and 80 of this title for violation of Chapters 32 and 33 of the Texas Water Code, or the rules of the commission.

Adopted November 20, 1996 Effective December 18, 1996

TAB

APPENDIX C

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GROUNDWATER SAMPLING PROCEDURES

FINAL
GROUNDWATER SAMPLING PROCEDURES
BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN
NAS FORT WORTH JRB, TEXAS

Prepared for

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

Contract Number F41624-95-D-8005-0033

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Prepared by

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May 2001

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

Page

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LIST OF ACRONYMS AND ABBREVIATIONS

AFCEE	Air Force Center for Environmental Excellence
ASTM	American Society for Testing and Materials
COC	chain of custody
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
EC	electrical conductance
Eh	oxidation-reduction potential
EPA	U. S. Environmental Protection Agency
ERPIMS	Environmental Restoration Program Information Management System
Fe (II)	ferrous iron
GSAP	Groundwater Sampling and Analysis Plan
HydroGeoLogic	HydroGeoLogic, Inc.
IDW	investigative derived waste
LNAPL	light non-aqueous phase liquid
NGVD	National Geodetic Vertical Datum
NTU	nephelometric turbidity unit
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyls
PID	photoionization detector
PM	project manager
QAPP	Quality Assurance Project Plan
QC	quality control
TA	terrace alluvium
TAT	turnaround time
TOC	total organic carbon
VOC	volatile organic compound

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APPENDIX C
GROUNDWATER SAMPLING PROCEDURES

C.1 SITE RECONNAISSANCE AND PREPARATION

Prior to the groundwater sampling event, a site reconnaissance will be performed to check each new well location for accessibility to finalize the sampling sequence and identify storage areas for investigative derived wastes (IDW). Maps detailing vehicle access routes to new well locations will be prepared at this time for field sampling personnel.

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

C.1.1 WELL GAUGING/INSPECTION

Prior to groundwater sampling, wells will be inspected for signs of tampering or other damage. Repairs will be made to the wells in accordance with the well maintenance program in Section 4.0 of the Groundwater Sampling and Analysis Plan (GSAP). If tampering is suspected, (i.e., casing damage, missing locks or caps) this will be recorded in the field log book and on the well sampling form, and reported to the Field Coordinator. Wells that are suspected to have been tampered with will not be sampled until the Field Coordinator has discussed the matter with the Project Manager (PM).

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 to prevent any soil contaminants from contacting sampling equipment. Water will be removed, when present, from the vault around the well casing of flush mounted wells prior to venting and purging. At the moment the well cap is removed, the headspace in the casing will be recorded with a photoionization detector (PID). Procedures in the Health and Safety Plan will be followed when concentrations of organic vapors or explosive gases are detected. Air monitoring data will be recorded on the well sampling form and the field book (Section C.8).

C.1.2 GROUNDWATER LEVEL MEASUREMENTS

Water-level measurements will be taken semi-annually from the majority of wells at the Base to determine the elevation of the water table or potentiometric surface. The wells will be measured consecutively and within the shortest time period possible. These measurements will be taken after all wells 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 book.

Static water levels will be measured with water level meters prior to equipment entering the well. If the casing cap is airtight prior to measurement, time will be allowed for equilibration of the potentiometric surface after the cap is removed. Measurements will be repeated until

the water level is stabilized. 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.

An interface probe will be used if a light non-aqueous phase liquid (LNAPL) layer or dense non-aqueous phase liquid (DNAPL) is suspected in the well. It will be slowly lowered to the groundwater in order to produce the least disturbance to the liquid surface in the casing. The groundwater level will then be measured to the nearest 0.01 foot. The probe will be used to determine the presence of floating product, if any, prior to measurement of the groundwater. Hydrocarbon detection paste or any other method that may affect water chemistry, will not be used. When detected, the presence of LNAPL or DNAPL will be confirmed by withdrawing a sample with a clear, bottom-loading disposable bailer.

Well depths obtained from well logs will be used to estimate the length of the screened water column. All water level and total depth measuring devices will be decontaminated between wells and routinely checked with a tape measure to ensure that measurements are accurate.

C.1.2.1 LNAPL Removal Procedures

If the measured LNAPL thickness is greater than 0.05 feet, product removal will be initiated and continued until no measurable (<0.01 feet) free product remains. 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 or pad 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 C.9.2. A description of the LNAPL removal technique used will be summarized in the groundwater monitoring reports and recommendations included to potentially improve LNAPL recovery efforts. The well will not be sampled until free product removal is complete as indicated by no detectable product in consecutive measurements.

C.2 PURGING PRIOR TO SAMPLING

C.2.1 MICROPURGE

Purging of monitor wells is performed to evacuate water that has stagnated in the well and may not be representative of the surrounding 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 aquifer, horizontally through the

well screen, and into the sampling device. In order to ensure that the most current techniques are employed for low-flow purging and sampling, recommendations as outlined in U.S. Environmental Protection Agency (EPA) research paper entitled *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures (April 1996)* have been adapted where practical to augment current Air Force Center for Environmental Excellence (AFCEE) procedures.

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

C.2.2 DEDICATED PUMPS

Dedicated pumps have been installed in 60 monitoring wells. Dedicated pumps decrease the amount of time required to purge and sample the well by not disturbing the water column and by eliminating the necessity for pump decontamination. Using dedicated equipment also eliminates the need for equipment blanks and excess IDW. In several of the wells, the water table is below the top of the 4-foot pump and cannot be measured without removing the pump. When this occurs, the depth to water will not be recorded; however, the pumps will be removed once per year to determine if siltation of the well is occurring and the water table will be recorded at that time.

If changing the depth of the pump becomes necessary, the pump will be removed from the well and placed directly on a clean sheet of plastic to ensure that contamination to the pump or the surrounding soil does not occur. A new air/water tube, cut to the desired length, will be attached to the dedicated pump. The well will be sampled 24 hours after the pump was removed from the well to ensure that equilibrium has been achieved.

C.2.3 NON-DEDICATED PUMPS

All purging and sampling equipment will be decontaminated according to the specifications in Section C.9.1.3 prior to any sampling activities.

If more than one monitor well is to be sampled using a non-dedicated pump, the wells will be sampled in order of increasing expected contamination. This practice will help reduce the potential for cross contamination between wells. The depth to water and total well depth will be measured, the well records will be examined to determine the placement of the screen, and the pump will be lowered as outlined in Section C.2.4. All sampling activities will be recorded in the field log book. Additionally, all sampling data will be recorded on a Field Sampling Report form. Record-keeping procedures are specified in Section C.8.

C.2.4 PURGING PROCEDURES

Dedicated and non-dedicated pumps will be set at the middle of the saturated 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). A minimum of six inches will be maintained between the bottom of the pump and the bottom of the well. These procedures will minimize the potential mixing of stagnant water trapped in the casing above the screen and the resuspension of solids that have collected at the bottom of the well. When lowering a pump, care will be taken to minimize the disturbance of water and solids in the well casing. Under no circumstances will a pump be lowered beyond the final placement depth, and raised back up. If this should occur, the well will be sampled 24 hours later to ensure that equilibrium has been achieved.

Water levels will be continuously recorded to monitor drawdown in the well and to allow for flow rate adjustment before the maximum drawdown is exceeded. When the placement of the pump inhibits the measurement of the water level in the well, purge rates from previous sample events will not be exceeded and the water discharge line will be closely monitored for air bubbles. If air bubbles are detected at any point during purging, the bladder pump will be shut down and the validity of lowering the pump will be evaluated. The goal is to purge the well at a rate that does not draw down the static water level more than 0.33 feet. Groundwater discharge will be calculated from the flow rate using containers of known volumes during purging. This information will be recorded on the Groundwater Field Sampling Data Sheet.

Temperature, pH, electrical conductance (EC), dissolved oxygen (DO), oxidation-reduction potential (Eh), and turbidity will be measured while purging, and recorded on the Groundwater Field Sampling Data Sheet. Measurements will be taken every three to five minutes when flow rates are in the 0.1-0.5 L/min range. Stabilization is achieved after all parameters have stabilized for three consecutive readings as outlined in Section C.4.1. Water samples will be collected immediately after parameter stabilization using the same pump used in purging. Field equipment will be calibrated in accordance with the Final 2000 Basewide Quality Assurance Project Plan (QAPP) (HydroGeoLogic, Inc. [HydroGeoLogic] 2000b). Once the AFCEE 3.1 QAPP is finalized, HydroGeoLogic will produce a 2001 Basewide QAPP that will supercede the 2000 Basewide QAPP.

For wells known to have a less than 0.1 L/min flow rate, a flow rate of 0.05-0.1 L/min will be attempted. If the drawdown is greater than 0.33 feet using this flow rate, then the micropurge technique is assumed to be invalid and will be discontinued because groundwater flow to the pump is no longer considered to be laminar across the screen within 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 screened casing.

When micropurging is not effective on wells containing at least 1 feet of water, the well construction data will be reevaluated to determine if the well was properly installed within the water bearing unit. If necessary, during the same sampling event, wells will be redeveloped, in accordance with AFCEE procedures. The well will be purged, and a minimum of 24 hours

will be allowed following redevelopment. If redevelopment of the well is not successful in achieving a flow rate conducive to micropurging, the well will be removed from the quarterly sampling event and scheduled for abandonment in accordance with applicable Texas Natural Resources Conservation Commission requirements. Redevelopment and abandonment of monitoring wells will be delayed during a drought.

Water removed from the well during purging will be containerized. Detailed information concerning IDW is presented in Section C.9.2.

C.3 WELL DEVELOPMENT, SURVEYING, AND ABANDONMENT

During the course of the GSAP it may be necessary to survey existing wells, redevelop wells with poor recharge, or abandon wells that are no longer useful or required. The following sections outline the procedures for each activity.

C.3.1 SURVEYING

All locations that are required to be surveyed will be measured by a state of Texas licensed land surveyor as the distance in feet from a reference location that is tied to the state plane system. The surveys will be third order (cf. Urquhart, L.C., 1962 Civil Engineering Handbook, 4th Edition, p. 96 and 97). All surveyed locations will be reported using the Texas State Plane Coordinate System, Texas North Central zone. The datum will be the North American Datum of 1983 and the units will be in U.S. Survey feet. The X-coordinate will be the East-West axis; the Y-coordinate will be the North-South axis. The reference location is the origin. The surveyed control information for all data collection points will be recorded and displayed in a table supplying the ground elevation, and the measuring point elevation. The elevation of all newly installed wells and piezometers will be surveyed at the water level measuring point (notch) on the riser pipe. The elevation of the ground surface at each water level measuring point will be included in the survey. Vertical control will be to the National Geodetic Vertical Datum (NGVD) and will be within 0.01 feet for all sampling locations.

C.3.2 MONITORING WELL DEVELOPMENT/REDEVELOPMENT

The monitoring well development requirements are as follows: (1) all newly installed monitoring wells will be developed no sooner than 24 hours after installation to allow for grout curing, (2) all drilling fluids used during well construction will be removed during development, (3) wells will be developed using surge blocks, bailers, and or pumps (prior approval for any alternate method will be obtained, in writing, from AFCEE before well development begins), and wells will be developed until the turbidity of the well is less than or equal to 10 nephelometric turbidity units (NTU) and remains within a 5 NTU range for at least 30 minutes and the stabilization criteria in Section C.4.1 are met, if a period of 4 hours has elapsed and turbidity has not stabilized at less than 10 NTUs and all other criteria have been meet the development will stop, providing the turbidity is above 40 NTUs (4) discharge water color and volume will be documented, (5) no sediment will remain in the bottom of the well,

(6) no detergents, soaps, acids, bleaches, or other additives will be used to develop a well, and (7) all development equipment will be decontaminated according to the specifications of Section C.9.1.3.

C.3.3 ABANDONING MONITORING WELLS

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

C.4 SAMPLING PROCEDURES

C.4.1 SAMPLE COLLECTION

At newly developed wells, groundwater samples will be collected after a minimum 24-hour period has elapsed from the conclusion of monitoring well development or redevelopment activities. If a pump has been raised, groundwater samples will be collected 24 hours after the depth to the dedicated pump has been changed.

Groundwater samples will be collected after the critical water quality indicators have stabilized for three consecutive readings. Stabilization will be defined as follows (EPA, 1996):

- temperature $\pm$ 1° C
- pH $\pm$0.1 units
- EC $\pm$3 %
- DO $\pm$ 0.10 mg/L or 10% of value (whichever is greater)
- Eh $\pm$10 mV, and
- turbidity $\pm$ 10 % or less than 10 NTUs

Turbidity readings below 10 NTUs are desired, especially when metal samples are to be collected. When turbidity is high, the purge time will be extended in order for turbidity to reach 10 NTUs; however, if turbidity stabilizes above 10 NTUs for 15-30 minutes, then turbidity will be considered stable as defined above. Groundwater samples will be collected using the same pump used in the purging procedure. If the parameters do not stabilize after one to two hours when the drawdown indicates a laminar flow, a subset (pH, EC, and turbidity or DO) will be used as the stabilization parameters. If subset parameters do not stabilize, then the sample will be collected when a maximum number of parameters stabilize, and the

anomalous parameters will be brought to the Field Coordinator's attention. Field equipment will be calibrated in accordance with the Final 2000 Basewide QAPP (HydroGeoLogic, 2000b) and Section C.9.1.1 of this document.

Before sample collection, the flow through chamber used to measure parameters will be disconnected and the flow rate adjusted to maintain the established purge rate. VOC sample bottles will be pre-preserved by the laboratory. The sample will be collected from the pump discharge line using a slow, controlled pour down the side of a tilted sample vial to minimize volatilization and loss of preservative. The sample vial will be filled until a meniscus is visible and the sample vial will be immediately sealed. When the bottle is capped, it will be inverted and gently tapped to ensure that no air bubbles are present in the vial. If, after the initial filling bubbles are present, the vial will be discarded and the VOC sampling effort will be repeated. If repeated attempts result in VOC samples containing air bubbles, the laboratory will be contacted to see if they can meet the turnaround time (TAT) required for analysis of non-preserved VOC samples (7 days). If the laboratory can meet the TAT, the VOC samples will not be preserved for any samples meeting this criteria. After the containers are sealed, sample degassing may cause bubbles to form. These bubbles will be left in the container. These samples will never be re-opened, composited, homogenized, or filtered.

Following the collection of VOC samples, the remaining water samples will be collected in the following order: semi-volatile organic compounds, including polynuclear aromatic hydrocarbons (PAHs); organochlorine pesticides/polychlorinated biphenyls (Pest/PCBs); organophosphorus pesticides; herbicides; dioxins/furans; metals, including mercury and cyanide; total organic carbon (TOC); methane; ferrous iron (Fe (II)); alkalinity; and common anions.

Any further sample preservation completed in the field will involve the addition of preservative from pre-measured vials provided by the laboratory. Field confirmation of preservation will not be required. Field filtering of metals will not occur.

Required sample containers, preservation methods, volumes and holding times are given in Table C.1. Sampling equipment will be decontaminated in accordance with Section C.9.1.3 upon completion of sampling activities.

C.4.2 ANALYTICAL METHODS

All analytical methods specified in the GSAP can be found in the Final 2000 Basewide QAPP (HydroGeoLogic, 2000b), with the exception of Fe (II) analysis for groundwater. The Fe (II) analyses are necessary as part of the data required to evaluate the effectiveness of natural chemical attenuation processes. The Fe (II) content in a water sample is determined using a HACH® spectrophotometer. Approximately 100 mL of sample is collected in a glass container. An ampule containing a premeasured reagent in a vacuum seal is inverted in the glass container and broken to allow the sample to be drawn into the ampule and mix with the reagent. The ampule is inserted into the portable spectrophotometer when the allotted mixing

time has elapsed and the results are recorded in the field book and the Groundwater Field Sampling Data Sheet.

C.5 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.

C.5.1 SAMPLE CONTAINERS

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

C.5.2 SAMPLE VOLUMES, CONTAINER TYPES, AND PRESERVATION REQUIREMENTS

Sample volumes, container types, preservation requirements, and holding times for the specific analytical methods performed on the samples are listed in Table C.1. Sample holding time tracking begins with the collection of samples and continues until the analysis is complete.

C.5.3 SAMPLE IDENTIFICATION

Each sample collected will be assigned a unique sample identification number. The unique Environmental Restoration Program Information Management System (ERPIMS) well identification will be used for each sample. Sample containers will be labeled with the sample number and will be entered on the Chain of Custody (COC) form. To eliminate any bias by the laboratory, the relationship between the unique sample identification number for duplicate samples and the associated samples will be known only to HydroGeoLogic.

