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DRAFT RCRA FACILITY INVESTIGATION CORRECTIVE MEASURE STUDY WORK PLANS FOR WP07 AND LANDFILLS 4, 5 AND 8 NAS FORT WORTH TX

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HydroGeoLogic Inc.

RCRA Facility Investigation/ Corrective Measures Study Draft Work Plans for WP-07 and Landfills 4, 5, and 8 Carswell AFB, Texas

Prepared for
Air Force Center for Environmental Excellence
Brooks AFB, Texas
Contract No. F41624-95-D-8005

January 1997

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RCRA FACILITY INVESTIGATION/ CORRECTIVE MEASURES STUDY DRAFT WORK PLANS FOR WP-07 AND LANDFILLS 4, 5, AND 8 CARSWELL AIR FORCE BASE, TEXAS

Prepared for:

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

Contract Number F41624-95-D-8005

Prepared by:

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January 1997

PREFACE

Draft Work Plan for RCRA Facility Investigation/Corrective Measures Study at Carswell Air Force Base

This document contains Draft Plans for the proposed RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) of selected sites at Carswell Air Force Base (CAFB). The plans consist of a Work Plan (WP); a Sampling and Analysis Plan (SAP), comprising a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP); and a Health and Safety Plan (HSP).

HydroGeoLogic, Inc. (HydroGeoLogic) prepared the plans under contract to the U.S. Air Force Center for Environmental Excellence (AFCEE), Contract No. F41624-95-D-8005, Delivery Order 002, in support of the U.S. Air Force Installation Restoration Program.

The Draft Plans were written at HydroGeoLogic's headquarters office in Herndon, Virginia, under the direction of Ms. Miquette Gerber, the HydroGeoLogic Project Manager. The documents were prepared with the assistance of Mr. Olen Long, CAFB AFBCA, Site Manager and Mr. Charles Rice, AFCEE Team Chief at Brooks AFB.

Approved: John B. Robertson   Date: Jan. 10, 1997

Mr. Jack B. Robertson
HydroGeoLogic, Inc.
Contract Program Manager

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PURPOSE OF DOCUMENT STATEMENT

LETTER OF INSTRUCTION

a. These WPs for the RFI/CMS are to be used for all activities (including tenants) that generate or manage hazardous waste or potential hazardous waste on CAFB property. Procedures and policies outlined in this plan are designed to meet the needs of Generating Activities and to facilitate compliance with all applicable Federal, state, and local laws governing hazardous waste management.

b. Compliance with this plan will help protect the environment and the health of everyone at CAFB and in the local community. In addition to health risks, failure to fully comply with this plan at all times could result in Federal or state regulatory action requiring substantial expenditure of United States Air Force (USAF) resources and possibly criminal prosecution of the individuals responsible for noncompliance.

c. The success of CAFB's hazardous waste management program depends on team effort and total dedication from all parties involved. Therefore, efforts should be focused on doing what is smart, what is right, and more importantly, what is lawful to achieve and maintain compliance with all laws governing hazardous waste management.

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NOTICE

These WPs for the RFI/CMS at the CAFB have been prepared for the USAF by HydroGeoLogic for the purpose of aiding in the implementation of a final remedial action plan under the Air Force Installation Restoration Program (IRP). Because the plans relate to actual or possible releases of potentially hazardous substances, their release prior to an USAF final decision on remedial action may be in the public's interest. The limited objectives of these plans and the ongoing nature of the IRP, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered in the evaluation of this document because subsequent facts may become known that may make this document premature or inaccurate. Acceptance of this document in performance of the contract under which it is prepared does not mean that the Air Force adopts the conclusions, recommendations, or other views expressed herein, which are those of the contractor only and do not necessarily reflect the official position of the United States Air Force.

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This document presents the Work Plans for the RFI/CMS at Landfills No. 4, 5, 8 and Waste Burial Area No. 7 at the Former Carswell Air Force Base, Texas.

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

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DRAFT WORK PLAN

RCRA FACILITY INVESTIGATION/ CORRECTIVE MEASURES STUDY CARSWELL AFB, TEXAS

Contract Number F41624-95-D-8005

Prepared for:

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

Prepared by:

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January 1997

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1,2-DCE	1,2-Dichloroethene
1,1,1-TCA	1,1,1-Trichloroethane
ACC	Air Combat Command
AFB	Air Force Base
AFBCA	U.S. Air Force Base Realignment and Closure Agency
AFCEE	U.S. Air Force Center for Environmental Excellence
AFP-4	Air Force Plant No. 4
ARARs	Applicable or Relevant and Appropriate Regulations
BLRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure Commission
CAFB	Carswell Air Force Base
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CMS	Corrective Measures Study
COPC	Chemical of Potential Concern
DEQPPM	Defense Environmental Quality Program Policy Memorandum
DOD	Department of Defense
DQO	Data Quality Objectives
DRMO	Defense Reutilization and Marketing Office
DTIC	Defense Technical Information Center
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
FSP	Field Sampling Plan
FT-08	Fire Training Area 1
FT-09	Fire Training Area 2
HSP	Health and Safety Plan
IRP	Installation Restoration Program
ISM	Interim/Stabilization Measures
JRB	Joint Reserve Base

LIST OF ACRONYMS

LF-04	Landfill No. 4 (a.k.a. SWMU 22)
LF-05	Landfill No. 5 (a.k.a. SWMU 23)
LF-08	Landfill No. 8 (a.k.a. SWMU 25)
MSCs	Medial Specific Concentrations
NAS	Naval Air Station
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
SAC	Strategic Air Command
SAP	Sampling and Analysis
SARA	1986 Superfund Amendments and Reauthorization Act
SI	Site Investigation
SVOCs	Semi-Volatile Organic Compounds
SWMU	Solid Waste Management Unit
TCE	Trichloroethylene
TNRCC	Texas Natural Resource Conservation Commission
TSWQS	Texas Surface Water Quality Standards
USACE	U.S. Army Corps of Engineers
USAF	United States Air Force
VOCs	Volatile Organic Compounds
WP	Work Plan
WP-07	Waste Burial Area No. 7 (a.k.a. SWMU 24)

1.0 INTRODUCTION/FACILITY BACKGROUND

These Work Plans (WPs) describes the RCRA Facility Investigation/Corrective Measures Study (RFI/CMS) of selected sites at the former Carswell Air Force Base (CAFB, the Base) as part of the U.S. Air Force (USAF) Installation Restoration Program (IRP). These WPs are authorized as Delivery Order 0002 under U.S. Air Force Center for Environmental Excellence (AFCEE) Contract No. F41624-95-D-8005. HydroGeoLogic, Inc. (HydroGeoLogic) has been contracted to conduct RFI/CMS activities at selected CAFB sites to fill data gaps, and to determine if remediation is warranted, and if so, identify the appropriate remedial alternative and propose a preferred alternative.

1.1 DESCRIPTION OF INSTALLATION RESTORATION PROGRAM (IRP)

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

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

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

1.2 OBJECTIVES AND SCOPE OF WORK

The objective of this investigation is to characterize the extent of contamination at four solid waste management units (SWMU), determine if any contamination present poses an unacceptable threat to human health and the environment, and if so, to propose appropriate remedial alternatives. The four SWMUs are Landfill No. 4 (SWMU 22 or LF-04), Landfill No. 5 (SWMU 23 or LF-05), Waste Burial Area No. 7 (SWMU No. 24 or WP-07) and Landfill No. 8 (SWMU 25 or LF-08).

1.2.1 Project Objectives

The following is a list of project objectives for the RFI/CMS:

- Develop a plan to fill the data gaps remaining from previous investigations.
- Perform field investigations to characterize potential soil, groundwater, surface water, and sediment contamination not fully characterized in previous investigations
- Perform a quantitative human health baseline risk assessment (BLRA) and qualitative ecological risk assessment (ERA) at each of the investigation sites.
- Conduct a CMS for each of the sites to determine the appropriate remedial alternatives retaining No Further Action (NFA) as one of the alternatives for consideration at each of the sites.

A significant amount of investigative work has preceded the current effort at CAFB. The focus of this study is to fill any data gaps in order to develop the information needed to prepare Decision Documents for the four subject sites.

1.2.2 Scoping Documents

The Resource Conservation and Recovery Act (RCRA) is the primary regulatory driver for the four sites included in this RFI/CMS. However, the IRP program and RCRA rely heavily on guidance documents prepared under the CERCLA. These WPs have been prepared using guidance documents from all three programs (i.e., RCRA, IRP, CERCLA) in an effort to address as many of the concerned parties as possible. The WPs for the project consist of the following documents:

A Work Plan, which describes the work to be performed, explains project objectives, and presents the rationale for conducting specific project activities. The WP describes the site history and setting along with a summary of environmental investigations on the Base. Each site is described, along with data needs and the proposed sampling program for each site. Risks associated with human health and ecological impacts are presented, including contaminant identification and risk characterization. Technical reports and presentation formats are also discussed in the WP.

A Sampling and Analysis Plan, consisting of a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP).

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

The Quality Assurance Project Plan describes the field and analytical procedures which will be used to provide quality control for the project. The QAPP provides the project organization responsibility and defines quality assurance objectives on a project wide basis. Laboratory operating procedures are presented, including calibration, data management, validation, and reporting. Internal controls and procedures are also defined.

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

1.3 INSTALLATION DESCRIPTION AND HISTORY

This section describes the location, physical setting, operational history, and previous environmental investigations.

1.3.1 Installation Description

CAFB was located on 2,555 acres of land in Tarrant County, Texas, eight miles west of downtown Fort Worth (Figure 1.1). It consisted of the main Base and two noncontiguous parcels (the ILS marker beacon and the Weapon Storage Area) located west of the town of White Settlement. The main Base comprised 2,264 acres and was bordered by Lake Worth to the north, the West Fork of the Trinity River, River Oaks, and Westworth Village to the east, other urban areas of Fort Worth to the northeast and southeast, White Settlement to the west and southwest, and AF Plant 4 to the west. The area surrounding CAFB is mostly suburban. Land use in the immediate vicinity of the Base is industrial, commercial, residential, and recreational.

1.3.2 Installation History and Present Mission

Prior to 1941, the area that is now occupied by CAFB consisted of woods and pasture in an area called White Settlement. CAFB started as a modest dirt runway built to service the aircraft manufacturing plant located were AF Plant 4 (AFP-4) is now. Figure 1.2 presents the relationship between AFP-4 and CAFB. In August 1942, the Base was opened as Tarrant Field Airdrome and used to train pilots to fly the B-24 under the jurisdiction of the Gulf Coast Army Air Field Training Command. In May 1943, the field was re-designated as Fort Worth Army Air Field with continued use as a training facility for pilots. The Strategic Air Command (SAC) assumed control of the installation in 1946 and the Base served as the headquarters for the Eighth Air Force. It was renamed CAFB in 1948 and 7th Bomber Wing became the Base host unit. The Headquarters 19th Air Division was located at CAFB in 1951 were it remained until September 1988.

The SAC mission remained at CAFB until 1992 when the Air Combat Command (ACC) assumed control of the Base upon disestablishment of SAC. In October 1994, the U.S. Navy assumed responsibility for much of the facility and its name was changed from CAFB to Naval Air Station (NAS) Fort Worth Joint Reserve Base (JRB). NAS Dallas and elements of Glenview and Memphis NASs were combined into NAS Fort Worth JRB to streamline naval operations into one central area. The principle activities on the Base have been maintaining and servicing bombers, fuel tankers, and fighter jet aircraft. Throughout these WP documents, the former CAFB will continue to be referred to as CAFB.

1.3.3 Site Operational History

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

1.3.3.1 Industrial Activities

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

Waste oils generally refers to lubricating fluids/oils and to a lesser extent hydraulic fluids. Recoverable fuels refers to fuels drained from aircraft tanks and other Base vehicles, such as JP-4 and unleaded gasoline. Spent solvents and cleaners refers to stripping liquids used for degreasing and cleaning of aircraft, aircraft systems and parts, electronic components and vehicles. Included in this category are PD-680 (petroleum naphtha) and various chlorinated organic compounds. Specific types of degreasing solvents used by the U.S. Air Force have changed over the years. In the 1950s, carbon tetrachloride was commonly used until it was replaced by trichloroethylene (TCE) in about 1960. Since then, TCE and 1,1,1-trichloroethane (1,1,1-TCA) have been used though TCE usage has decreased in favor of 1,1,1-TCA. Today, PD-680 Type II, 1,1,1-TCA and, to a limited extent, TCE are used. Waste paint solvents and strippers are also generated onsite from corrosion control activities. Typical paint solvents include compounds like isobutyl acetate, toluene, methyl ethyl ketone, isopropanol, naphtha, and xylene. Paint strippers generally contain such compounds as methylene chloride, toluene, ammonium hydroxide, and phenolics. Servicing and maintenance of the engines and equipment of the B-52 and KC-135 aircraft generated the majority of waste liquids at CAFB (CHM2 Hill, 1996a).

1.3.3.2 Waste Disposal Operations

Wastes have been generated and disposed of at CAFB since the beginning of industrial operations in 1942. Historical waste management practices at CAFB were presented in the Phase I Initial Assessment Report (CH2M HILL, 1984) and the Phase I Remedial Investigation Report (Radian, 1989) and are summarized in the following paragraphs:

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

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

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

1983-Present: Waste oils, solvents, and cleaners have been collected in 55-gallon drums and temporarily (less than 90 days) stored at 12 hazardous waste accumulation points located throughout the Flightline Area of the Base. They are subsequently disposed of by contractor removal through DRMO. Recovered JP-4 fuel is stored at the fire department training area for subsequent burning in practice exercises or is reused in aerospace ground equipment operations. Removal of waste oils and PD-680 (Type II) from oil/water separators is also handled by off-base contractor through DRMO.

1.3.4 Site Investigation History

This RFI/CMS is being conducted at CAFB as part of the ongoing IRP. The IRP was designed to identify, characterize and remediate any contamination discovered onsite. The IRP effort at CAFB was initiated in 1984 and has continued to the present.

The following IRP investigations have been performed at CAFB:

- Phase I- Initial Assessment/Records Search (PA) by CH2M-HILL in 1984 (CH2M Hill, 1984).

- Phase II, Stage 1 - Problem Confirmation/Quantification Report (SI) by Radian Corp. in 1986 (Radian, 1986).

- Phase II, Stage 2- RI/FS Draft Technical Report for CAFB (Phase I RI) by Radian Corp. in 1989 (Radian, 1989).

- Phase II, Stage 2- RI/FS Final Report for the Flightline Area (Phase II RI) by Radian Corp. in 1991 (Radian, 1991).

The area of interest for this RFI is in the Flightline Area. The Flightline Area for the purpose of this report, is defined as the area near the southern end of the flightline at CAFB. During the PA, twelve sites were identified for further investigation. The 12 sites identified in the PA were chosen for further investigation under the site investigation (SI) (Phase II, Stage I). Of the 12 sites investigated, six were located in the Flightline Area. These six sites were Landfills No. 3, 4, and 5, Fire Department Training Areas 1 and 2, and the WP-07 (Radian, 1986). All of the sites were retained for further investigation during the Phase I RI/FS (Phase II, Stage II, 1989). The Phase I RI recommended NFA at Landfill No. 3 and Fire Department Training Area 1 (Radian, 1989). Landfills 4, 5, WP-07 and Fire Department Training Area 2 were retained for further investigation in the Phase II RI/FS (Phase II, Stage II, 1991). Groundwater pump and treat with air stripping treatment was the selected remedial alternative during the Phase II RI/FS (Radian, 1991). Remedial Action at the Fire Department Training Area 2 has led to a recommendation for NFA at this site. The selected remedial alternative proposed in the Phase II RI/FS was never fully implemented. These WP documents are designed to gather any additional data required to prepare Decision Documents for the subject sites. Table 1.1 summarizes the current status of each of the Flightline Area SWMUs. Figure 1.3 presents the location of the Flightline Area SWMUs.

This RFI will focus on three sites investigated during the SI, Phase I RI/FS and Phase II RI/FS (i.e., LF-04, LF-05, and WP-07), and one site (LF-08) which has not been investigated since the PA (Phase I IRP Investigation). A RCRA Facility Assessment (RFA) was conducted at CAFB in 1989. An RFI was recommended for each of the subject sites based on the findings in the RFA.

2.0 SITE GEOGRAPHICAL AND GEOLOGICAL CHARACTERISTICS

The climate, physiography, geology, hydrology, and ecology for the CAFB/AFP-4 area is described in the following sections. These data have primarily been derived from the Summary of Hydrologic and Chemical Characterization Studies Report (ESE, 1994) and the RI/FS Reports (Radian, 1989, 1991).

2.1 CLIMATE

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

Mean annual precipitation recorded at the Base is approximately 32 inches. The wettest months are April and May with a secondary maximum in September. The period from November to March is generally dry with a secondary minimum in August. Snowfall accounts for a small percentage of the total precipitation between November and March. Thunderstorm activity occurs at the Base an average of 45 days per year, with the majority of the activity between April and June. Hail may fall on two to three day per year. The maximum precipitation recorded in 24 hour period is 5.9 inches. On the average, measurable snowfall occurs 2 days per year.

Lake evaporation near CAFB is estimated to be approximately 57 inches per year. Evapotranspiration over land areas may be greater or less than lake evaporation depending on vegetative cover type and moisture availability. Average net precipitation is expected to be equal to the difference between average total precipitation and average lake evaporation, or approximately minus 25 inches per year. Mean cloud cover averages 50 percent at CAFB with clear weather occurring frequently during year round. Some fog is present on an average of 83 days per year. Wind speed averages 7 knots; however, a maximum of 80 knots has been recorded. Predominant wind direction is from the south-southwest throughout the year.

2.2 PHYSIOGRAPHY

The CAFB/AFP- 4 area is located along the border zone between two physiographic provinces. The southeastern part of the Base is situated within the Grand Prairie section of the Central Lowlands Physiographic Province. Most of CAFB is located within this province. This area 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 CAFB/AFP-4 area is situated within the Western Cross Timbers Physiographic Province. This area is characterized by rolling topography and a heavy growth of post and blackjack oaks.