The following information will be written on the field sampling report and on the sample label when samples are collected for laboratory analysis:

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

Each sample will be assigned a unique identification number that describes where and what type of sample was collected. The number that will be used in the field will consist of a maximum 13 digit alphanumeric code. Once data is ready to be entered into the ERPIMS database, the alphanumeric code will be truncated to 10 digits. This system is explained in detail as follows:

xxxxxxxxxzzaa

where:

xxxxxxxxx represents the well identification or well name (e.g., WHGLTA025)

zz represents the medium (WG for water-ground)

aa indicates the sampling event number for groundwater, surface water, and soil (e.g., 01, 02, 03, etc.)

For example, the groundwater sample collected from monitoring well WHGLTA025 during the April 2001 sampling event would be WHGLTA025WG14. Duplicate samples will be submitted to the laboratory blind. Duplicate samples will be assigned consecutive numbers in the office such as DUP01WG14, DUP02WG14, etc. A note in the field log book and the Field Sampling Report Form will identify the location and sample number that has been duplicated.

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

xxyyyyyy

where:

xx represents medium (e.g. EB for equipment blank, TB for trip blank, and AB for ambient blank)

yyyyyy represents the date (month, day, year)

For example, an equipment blank collected on the 15th day of April in the year 2001 would be "EB041501."

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

C.5.4 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. Custody and condition of the samples are maintained in field and laboratory records.

HydroGeoLogic shall maintain COC 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, or (4) it is in a designated secure area.

All sample coolers will be sealed in a manner that will discourage tampering. Samples will not be packaged with activated carbon.

The following minimum information concerning the sample will be documented on the COC form:

- Unique COC identification number
- Unique sample identification number
- Date and time of sample collection
- Designation of matrix spike/matrix spike duplicate
- Designation of serial dilution (metals only)
- Preservative used, if any
- Analyses required
- Name of collector(s)
- Serial numbers of custody seals and transportation cases (if used)
- Custody transfer signatures and dates and times of sample transfer from the field to transporters and to the laboratory or laboratories
- Bill of lading or transporter tracking number (if applicable)
- Matrix type
- Number of containers/sample

All samples will be uniquely identified, labeled, and documented in the field at the time of collection in accordance with Section C.5.3 of this Appendix. 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 (40 mL VOA vial filled with water) will be included in every cooler and to determine the internal temperature of the cooler upon receipt of the cooler at the laboratory.

Table C.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 chromium (VI) and mercury)	SW6010B SW6020 (ICP) and SW7000A series (AA methods)	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	180 days (water and soil)
Chromium (VI)	SW7196A	P, G, T	4°C	500 mL or 8 ounces	24 hours (water and soil)[d]
Mercury	SW7470A SW7471A	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	28 days (water and soil)
Chlorinated herbicides	SW8150B or SW8151A	G, 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	SW9012A	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	SW8280A SW8290	G, T	4°C, 0 008% $Na_2S_2O_3$ (Kept Dark)	1 liter or 8 ounces	30 days until extraction and 45 days after extraction (water and soil)
Organochlorine pesticides and polychlorinated biphenyls (PCBs)	SW8080A SW8081A, and SW8082	G, 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)
Organophosphorus Pesticides	SW8141A	G, T	4°C, pH 5-9	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Total Organic Carbon	SW9060 SW9060M	P, G, T	4°C; HCL or H_2SO_4 to pH < 2	500 mL or 4 ounces	28 days (water and soil)
Methane Ethane Ethene	RSK-175	G, T	4°C; HCL or H_2SO_4 to pH < 2	2 x 40mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid
Ferrous Iron	Per test kit instructions	G	NA	NA	Field method- analyze immediately
Alkalinity	E310.1	P, G	4°C	50 mL	14 days

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

Name	Analytical Methods	Container[a]	Preservation[b, c]	Minimum Sample Volume or Weight	Maximum Holding Time
Common Anions	SW9056 (*or* E300.0)	P, G	none requested	50 mL	28 days for Br^-, F^-, Cl^- and SO_4^{-2}; 48 hours for NO_3^-, NO_2^-, and PO_4^{-3}
Semivolatile organics/PAHs	SW8270C/ SW8310	G, T	4°C, 0.008% $Na_2S_2O_3$ (store in dark)	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 (including BTEX and MTBE)	SW80201A, SW8260B	G	4°C, 0.008% $Na_2S_2O_3$ (HCl to pH < 2	2 x 40 mL	14 days; 7 days if unpreserved by acid (water)

Notes:

[a] Polyethylene (P); glass (G) with Teflon® - lined cap (amber glass for water samples), unless otherwise noted; 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 0.6 g ascorbic acid is only required when residual chlorine is present.

[d] The maximum recommended holding time for completion of extraction into water is 48 hours. The extract shall be analyzed within 24 hours of completion of extraction.

C.6 FIELD QUALITY CONTROL SAMPLES

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

C.6.1 AMBIENT BLANK

The ambient blank consists of American Society for Testing and Materials (ASTM) Type II reagent-grade water poured into a VOC sample vial at the sampling site in the same vicinity as the associated samples. It is handled like an environmental sample and transported to the laboratory for analysis. Ambient blanks are prepared only when VOC samples are collected and are analyzed only for VOC analytes.

Ambient blanks are used to assess the potential introduction of contaminants from ambient sources (e.g., active runways, engine test cells, gasoline motors in operation, etc.) to the samples during sample collection. An ambient blank will be collected downwind of any possible VOC sources when ambient sources are proximal to the sample site.

C.6.2 EQUIPMENT BLANK

An equipment blank is a sample of ASTM Type II reagent-grade water poured into or over, or pumped through a 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 collected on each day that decontamination of sampling equipment occurs. Equipment blanks will be collected immediately after the equipment has been decontaminated. The blank will be analyzed for all laboratory analyses requested for environmental samples collected that day.

C.6.3 TRIP BLANK

Trip blanks consist of a VOA 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 samples are collected and are analyzed only for VOC analytes. Trip blanks are used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures. One trip blank will accompany each cooler containing samples to be analyzed for VOCs.

C.6.4 FIELD DUPLICATES

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously, or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field so that

they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection. Ten percent of all water samples will be field duplicates.

C.7 FIELD PERFORMANCE AND SYSTEM AUDITS

The Task Manager, 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
- Decontamination procedures

The first three items above will be checked for completeness. Sampling and decontamination operations will be reviewed to determine if they are performed as stated in the project-specific work plan, or as directed by the Task Manager. 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 PM and Task Manager during the first week of sampling if deemed necessary by the PM, Task Manager, 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 Task Manager 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 log book
- 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.

C.8 RECORD KEEPING

Field records sufficient to recreate all sampling and measurement activities, and to meet all ERPIMS 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 contracting office representative 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. In addition to this information, the following information will be recorded each time a well is purged and sampled: (1) depth to water before, during, and after purging, (2) the total depth of the well (if accessible), (3), depth to the top of the pump and the screened interval, (4) the condition of each well, (5) the thickness of any LNAPL or DNAPL layer and, (6) field parameters, such as pH, DO, temperature, EC, Eh, and turbidity. This information will be encoded in ERPIMS files when required.

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 as an attachment.

C.9 FIELD OPERATIONS

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

C.9.1 EQUIPMENT MAINTENANCE, CALIBRATION, AND DECONTAMINATION

C.9.1.1 Equipment Calibration And Quality Control

All equipment will be calibrated according to manufacturers' instructions outlined in the Final 2000 Basewide QAPP (HydroGeoLogic, 2000b). Calibration of all instruments will be conducted at the start of each day of sampling and the information will be recorded on the calibration log. Field parameters (temperature, pH, EC, DO, Eh, and turbidity) will be

measured using a flow through chamber in line with the pump during purging. Specific calibration procedures are outlined below.

- Temperature and ORP do not require field calibration. Proper maintenance of the probes will ensure consistent measurements and when discrepancies are noted, the probes will be returned to the manufacturer for repair and calibration.

- The pH will be field-calibrated with two buffer solutions which include the range of actual groundwater pH measurements. 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.

- The EC probe will be calibrated with a 1,000 microsiemen solution.

- The DO probe will be calibrated with a 100% saturated environment. The probe will be checked for potential drift at the end of each day.

- Turbidity will be measured with a nephelometer (also known as a turbidimeter). It will be calibrated using a set of laboratory certified calibration vials.

- The hand-held portable PID is used to screen the air vapors when the well casing cap is removed and monitor the breathing zone. It will be calibrated daily with 100-ppm isobutylene in air standard.

C.9.1.2 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 Manager, who 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.

C.9.1.3 Decontamination of Field Equipment

Decontamination areas as necessary for personnel and portable equipment will be set up at each well location, and at the field office. The flow through chamber will be decontaminated at the end of the sample event according to the manufacturer's directions. The probes of the temperature, pH, EC, DO, Eh, and turbidity will be rinsed with ASTM reagent-grade water at the end of each day. The measurement vials for the turbidity meter will be rinsed with deionized water before and after each use and the vials will be decontaminated at the end of the sampling event. A mild acid, such as vinegar, will be used to remove any water stains. No decontamination is required for the PID.

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, pumps, interface probes, and water level meters. 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 that can be hand-manipulated. The equipment will be scrubbed with a solution of potable water and Alconox, or equivalent laboratory-grade detergent. The equipment will then be rinsed with copious quantities of potable water followed by a ASTM Type II reagent-grade water. High pressure liquid chromatograph-grade water and distilled water purchased in stores are not acceptable substitutes for ASTM Type II reagent-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.

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. HydroGeoLogic will assure that these materials remain free of contaminants. If any question of purity exists, new materials will be used. All fluids generated during decontamination will be handled in accordance with section C.9.2.

C.9.2 WASTE HANDLING

Waste handling will be dealt with on a site-by-site basis. Waste will be classified as either non-investigative waste or investigative waste per the requirements of 30 TAC §335 Subchapter R and 40 CFR Part 261, Subpart C. Non-investigative waste, such as litter and household garbage, will be collected as-needed to keep each site clean and orderly. 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.

All purge water from on-site monitor wells and decontamination fluids will be containerized for disposition either on- or off-site in accordance with ARARs. Liquid waste will be temporarily stored at the site in 55-gallon drums or in a large aboveground storage tank, and subsequently transported to a waste storage area designated by the AFCEE.

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

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, United Nations-approved steel 55-gallon drums or combined in a large aboveground storage tank. The containers will be transported in such a manner as to prevent spillage. To facilitate handling, the containers will be no more than half full when moved.

Each container will be properly labeled with site identification, monitoring well identification, date, matrix, constituents of concern, and other pertinent information for handling.

C.9.3 SITE RESTORATION

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.

ATTACHMENT

FIELD FORMS

GROUNDWATER FIELD SAMPLING DATA SHEET

631 195

Well No.:		Location:	NAS Fort Worth JRB, Texas
Sampler (s)		Project Name	Semi-Annual Sampling
Well Depth:		Project #	AFC001-33 Date: Time:
DTW (ft):	DTP (ft).	Courier:	__X__FedEx ____UPS ____Hand ____Othe
MP Ht Above/Below GS:		Sampling Method :	Low Flow
Condition of Bottom of Well		Type of Pump:	Bladder
Screen Interval (ft):		Weather (sun/clear, overcast/rain, wind direction, ambient temperature):	
Well Diameter (in)			
Placement of Pump Inlet (ft):			

Field Parameters

Time	Depth to Water (ft)	Flow Rate (L/min)	Total Volume (L)	pH	Temp. (C)	Cond. (umhos/cm)	ORP (mv)	DO (mg/L)	Turb. (NTU)	Type, Size, and Amount of Sediment Discharged

Observations

Color: Clear Other (describe):
Odor None Low Medium High Very Strong H2S Fuel-like
Notes:
Signed/Sampler(s)

631 196

HYDRO GeoLogic INC

FIELD SAMPLING REPORT

LOCATION: NAS Fort Worth JRB, Texas PROJECT NAME Semi-Annual GW Sampling

SITE. _____ PROJECT NAME AFC001-33

SAMPLE INFORMATION

SAMPLE ID: DATE:_____ TIME:_____

MATRIX TYPE: WG WG

SAMPLING METHOD: Low Flow

LOT CONTROL #. ___ ___ ___ ___

(Ambient Blank # - Equipment Blank # - Trip Blank # - Cooler

CHAIN-OF-CUSTODY #:

SAMPLE BEG DEPTH (FT) N/A

SAMPLE END DEPTH (FT). N/A

GRAB (X) COMPOSITE ( )

ENTER SAMPLE NUMBERS FOR QC SAMPLES/ BLANKS ASSOCIATED WITH THIS SAMPLE:

MATRIX SPIKE (MS) _____

MATRIX SPIKE DUP (SD) _____

FIELD DUP (FD) _____

AMBIENT BLANK (AB) _____

EQUIPMENT BLANK (EB) _____

TRIP BLANK (TB) _____

CONTAINER SIZE/TYPE	#	PRESERVATIVE/ PREPARATION	ANALYTICAL METHOD	ANALYSIS

NOTABLE OBSERVATIONS

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

pH _____ Temperature _____(C) Dissolved Oxygen _____(mg/L) Conductivity _____(umhos/cm)

Iron _____(mg/L) Oxidation/Reduction Potential _____(mv) Turbidity_____ (NTU)

GENERAL INFORMATION

WEATHER SUN/CLEAR_____ OVERCAST/RAIN_____ WIND DIRECTION_____ AMBIENT TEMPERATURE

SHIPMENT VIA FEDEX __x__ HAND DELIVER _____ COURIER _____ OTHER _____

SHIPPED TO STL -Chicago

COMMENTS

SAMPLER _____ OBSERVER _____

MATRIX TYPE CODES		SAMPLING METHOD CODES	
DC=DRILL CUTTINGS	SL=SLUDG	B=BAILER	G=GRAB
WG=GROUND WATER	SO=SOIL	BP=BLADDER PUMP	HA=HAND AUGER
LH=HAZARDOUS LIQUID WAST	GS=SOIL GAS	BR=BRASS RING	H=HOLLOW STEM AUGER
SH=HAZARDOUS SOLID WAST	WS=SURFACE WATE	CS=COMPOSITE SAMPLE	HP=HYDRO PUNC
SE=SEDIMENT	SW=SWAB/WIPE	C=CONTINUOUS FLIGHT AUGER	SS=SPLIT SPOON
		DT=DRIVEN TUBE	SP=SUBMERSIBLE PUMP

HYDRO GeoLogic

WELL DEVELOPMENT RECORD

WELL/PIEZOMETER ID _____
SHEET _____ of _____

AFIID: _____ LOCID. _____ SITEID _____

PROJECT NAME _____ PROJECT NO. : _____ DATE: _____

LOCATION. _____ DATE INSTALLED: _____

TOTAL DEPTH (FTOC) _____ CASING DIAMETER _____ LOGCODE. HGL-H

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

Static Water Level Depth (C) _____ ft

Length of Static Water Colume (D) _____ (B) - _____ (C) = _____ ft.