The topography of CAFB is fairly flat except for the lower lying areas along the tributaries of the Trinity River. The land surface slopes gently northeastward toward Lake Worth, and eastward, toward the West Fork of the Trinity River. Surface elevations range from about 690 feet above national geodetic vertical datum (NGVD), at the southwest corner of the Base, to approximately 550 ft above NGVD, along the eastern side of the Base. Figure 2.1 is a section of the Lake Worth, Texas U.S. Geological Survey Topographic Map showing the relief of the CAFB/AFP-4 area.

2.3 GEOLOGY

2.3.1 Regional Geology

The geologic units of interest at the site, 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. The occurrence of these units in a generalized geologic section is presented in Figure 2.2 (Radian, 1989). The areal limits of surface exposure of these units at CAFB are shown in Figure 2.3 (Radian , 1989). The regional dip of these stratigraphic units beneath CAFB is between 35 to 40 feet per mile in an easterly to southeasterly direction. CAFB is located on the relatively stable Texas Craton, west of the faults that lie along the Ouachita Structural Belt. No major faults or fracture zones have been mapped near the Base.

The United States Soil Conservation Service has identified four major soil associations in the area of CAFB. The surficial soils of the study area include the nearly level to gently sloping clayey soils of the Sanger-Purves-Slidell and the Aledo-Bolar-Sanger Associations. The clayey soil of the Frio-Trinity Association and the loamy soil of the Bastsil-Silawa Association are found along the floodplain and stream terraces of the West Fork of the Trinity River. The characteristics of each soil group are summarized in Table 2.1 (ESE, 1994) and the areal limits of their occurrence onsite are shown in 2.4 (ESE, 1994).

2.3.2 Site Specific Geology

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

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

Below the Walnut Formation is the Paluxy Formation (or Paluxy Sand). The Paluxy Formation underlies all of CAFB. The Formation consists of several thick sandstone layers that are separated by thin discontinuous shale and claystone layers. Sandstones in the formation are primarily a fine to course grained sand with minor amounts of clay, sandy clay, pyrite, lignite, and shale. The lower section of the Paluxy is generally courser grained than the upper section (CHM2 Hill, 1996a). Total Formation thickness ranges from 130 to 175 feet, with variable thickness and occurrence of individual layers across the site. Only one unit in this formation, a shale/silty shale, can be extensively mapped across the Base.

The older Glen Rose and Twin Mountains Formations are not exposed at CAFB. The Glen Rose Formation consists primarily of calcareous sedimentary rock and some sands, clays, and anhydrite. The Glen Rose caps the Twin Mountain Formation, which is the oldest Cretaceous Formation in the CAFB area. The Twin Mountain Formation consists of a basal conglomerate of chert and quartz, grading upward into coarse- to fine-grained sand interspersed with varicolored shale.

2.3.2.1 Flightline Area Cross-Sections

The following six geologic cross-sections and the accompanying descriptions were taken from the Phase II RI (Radian, 1991). A location map for the cross-sections through the Flightline Area is provided in Figure 2.5. Two of the cross-sections (A-A' and B-B') are oriented from east to west through the Flightline Area and the other four are oriented from south to north (C-C' through F-F') through the Flightline Area. All of the cross-sections intersect the relatively thick sand and gravel sequence prevalent in the Flightline Area.

Cross-section A-A' (Figure 2.6) depicts the subsurface from east to west through LF-04 and LF-05 and WP-07. This cross-section is oriented through the thickest sands and gravels of the alluvial terrace in the Flightline Area. Boring locations from LF05-15 eastward all display a fining-upwards sequence in the alluvial terrace deposits, which is consistent with alluvial deposition. The lower bedrock surface observed in the eastern half of the cross-section is probably the result of stream erosion, as rounded limestone and chert gravels (typical of channel lag deposits) rest directly on the bedrock surface. These deposits are believed to coincide with the location of the former channel of what is now Farmers Branch Creek.

In cross-section B-B' (Figure 2.7), another steep incline is observed in the bedrock topography between monitoring well locations FT09-12A and FT09-12B. Paralleling the included bedrock surface is a steeply-dipping alluvial terrace water table. Fining-upwards sequences of sediments are seen in all borings included in this cross-section, with gravels occurring on the eroded bedrock surface east of FT09-12A.

In cross-section C-C' (Figure 2.8), gravels occur only in the middle area of the cross-section, with a relatively higher bedrock surface occurring in the northern and southern reaches of the section. The steeply inclined bedrock surface seen at location FT09-12A (B-B') is also reflected on this cross-section at location LF04-4A. Monitor well FT09-12C occurs at approximately the southern edge of the paleochannel deposits observed in the Flightline Area.

Cross-section D-D' is shown on Figure 2.9. A relatively thick sequence of coarse-grained materials occurs through the middle portion of the cross-section. Southward from boring LF05-12, the coarse-grained alluvial terrace deposits thicken, with the thickest deposits occurring in the vicinity of LF04-4F. Monitor well LF04-4F is the only location on this cross-section where gravels are found. Location LF04-4B, like LF04-4A (C-C'), is located on a relative high on the bedrock surface.

Cross-section E-E' (Figure 2.10) shows the thickest sequence of the alluvial terrace sands and gravels occurring in the vicinity of LF04-4G. Monitor well LF04-4G occurs within the trend of the thickest alluvial terrace sands and gravels observed in the Flightline Area. The trend axis is situated approximately on White Settlement Road.

Cross-section F-F' (Figure 2.11) is the easternmost south-north oriented cross-section through the Flightline Area. Although monitor well boring LF04-10 encountered the thickest sequence of alluvial terrace coarse-grained sediments, the potentiometric surface (derived from the June 18, 1990 water level survey) indicates groundwater flow toward the location of LF05-19, rather than parallel to the depositional trend, as might be expected. In this area, the tendency for the groundwater to discharge to Farmers Branch Creek apparently exerts a greater influence on the flow direction than the permeability of the alluvial terrace sediments.

2.4 HYDROLOGY

2.4.1 Groundwater

The water-bearing geologic formations located in the CAFB area may be divided into the following five hydrogeologic units, listed from the shallowest to the deepest: 1) an upper perched-water zone occurring in the alluvial terrace deposits associated with the Trinity River; 2) an aquitard of predominantly dry limestone of the Goodland and Walnut Formations; 3) an aquifer in the Paluxy Sand; 4) an aquitard of relatively impermeable limestone in the Glen Rose Formation; and 5) a major aquifer in the sandstone of the Twin Mountains Formation. Each of these units is examined in more detail in the following paragraphs.

2.4.1.1 Alluvial Terrace Deposits

The uppermost groundwater in the area occurs within the poor space of the grains of coarse sand and gravels deposited by the Trinity River. In some parts of Tarrant County, primarily in those

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areas adjacent to the Trinity River, groundwater from the terrace deposits is used for irrigation and residential use. Groundwater from the terrace deposits is rarely used as a source of potable water due to its limited distribution and susceptibility to surface/stormwater pollution. The storage capabilities of these deposits is minimal due to their limited areal and vertical extent and by the fact that the coarser-grained units are isolated into narrow lenses.

Recharge to the water-bearing deposits occurs through infiltration from precipitation and from surface water bodies. Extensive pavement and construction onsite restricts this recharge. However, additional recharge comes from leakage in water supply lines, sewer systems, and cooling water systems. This leakage has been calculated by GD Facility Management to be in excess of approximately 115.5 million gallons for CAFB and AFP-4 in 1991. This inflow of water to the shallow aquifer locally affects groundwater flow patterns and contamination transport, along with increasing hydraulic head, which acts as the force to potentially drive water into lower aquifer systems. This flow between aquifers is restricted by the Goodland/Walnut Formations and therefore the alluvial terrace groundwater is not hydraulically connected to the underlying aquifers in the Flightline Area. The primary water flow in the terrace deposits is generally eastward toward the West Fork of the Trinity River, although localized variations exist across the study area. The hydraulic gradient across the Base is variable, reflecting variations in the flow direction and localized recharge. Discharge from the aquifer occurs into surface water onsite, specifically Farmers Branch Creek. A potentiometric map of CAFB and AFP-4 terrace deposits is presented in Figure 2.12 (Jacobs, 1996).

As shown in Figure 2.12, regional groundwater flow is generally towards the east from AFP-4 into CAFB. This varies slightly in the Flightline Area of CAFB where groundwater flow is towards the northeast into Farmers Branch Creek. The location of monitoring wells in the Flightline Area are presented in Figure 2.13 and well construction specifications can be found in Table 2.2. Figure 2.14 shows third quarter 1995 alluvial terrace groundwater elevation contours in the Flightline Area. Figure 2.15 shows fourth quarter 1995 alluvial terrace groundwater elevation contours with very little variation in groundwater flow between the two groundwater surveys. Both figures show the northeasterly trend in groundwater flow over the Flightline Area of CAFB. Tabulated groundwater survey elevation results for the 1995 third and fourth quarter groundwater monitoring can be found in Table 2.3

2.4.1.2 Goodland/Walnut Aquitard

The groundwater within the terrace deposits is isolated from groundwater within the lower aquifers by the low permeability rocks of the Goodland Limestone and Walnut Formation. The primary inhibitors to vertical groundwater movement within these units are the fine-grained clay and shale layers that are interbedded with layers of limestone. Some groundwater movement does occur between the individual bedding planes of both of these units, but the vertical hydraulic conductivity has been calculated to range between 1.2E-09 cm/sec to 7.3E-11 cm/sec for the CAFB and AFP-4 area. This corresponds to a vertical flow rate that ranges between 1.16E-03 ft/d to 5.22E-03 ft/d (ESE, 1994). At the AFP-4 "window area", the Goodland/Walnut Aquitard is breached and the alluvial terrace groundwater is in direct communication with the groundwater in the Paluxy Aquifer. A significant number of wells and borings have been advanced on CAFB, and there is no evidence that a similar window exists on the Base property. Additionally, no evidence of contamination of the Paluxy aquifer has been found at CAFB.

2.4.1.3 Paluxy Aquifer

The Paluxy aquifer is an important source of potable groundwater for the Fort Worth area. Many of the surrounding communities, particularly White Settlement, develop their municipal water supplies from the Paluxy aquifer. Groundwater from the Paluxy is also used in some of the surrounding farms and ranches for agricultural purposes. Due to the extensive use of the Paluxy aquifer, water levels have declined significantly over the years. Water levels in the CAFB vicinity have not decreased as much as in the Fort Worth area due to its proximity to the Lake Worth recharge area and the fact that the Base does not develop water from the Paluxy aquifer. Drinking water at the Base is supplied by the City of Fort Worth which uses Lake Worth as its water source. The groundwater of the Paluxy aquifer is contained within the openings created by gaps between bedding planes, cracks, and fissures in the sandstones of the Paluxy Formation. Just as the Paluxy Formation is divided into upper and lower sand members, the aquifer is likewise divided into upper and lower aquifers. The upper sand is finer grained and contains a higher percentage of shale than the lower sand.

2.4.1.4 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.

2.4.1.5 Twin Mountains Aquifer

The Twin Mountains Formation is the oldest and deepest water supply source used in the CAFB area. The Twin Mountains Formation occurs approximately 600 feet below CAFB with a thickness of between 250 to 430 feet. Recharge to the Twin Mountains aquifer occurs west of CAFB where the formation crops out. Groundwater movement is eastward in the downdip direction. Like the groundwater in the Paluxy aquifer, the Twin Mountains groundwater occurs under unconfined conditions in the recharge area and becomes confined as it moves downdip. Transmissivities in the Twin Mountain aquifer range from 1,950 to 29,700 gpd/ft and average 8,450 gpd/ft in Tarrant County. Permeabilities range from 8 to 165 gpd/ft^2 and average 68 gpd/ft^2 in Tarrant County (CHM2 Hill, 1984).

2.4.2 Surface Water

CAFB is located within the Trinity River Basin, adjacent to Lake Worth. The lake is a man-made reservoir, created by damming the Trinity River at a point just northeast of the Base. The surface area of the lake is a approximately 2,500 acres. Lake Worth receives a limited amount of stormwater runoff from CAFB during and immediately after rainfall events. Runoff from the Flightline Area of CAFB does not discharge to Lake Worth. Elevation of the water surface is fairly consistent at approximately 594 feet above NGVD, the fixed elevation of the dam spillway. Part of the eastern boundary of CAFB is defined by the West Fork of the Trinity River, a major river in north central Texas. River flow is towards the southeast into the Gulf of Mexico.

Surface drainage is mainly east towards the West Fork of the Trinity River. The Base is partly drained by Farmers Branch Creek, a tributary into the West Fork of the Trinity River (Figure 2.1). Farmers Branch Creek begins within the community of White Settlement and flows eastward. Just south of AFP-4, Farmers Branch flows under the runway within two large culverts identified as an aqueduct. Two unnamed tributaries flow across the Flightline area and discharge into Farmers Branch Creek. One flows along the south and east side of LF-04 and joins Farmers Branch Creek. The other runs along the west and north sides of LF-05, connects with two small ponds on the golf course, before joining Farmers Branch Creek. Most of the Base drainage is intercepted by a series of storm drains and culverts, directed to oil/water separators, and discharged to the West Fork of the Trinity River downstream of Lake Worth. A small portion of the north end of the Base drains directly into Lake Worth.

2.5 ECOLOGY

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

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

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

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3.0 SUMMARY OF INTERIM/STABILIZATION MEASURES

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Two interim/stabilization measure (ISM) projects have been initiated in the Flightline Area. A source removal action was implemented at WP-07 to remove the drums buried at the site, and a groundwater remediation system was installed to extract and treat alluvial terrace groundwater near LF-04 and WP-07.

3.1 SOURCE REMOVAL ACTION AT WP-07

The results of the SI and Phase I RI confirmed that buried objects were present at WP-07. The U.S. Army Corps of Engineers (USACE) was contracted to identify and remove the buried objects at the site. A sample of liquid from one of the drums was collected and analyzed in January, 1991 and was determined to be TCE (USACE, 1992). The USACE contracted Ecology & Environment, Inc. (E&E) to conduct a geophysical study to refine the anomalies identified during the SI. E&E identified nine areas (A through H) with anomalous geophysical results that may represent buried drums or tanks. In October, 1991, the USACE's contractor initiated excavation at the locations identified by E&E. The results of these excavations are summarized are follows:

- Site A — Three drums (all empty)
- Site B — Three drums (1 empty, 1 with 8 gallons of product, 1 with 3 gallons of product) and ten five gallon cans
- Site C — One drum with 25 gallons of product
- Site D — One pipe three inches in diameter
- Site E — Nine drums (7 empty, 1 with 20 gallons of product and 1 with 5 gallons of product)
- Site F — Twelve drums (11 empty and 1 with 25 gallons of product)
- Site G — Five drums (2 empty, 3 with a total of 50 gallons of product)
- Site H — One empty drum
- Site I — One steel power pole anchor

The USACE had the contractor excavate between areas "C" and "G" and labeled this site "J". This site was excavated due to the locations of the drums found within the adjacent sites (west edge of "C" and east edge of "G"). The soil from sites "D" and "I" was backfilled immediately since no contaminant sources were identified at these sites. One soil sample was collected from the excavated soil pile from each of the other sites. The results of these laboratory analyses are presented in Table 3.1 and summarized on Figure 3.1 (USACE, 1992).

3.2 GROUNDWATER REMEDIATION IN FLIGHTLINE AREA

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Thirteen groundwater extraction wells have been installed to recover TCE-contaminated groundwater for treatment. The location of the wells and a schematic of the remediation system are presented on Figure 3.2. The initial phase of the groundwater remediation system installation involved drilling and testing three recovery wells in April and May 1993 (IT, 1993). Five more recovery wells were installed in June, 1993 by IT Corporation, a discharge permit was obtained for the Fort Worth Publicly Owned Treatment Works and the system was started on 3 December 1993. In July and August 1994, five additional recovery wells were installed to further enhance the groundwater remediation system (IT, 1994). The system was operated until 1995 at which time its operation was discontinued. The system is scheduled to be restarted in early 1997.

4.0 DATA QUALITY OBJECTIVES, APPLICABLE OR RELEVANT AND APPROPRIATE REGULATIONS

The objectives of this project are to determine whether remedial actions are warranted at the four SWMUs of interest, and if so, what those remedial actions should entail. To this end, the data quality objectives (DQOs) and regulations that apply to the project must be evaluated.

4.1 DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements which specify the quality of data required to support the objectives of the project and are determined based on the end use of the data to be collected. Overall, objectives of the data collection for the RFI/CMS at CAFB are:

- Scientific data which are generated for the project will be of sufficient quality to withstand scientific and legal scrutiny.

- Data will be gathered or developed in accordance with procedures appropriate for its intended use.

- Data will be of known precision, accuracy, representativeness, completeness, and comparability within the limits of the project.

There are five analytical levels which address various data uses, the QA/QC effort, and the methods required to achieve the desired level of quality for use in the risk assessment. These levels are:

- *Screening (DQO Level 1).* This provides the lowest data quality but the most rapid results. It is often used for health and safety monitoring at the site, preliminary comparison to applicable or relevant and appropriate requirements (ARARs), initial site characterization to locate areas for subsequent and more accurate analyses, and for engineering screening of alternatives (bench scale tests). These types of data include those generated on-site through the use of an OVA or other real-time monitoring equipment at the site.

- *Field Analyses (DQO Level 2).* This provides rapid results and better quality than in Level 1. This level may include mobile lab-generated data depending on the level of quality control exercised. Examples of Level 2 analyses required for this project are pH, conductivity, and turbidity.

- *Engineering (DQO Level 3).* This provides an intermediate level of data quality and is used for site characterization. Engineering analyses may include mobile lab generated data and some analytical lab methods (e.g., laboratory data with quick turnaround used for screening but without full quality control documentation). Level 3 analyses may or may not use the same CLP-like procedures required of CLP-like Level 4 analysis and miscellaneous wet chemistry parameters using SW-846 analytical methods. No Level 3 data are planned for this RFI/CMS.

- *Conformational (DQO Level 4).* CLP or CLP-like routine analytical services are level 4. CLP-like packages will be prepared for this project. Level 4 is characterized by rigorous QA/QC protocols and documentation. This provides the highest level of data quality and is used for purposes of risk assessment and evaluation of remedial alternatives. Most of the laboratory analyses for this project utilizing SW-846 methods are considered Level 4 analyses.

- *Nonstandard (DQO Level 5).* This refers to analyses by nonstandard protocols, for example, when exacting detection limits or analysis of an unusual chemical compound is required. These analyses often require method development or adaptation. The level of quality control is usually similar to DQO Level 4 data. CLP special analytical services are Level 5. No Level 5 procedures are anticipated for this project.

4.2 POTENTIAL ARARs

ARARs, as mandated by CERCLA are required to be addressed and satisfied by remedial actions. Federal statutes specifically included in CERCLA include: Solid Waste Disposal Act, RCRA, Toxic Substances Control Act, Safe Drinking Water Act, the Clean Air Act, the Clean Water Act, the Endangered Species Act, the Fish and Wildlife Coordination Act, and the Marine Protection Research and Sanctuaries Act. CERCLA also mandates that if state ARARs are more stringent that Federal ARARs, they must also be met.

There are three general types of ARARs:

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

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

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

For the RFI/CMS at the subject units, preliminary ARARs have been identified and are presented in Table 4.1. As the RFI/CMS progresses, the ARARs will be refined on the basis of more site specific information.

4.3 LITERATURE SEARCH

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To confirm earlier sampling locations and to evaluate possible environmental concerns at CAFB, a literature search was conducted before and during the preparation of the WP to gather data regarding facility history and prior investigations.

4.4 RECORD KEEPING

Records of field and laboratory activities will be documented on standard forms as noted in the accompanying FSP and QAPP, which are both part of the SAP.

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5.0 SITE DESCRIPTIONS, PRELIMINARY ASSESSMENT OF NATURE AND EXTENT OF CONTAMINATION, DATA NEEDS AND PROPOSED SAMPLING

5.1 FLIGHTLINE AREA SITE-WIDE GROUNDWATER

A considerable amount of groundwater analytical data has been collected for investigations conducted at AFP-4 and CAFB. This data confirms that a large plume of contaminated groundwater emanates from AFP-4 with another segment emanating from the LF-04 and WP-07 area. The principal contaminants in this plume are TCE and its degradation byproducts. The TCE degradation byproducts most often detected are cis- and trans- 1,2-DCE, and to a lesser extent, vinyl chloride. The TCE plume has contaminated the Puluxy Aquifer on AFP-4 property. However, beneath CAFB, the TCE contamination is restricted to the alluvial terrace groundwater. The remediation of the groundwater contamination originating at AFP-4 is addressed in the approved Record of Decision for AFP-4 (Rust Geotech, 1996).

The objective of this RFI/CMS is to evaluate that portion of the TCE plume which is a result of past waste management practices at LF-04, LF-05, WP-07, and LF-08. The physical and chemical characteristics of the alluvial terrace groundwater beneath the four subject SWMUs are similar in nature and will be discussed on a site-wide basis. The following paragraphs summarize the investigations conducted to characterize the Flightline Area portion of the TCE plume

5.1.2 Preliminary Nature and Extent of Contamination

Sampling of the alluvial terrace groundwater beneath the Flightline Area began during the SI (Radian, 1986) and has continued periodically until the most recent sampling conducted by Law Engineering and Environmental Services in January 1996 (Law, 1996). Table 5.1 presents a list of the parameter groups analyzed on a per well basis during each of the groundwater sampling events conducted in the Flightline Area. Tables 5.2 through 5.7 summarize the results of the laboratory analyses performed. These tables present the range of concentrations detected, the number and location of analyses that exceeded Media Specific Concentrations (MSCs) as defined in Texas Natural Resources Conservation Commission (TNRCC) Risk Reduction Standards No. 2 (TNRCC, 1996b).

MSCs were used as comparison criteria to evaluate the need for additional sampling for both inorganic and organic analyses. Background concentrations are not presently available for media at CAFB. Jacobs Engineering Group is under contract to conduct a background study at AFP-4 and CAFB. This data should be available in early 1997 and will be used to prepare the RFI/CMS document. The alluvial terrace groundwater sampling events are summarized below.

- *Site Investigation (Phase II, Stage I) February/March 1985 (Radian, 1986).* This investigation involved the initial installation and sampling of monitoring wells in the Flightline Area. Table 5.2 presents a summary of the results of the groundwater samples collected during this investigation. The results of this investigation showed that TCE contamination was present in the groundwater beneath the site and that the center of the portion of the plume associated with the

Flightline Area paralleled White Settlement Road between LF-04 and WP-07. Table 5.2 shows that chemicals other than TCE and it's associated daughter products were detected, but not at levels significantly above current MSCs.

- *Phase I RI/FS (Phase II, Stage II) February and April 1988 (Radian, 1989).* The Phase I RI/FS included two rounds of groundwater sampling in the Flightline Area. The results of these sample analyses show the Flightline Area portion of the chlorinated organic compound plume remained centered around WP-07. The concentrations of the Flightline Area portion of the plume did not change appreciably between the SI and Phase I RI/FS sampling. Several inorganic compounds including arsenic, lead, antimony, and selenium exceeded current MSCs by greater than an order of magnitude. However, future sampling events do not confirm these elevated concentrations suggesting these results may be anomalous readings. Table 5.3 presents a summary of the analytical results from this sampling event.

- *Phase II RI/FS (Phase II, Stage II) April/May 1990 (Radian, 1991).* The Phase II RI/FS was initiated to further investigate the TCE plume in the Flightline Area. Table 5.4 summarizes the result of the sample analyses conducted during this investigation. These results showed the Flightline Area portion of TCE plume centered at monitoring well LF04-4G, further east than previous sampling events. Additional downgradient wells were installed which showed the plume to extend farther north than previous investigations. The installation and sampling of additional wells to the east also shows the plume to extend farther east, perpendicular to groundwater flow. Only TCE and *cis*-1,2,-DCE exceeded MSCs by greater than one order of magnitude. The elevated inorganic results present in the earlier Phase I RI/FS study were not confirmed during this sampling event.

- *Recovery Well Sampling, April 1993 (IT, 1993) July 1994 (IT, 1994).* IT Corporation conducted sampling of the groundwater recovered during testing of extraction wells installed for the groundwater remediation system in the Flightline Area. The results of these analyses show the maximum TCE concentration at CAR-RW7, just east of the WP-07. It should be noted that IT collected dynamic samples for remediation system design. Dynamic samples collected from recovery wells are generally obtained at much higher flow rates than samples collected from monitoring wells. Therefore, the results of the recovery well sampling may not correlate well with samples collected during other sampling events. Table 5.5 summarizes the results of the IT sampling.

- *Quarterly Groundwater Sampling CAFB (Law, 1996a, 1996b).* Law Engineering conducted quarterly groundwater sampling in April 1995, July 1995, October 1995 and January 1996 in the Flightline Area. The results of these four sampling events show that the magnitude and extent of the TCE plume changed little between the first and fourth quarter. The center of the Flightline Area portion of the plume continues to be along White Settlement road between LF-04 and WP-07. Several inorganic chemicals exceeded MSCs during the four quarterly sampling events, but

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the concentrations were either within an order of magnitude of the MSC or appeared to be isolated anomalous results. The results of these sampling events are summarized in Table 5.6.

- ***Quarterly Groundwater Sampling AFP-4 (Jacobs, 1996).*** Jacobs Engineering Group has been conducting quarterly groundwater sampling at AFP-4 and CAFB to monitor the nature and extent of the TCE plume that originates in the East Parking Lot Area at AFP-4. The downgradient portion of this plume is commingled with the TCE plume originating in the Flightline Area. Jacobs Engineering samples several Flightline Area wells on a quarterly basis to monitor this plume. The results of the October 1995 sampling conducted by Jacobs is summarized in Table 5.7. Figure 5.1 show the AFP-4 TCE plume and indicates that TCE from an AFP-4 source has commingled with TCE from an apparent Flightline Area source near LF-04 and WP-07.

The Flightline Area portion of the TCE plume is defined in the upgradient (southwestern) direction based on the consistently low reading obtained in groundwater samples collected from LF04-4A, LF04-4B, and FT09-12A. The western extent of the TCE plume cannot be accurately delineated since the AFP-4 TCE plume originates in this direction and it is commingled with the Flightline Area TCE plume. The eastern (downgradient) extent of the TCE plume is not well defined based on the results from LF04-04 and LF05-18 during the October 1995 Jacobs Engineering sampling. However, these same wells sampled by Law in January 1996 were below detection limits. The northern extent of the TCE plume is not well defined east of the road that separates LF-05 and WP-07. West of this road, the consistently low readings obtained from FT08-11A delineate the northern extent of the TCE plume. The alluvial terrace deposits thin out and are exposed along stretches of Farmers Branch Creek. Therefore, Farmers Branch Creek can be considered the downgradient extent of the Flightline Area portion of the TCE plume. The extent of the TCE plume during the January 1996 sampling is presented on Figures 5.2, 5.3, and 5.4.

5.1.3 Data Needs and Proposed Sampling

The downgradient (north-eastern) and lateral gradient (northern) extent of the Flightline Area TCE plume segment are not well defined based on existing groundwater analytical data. CH2M Hill has been contracted by AFCEE to conduct quarterly groundwater sampling in the Flightline Area. This sampling is scheduled to begin in January 1996. The SAP for that project includes groundwater sampling of ten wells in the Flightline Area (CH2M Hill, 1996). In addition to the sampling to be conducted by CH2M Hill, HydroGeoLogic proposes sampling the following wells:

- LF04-4B - Provide upgradient control
- LF04-04 - Provide lateral/down-gradient control in the east direction
- LF05-5H, LF05-14, and FT08-11A - Provide lateral/down-gradient control in the north direction

Four additional wells will be installed to evaluate the extent of contamination in the alluvial terrace groundwater beneath the Flightline Area. These wells are designed to delineate the extent of the plume in the eastern and northern directions. The location of the existing wells to be sampled and the new wells to be installed are presented on Figure 5.5. The locations presented on the map are approximate proposed sites. The actual location will be based on additional field reconnaissance. All of the wells will be sampled for VOCs, SVOCs, and priority pollutant metals. The sampling procedures are presented in the FSP and the analytical protocols are presented in the QAPP.

5.2 FLIGHTLINE AREA SITE-WIDE SURFACE WATER

Five surface water bodies are present in the Flightline Area at CAFB. These include Farmers Branch Creek, two unnamed tributaries to Farmers Branch Creek, and two small ponds on the golf course. Table 5.8 lists the laboratory analyses conducted on surface water samples conducted during previous investigations.

5.2.1 Preliminary Nature and Extent of Contamination

There is no record of sediment sample collection during any of the previous site investigations. Surface water samples were collected from three locations during the SI (Radian, 1986). Table 5.8 lists the laboratory analyses conducted on surface water samples conducted during previous investigations. These locations are plotted on Figure 5.6 as SW85-LF4, SW85-LF5, and SW85-FT2. The results of these sample analyses are summarized on Table 5.9. These samples showed that arsenic, cadmium, lead, mercury, and vinyl chloride exceeded current Texas Surface Water Quality Standards (TSWQS) (TAC-Title 30, Table 3). Surface water samples were collected from seven locations during the Phase II RI/FS (Radian, 1990). These samples showed that five of the eight samples collected exceeded the TSWQS for TCE. The maximum TCE concentration was detected in the surface water sample collected at LF05-S7 (1,400 μg/L). Table 5.9 summarizes the surface water sampling results obtained during the Phase II RI/FS. Jacobs Engineering samples four surface water locations in the Flightline Area periodically during the quarterly sampling conducted at AFP-4. These locations are the influent (EGL-1) and effluent (EGL-2 or LF05-S1) to the aqueduct under the runways, LF05-S5, LF05-S6, and LF05-S7. The results of the sampling conducted in October 1995 by Jacobs Engineering are also summarized on Table 5.9.

5.2.2 Data Needs and Proposed Sampling

The results of the sampling events discussed in the previous section suggest that communication between the alluvial terrace groundwater and the surface water in Farmers Branch Creek exists. The data suggests that groundwater is also discharging to the unnamed tributaries to Farmers Branch Creek.

Three surface water and sediment sampling locations are proposed along the unnamed tributary to Farmers Branch Creek that runs along the south and east sides of LF-04 (HGL-S8, HGL-S10, LF05-S7). All of the historical and proposed surface water/sediment sampling locations are presented on Figure 5.6. HGL-S8 will serve as an upgradient background location not influenced by the waste handling practices at any of the subject SWMUs. HGL-S10 will serve as an intermediate sampling location along this unnamed tributary. LF05-S7 will be sampled to provide an additional data point at this historically contaminated surface water location.

Two surface water/sediment locations will be sampled along the unnamed tributary to Farmers Branch Creek that runs along the west and north sides of LF-05. Location HGL-S11 will serve as an upgradient surface water/sediment location not affected by waste handling practices by any of the subject SWMUs. SW85-LF5 will be sampled to determine if surface water/sediments have been impacted by the operations at LF-05.

Surface water and sediment samples will be collected from locations LF05-S3 and LF05-S4. These locations were originally sampled during the Phase II RI/FS. The locations will be sampled again to determine if the surface water and sediments in the golf course ponds have been impacted by the subject SWMUs.

Five locations will be sampled along Farmers Branch Creek. One location will serve as an upgradient background location (LF05-S1), one as a intermediate point in the area of interest (LF05-S2), one immediately upgradient of the confluence with the unnamed tributary (LF05-S5), one immediately downgradient of this confluence (LF05-S6) and one further downgradient from the confluence with the unnamed tributary to evaluate the downgradient extent of the surface water contamination (HGL-S9). Figure 5.6 shows the location of each of the existing and the twelve proposed surface water/sediment sampling locations.

5.3 LANDFILL NO. 4

5.3.1 Site Description

LF-04 includes approximately six aces of land located east of the south end of Taxiway 197. It was the main landfill during much of the history of CAFB. While in active use, at least six large pits, approximately twelve feet deep, were filled with refuse which was burned and buried. Various potentially hazardous wastes including drums of waste liquids, partially full paint cans, and cadmium batteries were reported disposed of at this site.

5.3.2 Preliminary Nature and Extent of Contamination

Media that may have been impacted due to historical waste handling practices at LF-04 include groundwater, soil, surface water, and sediment. It is possible that groundwater beneath the site was impacted from waste liquids buried in the landfill migrating directly to the groundwater. However, another significant transport pathway would be groundwater contamination resulting from leaching of wastes buried in the soil. Surface water and sediments may have been impacted by transport over land as stormwater flow or from discharge of the groundwater into Farmers Branch Creek and the tributary to the south and east of LF-04. Table 5.10 is a summary of the laboratory analyses conducted on soil samples collected in the Flightline Area. The preliminary assessment of groundwater and surface water contamination are presented in Sections 5.1, and 5.2 respectively

Soil samples were collected around the perimeter of the landfill during the SI and the Phase I RI. Table 5.10 contains a summary of analyses performed on soil samples collected during these investigations. Table 5.11 presents a summary of the results of the laboratory analysis of these soil samples. Included in Table 5.10 are soil analytical results from Fire Training Area 2 (FT-09) which is adjacent to LF-04 to the west. Figure 5.7 presents those inorganic sample results which exceeded MSC as defined in Texas Natural Resource Conservation Commission (TNRCC) Risk Reduction Standard No. 2 (TNRCC, 1996) and organic compound concentrations exceeding detection limits. Background concentrations for inorganic compounds are expected to be available from a study being conducted by CH2M Hill for AFCEE by the end of January 1997.

Arsenic, antimony, lead, cadmium, selenium, beryllium, mercury, chromium, and cadmium concentrations from soil samples collected around LF-04 during the SI and Phase I RI exceeded MSCs. However, they were generally less than an order of magnitude greater than the MSC. Several organic compounds were detected in these soil samples, however, the results can be broadly characterized as low concentrations or compounds commonly detected as laboratory contaminants.

5.3.3 Data Needs and Proposed Sampling

Groundwater, surface water, sediment data gaps, and the proposed sampling to be conducted during the RFI/CMS were presented in previous sections of this WP. The primary data gap left to be addressed at LF-04 is to characterize the soil from within the unit boundary. Soil samples collected around the perimeter of the unit during previous investigations have shown contaminant concentrations to be within acceptable concentrations. The focus of the proposed investigation will be to investigate the surface and subsurface soil from within the unit to determine if the unit poses a threat to human health and the environment.

Test pits were selected as the proposed method to investigate the source and soil characteristics at LF-04. Surface soil (0 to 2 ft bgs) samples will be collected using a hand auger prior to initiating the test pit excavation. The test pits will be excavated using a backhoe/trackhoe and logged by a geologist. Particular attention will be paid to the nature of the wastes uncovered during the excavation. Each pit will be forty feet long and up to fifteen feet deep. The maximum depth of each pit will be fifteen feet, the depth at which virgin soil beneath the debris is reached, depth of bedrock, or the depth at which groundwater is encountered, whichever is most shallow. A subsurface soil sample will be collected from the Base of the excavation. The surface soil sample and the subsurface soil sample will be sent to the laboratory for analysis of volatile organic compounds (VOCs) by EPA Method 8260, semi-volatile organic compounds (SVOCs) by EPA Method 8270, and priority pollutant metals (6000/7000 series). More detailed description of the field procedures for test pit excavation and soil sampling is presented in the FSP. Detailed presentation of the analytical procedures are presented in the QAPP.

Ten test pits will be excavated in the areas where the burial pits reportedly existed (Figure 5.8). Aerial photograph interpretation and the geophysical investigation results from the SI were used to plot the proposed test pit locations on Figure 5.8. The present topography of LF-04 is described as hummocky as a result of the burial pit activity. The actual field location of the test pits may be altered based on visual observations and location of above/below ground structures.