Casing Water Volume (E) = _____ (A) x _____ (D) = _____ gal

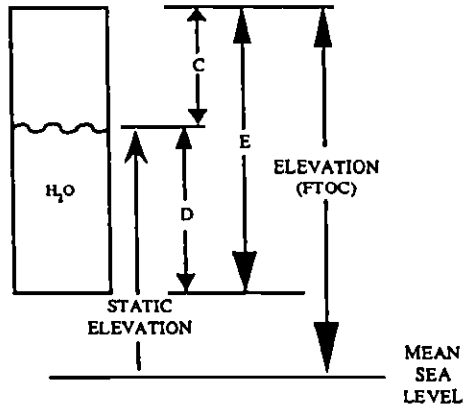
Total Purge Volume = _____ (gal)

Pumping/Purge Rate (PRODRATE) = _____ (gal/min)

Pumping Depth (PUMPDEP) = _____ (ft)

Water Level Recovery Depth (DEPWAT) = _____ (ft)

Recovery Time (LECTIME) = _____ (min)



Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC	Temperature °F or °C	Turbidity (NTU)	Comments

TAB

APPENDIX D

APPENDIX D

HEALTH AND SAFETY PLAN

FINAL
HEALTH AND SAFETY PLAN
BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN
NAS FORT WORTH JRB, TEXAS

Prepared for

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

May 2001

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FINAL
HEALTH AND SAFETY PLAN
BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN
AT NAS FORT WORTH JRB, TEXAS

PROJECT:	U.S. Air Force Center for Environmental Excellence
PROJECT NUMBER:	Contract No. F41624-95-D-8005-0033 HydroGeoLogic Project No. AFC001
PROJECT SITE LOCATION:	NAS Fort Worth JRB, Texas
PROJECT MANAGER:	Todd Harrah
HEALTH AND SAFETY OFFICER:	James Heringer
SITE SAFETY OFFICER:	TBA
PLAN PREPARERS:	Michael J. Rodtang, P.G., Kenneth J. Hurley
PLAN REVIEWER:	James Heringer
PREPARATION DATE:	May 2001

APPROVED BY:

5/4/01

James Heringer — Date
HydroGeoLogic, Inc.
Health and Safety Officer

Todd Harrah 5/14/01

Todd Harrah — Date
HydroGeoLogic, Inc.
Project Manager

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TABLE OF CONTENTS

Page

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ANSI	American National Standards Institute
°C	degrees Celsius
CFR	Code of Federal Regulations
COR	contracting officer's representative
CPC	chemical protective clothing
CPR	cardiopulmonary resuscitation
dB	decibel
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
FAR	Federal Acquisition Regulations
FSP	Field Sampling Plan
GSAP	Groundwater Sampling and Analysis Plan
HAZWOPER	Hazardous Waste Site Operations and Emergency Response
HCS	hazard communication standard
HPS	hantavirus pulmonary syndrome
HSO	Health and Safety Officer
HSP	Health and Safety Plan
HydroGeoLogic	HydroGeoLogic, Inc.
IDLH	immediately dangerous to life and health
IDW	investigation derived waste
LEL	lower explosive limit
MSDS	Material Safety Data Sheet
NAS Fort Worth JRB	Naval Air Station Fort Worth Joint Reserve Base
NIOSH	National Institute for Occupational Safety and Health
O_2	oxygen
OSHA	Occupational Safety and Health Administration

LIST OF ACRONYMS AND ABBREVIATIONS (continued)

PEL	permissible exposure limit
PID	photoionization detector
PM	Project Manager
POC	point of contact
PPE	personal protective equipment
ppm	parts per million
PVC	polyvinyl chloride
RCO	Responsible Corporate Officer
SSO	Site Safety Officer
T	ambient air temperature
T_{aj}	adjusted air temperature
TCE	trichloroethene
TLV	Threshold Limit Value
UEL	upper explosive limit
	United Nations
USCG	U.S. Coast Guard
WP	Work Plan

FINAL
HEALTH AND SAFETY PLAN
BASEWIDE GROUNDWATER SAMPLING AND ANALYSIS PLAN
NAS FORT WORTH JRB, TEXAS

1.0 INTRODUCTION

1.1 PURPOSE

This Health and Safety Plan (HSP) is designed to assign responsibilities, establish personnel protection standards, specify mandatory operating procedures, and provide for emergency contingencies with respect to health and safety issues that may arise while HydroGeoLogic, Inc. (HydroGeoLogic) personnel and subcontractor personnel are engaged in site investigation activities at the former Carswell Air Force Base, now referred to as the Naval Air Station Fort Worth Joint Reserve Base (NAS Fort Worth JRB), located in Fort Worth, Texas. The request for these activities was identified in the statement of work dated January 21, 1997, under the authorization of the Air Force Center for Environmental Excellence (AFCEE) Contract Number F41624-95-D-8005, Delivery Order Number 0033. This HSP conforms to the requirements of the Occupational Safety and Health Administration (OSHA) Standard 29 Code of Federal Regulations (CFR) 1910 and 1926. Detailed OSHA requirements for hazardous waste operations are contained in OSHA Standard 29 CFR 1910.120 and OSHA Standard 29 CFR 1926.65, "Hazardous Waste Operations and Emergency Response (HAZWOPER)." Additional guidance for hazardous waste operations may be found in the U.S. Environmental Protection Agency (EPA) publication "Standard Operating Safety Guides" (November 1987), the National Institute for Occupational Safety and Health (NIOSH)/OSHA/U.S. Coast Guard (USCG)/EPA publication "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" (October 1985), and the Federal Acquisition Regulations (FAR) clause 52.236-13, Accident Prevention.

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

1.2 APPLICABILITY

The provisions of the HSP are mandatory for all official visitors, HydroGeoLogic employees, and subcontractors while investigations are being conducted at NAS Fort Worth JRB. This HSP applies to groundwater sampling of existing monitoring wells to evaluate the nature and extent of potential contamination basewide. Inadequate health and safety precautions on the part of visitors or subcontractors, or the belief that personnel on the site are or may be exposed to an immediate health hazard, can be cause for HydroGeoLogic to suspend on-site activities and require all personnel to evacuate the area of concern.

1.3 PROJECT ORGANIZATION, PERSONNEL, AND RESPONSIBILITIES

This section presents HydroGeoLogic's personnel organization for this project and establishes the roles and responsibilities of various project personnel concerning site health and safety. The authority and responsibilities of each HydroGeoLogic individual utilized for this project are presented in the following subsections.

1.3.1 Responsible Corporate Officer

The Responsible Corporate Officer (RCO) for this project will be Dr. Peter Huyakorn (Executive President). The RCO has authority to direct changes to the corporate health and safety program and determines and implements personnel disciplinary actions, as required. The RCO's responsibilities for this project will be to:

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

1.3.2 Health and Safety Officer

The Health and Safety Officer (HSO) for this project will be Mr. James Heringer. The HSO will have the authority to:

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

The HSO for this project will perform the following activities:

- Interface with the Project Manager (PM) in matters of health and safety.
- Keep the RCO and PM informed on the status of the site health and safety plan.

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

1.3.3 Project Manager

The Project Manager (PM) for this project will be Mr. Todd Harrah. The PM has the authority to:

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

The PM for this project will perform the following activities:

- Ensure that the project is performed in a manner consistent with the health and safety program.
- Ensure that the project health and safety plan is prepared, approved, and properly implemented.
- Provide the HSO with the information needed to develop health and safety plans.

- Ensure that adequate funds are allocated to implement project health and safety plans fully.

1.3.4 Site Safety Officer

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

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

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

- Ensuring that all air monitoring and equipment calibrations required by the HSP are preformed and recorded, and that logs/forms that include these activities are maintained (Section 14.1).

- Ensuring that all subcontractors' medical monitoring programs are adequate per OSHA Standard 29 CFR 1910.120 and this document.

- Verifying OSHA 40-hour health and safety training before admitting official site visitors (e.g., Air Force and regulatory representatives) into any work exclusion zone.

1.3.5 Project Field Personnel

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

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

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

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

1.3.6 Subcontractor Responsibilities

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

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2.0 SITE DESCRIPTION INFORMATION

Detailed descriptions of the NAS Fort Worth JRB sites are presented in Section 2.0 of the Draft Final 2001 Basewide Groundwater Sampling and Analysis Plan (GSAP) (HydroGeoLogic, 2001). Please refer to this section for detailed site description information.

NAS Fort Worth JRB is a parcel of the former Carswell AFB that officially closed on September 30, 1993. NAS Fort Worth JRB is bounded on the north by Lake Worth, on the east by Highway 183 and industrial acreage, on the south by Carswell AFB property that is being converted for public redevelopment, and on the west by the base runways and AFP 4. NAS Fort Worth JRB is presently composed of personnel and equipment from three naval air stations.

The areas of interest for this investigation are the northern and southern regional lobes of the trichloroethene (TCE) groundwater plume, as well as benzene, toluene, ethylbenzene, and xylene contamination at Area of Concern 1. Additional contaminants of concern associated with the TCE plumes are *cis*-1,2-dichloroethene and vinyl chloride.

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3.0 SITE INVESTIGATION ACTIVITIES

The field activities to be conducted at the NAS Fort Worth JRB are explained in Appendix C of the GSAP and will include:

- Well inspection and water level measurements.
- Well maintenance.
- Well purging and groundwater sampling with a low-flow bladder pump.
- Investigation derived waste (IDW) management.

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4.0 HAZARD ASSESSMENT

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

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

4.1 CHEMICAL HAZARDS

The primary concerns from a chemical exposure standpoint are inhalation, ingestion, and absorption by direct skin contact with contaminants in locations expected to be source areas. Based upon the information obtained from previous site investigations (groundwater and soil), the primary chemicals of concern at NAS Fort Worth JRB have been identified and are listed in Table 4.1, along with their exposure limits and recognition properties. The acute and chronic symptoms of overexposure to these chemical contaminants and first aid procedures are presented in Table 4.2. If additional contaminants are identified as being present at the sites under investigation, this HSP will be amended accordingly.

4.2 DECONTAMINATION SOLUTIONS AND PRESERVATIVES

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

- Sodium hydroxide
- Sulfuric acid
- Nitric acid
- Hydrochloric acid
- Methanol
- Hexane
- Alconox™

Although overexposure to these chemicals is unlikely, they are included in Tables 4.1 and 4.2.

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

4.3 PHYSICAL HAZARDS

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

- Hot or cold work environments (stress)
- Noise hazards
- Materials handling
- Utility hazards
- Fall, trip, and slip hazards (Section 11.0)
- Heavy equipment/vehicular activity (Section 11.0)

Control measures to help protect site personnel from these potential hazards are incorporated in the following subsections and throughout this HSP.

4.3.1 Heat Stress

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

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

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

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

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

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

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

- If oral temperature exceeds 99.6 degrees Fahrenheit (°F) (37.6 degrees Celsius (°C)), shorten the next work cycle by one-third without changing the rest period.

- If oral temperature still exceeds 99.6 °F (37.6 °C) at the beginning of the next rest period, shorten the following work cycle by one-third.

- Do not permit a worker to wear a semipermeable or impermeable garment when his/her oral temperature exceeds 100.6 °F (38.1 °C).

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

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

- Worker's body fluids should be maintained at normal levels to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water in sweat, which will vary from day to day. The normal thirst mechanism is not sensitive enough to ensure that water intake is sufficient to replace lost sweat. When heavy sweating occurs, the worker should be encouraged to drink more. Have workers drink fluid (preferably water or diluted drinks) before beginning work. Urge workers to drink a cup or two at each scheduled break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day is recommended, but will depend on actual fluid replacement needs, which will vary depending on the sweat rate.

- The drinking water temperature should be maintained at 50 °F to 60 °F (10 °C to 15.6 °C).

- Disposable cups that hold about 16 ounces should be provided.

- Encourage workers to maintain an optimal level of physical fitness. Where indicated, acclimatize workers to site work conditions.

- Train workers to recognize, identify, and treat heat stress.

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

- Get the victim out of the heat.

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

4.3.2 Cold Stress

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

The following are the five degrees of cold stress in increasing order of severity:

- Incipient frostbite is a mild form of cold stress characterized by sudden blanching or whitening of the skin.
- Chilblain is an inflammation of the hands and feet caused by exposure to cold moisture. It is characterized by a recurrent localized itching, swelling, and painful inflammation of the fingers, toes, or ears. Such a sequence produces severe spasms, accompanied by pain.
- Second-degree frostbite is manifested by skin with a white, waxy appearance that is firm to the touch. Individuals with this condition are generally not aware of its seriousness, because the underlying nerves are frozen and unable to transmit signals to warm the body. Immediate first aid and medical treatment are required.
- Third-degree frostbite will appear as blue, blotchy skin. The tissue is cold, pale, and solid. Immediate medical attention is required.

- Hypothermia develops when body temperature falls below a critical level. In extreme cases, cardiac failure and death may occur. Immediate medical attention is warranted when the following symptoms are observed: involuntary shivering; irrational behavior; slurred speech; and sluggishness.

To care for any frostbite, handle the area gently. Never rub an affected area because rubbing causes further damage to soft tissues. Warm the affected area gently by soaking the affected part in water no warmer than 105 °F. Keep the frostbitten part in the water until it looks red and feels warm. Loosely bandage the affected area with a dry, sterile dressing. If fingers or toes are frostbitten, place cotton or gauze between them. Do not break any blisters caused by frostbite. Obtain professional medical attention as soon as possible.

To care for hypothermia, start by caring for any life-threatening problems and call for emergency medical assistance. Remove any wet clothing and dry the victim. Warm the body gradually by wrapping the victim in blankets or putting on dry clothing and moving him or her to a warm place. If available, apply heat pads or other heat sources to the body, but be sure to keep a barrier such as a blanket, towel, or clothing between the heat source and the victim to avoid burning the victim. If the victim is alert, give warm liquids to drink. Do not warm the victim too quickly, such as by immersing the victim in warm water, because rapid rewarming can cause dangerous heart problems. In cases of severe hypothermia, the victim may be unconscious. Should the victim stop breathing, give rescue breathing and be prepared to administer cardiopulmonary resuscitation (CPR).

4.3.3 Noise Hazards

The SSO, or designee, will monitor high noise levels when heavy equipment or machinery is being used on-site or when nearby base activities (e.g., active runways, construction) cause a potential noise hazard. Whenever jet aircraft are being tested, the noise level is far in excess of 85 dB. Personnel in the proximity of the airfield are exposed to these noise levels. Field personnel working in areas where noise levels can be expected to reach or exceed 85 decibels (dB) will be issued and will be required to wear hearing protection to reduce the level below the 85 dB threshold. Compliance standards for occupational noise exposure are found in 29 CFR 1910.95.

4.3.4 Materials Handling

The most common type of materials handling accident involves fingers or toes of field personnel becoming caught between two objects. Special precautions must be implemented during the moving, shifting, or rolling of materials. These activities should never be attempted by a single individual. Workers are required to use proper lifting techniques for handling materials, and oversize or heavy loads require "team lift" procedures or mechanical assistance (lift gates, drum dollies, etc.).

4.3.5 Utility Hazards

The locations of all underground utilities must be identified and marked prior to initiating any subsurface investigations.

4.4 BIOLOGICAL HAZARDS

The biological hazards that could be encountered by site personnel include, but are not limited to, the following:

- Poisonous Animals
- Ticks
- Animal-Borne Diseases
- Poisonous Plants (e.g., poison sumac, poison ivy, poison oak)

Control measures to protect site personnel from these biological hazards are included in the following sections.

4.4.1 Poisonous Animals

Poisonous animals that pose a potential threat at NAS Fort Worth JRB include snakes, insects (fire ants, bees, wasps), and spiders. Rattlesnakes are the most common poisonous snake in the area. Reactions from a snakebite are aggravated by acute fear and anxiety. Other factors that affect the severity of local and general reaction from a poisonous snakebite include the amount of venom injected and the speed of absorption of venom into the victim's circulation; the size of the victim; protection provided by clothing, including shoes and gloves; quick anti-venom therapy; and location of the bite. Poisoning can occur from injection or absorption of venom through cuts or scratches. Personnel should avoid walking in grass or underbrush at night and not climb rocky ledges without prior visual inspection. Field personnel should wear high-top boots and heavy pants since more than half of all snakebites are on the lower parts of the legs. Workers should not attempt to kill snakes unnecessarily as many people are bitten in such attempts.

Biting and stinging insects, such as fire ants, bees, and wasps, are very common. Generally, the bite and stings from these insects, although painful, are not dangerous; however, if bitten or stung by a large number of these insects, an individual may experience serious injury or even death. This is especially true of individuals who are particularly sensitive or allergic to insect toxins. Most of these insects live in easily recognizable nests, but many are encountered far from their nest. Care should be taken when entering little-used structures (sheds, utility buildings) and when opening monitoring well covers.

Spiders in the United States are generally harmless, with two notable exceptions: the black widow spider (*Latrodectus mactans*) and the brown recluse or violin spider (*Lox osceles reclusa*). The symptoms of a black widow spider bite are slight local reaction, severe pain produced by nerve toxin, profuse sweating, nausea, painful cramps in abdominal muscles, and difficulty in breathing

and speaking. The symptoms of a brown recluse spider bite can be mild to severe. In the mildest form, the bite can cause pain and swelling like a bee sting or ant bite. If the reaction is severe, the bite area may become swollen, painful, and weep fluid. Swelling and reddening may spread to an entire limb, and if left untreated, the bite may cause necrosis of surrounding tissue and infection. Diarrhea, stomach cramps, and hot/cold flashes may also occur. Victims of poisonous spider bites recover in almost all cases, but an occasional death is reported.

Field personnel should exercise caution when lifting items such as logs, rocks, covers to manholes, and sump covers where poisonous animals could be encountered.

4.4.1.1 First Aid Procedures (Snakebite)

The objective of first aid is to reduce the circulation of blood through the bite area, delay absorption of venom, prevent aggravation of the local wound, and to sustain respiration. Several steps are listed to properly care for a snakebite victim. The most important step is to get the snakebite victim to the hospital quickly. In addition, take the following first aid measures:

- Keep the victim from moving around.
- Keep the victim as calm as possible and in a reclined position.
- Immobilize the bitten extremity and keep it at or below heart level. If the victim can reach a hospital within 4 to 5 hours, and if no symptoms develop, no further first aid measures need to be applied.
- If mild-to-moderate symptoms develop, apply a constricting band 2 to 4 inches above the bite, but not around a joint (the elbow, knee, wrist, or ankle) and not around the head, neck, or trunk The band should be: ¾ to 1½ inches wide, not thin like a rubber band. The band should be snug but loose enough for a finger to be slipped underneath. Watch for swelling and loosen the band if it becomes too tight, but do not remove it. Periodically check the pulse in the extremity beyond the bite to insure that the blood flow has not stopped.

Several other factors must be considered in cases of snakebite:

- Shock. Keep the victim reclined and comfortable, and maintain his or her body temperature.
- Breathing and heartbeat. If breathing stops, give mouth-to-mouth resuscitation. If breathing stops and there is no pulse, perform CPR if you have been trained to do so.
- Identifying the snake. If you can kill the snake without risk or delay, bring it to the hospital for identification, but exercise extreme caution in handling the snake.

- Cleaning the bitten area. You may wash the bitten area with soap and water and blot it dry with sterile gauze. You may apply dressings and bandages, but only for a short period of time.

- Medicine to relieve pain. Do not give the victim alcohol, sedatives, aspirin, or any medicine containing aspirin. Consult a doctor or other medical personnel for specific medications that may be used.

- Snakebite kits. Keep a kit accessible for all outings in primitive areas or areas known or suspected to be snake infested.

It is not recommended that cold compresses, ice, dry ice, chemical ice packs, spray refrigerants, or other methods of cold therapy be used in the first aid treatment of a snakebite.

4.4.1.2 General First Aid for Poisonous Insect Bites/Stings

For minor bites and stings use cold applications and soothing lotions, such as calamine. For more severe reactions, take the following first aid measures:

- Apply a constricting band above the injection site on the victim's arm or leg (between the site and the heart). Do not apply tightly. You should be able to slip your index finger under the band when it is in place.

- Keep the affected part below the level of the victim's heart.

- In case of a bee sting, use tweezers to remove and discard the stinger and venom sac.

- If medical care is readily available, leave the band in place; otherwise, remove it after 30 minutes.

- Apply ice contained in a towel or plastic bag, or cold cloths, to the site of the sting or bite.

- Give non-prescription medicine, such as aspirin, for pain.

- If the victim has a history of allergic reactions to insect bites/stings or is subject to attacks of hay fever or asthma, or if he or she is not promptly relieved of symptoms, call a physician or take the victim immediately to the nearest location where medical treatment is available. **In a highly sensitive person, do not wait for symptoms to appear, since delay can be fatal.**

- Give artificial respiration if necessary.

Workers who have had severe allergic reactions to bee/wasp stings in the past must inform the SSO when they arrive at the site for the first time.

4.4.2 Ticks

Field personnel should be aware of the presence of ticks at the site. When in an area suspected of harboring ticks (grassy, bushy, or woodland area) the following precautions can minimize the chances of being bitten by a tick:

- Wear long pants and long-sleeved shirts that fit tightly at the ankles and wrists.
- Wear light colored clothing so ticks can be easily spotted.
- Wear tick repellents.
- Inspect clothing frequently while in tick habitat.
- Inspect your head and body thoroughly when you return from the field.

Removal of ticks is best accomplished using small tweezers. Do not squeeze the tick's body. Grasp it where the mouth parts enter the skin and tug gently, not firmly, until it releases its hold on the skin. Save the tick in a jar labeled with the date, body location of the bite, and the place where it may have been acquired. Wipe the bite thoroughly with an antiseptic. Seek medical attention in the event tick-related disease symptoms develop.

Lyme disease is an illness caused by a bacterium that may be transmitted by the bite of a tick (*Ixodes dammini*), commonly referred to as the deer tick. Not all deer ticks are infected with the bacterium, however. When an infected tick bites, the bacterium is passed into the bloodstream of the host, where it multiplies. The various stages and symptoms of the disease are well recognized and, if detected early, can be treated with antibiotics.

The illness typically occurs in the summer and is characterized by a slowly expanding red rash, which develops a few days to a few weeks after the bite of an infected tick. This may be accompanied by flu-like symptoms along with headache, stiff neck, fever, muscle aches, and/or general malaise. At this stage treatment by a physician is usually effective, but, if left too long, these early symptoms may disappear and more serious problems may follow. The most common late symptom of the untreated disease is arthritis. Other problems that may occur include meningitis and neurological and cardiac abnormalities. It is important to note that some people do not get the characteristic rash but progress directly to the later manifestations. Treatment of later symptoms is more difficult than early symptoms and is not always successful.

4.4.3 Animal-Borne Diseases

There are three principal diseases that can be transmitted by contact with rodents and other animals: rabies, bubonic plague, and hantavirus pulmonary syndrome (HPS). For this reason, field personnel will avoid all contact with rodents and other animals (alive or dead), rodent droppings, and rodent nests. All of these should be considered to be potentially contaminated with life-threatening pathogens.

Rabies is a disease that is transmitted through the saliva of rodents, as well as other mammals, such as dogs, cats, raccoons, foxes, bats, and cattle. An animal infected with the disease may act strangely (e.g., not afraid of humans, out at the wrong time of day or night), drool, or appear partially paralyzed. **If left untreated, rabies is a fatal disease.** If someone is bitten by an animal, treat the wound first, especially if the bleeding is serious, then get the person immediate medical attention. Do not attempt to kill or capture the animal, as further injuries could result. Call the local animal control authorities, and provide them with a description of the animal and the location of the incident.

Bubonic plague is the disease that was the cause of the plague known as the Black Death that decimated the populations of Europe in the Middle Ages and Renaissance. The disease is caused by a bacterium carried by the oriental rat flea, *Xenopsylla cheopis*, which is found on rats, mice, and jackrabbits. Epidemics of the disease do not occur in the U.S., but isolated cases have occurred in the southwestern states. The symptoms of the disease are a dark, pimple-like inflammation at the site of the bite, followed by a swelling of the lymph node closest to the bite area. The victim will develop an extremely high fever and dark splotching due to subcutaneous hemorrhaging. Untreated bubonic plague has a mortality rate of approximately 60%; however, the disease responds well when treated promptly with antibiotics (though not penicillin).

HPS is an infectious respiratory disease caused by exposure to the hantavirus. While cases of HPS are rare (generally less than 50 per year), HPS is fatal in approximately half the reported cases. This virus is present throughout the southwestern U.S. and is carried by rodents, especially mice. The virus enters the human body by the inhalation of particles, such as dust, which has become contaminated by the virus by exposure to rodent saliva, urine, or droppings. If personnel are exposed to rodents, droppings, or rodent nests, get immediate medical attention. HPS can be diagnosed using an antibody test. The symptoms of HPS are initially flu-like; after three to five days, the victim will develop coughing and shortness of breath, which will rapidly become more serious. At this point, it is imperative that the victim receive medical attention. If treated in time, there is an excellent chance of surviving the disease; however, untreated HPS is very often fatal.

Armadillos are common in the Fort Worth area. These animals are nocturnal and avoid humans, but are often found dead, especially along roads. It is estimated that 5% of these animals carry the bacillus that causes leprosy, *Mycobacterium leprae*. This disease is not very contagious (it is believed that up to 95% of all humans are naturally immune); however, all dead armadillos encountered at the site should be treated as potentially infectious and avoided.

4.4.4 Poisonous Plants

The majority of skin reactions following contact with offending plants are allergic in nature and are characterized by general symptoms of headache and fever, itching, redness, and rash.

Some of the most common and most severe allergic reactions result from contact with plants of the poison ivy group including poison ivy, poison oak, and poison sumac. The most distinctive features of poison ivy and poison oak are their leaves, which are composed of three leaflets each. Both plants also have greenish-white flowers and berries that grow in clusters. Such plants produce a severe rash characterized by redness, blistering, swelling, and intense burning and itching. The victim can also develop a high fever and become very ill. Ordinarily, the rash begins within a few hours after exposure, but it may be delayed for 24 to 48 hours.

4.4.4.1 First Aid Procedure

- Remove contaminated clothing.
- Wash all exposed areas thoroughly with dish soap and cool water, to reduce absorption, followed by rubbing alcohol.
- Apply calamine or other soothing skin lotion if the rash is mild.
- Seek medical advice if a severe reaction occurs, or if there is a known history of previous sensitivity.

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5.0 HAZARD COMMUNICATION

The HydroGeoLogic hazard communication program complies with the OSHA Hazard Communication Standard (HCS) found in OSHA Standard 29 CFR 1910.120 and 1926.59, which applies to any chemical present in the workplace in such a manner that employees may be exposed to under normal conditions of use in a foreseeable emergency. Although waste materials are excluded from the OSHA requirements, decontamination chemicals for sampling equipment or protective clothing and calibration standards require MSDSs.

The principle of communicating the hazards of materials used in the workplace by employees applies to company-wide activities, from informational programs on the conduct of hazardous waste activities to the company's insistence upon adequate health and safety training. It is also important for personnel to have an awareness of client concern for hazard communication due to Federal, state, and local regulations directly affecting certain client activities.

In order to comply with the HCS, HydroGeoLogic has determined that:

- All containers of hazardous chemicals must be appropriately labeled or tagged to identify the hazard and provide information on effects and appropriate protective measures.
- Labels, tags, or signs must be properly affixed and visible at all times while a hazard is present and removed promptly when the hazard no longer exists.
- Written information (i.e., MSDSs) on hazardous chemicals in the workplace must be available to employees working with the substances.
- Appropriate MSDSs will be available to any contractor or subcontractor employee working on projects under HydroGeoLogic's control.

When investigation results indicate potential imminent health risks to contracted or federal personnel, or the public at large, the contracting officer's representative (COR) and the base point of contact (POC) will be notified as soon as practicable. Written notification and supporting documentation will be provided within three days of finding potential imminent health risks during investigation activities.

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6.0 AIR MONITORING

This section presents requirements for the use of real-time air monitoring instruments during site activities involving potential for exposure to site contaminants. It establishes the types of instruments to be used, the frequency of which they are to be used, techniques for their use, action levels for upgrading/downgrading levels of protection, and methods for instrument maintenance and calibration.

6.1 INSTRUMENTS AND USE

A photoionization detector (PID) equipped with an appropriate lamp will be utilized for detecting the presence of emissions from chemicals of concern. A Dräger pump and colorimetric tubes will be used to confirm any detections observed with the PID in accordance with Table 6.1.

A PID and Dräger pump, if necessary, will be used throughout the execution of the following activities:

- Well development
- Groundwater sampling
- Sampling equipment decontamination/equipment (heavy) decontamination
- Waste characterization, transfer, and disposal

6.2 AIR MONITORING REQUIREMENTS

6.2.1 Photoionization Detector

Air monitoring with a PID will be initiated at potential sources of vapor emissions (source monitoring) at specified frequencies. The following potential sources and monitoring frequencies are anticipated:

- Open well heads - Upon initial opening
- Environmental sampling - Every sample set
- IDW characterization - Every container to be sampled
- Transfer IDW - From one container to another

If source monitoring indicates the presence of airborne emissions, air monitoring will then be initiated in the breathing zones of those workers who could be affected by the emissions. Air monitoring will also occur upon the request of site workers who notice unusual site odors or an increase in their intensity. If work is to be performed downwind of a site, air monitoring will be conducted to determine what type, if any, of PPE is required to protect workers and to determine the potential for an imminent threat to public health.

The presence of elevated readings in the worker's breathing zone as identified in Table 6.1 may require amendments to the HSP before workers are allowed to enter the exclusion zone.

Depending on the air monitoring readings, air-purifying respirators may not be acceptable due to the fact that some contaminants of concern have poor warning properties and/or are unable to be filtered from inspired air with chemical cartridges (Table 6.1). Elevated readings will be based on confirmation sampling using a Dräger pump and colorimetric tubes in accordance with Table 6.1.

6.2.2 Dräger Pump and Tubes

A hand operated Dräger pump with colorimetric tubes will be used to confirm the results of PID testing. If the results of the PID tests show concentrations greater than 0.5 parts per million (ppm) above background concentrations in the breathing zone, then the colorimetric tubes will be used to identify the contaminants in the breathing zone. Colorimetric tubes to be utilized in the event of elevated PID readings will include vinyl chloride, benzene, tetrachloroethene, and/or trichloroethene in accordance with Table 6.1. The colormetric tube utilized will depend on the chemical(s) anticipated to be present at the site.

6.3 MODIFICATION OF AIR MONITORING REQUIREMENTS

The action levels and protection measures presented in Table 6.1 are based upon the assumption that the contaminants listed in Table 4.1 are the only contaminants that pose a potential health risk to site workers covered by this HSP. In the event that this assumption is found to be invalid through analysis of samples collected, or by some other means, the action levels will be modified as necessary.

6.4 INSTRUMENT MAINTENANCE AND CALIBRATION

Air and noise monitoring instruments are maintained and prefield-calibrated at the HydroGeoLogic field office in Fort Worth, Texas. Field maintenance will consist of daily cleaning of the instruments using a damp towel or rag to wipe off the instrument's outer casing, overnight battery recharging, and cleaning or replacing of the lamp whenever calibration cannot be attained. Procedures for accomplishing instrument maintenance is contained in the PID user's manual that will be provided with each instrument. The user's manual provided with each instrument will be followed to field calibrate the instruments prior to each day of use under the environmental conditions (temperature and humidity) that sampling will occur. Field equipment will also be calibrated at the end of each day to account for instrument drift and reliability.

6.5 RECORDKEEPING

Instrument calibrations and readings will be recorded on the air monitoring log sheet provided in Section 14.1 of this HSP. Copies of these log sheets will be maintained on-site until field activities covered by this HSP have been completed. Afterwards the log sheets will be transmitted to the HydroGeoLogic HSO and to the project file.

7.0 PERSONAL PROTECTIVE EQUIPMENT

This section presents requirements for the use of PPE for each of the activities being conducted. This section includes anticipated levels of protection for each of the activities, the criteria used for selecting various levels of protection, and criteria for modifying levels of protection based on monitoring instrument readings and personal observations.

7.1 ANTICIPATED LEVELS OF PROTECTION

All work is anticipated to be performed in Modified Level D protection, as defined in Appendix B of OSHA Standard 29 CFR 1910.120. Many activities may require the use of chemical resistant coveralls, gloves, and boot covers as presented in Table 7.1.

The items of PPE anticipated to be used for each activity are presented in Table 7.1. Where overlap in activities occur, the more protective requirement will apply.

7.2 PPE SELECTION CRITERIA

Respiratory protection is not anticipated for use during the initial stages of work until detection of site contaminants with air monitoring instruments warrants the donning of respirator protection in accordance with Table 6.1. See Section 7.3 for modification criteria of respiratory protection. Respirator use must be in accordance with the HydroGeoLogic Heath and Safety Program (located at HydroGeoLogic's Herndon, Virginia, office) and with the requirements of 29 CFR 1910.134(c)(1). Basic requirements of field personnel prior to using respiratory protection include:

- All field personnel will be medically certified to wear a full face respirator and have the proper fit test documentation within the past 12 months prior to assignment.

- Only NIOSH-approved respirators are to be used on-site. The respirators are to be properly cleaned, inspected, and maintained prior to and at the conclusion of the work day.

- Used cartridges for air-purifying respirators will be disposed of at the end of each change-out interval and at the end of each work day. Cartridge change-out schedules will be determined based on identification and concentration of air contaminants.

- Field personnel will be clean-shaven in areas that might prevent the seal of the respirator to the face, and contact lenses will not be permitted while wearing a respirator.

Prior to upgrading PPE to Level C, the Health and Safety Officer must be notified in order to have him advise the field team.

Hard hats, safety glasses, and steel-toed work boots were selected as minimum protection to reduce the potential for injury resulting from exposure to the physical hazards associated with on-site investigations.