5.4 LANDFILL NO. 5

5.4.1 Site Description

LF-05 is located northwest of LF-04 between Fire Training Areas 1 and 2. LF-05 is adjacent to a small tributary to Farmers Branch Creek and was constructed by building a clay berm next to the creek and filling the area behind the berm. The landfill received all types of flightline wastes and refuse, and was regularly burned prior to covering (Radian, 1986).

5.4.2 Preliminary Nature and Extent of Contamination

The media that may be impacted by the past waste handling practices at LF-05 are the same as LF-04. Groundwater may be impacted by direct spillage from wastes placed in the landfill or through leaching from buried wastes. Surface water and sediments may be impacted by overland stormwater runoff or by discharge from the groundwater to Farmers Branch Creek and the small tributary that forms the west and north boundaries of the unit.

The preliminary assessment of contamination, data gaps, and proposed sampling for the groundwater, surface water, and sediment are discussed in previous sections of this chapter. Soil samples were collected and analyzed during the SI and Phase I RI investigations. Table 5.10 summarizes the analytical testing that was performed on these samples. Table 5.12 presents a summary of the analytical results. The analytical results from the sampling conducted at Fire Training Area 1 (FT-08) are also presented in Table 5.12 due to the close proximity of the two units.

The results of theses analyses show generally low concentrations of contaminants when the sample was collected above the groundwater elevation. Soil samples collected below the water table often contain organic compounds at concentrations more in line with the contaminant concentrations dissolved in the groundwater. The soil contaminants in the vadose zone include inorganic chemicals (e.g., chromium, mercury, cadmium, lead) generally less than an order of magnitude greater than the MSC. Several SVOCs were detected in the soil samples collected from the vadose zone at the relatively low concentrations and may be a result of the sampling and analytical procedures. Figure 5.9 presents the results of the soil samples collected near LF-05.

5.4.3 Data Needs and Proposed Sampling

All of the soil samples collected during the SI and Phase I RI were collected from outside the limits of the former landfill. An investigation of the potential source of contamination and the magnitude of surface and subsurface contamination within the unit is needed. The proposed method to investigate the unit is through the use of test pits as described above for LF-04. HydroGeoLogic will install five test pits along the berm that surrounds the former landfill location. The five remaining pits will be placed based on field observations. Potential test pits locations are plotted on Figure 5.10. Surface and subsurface soil samples will be collected as described for LF-04.

5.5 WASTE BURIAL AREA NO. 7

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WP-07 is located in the southern part of CAFB at the northeast corner of the intersection of White Settlement Road and Cody Drive. The land surface is virtually flat at an approximate elevation of 620 feet above NGVD. There are no visible signs of the boundaries of the former disposal area. Surface drainage is generally to the north to an unnamed tributary of Farmers Branch Creek. The site was used for burial of wastes during the 1960s. Various types of hazardous materials, including drums of cleaning solvents, leaded sludge, and possibly ordnance materials, were reportedly disposed of at this site. Reportedly, these materials were buried in a natural impermeable clay stratum (Radian, 1989).

5.5.1 Preliminary Nature and Extent of Contamination

The source removal action for this site is summarized in Section 3.1. The removal action confirmed the presence of contaminants in the vadose zone. Soil samples were also collected around the perimeter of the unit during the SI and Phase I RI/FS. Table 5.10 lists the analytical tests performed on the samples. Table 5.13 is a summary of the analytical results. The results of the SI and Phase I RI/FS analyses were consistent with the results from the sampling at LF-04 and LF-05. Inorganic compounds rarely exceeded MSC, and most organic chemicals were either common laboratory contaminants or were present in samples collected from within the groundwater zone. Figures 5.7 and 5.9 present the results of these sampling events.

5.5.2 Data Needs and Proposed Sampling

The sampling conducted for waste disposal characterization of the excavated soil generated during the removal action showed TCE above MSCs in the sample collected from soil at excavation "H" and tetrachloroethene (PCE) above MSCs in the soil excavated at "J". Additional sampling to delineate the extent of the soil contamination is proposed.

Soil borings are proposed to delineate the extent of the contamination detected during the source removal action. One surface soil sample and one subsurface soil sample will be collected from each proposed location. The surface soil samples will be collected using a hand auger. The subsurface samples will be collected using direct push Geoprobe®-like equipment. The borings will be advanced until the top of the water table or bedrock, whichever is reached first. The samples will be sent to laboratory analysis for VOCs, SVOCs, and priority pollutant metals. Detailed procedures for the soil boring and sampling are presented in the FSP. Laboratory protocol and procedures are discussed in the QAPP. The location of the seven direct push boring locations are presented on Figure 5.11.

5.6 LANDFILL NO. 8

LF-08 appears as a grass-covered mound and is located adjacent to, and east of, the north-south Taxiway 197 and south of Taxiway 190. The RFA reported the area's operational history existed only during the mid 1960's and has not been used since the late 1960's (A.T. Kearney, 1989). Debris that was reportedly accepted by the landfill included wood, metal, construction rubble, asphalt, concrete, and trees. No evidence suggests that any hazardous materials were disposed of at this site. However, A.T. Kearney reported that some of the materials disposed of at this site may have contained hazardous materials.

5.6.1 Preliminary Nature and Extent of Contamination

The exact location and extent of LF-08 is not known. The only evidence of past activities in this area that was observed during the site visit conducted by HydroGeoLogic, AFCEE, and U.S. Air Force Base Realignment and Closure Agency (AFBCA) was the presence of a large grass-covered mound, which is believed to be the remnants of the landfill itself. The vertical and lateral extents of the landfill are not known and no records of operation have been found other than the period of operation. Several aerial photographs were reviewed but reveled little additional information with respect to the lateral extent of the landfill and debris that was reportedly buried at the site.

5.6.2 Data Needs and Proposed Sampling

Two geophysical surveys, electromagnetic induction (EM) and a magnetometer survey will be utilized to evaluate the extent of the landfill and any "hot spots" that may be present at LF-08. The EM survey will be used to initially identify and pin point areas with conductivity contrasts, i.e., "hot spots." The grid will then be resurveyed, including the "hot spots" using the magnetometer as a confirmatory tool. The data gathered from these surveys will help identify areas of buried wastes and provide indications on the depths of groundwater, bedrock, and stratigraphy. This information will be used to assure that optimal trenching and soil sampling locations are selected.

Following the reduction of data from the geophysical survey, approximately eight test pits will be advanced at the "hot spots" to verify the anomalous reading. One surface soil sample and one subsurface soil sample will be collected at each test pit location. All soil samples will be analyzed for VOCs, SVOCs, and priority pollutant metals. Trenches will be constructed using a standard rubber mount backhoe and extend to either the water table, bedrock, or 15 feet, whichever occurs first. Subsurface samples will be collected from the bucket of the backhoe while excavating each trench and sent to an AFCEE certified laboratory for analysis. At no time will personnel enter any of the test trenches. Surface soil samples will be collected using a hand auger prior to excavating the test pits. All sampling activities, procedures, and analytical methods will be in accordance with the SAP and QAPP.

5.6.2.1 Electromagnetic Method and Rationale

Geonics' EM-31 will be used to measure the apparent conductivity of the soil at various depths. The instrument consists of a transmitter coil energized with an alternating current at a 9.9 kHz frequency and a receiver coil, separated by a rigid boom. The time-varying magnetic field arising from the alternating current in the transmitter coil induces very small currents in the earth. These currents generate a secondary magnetic field, which is received, together with the primary field, by the receiver coil. The instrument then measures the terrain conductivity by comparing the strength of the two signals.

The EM-31 has an intercoil spacing of 3.7 meters, which yields an effective depth of exploration of about twenty feet depending on geologic conditions. Both quadrature and in-phase channels will be utilized. The quadrature phase channel reads the apparent terrain conductivity of the soil, while the in-phase provides a measure of the terrain magnetic susceptibility. The instrument is calibrated to read terrain conductivity in millimhos per meter. The subsequent readings along with line and station location can be digitally recorded in the field using a portable data logger. This device provides an efficient data interface for computer enhancement and mapping.

The EM-31 survey looks for changes in the terrain conductivity and magnetic susceptibility values as compared with the natural undisturbed soils. This technique has been proven successful in locating buried metallic objects such as pipes, drums, and tanks. Values for buried metallic objects depend upon size and depth of, and distance from the object to the instrument. The presence of subsurface metallic objects near the EM-31 will cause a dramatic change in the instrument readings.

5.6.2.2 Magnetometer Method and Rationale

The GeoMetrics 856AG magnetic gradiometer uses the earth's magnetic field and local variations in the field. The magnetic survey involves the measurement of the earth's magnetic field at various points on the ground surface. Variations in the magnetic susceptibility of the subsurface materials produce anomalies within the earth's magnetic field that can be resolved using a magnetic gradiometer. For environmental application, such as subsurface surveys, magnetics can be used to detect ferromagnetic objects, such as drums or tanks, to depths of 10 to 15 feet below the ground surface. For larger objects, or groups of objects, the survey can penetrate as deep as 25 feet. Magnetics will also be used for geologic reconnaissance to discern between native materials and those that are relict. An added benefit of using the magnetometer is that ferromagnetic objects on the land surface, such as fences and manhole covers, will not create interference i.e., false anomalies with the survey.

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

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

6.0 RISK ASSESSMENT

A brief description of the methods proposed for the BLRA is provided in this section. An initial conceptual model has been developed to define the nature and extent of contamination, the hydrogeologic regime, the fate and transport of contaminants, exposure pathways, and potential receptors.

6.1 RISK ASSESSMENT METHODOLOGY

The risk assessment will be broadly divided into human health and ERAs. The human health risk assessment will be conducted in accordance with the following guidance documents:

- "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation, Part A" (USEPA, 1989)

- "Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation, Part B" (USEPA, 1991a)

- "Human Health Evaluation Manual, Supplemental Guidance Manual, Standard Default Factors" (USEPA, 1991b)

Risk assessment consists of three distinct stages: 1) toxicity assessment, 2) exposure assessment, and 3) risk characterization and uncertainty analysis.

Toxicity assessment consists of two stages: hazard identification and dose-response assessment. Hazard identification evaluates whether a particular chemical can cause a particular health effect such as cancer, birth defects, etc., and whether the adverse health effect can occur in humans. Hazard identification also evaluates the nature and strength of the evidence of causation. Dose-response assessment quantitatively evaluates toxicity information for the chemical to determine the relationship between the administered dose of the chemical to the incidence of a particular adverse effect in the exposed population. Toxicity values for carcinogens are expressed in units of cancer incidence per unit dose of the chemical; for noncarcinogens, the toxicity values are expressed in terms of a threshold value below which no adverse effects are expected to be observed.

Exposure assessment estimates the magnitude, frequency, duration, and routes of exposure. An assessment may include past, present, and future exposures, using different assessment techniques for each phase. Exposure assessment involves three distinct processes: 1) characterizing the exposure setting, 2) identifying exposure pathways, and 3) quantifying exposure.

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

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

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

The final state of the BLRA process is risk characterization and uncertainty analysis. Therefore, the risk characterization step combines information from the toxicity and exposure assessments to express risk quantitatively. Carcinogenic risk is calculated as the product of the chemical-specific slope factor and the chemical intake. The risk is expressed as a dimensionless number. Noncarcinogenic effects are expressed in terms of dimensionless numbers called hazard quotients. A hazard quotient is the ratio of the chemical intake and the chemical-specific reference dose. In the event that the receptor is exposed to multiple contaminants through multiple pathways, the combined risk (for carcinogens) and hazard indices (for noncarcinogens) are presented as arithmetic sums of individual risks and hazard quotients. An analysis of uncertainties associated with various parameters of the risk calculation will be performed according to guidance in Risk Assessment Guidance for Superfund, Volume I (USEPA, 1989).

6.2 SITE CONCEPTUAL MODEL

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

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

- Sources and potential chemicals of potential concern (COPCs)
- Release mechanisms
- Transport pathways
- Exposure pathway scenarios
- Receptors

Individual SWMUs to be investigated during this RFI/CMS, and their associated potential contaminant pathways, include:

- ***LF-04.*** Approximately six acres of land that consists mostly of vacant land. A radar installation is located in the west central portion of the former landfill. The site is covered with vegetation and surrounded by a fence. Contaminants may be releases by volatilization and particulate emissions from potential contaminants present in surface soil and by from leaching of contaminants from surface and subsurface soil to the groundwater.

  The groundwater beneath LF-04 is present in three hydrogeologic units. The alluvial terrace unit is the most shallow. The other two units are the Paluxy aquifer and the Twin Mountains aquifer. These units are separated from the contaminated groundwater beneath the subject SWMUs by aquitards that are acting to retard downward migration of the contaminants. The alluvial terrace groundwater may release contaminants to surface water in Farmers Branch Creek, two unnamed tributaries to Farmers Branch Creek and two ponds on the golf course.

- ***LF-05.*** This former landfill is also covered by vegetation and within the Flightline Area with restricted access. Contaminants may be present in surface and subsurface soils. Migration pathways are the same as for LF-04.

- ***WP-07.*** This former burial area was subject to a source removal action in 1991. The site is currently covered by vegetation and current land use is limited to maintenance workers. Migration pathways and receptors are the same as those identified for the landfills presented previously.

- ***LF-08.*** This site was identified in the RFA as a construction and debris landfill. No evidence of disposal of hazardous materials has been documented for this unit. A source investigation and contamination assessment will be conducted during this RFI/CMS. Current land use of the site is similar to that of the other SWMUs discussed. Therefore, the potential migration pathways are the same as those described for each of the other units. If contamination is confirmed, then the unit will be included in the BLRA.

6.3 RECEPTORS AND EXPOSURE SCENARIOS

The conceptual model for potential human and environmental exposures to the soils, sediments, surface waters, and groundwater are summarized in Figures 6.1 and 6.2. Figure 6.1 pertains to exposure and risk to contaminants contained in surface soil, while 6.2 pertains to contaminants in subsurface soils. This separation is significant, because certain release mechanisms, and corresponding exposure scenarios, such as exposure to dust and volatile emission from soil, are of concern only if contaminants are in fact present in surface soil. If surface soil sampling to be conducted during the RFI does not show the presence of contaminants in surface soil, these exposure pathway scenarios can accordingly be eliminated for the BLRA. The exposure scenarios shown in Figures 6.1 and 6.2 distinguish between current receptors and potential future receptors. The receptors included in the future scenarios are those that may reasonably be expected to be different from the current scenarios. To the extent that in may cases current and future receptors are in fact likely to be the same, their risks are already being considered under the "current" scenario. The receptor exposure scenarios in the conceptual model include:

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

  - Incidental ingestion of surface soil
  - Inhalation of fugitive dusts and volatile organics in the surface soil
  - Dermal contact and ingestion of chemicals in the surface soil, surface water, and sediments

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

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

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

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

6.4 ECOLOGICAL RISK ASSESSMENT

The ERA will be performed according to the protocols described in TNRCC Draft Guidance for Conducting Ecological Risk Assessments Under the Texas Risk Reduction Program (TNRCC, 1996b). This guidance document calls for a tiered approach to ERAs. The methodology outlined in the guidance document consists of three components:

- Tier I - Ecological Assessment Checklist
- Tier II - Screening-Level Ecological Risk Assessment (3 levels)
- Tier III - Quantitative Ecological Risk Assessment

7.0 CORRECTIVE MEASURES STUDY

The purpose of the CMS is to develop and evaluate remedial alternatives to reduce risks to human health and the environment to acceptable levels. The risks to human health and the environment evaluated in the CMS will be based on the results of the RFI and the BLRA. If the results of the BLRA show that the SWMUs investigated do not pose unacceptable risks to human health and the environment, then a CMS will not be required.

Based on historical information, if corrective measures at the four subject SWMUs are required, they will likely be implemented to address risks posed by chlorinated VOCs, particularly TCE.

7.1 CORRECTIVE ACTION OBJECTIVES

Specific response objectives will be developed using ARARs and risk-based methods to define media specific cleanup levels that would reduce risks to public health and the environment to acceptable levels. Potential contaminant migration pathways and exposure pathways, identified in the BLRA will be examined further as a basis for estimating acceptable onsite residual contamination levels. Acceptable exposure levels for potential receptors will be identified and onsite cleanup levels will then be estimated by extrapolating from receptor points back to source areas along critical migration pathways. Development of CMS objectives will also include refinement of ARARs specific to CAFB.

7.2 IDENTIFICATION OF CORRECTIVE MEASURE ALTERNATIVES

Based on the CMS objectives, contaminated media, and site contaminants, a list of potential remedial alternatives will be developed and evaluated.

7.3 SCREENING OF CORRECTIVE MEASURE ALTERNATIVES

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

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

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

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

7.4 DEVELOPMENT OF CORRECTIVE MEASURE ALTERNATIVES 320 55

A number of preliminary Corrective Measure Alternates have been considered for groundwater and soil. These are summarized in Tables 7.1 and 7.2, respectively. Remedial technologies and alternatives that pass the initial screening process will be further evaluated and compared.

7.5 EVALUATION OF FINAL CORRECTIVE MEASURE ALTERNATIVES

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

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

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

7.5.1 Overall Protection of Human Health and the Environment

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

7.5.2 Compliance with Media Cleanup Standards

Alternatives will be assessed as to whether they attain legally applicable or relevant and appropriate requirements or other Federal and state environmental and public health laws and guidance. Included in Table 4.1 are contaminant specific, location specific, and action specific ARARs.

7.5.3 Control the Source of Release

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

7.5.4 Compliance with Applicable Standards for Management of Wastes

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

7.5.5 Long-term Reliability and Effectiveness

Alternatives will be assessed for the long term effectiveness and permanence they afford along with the degree of certainty that the remedy will prove successful. Each technology will be evaluated for the potential deterioration over time and the impact this may have on receptors.

7.5.6 Reduction in Mobility, Toxicity, or Volume of Wastes

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

- The treatment process and the materials it will treat
- The amount of hazardous material that will be destroyed or treated
- The degree to which the treatment will be irreversible
- The type and quantity of treatment residuals that will remain following treatment
- Whether the alternative would satisfy the statutory preference for treatment as a principal element.