Boot covers, disposable nitrile gloves, and Tyvek® coveralls were selected to minimize contamination of work clothes and to prevent direct skin contact with low-level contamination. Nitrile gloves of 11-mil thickness or greater were selected for activities that may involve direct contact with appreciable concentrations of contaminants. TCE has a short breakthrough time for nitrile gloves. If contact with appreciable quantities of TCE or TCE-containing mixtures is anticipated, inner gloves of polyvinyl alcohol or other chlorinated solvent impermeable material will be under nitrile gloves. Polyvinyl chloride (PVC) or Saranex® coveralls, hoods, and/or splash shields were selected to prevent saturation of work clothes during activities involving large volumes of liquids and/or saturated soils/equipment.

7.3 PPE MODIFICATION CRITERIA

This section presents criteria for upgrading and downgrading chemical protective clothing (CPC) and/or respiratory protection. Where uncertainties arise, the more protective requirements will apply.

7.3.1 CPC Modification Criteria

Tyvek® coveralls and boot covers must be worn anytime there is a reasonable potential for contamination of street clothes.

Disposable nitrile gloves must be worn anytime there is a reasonable potential for contact with unsaturated soils or equipment which may contain trace contamination.

Nitrile gloves (4-mil or greater) must be worn anytime there is a reasonable potential for contact with groundwater, saturated soils, and/or soils producing elevated PID readings.

PVC or Saranex® coveralls must be worn anytime there is a reasonable potential for saturation of work clothes.

8.0 DECONTAMINATION

This section describes the steps site personnel will follow to prevent the spread of site contaminants into areas that may affect unprotected, unsuspecting site personnel or the public. It includes requirements for decontamination of personnel, sampling equipment, and augering/ drilling equipment.

8.1 PERSONNEL DECONTAMINATION

The decontamination of personnel and their protective clothing will be performed within the decontamination zone. Table 8.1 presents the six stages for decontamination for Level D protection.

Wash tubs containing an appropriate decontamination solution and soft-bristle brushes will be used to wash reusable personal protective equipment and boots. Clean water will be used for the final rinse. The choice of decontamination solution is dependent upon the type of materials that must be removed from reuseable protective equipment. Based on the current understanding of potential site contaminants, a detergent and water solution is recommended for general purpose decontamination. Acceptable detergents include laboratory-grade cleaners (e.g., Alconox™, or equivalent), or a high strength consumer detergent such as Liquid Tide™.

Alternative decontamination solutions may be called for if the contaminants encountered are different or in a more concentrated state than anticipated. Alternative solutions include the following:

1. Dilute acids for removal of basic (caustic) compounds, metals, amines, and hydrazines.

2. Dilute bases (soaps and detergents) for removal of acidic compounds, phenols, thiols, and some nitro and sulfonic compounds.

3. Organic solvents for removal of nonpolar compounds (organic).

Gloves and other PPE should be inspected frequently for integrity, and manufacturers' data for breakthrough times should be considered if concentrated contaminants are encountered.

The decontamination of personnel and their protective clothing will be performed in 18 stages for Level C protection, if necessary. The 18 stages are presented in Table 8.2 below.

All decontamination fluids generated will be contained and disposed of as specified in Appendix C. The decontamination area will be physically identified with rope or flagging and will be sufficiently equipped to be conducive for completion of the stages listed above.

8.1.1 Closure of the Personnel Decontamination Station

All disposable clothing and plastic sheeting used during the operation will be double-bagged and contained on-site prior to removal to an approved off-site disposal facility as identified in the Work Plan (WP). Decontamination and rinse solution will be contained on-site prior to disposal. Reusable rubber clothing will be cleaned, dried, and prepared for future use. If decontamination of reusable clothing is not possible, the items will be discarded. All wash tubs, pail containers, etc., will be thoroughly washed, rinsed, and dried prior to removal from the site.

8.1.2 Disposal of Decontamination and Other Wastes

All PPE, polyethylene sheeting, and sampling support materials (e.g., paper towers, ziplock bags) will be collected at the end of each work day, placed in plastic trash bags, and kept at the field office. On the following day the air within the plastic trash bag will be tested using a PID. If the air within the bag does not show significant concentrations of organic vapors (greater than 10 ppm above background), the plastic trash bag will be double-bagged and placed in the municipal waste dumpster for disposal.

All other wastes generated during decontamination other than decontamination fluids will be placed into United Nations 55-gallon drums; each drum will have a removable top cover fitted with a top cover bung (type 17E/H) as identified in the Field Sampling Plan (FSP). The drums will be filled partially or completely, depending upon the difficulty of transporting them from the work site. All containers will be numbered and clearly labeled with the boring/well number and date of filling. The mixing of solid and liquid wastes will be avoided. The containers will be stored at a predesignated site for disposal after the analyses of the samples have been obtained.

8.2 EQUIPMENT DECONTAMINATION

All sampling equipment will be decontaminated prior to use, between sampling locations, and at the end of sampling activities to avoid cross-contamination. Furthermore, this approach will decrease the amount of contact of personnel with contaminated materials and reduce the probability of removing contamination from the site. The procedures for decontaminating equipment are presented in Appendix C of the GSAP.

9.0 MEDICAL SURVEILLANCE

9.1 REQUIREMENTS FOR HYDROGEOLOGIC PERSONNEL

All employees involved in field activities will be active participants in the HydroGeoLogic medical surveillance program. All medical examinations and procedures will be performed by or under the supervision of a licensed occupational physician. The examination will include the tests, procedures, and frequencies that comply with the requirements of OSHA Standard 29 CFR 1910.120 (f) and American National Standards Institute (ANSI) Z-88.2 and will ensure that the employee is medically qualified to perform hazardous waste site work under respiratory protection. Medical surveillance documents confirming the worker's fitness to perform hazardous waste operations on this project are on file at HydroGeoLogic's headquarters in Herndon, Virginia, and can be made available upon request.

9.2 REQUIREMENTS FOR SUBCONTRACTORS

Subcontractors are also required to obtain a certificate of their ability to perform hazardous waste operations work and to wear respiratory protection. Subcontractors who have a company medical surveillance program meeting the requirements of OSHA Standard 29 CFR 1910.120 (f) will be required to submit a letter, on company letterhead, confirming that all on-site workers to be utilized for this project are medically qualified to perform the investigation activities. In addition, medical surveillance documents for personnel assigned to this project must be made available upon request.

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10.0 TRAINING REQUIREMENTS

10.1 INITIAL TRAINING

10.1.1 Requirements for HydroGeoLogic Personnel

All investigation personnel to be utilized are currently enrolled in HydroGeoLogic's continuous training program in accordance with OSHA Standard 29 CFR 1910.120. Individuals working on a site have successfully completed an approved 40-hour HAZWOPER course including 24 hours of actual field experience under the direction of a trained supervisor, and any subsequent annual 8-hour refresher courses. In addition, the on-site field leader will have completed an 8-hour supervisory course. In addition, a majority of HydroGeoLogic field investigation personnel are also current in first aid/CPR training requirements. HydroGeoLogic employee records are on file in the company's home office in Herndon, Virginia.

10.1.2 Requirements for Subcontractors

All HydroGeoLogic subcontractor personnel must also have completed a 40-hour HAZWOPER training course or have equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e) prior to performing work at the site. In addition, subcontractor personnel must also have successfully completed any subsequent annual 8-hour refresher training.

HydroGeoLogic subcontractors must certify that each subcontractor employee who will perform work at the site has had training meeting the requirements of OSHA Standard 29 CFR 1910.120(e). This certification can be accomplished by submitting a letter to HydroGeoLogic, on company letterhead, containing such information.

10.1.3 Requirements for Site Visitors

No person will be allowed in the work zones (exclusion and decontamination) unless they have completed the necessary health and safety training as required by OSHA Standard 29 CFR 1910.120(e) and are wearing the necessary protective equipment as required by this HSP.

10.2 SITE-SPECIFIC TRAINING

HydroGeoLogic will provide site-specific training to all HydroGeoLogic employees and subcontractor personnel who will perform work at the site. Daily health and safety meetings will be held prior to beginning field activities to discuss each day's activities, potential hazards, and any new health and safety issues not previously discussed. Any personnel who does not participate in training will not be permitted to perform work at the site. Site-specific training will include the following:

- The contents of the HSP
- Names of personnel and alternates responsible for site health and safety
- Safety, health, and other hazards present on the site
- Use of personal protective equipment
- Work practices by which the employees can minimize risks from hazards
- Safe use of engineering controls and equipment on the site
- Medical surveillance requirements, including recognition of symptoms and signs that might indicate overexposure to hazards
- Decontamination procedures
- Emergency response procedures

HydroGeoLogic and subcontractor personnel will be required to sign a statement indicating receipt of site-specific training and understanding of site hazards and control measures. This form is presented in Section 14.1.

11.0 STANDARD WORK PRACTICES

All site investigation activities will follow these appropriate health and safety standard work practices.

11.1 GENERAL REQUIREMENTS/PROHIBITIONS

- A copy of this HSP will be available on-site for all field personnel, including visitors, to reference during investigation activities.
- No running or horseplay.
- Eating, drinking, chewing gum or tobacco, taking medication, applying cosmetics, and/or smoking are prohibited in the exclusion and decontamination zones, or any location where a possibility for contact with site contaminants exists.
- The required level of PPE must be worn by all on-site personnel to include at a minimum steel-toed safety boots, safety glasses, and hard hat, if necessary.
- Upon leaving the exclusion zone, hands and face must be thoroughly washed. Any protective outer clothing is to be decontaminated and removed as specified in this HSP, and left at a designated area prior to entering the clean area.
- Contact with potentially contaminated substances must be avoided. Contact with the ground or with contaminated equipment must also be avoided. Air monitoring equipment must not be placed on potentially contaminated surfaces.
- No facial hair that interferes with a satisfactory fit of the mask-to-face seal is permitted on personnel required to wear respiratory protective equipment.
- All personnel must satisfy medical monitoring procedures.
- No flames or open fires will be permitted on-site.
- All personnel must be aware of and follow the action levels presented in this HSP for upgrading respiratory protection.
- Any new analytical data must be promptly conveyed via telephone to the project HSO by the laboratory technician or field leader.
- Personnel must develop hand signals with operators of heavy equipment (i.e., drillers, geoprobe operators, etc.). Standard hand signals to be used by personnel for nonverbal communication include the following:

Stop	With arm extended to the side and palm down, hold position rigidly.
Hoist	With forearm and forefinger pointing up, move hand in small horizontal circle.
Lower	With forearm extended and forefinger pointing down, move hand in a small horizontal circle.
Travel	With palm up, fingers closed, and thumb pointing in the direction of motion, jerk hand horizontally.
Slow Move	Use one hand to give any motion signal, and place the other hand motionless next to hand giving the motion signal.
Emergency Stop	With arm extended to the side and palm down, move hand rapidly right and left.

Standard hand signals will be discussed during each daily health and safety meeting when the use of heavy equipment is anticipated.

- A copy of the OSHA "Job Safety and Health Protection" poster must be prominently posted at the field office.

- Only equipment that has been approved by the manufacturer may be used in conjunction with site equipment.

- Medicine and alcohol can exacerbate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel on operations where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Alcoholic beverage intake will not be allowed at any time, including during breaks.

- No person will enter an exclusion zone alone.

- Safety devices on equipment must be left intact and used as designed.

- Equipment and tools will be kept clean and in good repair and used only for their intended purpose.

- Eye protection must be worn when any hammering or pounding is performed that may produce flying particles or slivers.

- Field personnel are not allowed to lift more than 60 pounds. Rules to remember when attempting to lift heavy objects include the following:

  - Size up the load before trying to lift it, test the weight, and get help if needed.
  - Bend the knees and look up to keep the neck and back straight.
  - Do not twist or turn your body once you have made the lift.

  - Make sure you can carry the load where you need to go before lifting it.
  - Set the load down properly, lower slowly by bending the knees.
  - Always push, not pull, the object when possible.

- Heavy lifting (more than 60 pounds per worker) must be accomplished using mechanical lifting equipment. Mechanical lifting equipment that will be available on-site will include forklifts, hoists, dollies, backhoe/trackhoe, and other types of equipment that can be easily rented from an off-site location.

- Leather gloves must be worn when handling objects that may produce slivers or have sharp or pinching edges (e.g., driving wood stakes, handling drill rods/augers).

- The SSO must make an entry into the site field log book, at least daily, to include the following:

  - Weather conditions
  - Site personnel
  - New arrivals and their clearance for site work
  - Air monitoring data summary
  - Monitoring instrument calibration
  - Indications of inhalation exposure
  - PPE used per task
  - Deviations from HSP
  - Inspection and cleaning of respiratory equipment
  - General health and safety problems/corrective actions

- If personnel note any warning properties of chemicals (irritation, odors, symptoms, etc.) or even remotely suspect the occurrence of exposure, they must immediately notify the SSO for further direction.

11.2 HOUSEKEEPING

Housekeeping is a very important aspect of an investigation program and will be strongly stressed in all aspects of field work. Good housekeeping plays a key role in occupational health protection and is a way of preventing dispersion of dangerous contaminants. All work areas will be kept as clean as possible at all times, and spills will be cleaned up immediately. Housekeeping will be the responsibility of all employees.

HydroGeoLogic will implement a housekeeping program for the field activities to minimize the spread of contamination beyond the work site. The program will include the following:

- Daily policing of the area for debris, including paper products, cans, and other materials brought on site

- Changing of wash and rinse water for hands, face, and equipment as needed

- Periodic (daily minimum) removal of all garbage bags and containers used to dispose of food products, plastic inner gloves, and contaminated disposable clothing

11.3 WORK LIMITATIONS

All investigation activities will be performed during normal daylight hours.

11.4 CONFINED SPACE ENTRY

Site personnel are not to undertake any activity in an area that could be considered to have a confined-space entry.

11.5 SPILL CONTAINMENT

The procedures defined in this section comprise the spill containment activities in place at the site.

- All drums and containers used during the cleanup will meet the appropriate Department of Transportation, OSHA, and EPA regulations for the waste that they will contain.

- Drums and containers will be inspected and their integrity verified prior to being moved. Drums or containers that cannot be inspected before being moved because of storage conditions will be positioned in an accessible location and inspected prior to further handling.

- Operations on-site will be organized so as to minimize drum or container movement.

- Employees involved in drum or container operations will be warned of the hazards associated with the containers.

- Where spills, leaks, or ruptures may occur, adequate quantities of spill containment equipment (absorbent, pillows, etc.) will be stationed in the immediate area. The spill containment program must be sufficient to contain and isolate the entire volume of hazardous substances being transferred.

- Drums or containers that cannot be moved without failure will be emptied into a sound container.

- Fire extinguishing equipment meeting 29 CFR Part 1910.157 and Subpart L Appendices shall be on hand and ready for use to control fires.

12.0 SITE CONTROL

12.1 WORK ZONES

Each investigation location will be physically barricaded with rope flagging or caution tape to control entry and exit into and from the area. These barricaded areas will be referred to as the exclusion zones. The exclusion zone will be identified by the site supervisor and consist of a 20-foot radius surrounding the drilling or test pit location. Each person leaving an exclusion zone will proceed directly to the decontamination zone, which will be located adjacent to the exclusion zone and also identified by physical barriers. The decontamination zone will consist of a low-lying area covered with a plastic sheeting. At the completion of decontamination procedures at each location, the debris will be enclosed in the plastic sheeting and deposited into 55-gallon type 17 E/H drums for later disposal as identified in the WP and FSP. Only personnel who are cleared by the HydroGeoLogic field leader and SSO will be permitted in the exclusion zones and/or decontamination zones. Clearance for accessing these areas will only be given to personnel who meet the training and medical surveillance requirements of OSHA Standard 29 CFR 1910.120 and are wearing the appropriate PPE required for the work activity.

The support zone, where the administrative, communications, and other support services will be based, will be in a controlled area off the site or on the far end upwind of potential site contamination or areas of potential exposure. Only persons and equipment that are free of contamination will be permitted in the support zone.

12.2 ON-SITE/OFF-SITE COMMUNICATIONS

Communications will consist of a centrally located telephone within the designated support zone (i.e., trailer, office) in addition to a mobile phone stationed within the on-site vehicle utilized for transportation. Field personnel may also utilize telephones located at NAS Fort Worth JRB in emergency situations.

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13.0 EMERGENCY RESPONSE

This HSP has been develop in an attempt to prevent the occurrence of situations that may jeopardize the health and safety of on-site personnel. However, supplemental emergency procedures must be identified in the event that an unforeseen health and safety accident or incident occurs. In general, HydroGeoLogic will evacuate their employees and subcontractors from the workplace if an emergency involving chemical spills, chemical fires, chemical exposure, and/or chemical emissions occurs. For this reason, emergency response planning will be in accordance with OSHA Standard 29 CFR 1910.38(a).

13.1 PREPLANNING

Upon initial arrival at the site, the HydroGeoLogic field leader and SSO will visit the NAS Fort Worth JRB's fire department to determine the status of emergency response services. This meeting will include a determination as to the need for further coordination with local rescue and police services.

Another aspect of preplanning for emergencies includes completion of the medical data sheet (Section 14.1). This sheet must be completed by all HydroGeoLogic personnel and subcontractors so that, in the event of personal injury or illness, the examining physician has background information readily available on the injured/ill party.

13.2 EMERGENCY PROCEDURES AND ASSIGNMENTS

Upon notification of a site emergency requiring evacuation, all HydroGeoLogic personnel and subcontractors will proceed directly to the support zone (i.e., trailer, office). If personnel cannot reach the support zone without endangering life or health, an alternate meeting point will be specified by the HydroGeoLogic SSO.

In the event of an emergency, the following procedures will be implemented:

- The site supervisor will evaluate the incident, assess the need for assistance, and call the appropriate contacts, if necessary.
- The site supervisor will act as the POC for outside emergency personnel and on-site personnel.
- The site supervisor will advise emergency response and emergency room personnel to the types of contamination potentially contacted by injured workers receiving emergency care.
- The site supervisor will ensure that the SSO promptly notifies the HydroGeoLogic PM and HSO of the incident.

13.2.1 Chemical Inhalation

It is not anticipated that chemicals of concern are present at the site in concentrations to cause immediate danger to life and health. However, any field personnel exhibiting or complaining of symptoms of chemical exposure as described in Section 4.1 will be removed from the work zone and transported to the designated medical facility for examination and treatment.

13.2.2 Eye and Skin Contact

Field personnel who have come into contact with contaminants while in the exclusion zone will immediately proceed to the decontamination zone, where an eyewash station will be located. Do not decontaminate prior to using the eyewash. Remove necessary PPE to perform the eyewash procedures. Flush the eye with clean water for at least 15 minutes and arrange for prompt transport to the designated medical facility.

Unless skin contact with contaminants is severe, proceed through the decontamination zone. Field personnel should remove any contaminated PPE and wash the affected area for at least 15 minutes. If the personnel show signs of skin irritation, they will be transported to the designated facility.

13.3 PROCEDURES FOR PERSONNEL REMAINING ON SITE

No HydroGeoLogic or subcontractor personnel will remain on-site to perform critical site emergency operations.

13.4 PROCEDURES TO ACCOUNT FOR SITE PERSONNEL

The HydroGeoLogic and subcontractor work force will be small enough so that accounting for site personnel will not be a problem. The HydroGeoLogic field leader and SSO will ensure that the whereabouts of all personnel are known.

13.5 RESCUE AND MEDICAL DUTIES

Only those persons who have been trained by the American Red Cross, or equivalent, will be permitted to perform first aid, and/or CPR treatment. Outside emergency services and medical facilities will be the primary providers of such services. At least one person who is currently certified in first aid and CPR will be on-site at all times during field activities. A "physicians approved" first aid kit, an ANSI-approved eye wash station with 15 minutes of free flowing freshwater, and a Class ABC fire extinguisher will be readily available on-site.

Any HydroGeoLogic employee who shows signs of symptoms of overexposure must immediately be examined by a licensed physician. Subcontractor personnel who show signs or symptoms of overexposure will be encouraged to visit a licensed physician as well. Table 13.1 gives the directions to the nearest medical facility.

13.6 EMERGENCY COMMUNICATION PROCEDURES, CONTACTS AND PHONE NUMBERS

Persons who observe an emergency situation must immediately notify the HydroGeoLogic field leader and/or SSO. The field leader or SSO will then immediately assess the emergency and appoint someone to telephone appropriate outside emergency services and will coordinate site evacuation. Emergency telephone numbers and directions to the nearest medical facility are included as Table 13.1, a copy of which will be posted at the nearest telephone. In addition, Figure 13.1 illustrates the directions to the nearest medical facility.

13.7 ACCIDENT/INCIDENT FOLLOW-UP AND REPORTING

On receiving a report of accident/incident (or near-incident) occurrence the SSO shall immediately investigate the circumstances and shall make appropriate recommendations to prevent recurrence. The HSO shall also be immediately notified by telephone of any serious accident or incident. At his discretion, he may also participate in the investigation.

Details of the incident shall be documented on an accident/incident report form (Section 14.1) within 24 hours of the incident and shall be distributed to the PM, HSO, and COR. A copy of this report shall also be sent to the appropriate administrative contact for inclusion into the OSHA Form 101 and 200 log. Incident report forms will be available at the site support facilities.

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14.0 DOCUMENTATION AND EQUIPMENT

This section summarizes the documentation and equipment needs for the project as specified in the HSP. Its purpose is to serve as a partial checklist to help ensure that all of the necessary resources are available to carry out the requirements of the HSP.

14.1 DOCUMENTATION AND FORMS

The following documents are presented in the following pages for use during site operations:

- Site safety briefing forms
- HSP compliance agreement forms
- HSP amendments forms
- Accident/incident report forms
- Personnel medical data sheets
- Equipment calibration logs
- Air monitoring logs

In addition, the following documentation will be present on-site during operations:

- Approved HSP (signed copy)
- OSHA poster
- MSDSs
- Employee training and medical surveillance certificates
- Subcontractor training and medical surveillance certificates

14.2 EMERGENCY, HEALTH AND SAFETY EQUIPMENT

- First aid kit
- Ear plugs/defenders
- Eye wash
- Inner latex or vinyl gloves
- Outer nitrile gloves (disposable 4-mil and 11-mil thickness)
- Boot covers
- Hard hats and safety glasses
- Tyvek® coveralls
- PVC and/or Saranex® coveralls (with hoods)
- Decontamination kit
- Fire extinguisher
- Fall protection devices (body harness and lanyard)
- Duct tape
- LEL/oxygen (O_2) meter

- Methane detector
- PID

The site supervisor and/or SSO shall be responsible for maintaining first aid kits and fire extinguishers at each site where field activities are taking place. The location of first aid kits and fire extinguishers will be discussed during each daily health and safety meeting.

15.0 REFERENCES

Dräger Aktiengesellschaft (Kurt Leichnitz), 1989, Detector Tube Handbook, 7th edition, dated July 1989.

HydroGeoLogic, Inc. (HydroGeoLogic), 2001, Final 2001 Basewide Groundwater Sampling and Analysis Plan, May 2001.

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health (NIOSH), 1997, *Pocket Guide to Chemical Hazards*, dated June 1997.

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, 1985, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, DHHS (NIOSH) Publication No. 85-115, dated October 1985.

U.S. Environmental Protection Agency (US EPA), 1992, *Standard Operating Safety Guides*, NTIS Publication No. 9285.1-03, dated June 1992.

U.S. Federal Acquisition Regulation, FAR Clause 52.236-13: Accident Prevention.

U.S. National Archives and Records Administration, 1997, *Code of Federal Regulations,* Occupational Safety and Health Administration General Industry Standards, 29 CFR 1910; Construction Industry Standards, 29 CFR 1926; 29 CFR 1910.120; 29 CFR 1926.65 "Hazardous Waste Site Operations and Emergency Response."

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HEALTH AND SAFETY FORMS

SITE SAFETY BRIEFING FORM

Project _____

Date _____ Time _____ Job No. _____

Location _____

Type of Work _____

_____

_____

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment _____

_____

Chemical Hazards _____

_____

Physical Hazards _____

_____

Emergency Procedures _____

_____

Hospital/Clinic _____ Phone _____

Hospital Address _____

Special Equipment _____

_____

Other _____

_____

_____

_____

ATTENDEES

Name (Printed)	Signature

Meeting Conducted by: _____

Site Safety Officer: _____

HEALTH AND SAFETY PLAN

COMPLIANCE AGREEMENT FORM

PROJECT: Basewide Groundwater Sampling and Analysis

CLIENT: U.S. Air Force Center for Environmental Excellence

LOCATION: NAS Fort Worth JRB, Carswell Field, Texas

PROJECT NO: AFC001-0033

I, _____, have received a copy of the Health and Safety Plan for the above-referenced project. I have read the plan, understand it, and agree to comply with all its provisions. I understand that I can be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Signed:

_____ _____

Signature Date

_____

Company

HEALTH AND SAFETY PLAN AMENDMENT FORM

Change in field activities or hazards: _____

Proposed amendments: _____

Proposed by: _____ Date: _____

Approved by: _____

Accented: _____ Declined: _____ Date: _____

Amendment Number: _____

Amendment Effective Date: _____

HYDROGEOLOGIC, INC.
Accident/Incident/Near Miss Investigation Form

Employee's Name: _____
Address: _____
SS# _____
Job Title: _____ Supervisor's Name: _____
Office Location: _____
Location at Time of Incident: _____
Date/Time of Incident: _____

Describe clearly how the accident occurred: _____

Was incident: Physical _____ Chemical _____
Parts of body affected _____ Exposure: Dermal _____
right left Inhalation _____
Ingestion _____

Witnesses: 1) _____ 2) _____

Conditions/acts contributing to this incident _____

Managers must complete this section:
Explain specifically the corrective action you have taken to prevent a recurrence: _____

Did injured go to doctor: _____ Where: _____
When: _____
Did injured go to hospital: _____ Where: _____
When: _____

Signatures:

Employee	Reporting Manager	Health and Safety Officer
Date	Date	Date

Accidents must be reported immediately; this form must be completed and returned to the Health and Safety Officer within **24 hours.**

MEDICAL DATA SHEET

This brief Medical Data Sheet will be completed by all on-site personnel and will be kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project _____

Name _____ Home Telephone _____

Address _____

Age _____ Height _____ Weight _____

Name of Next of Kin _____

Drug or other Allergies _____

Particular Sensitivities _____

Do You Wear Contacts? _____

Provide a Checklist of Previous Illnesses or Exposure to Hazardous Chemicals.

_____

_____

What medications are you presently using? _____

_____

_____

Do you have any medical restrictions? _____

_____

_____

Name, Address, and Phone Number of personal physician: _____

_____

_____

_____

_____

_____

I am the individual described above. I have read and understand this HSP:

_____

_____ _____

Signature Date

DAILY EQUIPMENT CALIBRATION LOG

Project Name:

Project No:

Date/Time	Initials	Instrument	Calibration Solution Or Gas Concentration	Adjustments Required/ Comments

Project _____

HEALTH AND SAFETY/AIR MONITORING LOG

Date: _____ Logged by: _____

Weather: _____
Field Tasks: _____

HydroGeoLogic Personnel (or subs) working on the site (name and affiliation):

HydroGeoLogic Personnel (or subs) working in restricted zone:

HydroGeoLogic Site Visitors:

Air Quality Monitoring Measurements:

Time	Instrument	Parameter	Concentration	Locations

Background:

Exclusion zone:

Level of PPE: _____

Comments on other safety-related matters:
(including infractions, accidents, injuries, unusual occurrences, physical complaints)

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TABLES

Table 4.1
Exposure Limits and Recognition Qualities

Compound	Permissible Exposure Limit (PEL)[A]	IDLH Level[b]	Recognition Qualities			Odor Warning Concentration (ppm)	LEL[c] (%)	UEL[d] (%)	Ionization Potential (eV)
			Color	Odor	State				
Organic materials									
Benzene	1 ppm	500 ppm (Ca[e])	Colorless	Aromatic	Liquid (freezes at 42EF)	1.5-5	1.2	7.8	9 24
bis (2-Ethylhexyl)phthalate	5 mg/m^3	5,000 mg/m^3 (Ca[e])	Colorless	Slight	Oily liquid	ND	0.3% (at 474EF)	ND	ND
n-Butylbenzene	NA	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	ND
sec-Butylbenzene	NA	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	ND
tert-Butylbenzene	NA	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	ND
Chlorobenzene	75 ppm	1000 ppm	Colorless	Almond-like	Liquid	0.2	1 3	9.6	9.07
Chloroform	50 ppm (ceiling)	500 ppm (Ca[e])	Colorless	Pleasant	Liquid	200	NA	NA	11.42
1,4-Dichlorobenzene	75 ppm	150 ppm (Ca[e])	White	Mothball-like	Crystals	ND	2.5	ND	8 98
1,1-Dichloroethane	100 ppm	3,000 ppm	Colorless	Chloroform-like	Oily liquid	ND	5.4	11.4	11.06
1,1-Dichloroethene	None	ND (Ca[e])	Colorless	Mild, sweet	Liquid (gas above 89EF)	50	6.5	15.5	10.00
1,2-Dichloroethene (total)	200 ppm	1,000 ppm	Colorless	Acrid, chloroform-like	Liquid	ND	5 6	12.8	9.65
1,2-Dichloropropane	75 ppm	400 ppm (Ca[e])	Colorless	Chloroform-like	Liquid	ND	3.4	14.5	10.87
Ethylbenzene	100 ppm	2,000 ppm	Colorless	Aromatic	Liquid	4 7-50	1.00	6.70	8.76
Gasoline	ND	ND	Clear	Gasoline	Liquid	ND	1.4	7.6	ND

Table 4.1 (continued)
Exposure Limits and Recognition Qualities

Compound	Permissible Exposure Limit (PEL)[A]	IDLH Level[b]	Recognition Qualities			Odor Warning Concentration (ppm)	LEL[c] (%)	UEL[d] (%)	Ionization Potential (eV)
			Color	Odor	State				
		(Ca[e])							
Hexane	500 ppm	1,100 ppm	Colorless	Gasoline	Liquid	ND	1.1	7 5	10.18
Isopropylbenzene (cumene)	50 ppm	900 ppm	Colorless	Sharp, aromatic	Liquid	ND	0.9	6.5	8.75
p-Isopropyltoluene (p-cymene)	None	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	ND
Methanol	200 ppm	6,000 ppm	Colorless	Pungent	Liquid	5	6 0	36.0	10.84
Methyl tert-butyl ether (MTBE)	None	ND	Colorless	ND	Liquid	ND	ND (combustible)	ND (combustible)	ND
Naphthalene	10 ppm	250 ppm	Colorless to brown	Mothballs	Solid	ND	0.9	5.9	8.12
n-Propylbenzene	None	ND	Clear	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	D
1,1,2,2-Tetrachloroethane	5 ppm	100 ppm (Ca[e])	Colorless to pale yellow	Pungent, chloroform-like	Liquid	ND	NA	NA	11 10
Tetrachloroethene (PCE)	100 ppm	150 ppm	Colorless	Chloroform-like	Liquid	ND	NA	NA	9.32
Toluene	200 ppm	500 ppm	Colorless	Aromatic	Liquid	0.17-40	1.1	7.1	8.82
1,1,1-Trichloroethane	350 ppm	700 ppm	Colorless	Mild, chloroform-like	Liquid	< 100	7.5	12.5	11.00
1,1,2-Trichloroethane	10 ppm	100 ppm (Ca[e])	Colorless	Sweet, chloroform	Liquid	ND	6	15.5	11.00
Trichloroethene (TCE)	100 ppm	1,000 ppm	Colorless	Chloroform-like	Liquid	20	8.0	10.5	9.45
1,2,4-Trimethylbenzene (pseudocumene)	25 ppm (TLV)	ND	Colorless	Aromatic	Liquid	ND	0.9	6.4	8 27

Table 4.1 (continued)
Exposure Limits and Recognition Qualities

Compound	Permissible Exposure Limit (PEL)[A]	IDLH Level[b]	Recognition Qualities			Odor Warning Concentration (ppm)	LEL[c] (%)	UEL[d] (%)	Ionization Potential (eV)
			Color	Odor	State				
1,3,5-Trimethylbenzene (mesitylene)	25 ppm (TLV)	ND	Colorless	Aromatic	Liquid	ND	ND (combustible)	ND (combustible)	8.39
Vinyl chloride	1 ppm	ND (Ca[e])	Colorless	Pleasant	Gas (liquid < 7EF)	62.5	3 6	33 0	9.99
Xylenes (total)	100 ppm	900 ppm	Colorless	Aromatic	Liquid	1-1.5	1.1	7.0	8.50
Inorganic materials									
Arsenic	0.05 mg/m^3	5 mg/m^3 (Ca[e])	Colorless	NA	Solution	NA	NA	NA	NA
Hydrochloric acid	5 ppm (ceiling)	50 ppm	Clear to yellowish	Pungent	Solution	<5	NA	NA	12 74
Manganese	5 mg/m^3 (ceiling)	500 mg/m^3	Colorless	NA	Solution	NA	NA	NA	NA
Nitric acid	2 ppm	25 ppm	Colorless, yellow, or red	Acrid, suffocating	Solution	0.5 (as nitrogen dioxide)	NA	NA	11.95
Sodium hydroxide	2 mg/m^3	10 mg/m^3	a) White b) Colorless	NA	a) Crystals b) Solution	NA	NA	NA	NA
Sulfuric acid	1 mg/m^3	15 mg/m^3	Colorless, yellow, or brown	Odorless	Solution	NA	NA	NA	ND

Notes:

[a] OSHA Permissible Exposure Limit (PEL) or American Conference of Governmental Industrial Hygienists Threshold Limit Value (TLV)
[b] Immediately Dangerous to Life or Health (IDLH)
[c] Lower Explosive Limit (LEL)
[d] Upper Explosive Limit (UEL)
[e] To be treated as a carcinogen
[f] This class of compounds comprises the benzene-soluble fraction of coal tar.