7.5.7 Short-term Effectiveness

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

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- Protection of human health and the environment during the remedial action, including such factors as exposure to dust during construction and potential exposure during transportation.

- Protection of workers during the remedial alternative implementation.

- Evaluation of the impact caused to the environment from the implementation of the remedial action.

- Time required to reach the remedial alternative objectives.

7.5.8 Cost

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

7.6 RECOMMENDED FINAL CORRECTIVE MEASURE ALTERNATIVE

The analysis of the individual corrective measure alternatives with respect to the criteria outlined above will be presented in the CMS report as a narrative discussion and also in tabular form. The recommended corrective measure alternative will be clearly identified and a description supporting the rationale for the proposed remedy will be presented.

8.0 PROJECT MANAGEMENT PLAN

8.1 PROJECT ORGANIZATION AND RESPONSIBILITIES

Figure 8.1 shows the project organization, reporting relationships, and line authority. Other personnel will be assigned as necessary. The specific responsibilities are described in the following subsections.

8.2 MANAGEMENT RESPONSIBILITIES

8.2.2 Program Manager

The program Manager's responsibilities will include:

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

8.2.3 Project Manager

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

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

- Ensuring that the requirements of the QAPP are satisfied

- Communicating regularly project status, progress, and any problems to the Program Manager

8.3 QA AND HEALTH AND SAFETY RESPONSIBILITIES

8.3.1 QA Manager

Responsibilities of the QA Manager will include:

- Serving as official contact for QA matters for the project

- Identifying and responding to QA/QC needs and problem resolution needs, and answering requests for guidance or assistance

- Reviewing, evaluating, and approving the FSP and QAPP and all changes to these documents

- Verifying that appropriate corrective actions are taken for all nonconformances

- Verifying that appropriate methods are specified in the WP, FSP, and QAPP for obtaining data of known quality and integrity

- Fulfilling other responsibilities as requested by the Project Manager

8.3.2 Health and Safety Coordinator

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

- Ensuring that site personnel adhere to site safety requirements

- Providing other responsibilities as identified in the HASP

8.4 LABORATORY RESPONSIBILITIES

8.4.1 Laboratory Project Manager

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

- Ensuring all resources of the laboratory are available on an as-required basis

- Overseeing final analytical reports

8.4.2 Laboratory Operations Manager

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

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

8.4.3 Laboratory QA Officer

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

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

8.4.4 Laboratory Sample Custodian

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

- Receiving and inspecting the incoming sample containers
- Recording the condition of the incoming sample containers

- Signing appropriate documents

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

8.5 FIELD RESPONSIBILITIES

8.5.1 Project Geologist

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

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

8.5.2 Subcontractors

Qualified subcontractors will be selected in accordance with AFCEE requirements and HydroGeoLogic Procurement and QA procedures. Subcontractors must meet the predetermined qualifications developed by the Project Manager and defined in the procurement bid packages. Each bid submitted will be reviewed for technical, QA, and purchasing requirements. All subcontractors will be required to follow the procedures of the WP, FSP, QAPP, and HSP. Periodic QC inspections of each subcontractor may be performed as specified in the FSP, QAPP, and HASP.

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9.0 DATA MANAGEMENT PLAN

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The data management plan provides an approach for collecting, processing, storing, and reporting field and laboratory data. All data will be traceable and auditable from the collection of samples in the field through presentation in the final reports. Data will be received, cataloged, and transferred into a computer database maintained on a computer network located in the HydroGeoLogic - Herndon, Virginia office. The reporting feature of the database will be used to generate reports in support of the data evaluation as well as all project reports and documentation. The HydroGeoLogic database will be transferred to a format compatible with the USAF's Installation Restoration Program Information Management System (IRPIMS) database.

Data for a single site (or sets of sites) will be presented in the text of the report as condensed summaries in tables and maps. The QAPP contains a complete description of the data management plan to be followed during the project.

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10.0 PUBLIC INVOLVEMENT PLAN

The IRP provides a framework for community involvement and participation in the Base closure process. A community relations plan has been drafted and includes a detailed presentation of the rights and responsibility of the government and the public at large (USAF, 1994).

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11.0 REPORTING REQUIREMENTS

The primary report of the project will be the RFI/CMS. The report will characterize the environmental conditions at each site, check each sample package for completeness and quality, evaluate data from each site in the from of a quantitative risk assessment and recommend a future course of action for each site. Each site potentially has one of three recommended future courses: no action, further investigation, or advancement to CMS. Sites continuing to the CMS will be screened for potential remedial alternatives. One alternative will be selected and proposed as the remedial action to be conducted at the site. The RFI/CMS reports are proposed as a joint document based on the volume of existing information available from previous studies conducted at the subject SWMUs.

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12.0 PROJECT SCHEDULE

The activities described in this WP will be implemented in accordance with the schedule provided in Figure 12.1. The starting date for the field effort will be the date of agency concurrence of the relevant portions of the WP. If possible, this schedule will be accelerated with select activities (e.g., procurement of materials and supplies) occurring when resolution of significant technical issues is made between CAFB and regulatory agencies. Field work is expected to begin as soon as relevant portions of the WP are approved.

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13.0 REFERENCES

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U.S. Environmental Protection Agency (EPA), 1991b, Human Health Evaluation Manual, Supplemental Guidance Manual, Standard Default Factors.

Table 1.1
Flightline Area SWMU Summary Table

IRP Site ID	SWMU No.	Description	Material Disposed of	Operation	Status
LF04	22	Landfill 4	paint, thinners, strippers, cadmium batteries, waste solvents, burned waste	1956-1973	RCRA Facility Investigation
LF 05	23	Landfill 5	all types of flightline wastes and refuse. TCE regularly buried	1963-1975	RCRA Facility Investigation
WP 07	24	Waste Burial Area	buried drums containing cleaning solvents and leaded sludge from flightline	1960's	RCRA Facility Investigation
LF 08	25	Landfill 8	buried wood, metal and construction debris	1960's	Previously Recommended NFA RCRA Facility Investigation
LF 03	17	Landfill 3	construction rubble fill area, small amount of Hazardous waste	1950-1952	Recommended NFA
FT 08	18	Fire Training Area 1	waste oils and fuels were burned	Prior to 1963	Recommended NFA
FT 09	19	Fire Training Area 2	waste oils and solvents were burned, unused JP-4 observed	1963-1989	RA/CM

Notes:

NFA = No Further Action
RA/CM = Remedial Action/Corrective Measures

Table 2.1
Flightline Area Soil Associations
Carswell AFB, Texas

Association	Description	Thickness (inches)	Permeability (cm/sec)
Sanger-Purves-Slidell: Clayey soils of nearly level to gently sloping uplands.	Clay loam Clay over bedrock Silty clay	8 - 80	$<4.2\times10^{-5}$ to 3×10^{-4}
Aledo-Bolar-Sanger: Loamy and clayey soils of gently sloping to moderately steep uplands.	Clay loam over bedrock Clay loam	8 - 70	$<4.2\times10^{-5}$ to 9×10^{-4}
Frio-Trinity: Clayey soil on nearly level flood plains.	Silty clay or loam Clay	25 - 75	$<4.2\times10^{-5}$ to 3×10^{-4}
Bastsil-Silawa: Loamy soils on nearly level to sloping stream terraces.	Sandy clay loam	40 - 80	9×10^{-4} to 3×10^{-3}

Source:

ESE, 1994.

Table 2.2
Monitoring Well Construction Specifications
Carswell AFB, Texas

Well ID	Borehole Depth (feet)	Screen Length (feet)	Screen Diameter (feet)	Depth to Screen (feet)	Depth to Sand Pack (feet)	Sand Pack Thickness (feet)	Depth to Seal (feet)	Seal Thickness (feet)
FT08-11A	14.5	10	2	4	3.5	11	2	1.5
FT08-11B	15	10	2	3.5	3	12	2	1
HM122	NA	NA	NA	NA	NA	NA	NA	NA
FT09-12A	25	10	2	13	10.5	14.5	8	2.5
FT09-12B	40	10	2	27.5	26	14	24	2
FT09-12C	38	10	2	27.5	25	13	23	2
FT09-12D	35.4	13	2	21.4	NA	NA	NA	NA
FT09-12E	38.5	3.5	2	24	NA	NA	NA	NA
P6A	16.5	NA	2	NA	9.5	7	6.5	3*
LF04-01	40.1	9.75	2	30	28	12.1	26	2
LF04-02	37.7	14.35	2	23.1	20.9	16.8	18.9	2
LF04-03	37.6	14.26	6	22.4	19.4	18.12	17.1	2.3
LF04-04	25.2	9.73	2	15.15	13.6	11.6	11.5	2.1
LF04-10	49.5	9.73	2	39.22	30	19.5	25.8	4.2
LF04-4A	24	10	2	14	11	12.5	8.0	3.0
LF04-4B	24	10	2	13	12	12	9.5	2.5
LF04-4C	29.5	10	2	18.5	17	12.5	14.5	2.5
LF04-4D	30.5	10	2	18	17	13.5	15	2

Table 2.2 (continued)
Monitoring Well Construction Specifications
Carswell AFB, Texas

Well ID	Borehole Depth (feet)	Screen Length (feet)	Screen Diameter (feet)	Depth to Screen (feet)	Depth to Sand Pack (feet)	Sand Pack Thickness (feet)	Depth to Seal (feet)	Seal Thickness (feet)
LF04-4E	35	10	2	25	24.5	10.5	22.5	2
LF04-4F	35.5	14	2	20	15.5	20	13.5	2
LF04-4G	40	14	2	21	19	21	17	2
LF04-4H	29	14	2	13	10	19	8	2
LF05-01	25.2	9.75	2	14.95	11.8	13.4	9.8	2
LF05-02	27.2	9.75	2	16.95	15	12.2	13	2
LF05-14	13.3	7.9	2	5.12	4.8	8.5	2.8	2
LF05-18	23.95	9.74	2	13.91	11.2	12.75	9.2	2
LF05-19	20.75	9.75	2	10.25	8.15	12.6	5.6	2.55
LF05-5A	32	10	2	18	16.5	15.5	14.5	2
LF05-5B	9	5	2	4	3.5	5.5	2	1.5
LF05-5C	22	15	2	7	6	16	4	2
LF05-5D	24	9	2	10.5	8	16	6	2
LF05-5E	40	14	2	24.1	21.5	18.5	19.5	2
LF05-5F	37	14	2	21	16	21	14	2
LF05-5G	29	11.75	2	14.25	11	18	9	2
LF05-5H	25.6	10.75	2	12.85	8	17.6	6	2
HM123	NA	NA	NA	NA	NA	NA	NA	NA

Table 2.2 (continued)
Monitoring Well Construction Specifications
Carswell AFB, Texas

Well ID	Borehole Depth (feet)	Screen Length (feet)	Screen Diameter (feet)	Depth to Screen (feet)	Depth to Sand Pack (feet)	Sand Pack Thickness (feet)	Depth to Seal (feet)	Seal Thickness (feet)
WP07-10A	39	10	2	27.25	26	13	24	2
WP07-10B	36	10	2	23	18	18	15	3
WP07-10C	32.5	10	2	20	18.5	14	16	2.5
CAR-RW1	34.1	15	6	19	17	17.1	14.9	2.1
CAR-RW10	35.5	10	6	24.75	22.7	12.8	18.7	4
CAR-RW11	35.5	10	6	24.75	21.9	13.6	17.1	4.8
CAR-RW12	40.5	15	6	24.67	22	18.5	19.1	2.9
CAR-RW2	34.8	15	6	19.5	17	17.8	14.8	2.2
CAR-RW3	28	10	6	16	14	14	10.5	3.5
CAR-RW4	33	15	6	17	13.5	19.5	11.5	2
CAR-RW5	31.8	15	6	16.2	14	17.8	12	2
CAR-RW6	33	20	6	13	11	22	9	2
CAR-RW7	35	15	6	18.7	15.7	19.3	13.7	2
CAR-RW8	37	20	6	22	18	19	16	2
CAR-RW9	26.33	10	6	14.75	12.7	13.63	10.5	2.2
CAR-P1	109	40	NA	69	- NA	NA	NA	NA
CAR-P2	109	40	NA	69	NA	NA	NA	NA

*Fine sand seal. N/A = Not Available

Table 2.3
Groundwater Elevation Summary
Carswell AFB, Texas

Well ID	Ground Surface Elevation[1] (NGVD)[3]	TOC[1] (NGVD)	Depth to Water[2] (feet)		Groundwater Elevation (NGVD)	
			3rd Quarter[4]	4th Quarter[5]	3rd Quarter	4th Quarter
FT08-11A	604.8	608.22	9.24	9.73	595.56	595.07
FT08-11B	603.8	608.14	5.54	6.17	598.26	597.63
FT09-12A	632	635.66	14.21	14.98	617.79	617.02
FT09-12B	625.6	627.55	28.77	29.48	596.83	596.12
FT09-12C	625.5	628.05	29.1	29.8	596.4	595.70
FT09-12D	624.8	627.45	NM	NM	NM	NM
FT09-12E	624.5	627.48	NM	NM	NM	NM
LF04-01	626.5	629.24	NM	NM	NM	NM
LF04-02	621	623.68	NM	NM	NM	NM
LF04-03	620.5	623.25	NM	NM	NM	NM
LF04-04	609.4	612.07	NM	16.55	NM	592.85
LF04-10	626.9	626.54	NM	33.78	NM	593.12
LF04-4A	624.6	625.76	12.97	14.18	611.63	610.42
LF04-4B	618.4	619.9	19.84	20.32	598.56	598.08
LF04-4C	610.9	613.04	NM	NM	NM	NM
LF04-4D	613.1	615.35	18.24	18.73	594.86	594.37
LF04-4E	617.5	618.54	22.68	23.21	594.82	594.29

Table 2.3 (continued)
Groundwater Elevation Summary
Carswell AFB, Texas

Well ID	Ground Surface Elevation[1] (NGVD)[3]	TOC[1] (NGVD)	Depth to Water[2] (feet)		Groundwater Elevation (NGVD)	
			3rd Quarter[4]	4th Quarter[5]	3rd Quarter	4th Quarter
LF04-4F	622.8	625.36	26.77	27.42	596.03	595.38
LF04-4G	619.1	620.02	NM	NM	NM	NM
LF04-4H	610.5	613.43	NM	NM	NM	NM
LF05-01	619.3	621.96	NM	NM	NM	NM
LF05-02	620	622.69	NM	23.63	NM	596.37
LF05-14	603.2	602.98	NM	NM	NM	NM
LF05-18	612.1	611.84	NM	19.62	NM	592.48
LF05-19	606.3	606.08	NM	NM	NM	NM
LF05-5A	619.4	623.18	NM	NM	NM	NM
LF05-5B	597.4	600.45	NM	NM	NM	NM
LF05-5C	606.8	608.68	9.47	9.97	597.33	596.83
LF05-5D	608.5	611.71	9.66	10.6	598.84	597.90
LF05-5E	623.9	626.89	NM	NM	NM	NM
LF05-5F	619.4	618.95	NM	NM	NM	NM
LF05-5G	612	615.39	17.71	17.99	594.29	594.01
LF05-5H	608.4	610.62	NM	NM	NM	NM
WP07-10A	624.2	626.7	NM	NM	NM	NM

Table 2.3 (continued)
Groundwater Elevation Summary
Carswell AFB, Texas

Well ID	Ground Surface Elevation[1] (NGVD)[3]	TOC[1] (NGVD)	Depth to Water[2] (feet)		Groundwater Elevation (NGVD)	
			3rd Quarter[4]	4th Quarter[5]	3rd Quarter	4th Quarter
WP07-10B	621.1	624.46	24.46	25.12	596.64	595.98
WP07-10C	615.4	617.24	NM	19.24	NM	596.16

Notes:

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

[2]Depth to Water Measured from Ground Surface Elevation; NM = Not Measured.

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

[4]Depth to Water 3rd Quarter Water Level Survey conducted in October, 1995 in the three days prior to the start of Quarterly Groundwater Sampling (LAW, 1996).

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

Table 3.1
Summary of Soil Analytical Results from Waste Burial Area No. 7 Excavations
October 1991
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2 [3]	Sample Location [1,2]							
		Pile B	Pile C	Pile F	Pile G	Pile H	Pile J	Pile E	Background
Oil & Grease (mg/Kg)	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0
Metals (mg/Kg)									
Arsenic	5	2.3	2.2	2	1.9	2	1.9	2.1	1.1
Barium	200	68	57	95.9	60.4	66.5	79.5	79	16
Cadmium	0.5	(3.7)	(2.4)	(3.3)	(2.0)	(3.3)	(4.3)	(3.2)	< 1.0
Chromium	10	(13.4)	(10.4)	(12.9)	(10.2)	(12.8)	(13.6)	(12.6)	(4.8)
Mercury	0.2	0.01	0.09	0.01	0.07	0.06	0.03	0.02	0.01
Nickel	10	7.8	7	9.1	6.4	7.9	8.5	9.1	1.9
Lead	1.5	(2.0)	(37.2)	(7.9)	(26.4)	(15.4)	(22.8)	(28.0)	(1.7)
Selenium	5	0.4	<0.2	0.3	0.2	0.2	<0.2	0.2	<0.1
Silicon	NA	277	268	296	379	301	296	222	406
Zinc	NA	18.8	36.5	16.9	25.8	22.7	29.5	20.5	5.2
Total Petroleum Hydrocarbons (mg/Kg)	NA	< 10.0	87	110	19	90	65	37	< 10.0
Organics (mg/Kg)									
Xylenes	1000	<0.0022	<0.0022	<0.0022	0.0022	<0.0022	<0.0022	<0.0022	<0.0022
Di-n-butylphthalate	1020	<0.66	<0.66	<0.66	<0.66	0.83	<0.66	0.85	<0.66

Table 3.1 (continued)
Summary of Soil Analytical Results from Waste Burial Area No. 7 Excavations
October 1991
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2 [3]	Sample Location [1,2]							
		Pile B	Pile C	Pile F	Pile G	Pile H	Pile J	Pile E	Background
Tetrachloroethene	0.5	0.0099	0.013	<0.005	<0.005	<0.005	0.245	<0.005	<0.005
1,1,2-Trichloroethane	0.5	<0.005	<0.005	<0.005	<0.005	<0.005	0.0051	<0.005	<0.005
Trichloroethene	0.5	0.153	0.0177	0.0359	0.0106	<0.005	1.35	<0.005	0.0284
Phenanthrene	NA	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	0.76
Fluoranthene	409	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	1.6
Pyrene	310	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	1.3
Chrysene	NA	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	0.66
Benzo*[b]*fluoranthene	NA	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	<0.66	0.72

Notes:

[1] ND = Not Detected

[2] Parenthesis ( ) indicates concentration exceeds TNRCC Risk Reduction Standard Number 2.