NA Not applicable
ND Not determined
Ca Carcinogen
ppm parts per million

Sources: NIOSH, 1997
Dräger, 1989

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

Compound	Symptoms of Overexposure	First Aid Treatment
Organic materials		
Benzene	Irritation to eyes, nose, respiratory systems; giddiness; headache, nausea; staggered gait; fatigue; anorexia; lassitude; dermatitis; bone marrow depressant/depression; abdominal pain; (carcinogenic)	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation. Move to fresh air; respiratory support Ingestion: Medical attention immediately
bis(2-Ethylhexyl)phthalate	Irritation to eyes and mucous membranes; carcinogenic	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
n-Butylbenzene	Toxic by ingestion; see gasoline	
sec-Butylbenzene	Toxic by ingestion; see gasoline	
tert-Butylbenzene	Toxic by ingestion; see gasoline	
Chlorobenzene	Irritation to eyes, skin, nose; drowsiness, incoherence; central nervous system depression; in animals: kidney, liver, lung injury	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion. Medical attention immediately
Chloroform	Irritation to eyes, skin, dizziness, mental dullness, nausea, confusion; headache, fatigue; anesthesia; enlarged liver; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion. Medical attention immediately
1,4-Dichlorobenzene	Eye irritation, swollen periorbital; profuse rhinitis; headache, anorexia, nausea, vomiting; weight loss, jaundice, cirrhosis; in animals. liver and kidney injury; carcinogen	Eye: Irrigate immediately Skin. Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
1,1-Dichloroethane	Irritation to skin; central nervous system depression; liver, kidney, lung damage	Eye: Irrigate immediately Skin: Soap flush promptly Inhalation. Move to fresh air; respiratory support Ingestion Medical attention immediately

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

Compound	Symptoms of Overexposure	First Aid Treatment
1,1-Dichloroethene	Irritation to eyes, skin, throat; dizziness, headache, nausea; dyspnea; liver, kidney dysfunction; pneumonitis; carcinogenic	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Move to fresh air, respiratory support Ingestion: Medical attention immediately
1,2-Dichloroethene (total)	Irritation to eyes and respiratory system; central nervous system depression	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion. Medical attention immediately
1,2-Dichloropropane	Irritation to eyes, skin, respiratory system, drowsiness, light-headedness; liver and kidney damage, in animals: central nervous system depression; carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Ethylbenzene	Irritation to eyes, mucous membranes; headache; dermatitis; narcosis; coma	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Gasoline	Irritation to eyes, skin, and mucous membranes, dermatitis; headaches, fatigue, blurred vision, slurred speech, confusion, convulsions; chemical pneumonia, possible liver and kidney damage; carcinogenic	Eye. Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Hexane	Irritation to eyes and nose; light-headedness, headache, numb extremities; muscle weakness, dermatitis; giddiness; chemical pneumonia	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Isopropyl benzene	Irritation to eyes, skin, and mucous membranes, dermatitis; headaches, narcosis, coma	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately

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

Compound	Symptoms of Overexposure	First Aid Treatment	
Isopropyltoluene	Toxic by ingestion; see gasoline		
Methanol	Irritation to eyes, skin, and upper respiratory system; headache, drowsiness, dizziness, vertigo, light-headedness, nausea, and vomiting; visual disturbance, optic nerve damage (blindness); dermatitis	Eye: Skin: Inhalation: Ingestion:	Irrigate immediately Water flush promptly Move to fresh air; respiratory support Medical attention immediately
Methyl tert-butyl ether	No hazard reference available	Eye: Skin: Inhalation: Ingestion:	Irrigate immediately Soap wash promptly Move to fresh air; respiratory support Medical attention immediately
Naphthalene	Eye irritation, headache, confusion, excitement, malaise, nausea, vomiting, abdominal pain; irritated bladder, profuse sweating; jaundice; blood in urine; hemoglobinuria; renal shutdown; dermatitis; optical neuritis; cornea damage	Eye: Skin: Inhalation. Ingestion:	Irrigate immediately Soap wash promptly Move to fresh air; respiratory support Medical attention immediately
n-Propylbenzene	Toxic by ingestion; see gasoline		
1,1,2,2-Tetrachloroethane	Nausea, vomiting, abdominal pain, tremor in the fingers, jaundice, hepatitis, liver tenderness, dermatitis, monocytosis; kidney damage, carcinogen	Eye: Skin: Inhalation: Ingestion:	Irrigate immediately Soap wash immediately Move to fresh air; respiratory support Medical attention immediately
Tetrachloroethene	Irritation to eyes, nose, and throat; nausea; flushed face and neck; vertigo, dizziness, incoherence; headache, somnolence; skin redness; liver damage; carcinogen	Eye: Skin: Inhalation: Ingestion.	Irrigate immediately Soap wash immediately Move to fresh air; respiratory support Medical attention immediately
Toluene	Fatigue; weakness; confusion; euphoria; dizziness; headache; dilated pupils; lacrimation; nervousness; muscle fatigue, insomnia; paresis; dermatitis; photophobia	Eye: Skin. Inhalation: Ingestion:	Irrigate immediately Soap wash promptly Move to fresh air; respiratory support Medical attention immediately

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

Compound	Symptoms of Overexposure	First Aid Treatment
1,1,1-Trichloroethane	Irritation to eyes and skin; headache, lassitude, central nervous system depression, poor equilibrium; dermatitis; cardiac arrhythmia; liver damage	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
1,1,2-Trichloroethane	Irritation to eyes and nose; central nervous system depression; liver and kidney damage; dermatitis; carcinogenic	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Trichloroethene	Headache, vertigo; visual disturbance, tremors, somnolence, nausea, vomiting; irritation of the eyes; dermatitis; cardiac arrhythmias, paresthesia, carcinogen	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
1,2,4-Trimethylbenzene	Irritation to eyes, skin, nose, throat, and respiratory system; bronchitis; hypochromic anemia; headaches, drowsiness, fatigue, dizziness, nausea, incoherence; vomiting, confusion; chemical pneumonia if aspirated	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air, respiratory support Ingestion: Medical attention immediately
1,3,5-Trimethylbenzene	Irritation to eyes, skin, nose, throat, and respiratory system; bronchitis; hypochromic anemia; headaches, drowsiness, fatigue, dizziness, nausea, incoherence; vomiting, confusion; chemical pneumonia if aspirated	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Vinyl chloride	Weakness; abdominal pain, gastrointestinal bleeding; enlarged liver; pallor or cyanosis of extremities; contact with liquid may cause frostbite; carcinogenic	Eye: Treat for frostbite Skin: Treat for frostbite Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Xylenes (total)	Dizziness; excitement; drowsiness; incoordination; staggering gait; irritation of eyes, nose, throat; corneal vacuolization; anorexia; nausea; vomiting; abdominal pain; dermatitis	Eye: Irrigate immediately Skin: Soap wash promptly Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately

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

Compound	Symptoms of Overexposure	First Aid Treatment
Inorganic materials		
Arsenic	Ulceration of nasal septum; dermatitis; gastrointestinal disturbances; peripheral neuropathy; respiratory irritation; hyperpigmentation of the skin; carcinogenic	Eye: Irrigate immediately Skin: Soap wash immediately Inhalation: Move to fresh air; respiratory support Ingestion. Medical attention immediately
Hydrochloric acid	Irritation to nose, throat, and larynx; coughing, choking; dermatitis; eye and skin burns	Eye. Irrigate immediately Skin: Water flush immediately Inhalation: Move to fresh air; respiratory support Ingestion. Medical attention immediately
Nitric acid	Irritation to eyes, skin, mucous membranes; delayed pulmonary edema, pneuitis, bronchitis; dental erosion; skin and eye burns	Eye: Irrigate immediately Skin: Water flush immediately Inhalation· Move to fresh air; respiratory support Ingestion: Medical attention immediately
Sodium hydroxide	Irritation to eyes, skin, and mucous membrane; pneuitis; eye and skin burns; temporary loss of hair	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately
Sulfuric acid	Irritation to eyes, nose, and throat; pulmonary edema; bronchitis; emphysema, conjunctivitis, stomitis; dental erosion; tracheobronchitis; eye and skin burns; dermatitis	Eye: Irrigate immediately Skin: Water flush immediately Inhalation: Move to fresh air; respiratory support Ingestion: Medical attention immediately

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

Adjusted Temperature[1]	Normal Work Ensemble[2]	Impermeable Ensemble
90 °F or above	After each 45 minutes of work	After each 15 minutes of work
87.5 - 90 °F	After each 60 minutes of work	After each 30 minutes of work
82.5 - 87.5 °F	After each 90 minutes of work	After each 60 minutes of work
77 5 - 82.5 °F	After each 120 minutes of work	After each 90 minutes of work
72.5 - 77.5 °F	After each 150 minutes of work	After each 120 minutes of work

Notes:

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

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

Source: NIOSH/OSHA/USCG/EPA, 1985

Table 6.1
Hazard Monitoring Methods, Action Levels, and Protection Measures

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Toxic Vapors (as identified in Table 4.1)	PID	0.0 to <0.5 ppm above background based on judgment of SSO	Level D (see Table 7.1)	-continue with regular monitoring of breathing zone
		0.5 ppm above background based on judgment of SSO	Level D (see Table 7.1)	-confirm/deny reading with vinyl chloride and benzene colorimetric tubes -if confirmed as vinyl chloride and/or benzene, then see vinyl chloride/benzene hazard identified below -if denied as vinyl chloride and benzene, then continue with regular monitoring of breathing zone
		≥0.5 ppm to <25 ppm above background based on judgment of SSO (if denied as vinyl chloride and benzene)	Level D (see Table 7.1)	-confirm/deny reading with tetrachloroethene and TCE colorimetric tubes -if confirmed as tetrachloroethene and/or TCE, then see specific hazard identified below -if denied as tetrachloroethene or TCE, then continue with regular monitoring of breathing zone
		≥25 to <250 ppm above background based on judgment of SSO (if denied as vinyl chloride, benzene, and tetrachloroethylene)	Level C (see Table 7 1)	-continue with regular monitoring of breathing zone - contact HSO and Project Manager - continue use of tubes, attempt to identify unknown air contaminants
Vinyl Chloride	Colorimetric Tubes	confirmed 1.0 to 10 ppm based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone
Benzene	Colorimetric Tubes	confirmed 0.5 to 5 ppm or greater based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone
Tetrachloroethene	Colorimetric Tubes	confirmed 25 to 50 ppm based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone
Trichloroethene	Colorimetric Tubes	confirmed 50 to 500 ppm based on judgment of SSO	Level C (See Table 7.1)	-continue regular monitoring of breathing zone

Table 6.1 (continued)
Hazard Monitoring Methods, Action Levels, and Protection Measures

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Flammable/Explosive Gases and/or Vapors	LEL/O_2 and Methane Detector	0.0 to 5 0 percent LEL	-notify sampling team of readings	-prior to and during sampling activities, monitor all areas suspected of containing flammable/explosive gases and/or vapors -continue with regular monitoring of breathing zone
Flammable/explosive bases and vapors	LEL/O_2 and Methane Detector	5.0 to < 10.0 percent LEL	-use spark proof equipment/tools	-continue with regular monitoring of breathing zone - notify HSO and Project Manager
		> 10 0 percent LEL	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments unless readings subside
Toxic Vapors (as identified in Table 4.1)	PID	≥250 ppm above background based on judgment of SSO (if denied as all chemicals listed above)	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires identification of new chemical hazard and HSP amendments
Vinyl Chloride	Colorimetric Tubes	confirmed 10 ppm or greater based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	- requires HSP amendments
Benzene	Colorimetric Tubes	confirmed 5 ppm or greater based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments
Tetrachloroethene	Colorimetric Tubes	confirmed 250 ppm or greater based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	-requires HSP amendments
Trichloroethene	Colorimetric Tubes	confirmed 500 ppm or greater based on judgment of SSO	STOP WORK, EVACUATE AREA, NOTIFY PROJECT MANAGER	- requires HSP amendments

Table 7.1
Protective Equipment for On-Site Activities

Activity	Level	Protective Equipment
MW Installation Groundwater Sampling Surface Soil Sampling Subsurface Soil Sampling	D	• Street clothes or overalls (long sleeves) • Impermeable safety boots/shoes (steel-toed) • Safety glasses/goggles (if hazard to eyes exists) • Hard hat (if hazard to head exists) • Gloves (nitrile, neoprene) • Ear plugs/defenders (if hazard exists)
	D (modified)	• Rubber boots; chemically resistant with steel toe • Gloves (nitrile, neoprene) • Tape for sealing ankle and wrist openings • Hard hat (if hazard to head exists) • Safety glasses/goggles (if hazard to eyes exists) • Uncoated Tyvek® or equivalent • Ear plugs/defenders (if hazard exists)
	C	• Coated Tyvek® or equivalent • Rubber boots, chemically resistant with steel toe • Rubber boot covers • Latex inner gloves • Tape for sealing ankle and wrist openings • Chemical resistant outer gloves (nitrile, neoprene) • Full-face respirator (organic vapor cartridges) • Additional items may be required (site-specific) • Ear plugs/defenders (if hazard exists)

Table 8.1
Six Stages for Decontamination for Modified Level D Protection

Stage	Procedure
Stage 1. Segregated Equipment Drop	Deposit equipment used on site on plastic drop cloths or in assigned containers with plastic liners.
Stage 2. Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decontamination solution, and rinse with water.
Stage 3· Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Stage 4: Boots, Gloves, and Disposable Clothing Removed	Deposit in appropriate plastic-lined container Discard disposable clothing.
Stage 5 Field Wash	Wash hands and face with soap and water
Stage 6. Redress	Put on clean clothes.