[3] Maximum Concentration of Groundwater Protection Standard for Industrial Use (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

Source: Investigation/Remediation Report (USACE, 1992)

Table 4.1
Preliminary Identified ARARs
Carswell AFB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Location Specific	National Environmental Policy Act (NEPA)	40 CFR 1500	Council on environmental quality regulations	Evaluates impacts of remediation on the environment
		40 CFR 6	EPA NEPA regulations	Regulations specific to EPA actions
		32 CFR 989 32 CFR 265	DOD-Air Force NEPA regulations DOD-Natural Resources Programs	Regulations specific to DOD-Air Force actions; the Air Force must evaluate and disclose impacts that will occur as a result of remediation
	National Historic Preservation Act (1966)	36 CFR 60, 62, 63, 65, 800	Culture resources regulations	Regulations pertaining to the protection of cultural resources. Includes Executive Order 11593
	Archaeological Resources Protection Act (1979)	36 CFR 296	Cultural resources regulations	Regulations pertaining to the protection of cultural resources. Includes Executive Order 11593
	Archaeological and Historical Preservation Act (1974)	40 CFR 6.301	Cultural resources regulations	Provides for data collection/ preservation listing on the National Registry of National Landmarks, etc. If any building and/or other landmarks/ resources are considered eligible, compliance must be accomplished prior to remediation.
	Floodplains/Wetlands	E.O. 11988 E.O. 11990		

Table 4.1 (continued)
Preliminary Identified ARARs
Carswell AFB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Location Specific (continued)	Migratory Bird Treaty Act	16 U.S.C. 703-712 50 CFR 10, 20, and 21	Regulates the taking of migratory birds	This act prohibits the "taking" of migratory birds without a permit. Accidental killing of birds by pollution from CAF B could be considered "taking".
Action Specific	Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)	40 CFR 300	National oil and hazardous substances pollution contingency plan	Regulations setting forth the procedures for reporting, responsibilities, and planning actions to remediate releases. OSWER Directive 9355.3-01 is applicable.
	Superfund Amendments and Reauthorization Act (SARA)	40 CFR 355, 370, 372	Emergency planning and reporting	Pertains to hazardous and toxic chemical reporting and planning requirements.
	Fish and Wildlife Coordination Act	16 USC 661-666	Requires consultation when Federal department or agency proposes or authorizes any modification of any stream or other water body and adequate provision for protection of fish and wildlife resources.	This requirement would be applicable if modification of Farmers Branch Creek may be required. Consultation with the U.S. Fish and Wildlife Service and the appropriate state agency is required.
	Endangered Species Act	50 CFR 200, 402	Requires action to conserve endangered species within critical habitats upon which endangered species depend; includes consultation with Department of Interior.	This requirement would be most applicable to bird and fish species found in Farmers Branch Creek ecosystems. Consultation with Federal and state agencies can be accomplished simultaneously with requirements under the Fish and Wildlife Coordination Act.

Table 4.1 (continued)
Preliminary Identified ARARs
Carswell AFB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Action Specific (continued)	Clean Water Act (CWA)	33 CFR 322	Structures or work within navigable waters of the United States	May be applicable to Farmers Branch Creek.
		33 CFR 323 33 CFR 328 33 CFR 329	Discharges of dredge or fill material to waters of the United States	May be applicable to Farmers Branch Creek.
		40 CFR 109	Criteria for state, local, and regional oil removal contingency plans	Applicable if oil may be managed or used during remediation due to proximity to Farmers Branch Creek.
		40 CFR 110	Oil discharge	May be applicable if determined that oil has contaminated or may contaminate adjacent water bodies.
		40 CFR 112	Oil pollution prevention	Applicable to prevent oil spills into adjacent water bodies. Requires that persons who may discharge oil in harmful quantities must prepare a Spill Prevention Control and Countermeasure (SPCC) plan (40 CFR 112.1, [b]).
		Texas Administrative Code (TAC), Title 31, Chapter 343	Oil and hazardous substances	Provides for immediate cleanup of hazardous substances without obtaining a permit (Texas Water Code, Chapter 26).
		Texas Water Code, Title 2, Chapter 26, Subchapter G	Oil and hazardous substances spill prevention and control	Also known as Texas Hazardous Substances Spill Prevention and Control Act. Establishes policy to prevent the spill or discharge of hazardous substances into waters of the state of Texas.

Table 4.1 (continued)
Preliminary Identified ARARs
Carswell AFB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Action Specific (continued)	CWA (continued)	Texas Water Code, Title 2, Chapter 26, Subchapter I	Underground and aboveground storage tanks	Refers to state of Texas Solid Waste Law as related to water quality.
		Natural Resources Code, Title 2, Subtitle 6, Chapter 40	Texas Oil Spill Prevention and Response Act	Established policy for protection of all waters of the state, but focuses on coastal waters.
		TAC, Title 31, Chapter 55	Pollution/fish kill investigations	May be applicable if a fish kill is suspected or confirmed as a result of the release of hazardous substances.
		TAC, Title 31, Chapter 343	Texas oil and hazardous substances regulations	Implements regulations under the Texas Water Code (TWC), Chapter 26, Subchapter G.
		40 CFR 122	Natural Pollutant Discharge Elimination System (NPDES) program	Requires permits for the discharge of pollutants from a point source into waters of the United States.
		40 CFR 125	Criteria and standards for the NPDES	Includes effluent discharge and stormwater discharge.
		TAC, Title 31, Part IX, Chapter 305	Texas consolidated NPDES permit rules	Set standards and requirements for applications, permits, and actions by the Texas Water Commission.
		TAC, Title 31, Part IX, Chapter 315	Texas criteria and standards for the NPDES; pre-treatment regulations	May be applicable depending on selected alternative.

Table 4.1 (continued)
Preliminary Identified ARARs
Carswell AFB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Action Specific (continued)	CWA (continued)	TAC, Title 31, Part IX, Chapter 319	General regulations incorporated into permit	Established allowable concentrations of hazardous metals to inland waters. Includes toxic pollutant quality control (319.26) and groundwater protection (319.27).
		TAC, Title 31, Part IX, Chapter 323	Waste disposal approvals	Applies to the collection of waste in floodplains, and groundwater protection requirements.
		TAC, Title 31, Chapter 331	Underground injection control	Applies to the injection of chemicals into non-potable aquifers to facilitate remediation.
	Hazardous Materials Transportation Act (HMTA)	49 CFR 107	Hazardous materials program procedures	
		49 CFR 171, 172, 173, 174, 177	Hazardous materials regulations	Includes general information communication requirements, emergency response information, and carriage by rail and public highway. Carriage by vessel or aircraft is not anticipated.
	Resource Conservation and Recovery Act (RCRA)	40 CFR 241	Land disposal of solid waste	May be applicable to four SWMUs if excavation is required.
		40 CFR 256	State solid waste management plans	May be applicable if excavation of the four SWMUs reclassifies the sites as an "open dump".

Table 4.1 (continued)
Preliminary Identified ARARs
Carswell AFB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Action Specific (continued)	RCRA (continued)	40 CFR 257	Classification of disposal facilities and practices	May be applicable to the four SWMUs if determined that they pose an adverse environmental or health risk.
		40 CFR 260	Identification and listing of hazardous wastes	Identifies solid waste subject to regulations as hazardous waste.
		40 CFR 262	Hazardous waste generator standards	Waste will be generated as a result of remediation.
		40 CFR 263	Hazardous waste transportation standards	Waste will be transported, including samples, as a result of remediation. Manifests are required
		40 CFR 264	Standards for treatment, storage, and disposal (TSD) facilities	Waste may be stored on-site during remediation.
		40 CFR 265	Interim status standards	May be applicable if CAFB is required to be a RCRA permitted facility.
		40 CFR 266	Management of specific wastes	
		40 CFR 268	Land disposal restrictions (LDRs)	Identifies wastes restricted from land disposal unless specific exemptions exist. Applicable to several contaminants of concern.
		40 CFR 270	Hazardous waste permit program	May be applicable if CAFB is required to be a RCRA permitted facility.
		40 CFR 280	Underground storage tank regulations	Applies to owners/operators of underground storage tanks.

Table 4.1 (continued)
Preliminary Identified ARARs
Carswell AFB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Action Specific (continued)	RCRA (continued)	Texas Solid Waste Disposal Act	Texas civil statutes Public Article 4477-7	Includes implementation of the Federal Resource Conservation and Recovery Act.
		Texas Underground Storage Tanks Act	Texas water code, Title 2, Chapter 26	Includes underground and aboveground storage tanks. Aboveground tanks pertain only to petroleum products.
		TAC, Title 31, Part IX, Chapter 334	Underground Storage Tank Rules	Applicable to underground storage tanks storing hazardous or petroleum products, and aboveground storage tanks containing petroleum.
		TAC, Title 31, Part IX, Chapter 330	Solid waste management regulations	Includes regulation of both hazardous and non-hazardous waste; however, targets municipal solid waste disposal.
		TAC, Title 31, Chapter 335	Texas industrial waste management regulations	Regulates the management and control of municipal hazardous waste and industrial wastes. Includes generators, transporters, and owners/ operators of TSD facilities.
		TAC, Title 31, Chapter 330	Disposal of lead acid batteries	May be applicable if batteries are disposed in any of the four SWMUs.
	Occupational Safety and Health Act (OSHA)	29 CFR 1900	Implementation of OSHA	Address standard safety practices including personal protective equipment.
Chemical Specific	CWA	40 CFR 129	Toxic pollutant effluent standards	Applicable if any toxic pollutants listed at 129.4 (including PCBs) are discovered.
		TAC, Title 31, Chapter 314	Texas toxic pollutant effluent standards	Adopts 40 CFR 129, by reference.

Table 4.1 (continued)
Preliminary Identified ARARs
Carswell AFB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Chemical Specific (continued)	CWA (continued)	40 CFR 130	Water quality planning and management	Water quality planning, management, and program implementation.
		40 CFR 131	Water quality standards	Procedures for development, review, and approval of state water quality standards.
		TAC, Title 31, Chapter 307	Texas surface water quality standards	Standards of the state to maintain the quality water consistent with public health and enjoyment.
		TAC, Title 31, Chapter 311	Watershed protection	Includes Lake Worth regarding wastewater disposal and effluent requirements.
	Safe Drinking Water Act (SDWA)	40 CFR 141, 143	National primary and secondary drinking water standards	Establishes maximum contaminant levels (MCLs) for organics, inorganics, radioactivity, and turbidity. The standards also serve as groundwater cleanup standards at RCRA sites. Trichloroethene is the primary contaminants of concern.
		TAC, Title 31, Part IX, Chapter 290	Texas drinking water standards	Essentially adopts 40 CFR 141, 143, and establishes standards for bacteriological, chemical, and radiological quality.
	Clean Air Act (CAA)	40 CFR 50	National primary and secondary ambient air quality standards	Establishes standards for sulfur oxides, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead.
		40 CFR 52 Subpart 55	Texas state implementation plan	Incorporates and cites revisions to Texas' 1972 original submittal of a state implementation plan.

Table 4.1 (continued)
Preliminary Identified ARARs
Carswell AFB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Chemical Specific (continued)	CAA (continued)	Texas CAA	Abatement of air pollution and contaminants	Includes dust, smoke, particulate matter, fumes, gas, vapor, odor produced by processes other than natural.
		TAC, Title 31, Part III, Chapter 101	Texas Air Pollution control regulations: General Provisions	Implements the Texas CAA.
			Section 101.4 Nuisance	Requires that air pollutants can not be discharged that may be adverse to, or may be injurious to humans, animals, vegetation, and property.
			Section 101.20 and 101.21	Compliance with National Standards
		TAC, Title 31, Part III, Chapter 111	Visible emissions and particulate matter	Includes incineration of hazardous waste.
			Section 111.145	Dust control required for land clearing, construction, etc., if more than one area.
		40 CFR 61	National Emission Standards for Hazardous Air Pollutants (NESHAPS)	Possible applicable due to trichloroethane.
		TAC, Title 31, Part III, Chapter 115	Control of air pollution for volatile organic compounds	a.k.a. "Texas Regulation V"; regulates synthetic organic chemicals including benzene, methylene chloride, and vinyl chloride which are contaminants of concern.

Table 4.1 (continued)
Preliminary Identified ARARs
Carswell AFB, Texas

ARAR Category	Federal Act	Regulation/ Standard/Code	Description	Comments
Chemical Specific (continued)	CAA (continued)	TAC, Title 31, Part III, Chapter 120	Control of air pollution from hazardous waste or solid waste sites	Applies to all hazardous waste facilities required to obtain a permit pursuant to the Texas Solid Waste Disposal Act.
	Toxic Substances Control Act (TSCA)	40 CFR 761	Regulation of PCBs	Applicable if PCBs discovered.
		40 CFR 763	Regulation of Asbestos	Applicable if asbestos containing materials are included in remediation.

Table 5.1a
Groundwater Sampling Analyses
February and March 1985
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
FT08-11A	X	X		X	X	X		X	X
FT08-11B	X	X		X	X	X		X	X
FT08-11C									
HM122									
FT09-12A	X	X		X	X	X			
FT09-12B	X	X		X	X	X			
FT09-12C	X	X		X	X	X			
FT09-12D									
FT09-12E									
FT09-12F									
P6A									
LF04-01									
LF04-02									
LF04-03									
LF04-04									
LF04-10									
LF04-4A	X	X		X	X	X		X	X
LF04-4B	X	X		X	X	X		X	X
LF04-4C	X	X		X	X	X		X	X

Table 5.1a (continued)
Groundwater Sampling Analyses
February and March 1985
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
LF04-4D	X	X		X	X	X		X	X
LF04-4E	X	X		X	X	X		X	X
LF04-4F									
LF04-4G									
LF04-4H									
LF05-01									
LF05-02									
LF05-14									
LF05-18									
LF05-19									
LF05-5A	X	X		X	X	X			
LF05-5B	X	X		X	X	X			
LF05-5C	X	X		X	X	X			
LF05-5D									
LF05-5E									
LF05-5F									
LF05-5G									
LF05-5H									
HM123									

Table 5.1a (continued)
Groundwater Sampling Analyses
February and March 1985
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
WP07-10A	X	X				X			
WP07-10B	X	X				X			
WP07-10C	X	X				X			
CAR-RW1									
CAR-RW10									
CAR-RW11									
CAR-RW12									
CAR-RW2									
CAR-RW3									
CAR-RW4									
CAR-RW5									
CAR-RW6									
CAR-RW7									
CAR-RW8									
CAR-RW9									
CAR-P1	X	X		X	X	X			
CAR-P2	X	X		X	X	X			

Table 5.1b
Groundwater Sampling Analyses
February and April 1988
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
FT08-11A	X	X	X		X		X		
FT08-11B	X	X			X		X		
HM122									
FT09-12A	X	X	X		X		X		
FT09-12B	X	X			X		X		
FT09-12C	X	X	X		X		X		
FT09-12D	X	X			X		X		
FT09-12E	X	X			X		X		
FT09-12G									
FT09-12H									
FT09-12I									
FT09-12J									
FT09-12K									
P6A									
LF04-01									
LF04-02									
LF04-03									
LF04-04									
LF04-10									

Table 5.1b (continued)
Groundwater Sampling Analyses
February and April 1988
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
LF04-4A	X	X	X		X				
LF04-4B	X	X	X		X				
LF04-4C	X	X			X				
LF04-4D	X	X			X				
LF04-4E	X	X			X				
LF04-4F	X	X			X				
LF04-4G	X	X			X				
LF04-4H	X	X			X				
LF05-01									
LF05-02									
LF05-14									
LF05-18									
LF05-19									
LF05-5A	X	X	X		X				
LF05-5B	X	X			X				
LF05-5C	X	X			X				
LF05-5D	X	X			X				
LF05-5E	X	X			X				
LF05-5F	X	X			X				

Table 5.1b (continued)
Groundwater Sampling Analyses
February and April 1988
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
LF05-5G	X	X			X				
LF05-5H	X	X			X				
HM123									
WP07-10A	X	X		X	X	X	X	X	X
WP07-10B	X	X		X	X	X	X	X	X
WP07-10C	X	X		X	X	X	X	X	X
WP07-10D									
WP07-10E									
WP07-10F									
CAR-RW1									
CAR-RW10									
CAR-RW11									
CAR-RW12									
CAR-RW2									
CAR-RW3									
CAR-RW4									
CAR-RW5									
CAR-RW6									
CAR-RW7									

320100

Table 5.1b (continued)
Groundwater Sampling Analyses
February and April 1988
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
CAR RW8									
CAR RW9									
CAR-P1	X	X	X		X				
CAR-P2	X	X			X				

Table 5.1c
Groundwater Sampling Analyses
April and May 1990
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
FT08-11A	X	X		X				
FT08-11B	X	X		X				
HM122								
FT09-12A	X	X		X				
FT09-12B	X	X		X				
FT09-12C	X	X		X				
FT09-12D	X	X		X				
FT09-12E	X	X		X				
P6A								
LF04-01	X	X		X				
LF04-02	X	X		X				
LF04-03								
LF04-04	X	X		X				
LF04-10	X	X		X				
LF04-4A	X	X		X				
LF04-4B	X	X		X				
LF04-4C	X	X		X				
LF04-4D	X	X		X				
LF04-4E	X	X		X				

320102

Table 5.1c (continued)
Groundwater Sampling Analyses
April and May 1990
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
LF04-4F	X	X		X				
LF04-4G	X	X		X				
LF04-4H	X	X		X				
LF05-01	X	X		X				
LF05-02	X	X		X				
LF05-14	X	X		X				
LF05-18	X	X		X				
LF05-19	X	X		X				
LF05-5A	X	X		X				
LF05-5B	X	X		X				
LF05-5C	X	X		X				
LF05-5D	X	X		X				
LF05-5E	X	X		X				
LF05-5F	X	X		X				
LF05-5G	X	X		X				
LF05-5H	X	X		X				
HM123								
WP07-10A	X	X		X				
WP07-10B	X	X		X				

Table 5.1c (continued)
Groundwater Sampling Analyses
April and May 1990
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
WP07-10C	X	X		X				
CAR-RW1								
CAR-RW10								
CAR-RW11								
CAR-RW12								
CAR-RW2								
CAR-RW3								
CAR-RW4								
CAR-RW5								
CAR-RW6								
CAR-RW7								
CAR-RW8								
CAR-RW9								
CAR-P1								
CAR-P2								

Table 5.1d
Groundwater Sampling Analyses
May 1993
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
CAR-RW1	X	X	X	X				
CAR-RW10	X	X	X	X				
CAR-RW11	X	X	X	X				
CAR-RW12	X	X	X	X				
CAR-RW2	X	X	X	X				
CAR-RW3	X	X	X	X				
CAR-RW4		X						
CAR-RW5		X						
CAR-RW6		X						
CAR-RW7		X						
CAR-RW8		X						
CAR-RW9	X	X	X	X				

Table 5.1e
Groundwater Sampling Analyses
October and November 1995
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
FT08-11A								
FT08-11B								
HM122				X				
FT09-12A								
FT09-12B								
FT09-12C								
FT09-12D								
FT09-12E								
P6A								
LF04-01			X	X				
LF04-02		X	X	X				
LF04-03								
LF04-04		X		X				
LF04-10				X				
LF04-4A								
LF04-4B								
LF04-4C		X	X	X				
LF04-4D								
LF04-4E								

320106

Table 5.1e (continued)
Groundwater Sampling Analyses
October and November 1995
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
LF04-4F								
LF04-4G		X		X				
LF04-4H								
LF05-01		X		X				
LF05-02		X		X				
LF05-14		X		X				
LF05-18		X		X				
LF05-19		X		X				
LF05-5A		X	X	X				
LF05-5B		X		X				
LF05-5C								
LF05-5D								
LF05-5E		X		X				
LF05-5F								
LF05-5G								
LF05-5H								
HM123				X				
WP07-10A								
WP07-10B								

Table 5.1e (continued)
Groundwater Sampling Analyses
October and November 1995
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
WP07-10C								
CAR-RW1								
CAR-RW10								
CAR-RW11								
CAR-RW12								
CAR-RW2								
CAR-RW3								
CAR-RW4								
CAR-RW5								
CAR-RW6								
CAR-RW7								
CAR-RW8								
CAR-RW9								
CAR-P1								
CAR-P2								
LF05-P1								
LF04-P2								

320108

Table 5.1f
Groundwater Sampling Analyses
1995 Quarterly Groundwater Sampling
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
FT08-11A		X	X	X				
FT08-11B		X	X	X				
HM122								
FT09-12A		X	X	X				
FT09-12B		X	X	X				
FT09-12C		X	X	X				
FT09-12D								
FT09-12E								
P6A		X	X	X				
LF04-01								
LF04-02								
LF04-03								
LF04-04		X	X	X				
LF04-10		X	X	X				
LF04-4A		X	X	X				
LF04-4B		X	X	X				
LF04-4C								
LF04-4D		X	X	X				
LF04-4E		X	X	X				

Table 5.1f (continued)
Groundwater Sampling Analyses
1995 Quarterly Groundwater Sampling
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
LF04-4F		X	X	X				
LF04-4G								
LF04-4H								
LF05-01								
LF05-02		X	X	X				
LF05-14								
LF05-18		X	X	X				
LF05-19								
LF05-5A								
LF05-5B								
LF05-5C		X	X	X				
LF05-5D		X	X	X				
LF05-5E								
LF05-5F								
LF05-5G		X	X	X				
LF05-5H								
HM123								
WP07-10A								
WP07-10B		X	X	X				

320110

Table 5.1f (continued)
Groundwater Sampling Analyses
1995 Quarterly Groundwater Sampling
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
WP07-10C		X	X	X				
CAR-RW1								
CAR-RW10								
CAR-RW11								
CAR-RW12								
CAR-RW2								
CAR-RW3								
CAR-RW4								
CAR-RW5								
CAR-RW6								
CAR-RW7								
CAR-RW8								
CAR-RW9								
CAR-P1								
CAR-P2								

Table 5.2a
Summary of Groundwater Analytical Results for February and March 1985
Carswell AFB - Landfill 4

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (µg/L)						
Barium	2000	34.0 - 870	6 (14)	13	0	
Mercury	2	<0.2 - 7.0	6 (14)	4	2	LF04-4A, 4D
Selenium, ICP	50	<80 - 80	6 (14)	1	1	LF04-4A
Selenium, AA	50	<3.0 - 4.0	6 (6)	3	0	
Mercury, AA	2	0.2 - 0.4	3 (3)	3	0	
Arsenic, AA	50	<3.0 - 9.0	6 (6)	5	0	
Organic Indicators (µg/L)						
Oil & Grease	NA	<1000 - 23000	6 (14)	3	NA	
Phenols	NA	<5.0 - 100	6 (14)	7	NA	
TOC	NA	<1000 - 28000	6 (14)	12	NA	
Purgeable Halocarbons (µg/L)						
Vinyl Chloride	2	ND - 12.5	6 (22)	4	4	LF04-4C, 4D
Chloroethane	730	ND - 7.6	6 (22)	4	0	
Methylene Chloride	5	ND - 4.3	6 (22)	2	0	
Trichlorofluoromethane	11000	ND - 6.8	6 (22)	12	0	
1,1-Dichloroethene	7	ND - 8.1	6 (22)	8	2	LF04-4D
1,1-Dichloroethane	3650	ND - 4.5	6 (22)	3	0	

320112

Table 5.2a (continued)
Summary of Groundwater Analytical Results for February and March 1985
Carswell AFB - Landfill 4

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
1,1,1-Trichloroethane	200	ND - 25.1	6 (22)	10	0	
1,2-Dichloropropane	5	ND - 2.3	6 (22)	2	0	
Trichloroethene	5	ND - 4550	6 (22)	16	10	LF04-4C, 4D, 4E
Tetrachloroethene	5	ND - 18.8	6 (22)	6	4	LF04-4C
Chlorobenzene	100	ND - 3.7	6 (22)	4	0	
1,4-Dichlorobenzene	75	ND - 9.1	6 (22)	2	0	
Purgeable Aromatics (µg/L)						
1,4-Dichlorobenzene	75	ND - 5.5	6 (22)	1	0	

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Source: Phase II, Stage 1 Final Report (Radian, 1986)

320113

Table 5.2b
Summary of Groundwater Analytical Results for February and March 1985
Carswell AFB - Landfill 5

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (µg/L)						
Barium	2000	23.0 - 590	4 (10)	10	0	
Mercury	2	<0.2 - 7.0	4 (10)	3	1	LF05-5A
Selenium, AA	50	<3.0 - 3.0	4 (4)	1	0	
Arsenic, AA	50	<3.0 - 19.0	4 (4)	3	0	
Organic Indicators (µg/L)						
Oil & Grease	NA	<1000 - 220000	4 (12)	5	NA	
Phenols	NA	<5.0 - 75.0	4 (12)	4	NA	
TOC	NA	<1000 - 9000	4 (10)	8	NA	
TOX	NA	<10 - 1500	4 (12)	10	NA	
Purgeable Halocarbons (µg/L)						
Vinyl Chloride	2	ND - 178	4 (14)	4	4	LF05-5B
1,1-Dichloroethene	7	ND - 7.5	4 (14)	1	1	LF05-5B
1,2-Dichloropropane	5	ND - 2.6	4 (14)	1	0	
Trichloroethene	5	ND - 3280	4 (14)	11	11	LF05-5A, 5B, 5C

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Source: Phase II, Stage I Final Report (Radian, 1986)

320114

Table 5.2c
Summary of Groundwater Analytical Results for February and March 1985
Carswell AFB - Waste Burial Area No. 7

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Organic Indicators (μg/L)						
Oil & Grease	NA	< 1000 - 310000	3 (6)	3	NA	
TOC	NA	< 1000 - 7000	3 (6)	5	NA	
TOX	NA	20.0 - 1400	3 (7)	7	NA	
Purgeable Halocarbons (μg/L)						
Vinyl Chloride	2	ND - 8.6	3 (12)	1	1	WP07-10B
Trichlorofluoromethane	11000	ND - 5.3	3 (12)	1	0	
1,1-Dichloroethane	3650	ND - 6.8	3 (12)	1	0	
Trichloroethene	5	1870 - 5000	3 (12)	12	12	WP07-10A, 10B,10C
Tetrachloroethene	5	ND - 102	3 (12)	4	4	WP07-10B

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Source: Phase II, Stage I Final Report (Radian, 1986)

Table 5.2d
Summary of Groundwater Analytical Results for February and March 1985
Carswell AFB - Fire Training Area 1

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (μg/L)						
Arsenic	50	<60	2 (4)	0	0	
Barium	2000	160 - 180	2 (4)	4	0	
Cadmium	5	<2.0	2 (4)	0	0	
Chromium	100	<5.0	2 (4)	0	0	
Lead, ICP	15	<80	2 (4)	0	0	
Mercury	2	0.2 - 0.5	2 (4)	4	0	
Selenium, ICP	50	<80	2 (4)	0	0	
Silver	183	<2.0	2 (4)	0	0	
Lead, AA	15	<2.0	2 (2)	0	0	
Selenium, AA	50	<3.0	2 (2)	0	0	
Arsenic, AA	50	4.0 - 41.0	2 (2)	2	0	
Organic Indicators (ug/L)						
Oil & Grease	NA	<1000 - 200000	2 (5)	3	NA	
Phenols	NA	<5.0 - 5.0	2 (4)	2	NA	
TOC	NA	7000 - 15000	2 (4)	4	NA	
TOX	NA	10.0 - 270	2 (6)	6	NA	

Table 5.2d (continued)
Summary of Groundwater Analytical Results for February and March 1985
Carswell AFB - Fire Training Area 1

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Herbicides (2,4,5-T) (ug/L)	NA	ND - 0.2	2 (5)	1	NA	
Purgeable Halocarbons (ug/L)						
Trichlorofluoromethane	11000	ND - 5.7	2 (8)	5	0	
Trichloroethene	5	ND - 1.8	2 (8)	2	0	
Purgeable Aromatics (ug/L)						
Benzene	5	ND - 3.6	2 (8)	2	0	

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Source: Phase II, Stage I Final Report (Radian, 1986)

Table 5.2e
Summary of Groundwater Analytical Results for February and March 1985
Carswell AFB - Fire Training Area 2

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (µg/L)						
Barium	2000	97.0 - 180	3 (7)	7	0	
Mercury	2	0.2 - 0.3	3 (7)	1	0	
Arsenic, AA	50	3.0 - 4.0	3 (3)	1	0	
Organic Indicators (µg/L)						
Oil & Grease	NA	< 1000 - 69000	3 (8)	4	NA	
Phenols	NA	<5.0 - 21.0	3 (7)	5	0	
TOC	NA	< 1000 - 5000	3 (7)	2	NA	
TOX	NA	<10 - 380	3 (8)	6	NA	
Purgeable Halocarbons (µg/L)						
Vinyl Chloride	2	ND - 9.4	3 (12)	2	2	FT09-12C
Trichlorofluoromethane	11000	ND - 15.7	3 (12)	6	0	
1,1-Dichloroethene	7	ND - 2.5	3 (12)	2	0	
1,1-Dichloroethane	3650	ND - 5.9	3 (12)	2	0	
1,1,1-Trichloroethane	200	ND - 2.9	3 (12)	6	0	
Trichloroethene	5	ND - 362	3 (12)	10	6	FT09-12B. 12C
Tetrachloroethene	5	ND - 164	3 (12)	10	6	FT09-12B. 12C

320118

Table 5.2e (continued)
Summary of Groundwater Analytical Results for February and March 1985
Carswell AFB - Fire Training Area 2

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Purgeable Aromatics (μg/L)						
1.4-Dichlorobenzene	75	ND - 4.1	3 (12)	3	0	
1.2-Dichlorobenzene	600	ND - 3.9	3 (12)	1	0	

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Source: Phase II, Stage I Final Report (Radian, 1986)

320119

Table 5.3a
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Landfill 4

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (µg/L)						
Silver	183	<9.0 - 29	9 (20)	4	0	
Aluminum	NA	<200 - 200000	9 (20)	14	NA	
Arsenic	50	<15.0 - 2000	9 (20)	1	1	LF04-4A
Boron	NA	<600 - 840	9 (20)	1	NA	
Barium	2000	28 - 1900	9 (20)	20	0	
Beryllium	4	<1.0 - 26.0	9 (20)	10	7	LF04-4A, 4C, 4D, 4G, 4H
Calcium	NA	11000 - 4100000	9 (20)	20	NA	
Cadmium	5	<3.0 - 25.0	9 (20)	6	5	LF04-4C, 4D, 4G
Cobalt	NA	<10 - 130	9 (20)	12	NA	
Chromium	100	<9.0 - 440	9 (20)	16	8	LF04-4A, 4C, 4D, 4G, 4H
Copper	NA	<10 - 270	9 (20)	14	NA	
Iron	NA	<30 - 360000	9 (20)	18	NA	
Potassium	NA	820 - 36000	9 (20)	20	NA	
Magnesium	NA	3800 - 61000	9 (20)	20	NA	

Table 5.3a (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Landfill 4

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Manganese	NA	7.0 - 28000	9 (20)	20	NA	
Sodium	NA	22000 - 110000	9 (20)	20	NA	
Nickel	100	<20 - 380	9 (20)	13	6	LF04-4A, 4C, 4D, 4G
Lead	15	<50 - 400	9 (20)	6	6	LF04-4A, 4C, 4D, 4G
Antimony	6	<60 - 790	9 (20)	15	15	LF04-4A, 4B, 4C, 4D, 4E, 4G, 4H, P2
Selenium	50	<300 - 1000	9 (20)	5	5	LF04-4C, 4D, 4G
Silicon	NA	5400 - 130000	9 (20)	20	NA	
Thallium	NA	<90 - 110	9 (20)	3	NA	
Vanadium	NA	<20 - 1000	9 (20)	17	NA	
Zinc	NA	<6.0 - 540	9 (20)	18	NA	
Arsenic, AA	50	<2.0 - 61	9 (20)	17	3	LF04-4A, 4C, 4G
Mercury	2	<0.12 - 0.2	9 (20)	1	0	
Lead, AA	15	<2.0 - 120	6 (7)	6	5	LF04-4A, 4C, 4G, 4H
Selenium, AA	50	<3.0 - 14.0	9 (20)	2	0	

320121

Table 5.3a (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Landfill 4

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Non-Metals (μg/L)						
Total Dissolved Solids	NA	350000 - 920000	9 (20)	20	NA	
Fluoride	4000	130 - 480	9 (20)	20	0	
Chloride	NA	9900 - 47000	9 (20)	20	NA	
Nitrate + Nitrite	NA	<20 - 4000	9 (13)	11	NA	
Orthophosphate	NA	<20 - 330	9 (20)	10	NA	
Sulfate	NA	43000 - 110000	9 (20)	20	NA	
Organics (μg/L)						
1,1,1-Trichloroethane	200	<0.09 - 0.9	9 (20)	1	0	
1,1-Dichloroethane	3650	<0.9 - 1.5	9 (20)	2	0	
1,1-Dichloroethene	7	<0.10 - 0.4	9 (20)	1	0	
Chloroform	100	<0.05 - 8.0	9 (20)	2	0	
Trichloroethene	5	<0.20 - 4200	9 (20)	16	14	LF04-4C, 4D, 4E, 4F, 4G, 4H
Toluene	1000	1.9 - 27	9 (20)	9	0	
Bis-(2-ethylhexyl)phthalate	6.08	4.2 - 6.0	2 (2)	2	0	

Table 5.3a (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Landfill 4

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
di-n-butylphthalate	3650	4.6 - 7.6	2 (2)	2	0	
1,4-Dichlorobenzene	75	<0.30 - 6.3	9 (42)	4	0	
Chlorobenzene	100	<0.30 - 2.8	9 (40)	4	0	
Tetrachloroethene	5	<0.30 - 4.6	9 (20)	2	0	
Vinyl Chloride	2	<0.20 - 3.8	9 (20)	2	1	LF04-4C
Benzene	5	<0.20 - 280	9 (20)	2	2	LF04-4C, 4G
1,2-Dichlorobenzene	600	<0.40 - 0.7	9(42)	1	0	

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Source: RI/FS Stage 2 Final Report (Radian, 1989)

Table 5.3b
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Landfill 5

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (μg/L)						
Silver	183	<9.0 - 20	9 (20)	3	0	
Aluminum	NA	<200 - 96000	9 (20)	18	NA	
Boron	NA	<600 - 1100	9 (20)	5	NA	
Barium	2000	29 - 1000	9 (20)	20	0	
Beryllium	4	<1.0 - 7.0	9 (20)	16	5	LF05-5A,5D,5E,5G,5H
Calcium	NA	12000 - 2100000	9 (20)	20	NA	
Cadmium	5	<3.0 - 7.0	9 (20)	3	3	LF05-5F,P1
Cobalt	NA	<10 - 80	9 (20)	15	NA	
Chromium	100	<9.0 - 230	9 (20)	18	7	LF05-5A,5D,5E,5F,5G,5H
Copper	NA	<10 - 120	9 (20)	18	NA	
Iron	NA	110 - 190000	9 (20)	20	NA	
Potassium	NA	2300 - 16000	9 (20)	20	NA	
Magnesium	NA	4800 - 28000	9 (20)	20	NA	
Manganese	NA	7.0 - 5700	9 (20)	20	NA	