Table 8.2
Eighteen Stages for Decontamination in Level C Protection

Stage	Procedure
Stage 1: Segregated Equipment Drop	Deposit equipment used on site on plastic drop cloths or in different containers with plastic liners. Segregation at the drop reduces the probability of cross-contamination. During hot weather operations, a cool-down station may be set up within this area
Stage 2. Boot Cover and Glove Wash	Scrub outer boot covers and gloves with decon solution of detergent and water
Stage 3. Boot Cover and Glove Rinse	Rinse off decon solution from Stage 2 using copious amounts of water.
Stage 4: Tape Removal	Remove tape around boots and gloves and deposit in container with plastic liner.
Stage 5: Boot Cover Removal	Remove boot covers and deposit in container with plastic liner.
Stage 6: Outer Glove Removal	Remove outer gloves and deposit in container with plastic liner
Stage 7: Suit, Glove, and Boot Wash	Wash splash suit, gloves, and safety boots. Scrub with long-handle scrub brush and decon solution.
Stage 8: Suit, Glove and Boot Rinse	Rinse off decon solution using water. Repeat as many times as necessary
Stage 9: Canister or Mask Change	Perform last step in the decontamination procedure (if worker is leaving exclusion zone to change canister or mask). Worker's canister is exchanged, new outer gloves and boot covers donned, and joints taped; worker returns to duty.
Stage 10: Safety Boot Removal	Remove safety boots and deposit in container with plastic liner.
Stage 11: Splash Suit Removal	Remove splash suit with assistance of helper Deposit in container with plastic liner.
Stage 12: Inner Glove Wash	Wash inner gloves with decon solution.
Stage 13: Inner Glove Rinse	Rinse inner gloves with water.
Stage 14: Face Piece Removal	Remove face piece. Deposit in container with plastic liner. Avoid touching face with fingers. Note: Certain parts of contaminated respirators, such as the harness assembly and leather or cloth components are difficult to decontaminate. If grossly contaminated, they may need to be discarded. Rubber components can be soaked in soap and water and scrubbed with a brush. Use a final rinse of water and allow to air dry before using again. Inspect the respirator for damage and wear before and after each use.
Stage 15: Inner Glove Removal	Remove inner gloves and deposit in lined container.
Stage 16: Inner Clothing Removal	Remove clothing soaked with perspiration and place in lined container. Do not wear inner clothing off the site since there is a possibility that small amounts of contaminants might have been transferred when removing the disposal coveralls.
Stage 17: Field Wash	Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present Wash hands and face if shower is not available.
Stage 18. Redress	Put on clean clothes

Table 13.1
Emergency Telephone Numbers, Contacts, and Directions to Nearest Medical Facility

Key Personnel	Number
Todd Harrah - Project Manager	(512) 336-1170
James Heringer - Health and Safety Officer	(916) 614-8770
Joseph Jurinski - CIH (NuChem Co)	(703) 535-3180
Peter Huyakorn - President	(703) 736-4550
Michael Dodyk - Base Point of Contact HQ AFCEE/ERD	(817) 782-7167
Don Ficklen - AFCEE/ERD Contracting Officer's Representative	(210) 536-5290
Emergency Phones Numbers	
Ambulance -	911 or (817) 922-3150
Fire Department -	911 or (817) 246-1741
On base, mobile for Ambulance or Fire Department -	(817) 782-6330
Poison Control	911 or (800) 441-0040
Hospital - Harris Methodist - Fort Worth 1301 Pennsylvania Avenue	911 or (817) 882-2000
Directions to Nearest Medical Facility (Figure 13.1)	
Exit NAS Fort Worth JRB south toward the East-West Freeway (Interstate 30) Follow signs for I-30 East. Follow I-30 for approximately 7 miles to the exit for Henderson Street. At Henderson Street turn left (south). Follow to Pennsylvania Avenue and turn right (west). Follow one block and turn left (south) onto Fifth Avenue. Emergency entrance is located on the right.	

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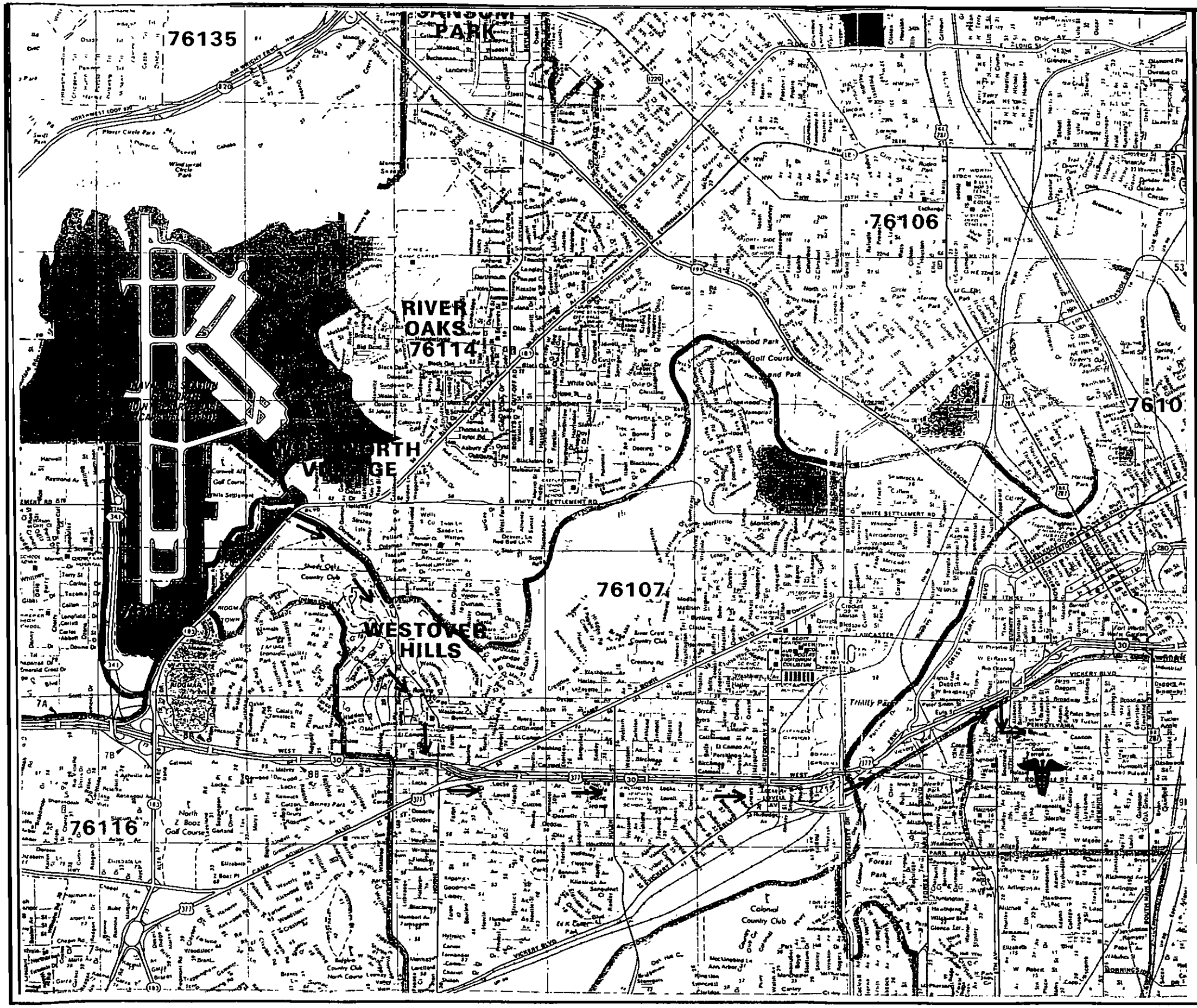
FIGURES



HydroGeoLogic, Inc.—HealthandSafetyPlan
NASFortWorthJRB, Texas

Figure 13.1

Nearest Medical Facility to NAS Fort Worth JRB

AirForceCenter ForEnvironmental Excellence BrooksAFB, Texas

Legend

Hospital

RoutetoHospital

Filename: X:AFC001\26IA\Report\Fig_13-1.cdr
Project: AFC001-26IA
Revised: 12/20/99 cf
Source: RandMcNally, 1996

HYDRO GeoLogic

TAB

APPENDIX E

APPENDIX E

GEOSTATISTICS METHODOLOGY

APPENDIX E
GEOSTATISTICS METHODOLOGY

E.1 APPLIED GEOSTATISTICS

For the 2001 GSAP, a geo-statistical analysis was performed to determine the potential reduction in estimation uncertainty by the addition of sampling locations where samples were not collected in the 2000 GSAP. Monitoring objectives were established based on the Record of Decision (ROD), and on HydroGeoLogic's interpretations of the key issues at the site.

TCE data from 51 monitoring points collected in the final quarter of 2000 were used in the geo-statistical analysis to produce statistically based concentration contours and estimates of errors in those contours. It should be noted that these contours assume homogeneous anisotropic conditions. Although heterogeneities in the underlying spatial correlation model are assumed not to exist, the correlation model does attempt to capture the variability of the model with respect to direction. Using the geo-statistical analysis, a scientist may identify regions of high estimation error, or uncertainty, to rank prospective new sampling locations by the potential to make the largest contributions to error reduction. This process of estimation error reduction has been described as identifying data gaps.

In this analysis, a candidate list of monitoring well locations has been constructed. Some of the monitoring locations in the list were sampled in the fourth quarter of 2000, while other monitoring wells were not sampled during the fourth quarter. A spatial correlation model was created based on all fourth quarter TCE data and then error estimates were made based only on the subset of proposed locations for 2001 that were sampled in the fourth quarter. The remaining proposed monitoring locations were superimposed on the error contours to examine their potential for error reduction.

E.2 UNIVERSAL OR TREND KRIGING BACKGROUND

Kriging is a point estimation method that is commonly used in the hydrogeologic communities. It has been described in great detail by Journal [1989] and by Isaaks and Srivastava [1989]. The method of kriging uses the spatially dependent parameter variability of known sample values to produce the Best Linear Unbiased Estimate (BLUE) of the parameter at another location. Kriging is Linear because its estimates are weighted linear combinations of the available data. It is Unbiased because the system of kriging equations assumes that the mean error between the estimate and the true parameter value (residual) is equal to zero. Kriging produces the Best linear regression estimate because the system of equations minimizes the residual. The relative contributions of known sample values incorporate their statistical structure and reflect the changes observed in the sample values with respect to their location. These weights are called kriging weights. The estimates calculated based on these weights will trend towards the mean sample value as the distance of the estimation point from the data grows. This is the case for ordinary kriging. However, an alternative trend can be specified

(*e.g.*, background concentration, zero concentration) a priori to which distant estimates will converge. This version of kriging is known as universal or trend kriging.

In addition to the point estimate, the method of kriging yields the variance of the estimation error. The variance of error gives useful information about the uncertainty of the parameter estimate. It may be used to calculate the confidence interval around the estimate. When a field of parameter estimates is generated, the variance of error filed may be used to quantify sample uncertainty at specific locations. High levels of uncertainty indicate areas where more information may be necessary. Conversely, areas with low levels of uncertainty indicate areas where there may be redundant information. This analysis will focus on the magnitude of the error variance at the proposed locations of previously, or recently, un-sampled monitoring wells.

E.3 APPLICATION

This method of analysis was applied to data gathered from October 2000 to December 2000 at the NAS Fort Worth JRB (Appendix A, Table A.1). The preliminary statistics were performed on the natural logarithm of the parameters due to the wide range of parameter values as quantified by the Coefficient of Variation (Isaaks and Srivastava, 1989) and normality plots (Table E.1). The preliminary statistics are used to describe the spatial relationship used to make the parameter estimates. This relationship is described by the variogram model. The variogram model predicts a change in the variance between values as a function of the distance between the values. The quality of the overall kriging estimate is largely dependent on how well the selected variogram model represents the true system. A number of samples are used to select and fit a variogram model, which are determined by the preliminary statistics. Distance is the independent or random variable and is plotted on the abscissa in the variogram model. Variance, the dependent variable, is plotted on the ordinate axis. In addition to the independent variable there are two other fitting parameters, the correlation length (or range) and the sill. The sill is the mean variance of the values. The range is the maximum distance at which the values at two locations are statistically related. At distances greater than the range, the variance between the two values is approximated as the mean variance or sill. Figure E.1 presents an example sample variogram and model variogram. The results, in the form of estimation uncertainty contours are in Figure E.2.

There is a significant amount of ongoing, or planned feasibility study work occurring at the base focusing on the regional trichloroethylene plume in the Terrace Alluvium aquifer. As such, there is an increased emphasis on reducing uncertainty in plume delineation through the well selection process for the 2001 GSAP. HydroGeoLogic used site knowledge and a review of several years of quarterly sampling data to develop a list of wells to consider for the 2001 GSAP. The initial well list was superimposed over developed uncertainty contours to support evaluating the candidate well list. Based on this review, some wells were removed from consideration, while others were added. Figure E.2 presents the final proposed well list overlaying the basewide uncertainty contours. In viewing Figure E.2, those wells with fourth quarter sampling data lie within areas of minimum uncertainty (i.e., peak certainty at the point

of data collection). These well locations are coded green on Figure E.2. Uncertainty increases the further away you travel from a fourth quarter sampling location, and continues to increase with each contour line. As can be seen from reviewing Figure E.2, the majority of the additionally proposed wells for the 2001 GSAP (colored blue in Figure E.2), lie in areas of high uncertainty. For the limited number of instances where additionally proposed wells are located in areas of low uncertainty, other factors were considered in the well selection process (e.g., close proximity to Federal property boundary). The sum of the fourth quarter 2000 wells sampled (green well locations), and the additionally proposed wells (blue well locations), make up the entire proposed list of Terrace Alluvium wells to be sampled semi-annually in 2001.

Table E.1
Preliminary Statistics for October through December 2000 from NAS Ft. Worth, JRB

Parameter	4th Quarter 2000
Sample Size	51
Covariance Model	Exponential
Nugget Value $(\log(C))^2$	0
Correlation Length in X (ft)	3000
Correlation Length in Y (ft)	1000
Sill $(\log(C))^2$	7.75

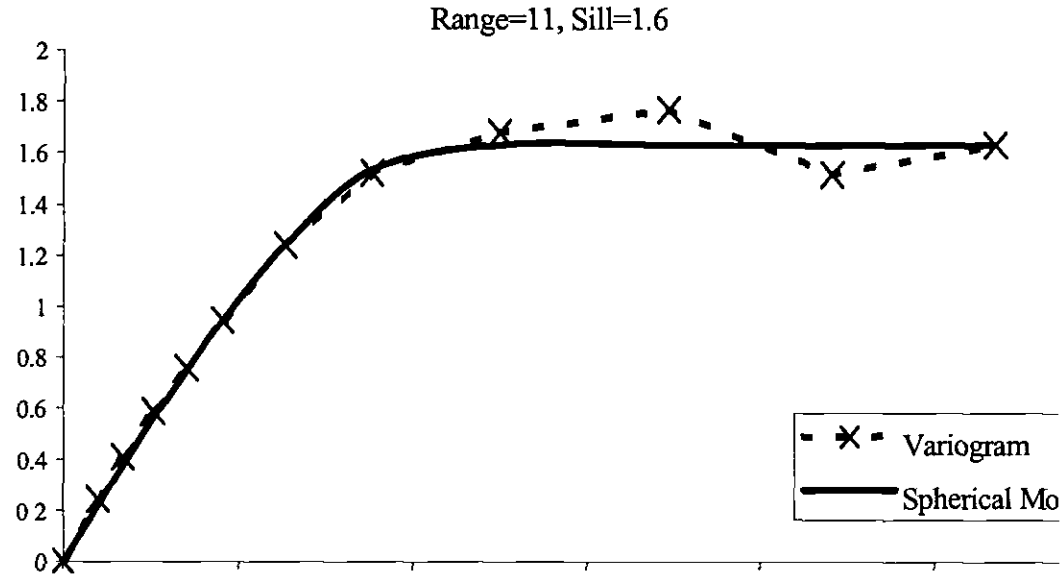


Figure E.1 Sample Variogram with Spherical Model.

E.5 REFERENCES

Isaaks, E. H., Srivastava, R. M., An Introduction To Applied Geostatistics, Oxford University Press, New York, 1989.

Journal, A. G., Fundamentals of Geostatistics in Five Lessons, Vol. 8, M.L. Crawfork and E. Padovani (Eds.), American Geophysical Union, 38 pages, 1989.

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FIGURES

HydroGeoLogic,Inc
2001 Basewide Groundwater Sampling and Analysis Plan
NAS Fort Worth JRB, Texas

Figure E.2

Statistical Confidence Assessment for 2001 Monitoring Well Selection

U S Air Force Center For Environmental Excellence

Legend

- NAS Fort Worth JRB Boundary
- Former Carswell Air Force Base Boundary
- Air Force Plant 4 Boundary
- Trichloroethene Contour (5 µg/L) (October 2000)
- Estimation Confidence Contours
- Solid Waste Management Unit (SWMU)
- Area of Concern (AOC)
- LTM Monitoring Wells Sampled During October 2000
- Additional Monitoring Wells Selected to Sample During 2001
- Removed Monitoring Wells Sampled During October 2000
- AOC 1 Monitoring Wells to be Sampled During 2001

Notes
1 AOC 1 monitoring well, MW-5 was used in statistical optimization
2 AFP 4 monitoring well LF04-10 is sampled by Jacobs and used in statistical optimization
3 WHGLTA029 and WITCTA003 will only be sampled during April 2001

N

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SCALE IN FEET

HYDRO GeoLogic INC

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Project AFC001-33FA
Created 03/07/01 jbelcher
Revised 03/08/01 jb
Map Source HydroGeoLogic Inc , ArcView GIS Database, 2001

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