320124

Table 5.3b (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Landfill 5

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Molybdenum	NA	<50	9 (20)	0	NA	
Sodium	NA	10000 - 110000	9 (20)	20	NA	
Nickel	100	<20 - 190	9 (20)	16	3	LF05-5F,5G
Lead	15	<50 - 180	9 (20)	8	8	LF05-5A,5C,5F,5G,5H,P1
Antimony	6	<60 - 350	9 (20)	10	10	LF05-5A,5B,5D,5E,5F,5G,5H
Selenium	50	<300 - 400	9 (20)	2	2	LF05-5D,5F
Silicon	NA	5200 - 120000	9 (20)	20	NA	
Thallium	NA	<90 - 220	9 (20)	5	NA	
Vanadium	NA	<20 - 410	9 (20)	19	NA	
Zinc	NA	<6.0 - 320	9 (20)	19	NA	
Arsenic, AA	50	<2.0 - 68	9 (20)	17	5	LF05-5D,5E,5F,5G
Mercury	2	<0.12 - 0.2	9 (20)	1	0	
Lead, AA	15	22 - 82	8 (8)	7	7	LF05-5A,5B,5C,5D,5E,5G,5H
Non-Metals (µg/L)						
Total Dissolved Solids	NA	370000 - 7200000	9 (20)	20	NA	

320125

Table 5.3b (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Landfill 5

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Fluoride	4000	170 - 610	9 (20)	20	0	
Chloride	NA	2300 - 28000	9 (20)	20	NA	
Nitrate + Nitrite	NA	<20 - 4900	8 (16)	15	NA	
Orthophosphate	NA	<20 - 520	9 (20)	12	NA	
Sulfate	NA	18000 - 110000	9 (20)	20	NA	
Organics (µg/L)						
1,1,1-Trichloroethane	200	<0.09 - 67.0	9 (20)	1	0	
Trichloroethene	5	<0.20 - 3800	9 (20)	16	16	LF05-5A,5C,5D,5E,5F,5G,5H
Toluene	1000	0.6 - 5.7	9 (20)	2	0	
Bis-(2-ethylhexyl)phthalate	6.08	3.0 - 5.2	2 (2)	2	0	
di-n-butylphthalate	3650	<2.5 - 9.4	2 (2)	1	0	
1,4-Dichlorobenzene	75	<0.40	9 (20)	0	0	
Chlorobenzene	100	<0.30	9 (20)	0	0	
Tetrachloroethene	5	<0.03	9 (20)	0	0	
Vinyl Chloride	2	<0.02 - 110	9 (20)	1	1	LF05-5B

Table 5.3b (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Landfill 5

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Benzene	5	<0.20 - 220	9 (20)	1	1	LF05-5G
trans-1,2-Dichloroethene	100	< 5.0 - 910	9 (20)	2	2	LF05-5F

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Source: RI/FS Stage 2 Final Report (Radian, 1989)

Table 5.3c
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Waste Burial Area No. 7

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples Exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (µg/L)						
Silver	183	<9.0 - 27.0	3 (7)	1	0	
Aluminum	NA	8200 - 43000	3 (7)	7	NA	
Barium	2000	140 - 1100	3 (7)	7	0	
Beryllium	4	<1.0 - 4.0	3 (7)	3	1	WP07-10A
Calcium	NA	180000 - 530000	3 (7)	7	NA	
Cadmium	5	<3.0 - 6.0	3 (7)	1	1	WP07-10C
Cobalt	NA	<10 - 30	3 (7)	5	NA	
Chromium	100	11.0 - 98.0	3 (7)	7	0	
Copper	NA	<10 - 60	3 (7)	6	NA	
Iron	NA	9900 - 83000	3 (7)	7	NA	
Potassium	NA	2100 - 8600	3 (7)	7	NA	
Magnesium	NA	7300 - 16000	3 (7)	7	NA	
Manganese	NA	210-7300	3 (7)	7	NA	
Sodium	NA	19000 - 27000	3 (7)	7	NA	

Table 5.3c (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Waste Burial Area No. 7

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples Exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Nickel	100	<20 - 110	3 (7)	6	1	WP07-10A
Lead	15	<50 - 100	3 (7)	1	1	WP07-10A
Antimony	6	<60 - 150	3 (7)	2	2	WP07-10B, 10C
Selenium	50	<300 - 400	3 (7)	2	2	WP07-10A, 10C
Silicon	NA	24000 - 81000	3 (7)	7	NA	
Thallium	NA	<90 - 110	3 (7)	2	NA	
Vanadium	NA	<20 - 200	3 (7)	6	NA	
Zinc	NA	16 - 140	3 (7)	7	NA	
Arsenic, AA	50	7.0 - 40	3 (7)	7	0	
Mercury	2	<0.12 - 0.3	3 (7)	1	0	
Lead, AA	15	7.0 - 37.0	3 (7)	7	6	WP07-10A, 10B, 10C
Non-Metals (µg/L)						
Total Dissolved Solids	NA	510000 - 670000	3 (7)	7	NA	
Fluoride	4000	240 - 300	3 (7)	7	0	
Chloride	NA	15000 - 32000	3 (7)	7	NA	

Table 5.3c (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Waste Burial Area No. 7

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples Exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Nitrate + Nitrite	NA	150 - 3600	3 (7)	7	NA	
Orthophosphate	NA	30 - 370	3 (7)	7	NA	
Sulfate	NA	17000 - 72000	3 (7)	7	NA	
Organics (μg/L)						
Oil & Grease	NA	<200 - 1000	3 (7)	3	NA	
Petroleum Hydrocarbons	NA	<200 - 600	3 (6)	2	NA	
2,4-Dinitrophenol	73	<13.0 - 14.0	3 (7)	1	0	
2-Chlorophenol	183	<0.2 - 13.0	3 (7)	1	0	
2-methyl-4,6-dinitrophenol	NA	<16.0 - 19.0	3 (7)	1	NA	
2,4-Dichlorophenol	110	<0.5 - 1.4	3 (7)	1	0	
Chloroethane	730	<500 - 850	3 (7)	1	1	WP07-10C
Trichloroethene	5	1900 - 11000	3 (7)	7	7	WP07-10A,10B,10C

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Source: RI/FS Stage 2 Final Report (Radian, 1989)

Table 5.3d
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Fire Training Area 1

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (µg/L)						
Silver	183	<9.0 - 9.0	2 (4)	1	0	
Aluminum	NA	4700 - 32000	2 (4)	4	NA	
Barium	2000	180 - 250	2 (4)	4	0	
Beryllium	4	1.0 - 6.0	2 (4)	4	1	FT08-11B
Calcium	NA	170000 - 350000	2 (4)	4	NA	
Chromium	100	12.0 - 53.0	2 (4)	4	0	
Copper	NA	<1.0 - 40	2 (4)	2	NA	
Iron	NA	5400 - 68000	2 (4)	4	NA	
Potassium	NA	3800 - 7400	2 (4)	4	NA	
Magnesium	NA	10000 - 13000	2 (4)	4	NA	
Manganese	NA	220 - 1500	2 (4)	4	NA	
Sodium	NA	14000 - 36000	2 (4)	4	NA	
Nickel	100	<20.0 - 50.0	2 (4)	2	0	
Lead	15	<50 - 100	2 (4)	2	2	FT08-11B
Antimony	6	<60 - 70	2 (4)	1	1	FT08-11B

320131

Table 5.3d (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Fire Training Area 1

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Silicon	NA	19000 - 80000	2 (4)	4	NA	
Vanadium	NA	<20 - 110	2 (4)	3	NA	
Zinc	NA	23.0 - 98.0	2 (4)	4	NA	
Arsenic, AA	50	2.0 - 96	2 (4)	4	2	FT08-11B
Lead, AA	15	5.0 - 36.0	2 (2)	2	1	FT08-11B
Non-Metals (µg/L)						
Total Dissolved Solids	NA	570000 - 820000	2 (4)	4	NA	
Fluoride	4000	200 - 250	2 (4)	4	0	
Chloride	NA	8900 - 68000	2 (4)	4	NA	
Nitrate	10000	<20 - 640	2 (4)	2	0	
Orthophosphate	NA	<20 - 40	2 (4)	1	NA	
Sulfate	NA	46000 - 120000	2 (4)	4	NA	
Organics (µg/L)						
Toluene	1000	0.60 - 19.0	2 (4)	4	0	
Bis(2-ethylhexyl)phthalate	6.08	<2.7 - 11.0B	2 (2)	1	1	FT08-11A
Butylbenzyl Phthalate	NA	<2.5 - 1.8J	2 (2)	1	0	

320132

Table 5.3d (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Fire Training Area 1

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
di-n-butyl phthalate	3650	<2.7 - 6.1B	2 (2)	1	0	
di-n-octyl phthalate	730	2.0J - 3.8B	2 (2)	2	0	

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected; J=Estimated Value (GC Test Codes); B=Detected in Reagent Blank, background subtraction not performed.

Source: RI/FS Stage 2 Final Report (Radian, 1989)

320133

Table 5.3e
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Fire Training Area 2

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (µg/L)						
Silver	183	<9.0 - 10.0	5 (11)	2	0	
Aluminum	NA	16000 - 190000	5 (11)	11	NA	
Arsenic	50	<300 - 1000	5 (11)	1	1	FT09-12A
Barium	2000	140 - 790	5 (11)	11	0	
Beryllium	4	<1.0 - 6.0	5 (11)	9	1	FT09-12D
Calcium	NA	220000 - 2900000	5 (11)	11	NA	
Cadmium	5	<3.0 - 15.0	5 (11)	9	5	FT09-12B, 12C, 12D, 12E
Cobalt	NA	<10 - 120	5 (11)	9	NA	
Chromium	100	33.0 - 350	5 (11)	11	8	FT09-12A, 12B, 12C, 12D, 12E
Copper	NA	<10 - 240	5 (11)	9	NA	
Iron	NA	15000 - 330000	5 (11)	11	NA	
Potassium	NA	2700 - 28000	5 (11)	11	NA	
Magnesium	NA	6400 - 45000	5 (11)	11	NA	
Manganese	NA	170 - 7900	5 (11)	11	NA	

320134

Table 5.3e (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Fire Training Area 2

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Sodium	NA	13000 - 34000	5 (11)	11	NA	
Nickel	100	<20 - 310	5 (11)	10	7	FT09-12B, 12C, 12D, 12E
Lead	15	<41 - 270	5 (11)	10	10	FT09-12A, 12B, 12C, 12D, 12E
Antimony	6	<60 - 590	5 (11)	8	8	FT09-12A, 12B, 12C, 12D, 12E
Selenium	50	<300 - 600	5 (11)	5	5	FT09-12B, 12C, 12D, 12E
Silicon	NA	42000 - 160000	5 (11)	11	NA	
Thallium	NA	77 - 130	5 (11)	5	NA	
Vanadium	NA	53 - 930	5 (11)	11	NA	
Zinc	NA	18 - 550	5 (11)	11	NA	
Arsenic, AA	50	10.0 - 82.0	5 (11)	11	5	FT09-12B, 12C, 12D
Mercury, AA	2	<0.10 - 0.3	5 (11)	5	0	
Lead, AA	15	6.0 - 130B	5 (6)	6	5	FT09-12B, 12C, 12D, 12E

Table 5.3e (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Fire Training Area 2

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Selenium, AA	50	<3.0 - 4.0	5 (11)	1	0	
Non-Metals (μg/L)						
Total Dissolved Solids	NA	380000 - 590000	5 (11)	11	NA	
Fluoride	4000	220 - 340	5 (11)	11	0	
Chloride	NA	4400 - 28000	5 (11)	11	NA	
Nitrate + Nitrite	NA	<100 - 1200	5 (11)	9	NA	
Orthophosphate	NA	<20 - 150	5 (11)	7	NA	
Sulfate	NA	15000 - 120000	5 (11)	11	NA	
Organics (μg/L)						
Petroleum Hydrocarbons	NA	<200 - 600	5 (11)	1	NA	
1,1,1-Trichloroethane	200	<0.09 - 0.4	5 (11)	2	0	
1,1-Dichloroethane	3650	<0.09 - 3.2	5 (11)	3	0	
Chloroform	100	<0.05 - 0.2	5 (11)	1	0	
Trichloroethene	5	<0.20 - 110	5 (11)	9	5	FT09-12B, 12D
Toluene	1000	<1.0 - 47	5 (11)	9	0	
Bis(2-ethylhexyl)phthalate	6.08	2.3J - 17.0	2 (2)	2	1	FT09-12A

Table 5.3e (continued)
Summary of Groundwater Analytical Results for February and April 1988
Carswell AFB - Fire Training Area 2

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
di-n-butylphthalate	3650	1.4J - 4.2B	2 (2)	2	0	
Butylbenzyl Phthalate	NA	<2.6 - 8.9	2 (2)	1	NA	
1,2-Dichlorobenzene	600	<0.40 - 2.3	5 (24)	2	0	
1,4-Dichlorobenzene	75	<0.30 - 5.2	5 (24)	5	0	
Chloroethane	730	<0.50 - 1.5	5 (11)	2	0	
Tetrachloroethene	5	<0.03 - 49	5 (11)	7	3	FT09-12B
Vinyl Chloride	2	<0.20 - 18	5 (11)	4	3	FT09-12C, 12E
Benzene	5	<0.20 - 0.3	5 (11)	1	0	

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Source: RI/FS Stage 2 Final Report (Radian, 1989)

Table 5.4
Summary of Groundwater Analytical Results for the Flightline Area
April - May 1990
Carswell AFB, Texas

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Constituents Detected exceeding Risk Reduction Standard #2
Metals (µg/L)					
Aluminum	NA	230 - 52000	35 (74)	39	
Arsenic	50	4.1 - 53	35 (148)	32	X
Barium	2000	70 - 470	35 (74)	74	
Beryllium	4	3.0 - 4.0	35 (74)	2	X
Boron	NA	61 - 920	35 (74)	4	
Calcium	NA	99000 - 740000	35 (74)	74	
Chromium	100	15 - 200	35 (74)	13	X
Cobalt	NA	12 - 39	35 (74)	12	
Copper	NA	24 - 47	35 (74)	9	
Iron	NA	41 - 61000	35 (74)	62	
Lead	15	3 - 90	35 (148)	55	X
Magnesium	NA	3400 - 20000	35 (74)	74	
Manganese	NA	12 - 5000	35 (74)	60	
Mercury	2	2.5 - 6.2	35 (74)	2	X
Nickel	100	22 - 120	35 (74)	12	X

Table 5.4 (continued)
Summary of Groundwater Analytical Results for the Flightline Area
April - May 1990
Carswell AFB, Texas

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Constituents Detected exceeding Risk Reduction Standard #2
Potassium	NA	31 - 10000	35 (74)	20	
Silicon	NA	4200-110000	35 (74)	74	
Silver	183	11 - 27	35 (74)	10	
Sodium	NA	10000 - 102000	35 (74)	74	
Strontium	NA	29 - 1100	35 (74)	74	
Non-Metals (µg/L)					
Chloride	NA	5100 - 71000	35 (74)	37	
Fluoride	4000	200 - 1000	35 (74)	37	
Nitrate as N	10000	24 - 6400	35 (74)	37	
Orthophosphate	NA	11 - 57	35 (74)	10	
Sulfate	NA	2200 - 140000	35 (74)	37	
Total Dissolved Solids	NA	9000 - 760000	35 (74)	37	
Purgeable Halocarbons (µg/L)					
1,1,1-Trichloroethane	200	0.37 - 0.70	35 (74)	3	
1,1-Dichloroethene	7	1.3 - 1.5	35 (74)	2	
1,1-Dichloroethane	3650	1.1	35 (74)	1	

Table 5.4 (continued)
Summary of Groundwater Analytical Results for the Flightline Area
April - May 1990
Carswell AFB, Texas

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Constituents Detected exceeding Risk Reduction Standard #2
1,4-Dichlorobenzene	75	9.6	35 (74)	1	
Chlorobenzene	100	2.3	35 (74)	1	
Chloroethane	730	1.8	35 (74)	1	
Methylene Chloride	5	64 - 90	35 (74)	2	X
Tetrachloroethene	5	0.55 - 30	35 (74)	6	X
Trichloroethene	5	0.56 - 4400	35 (74)	32	X
Vinyl Chloride	2	6.2 - 170	35 (74)	8	X
cis-1,2-Dichloroethene	70	0.37 - 730	35 (74)	32	X
trans-1,2-Dichloroethene	100	0.72 - 44	35 (74)	6	

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Source: Phase II, Stage 2 Final Report (Radian, 1991)

320140

Table 5.5
Summary of Groundwater Analytical Results for Flightline Area Recovery Wells
April 1993 and July 1994
Carswell AFB, Texas

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (µg/L)						
Barium	2000	ND - 142	7 (15)	10	0	
Calcium	NA	130000 - 170000	7 (8)	8	NA	
Iron	NA	250 - 580	7 (8)	7	NA	
Manganese	NA	16 - 140	7 (8)	6	NA	
Sodium	NA	20000 - 47000	7 (8)	8	NA	
Zinc	NA	20 - 57.6	7 (8)	6	NA	
Non-Metals (µg/L)						
Total Dissolved Solids	NA	49000 - 680000	7 (15)	15	NA	
Chemical Oxygen Demand	NA	ND - 180000	7 (14)	6	NA	
Total Organic Carbon	NA	ND - 1300	4 (4)	1	NA	
Total Suspended Solids	NA	ND - 31000	4 (5)	4	NA	
Chloride	NA	25000 - 50000	7 (15)	15	NA	
Nitrate as N	10000	980 - 1300	4 (4)	4	0	
Nitrite/Nitrate	NA	300 - 1900	3 (10)	10	NA	
Sulfate	NA	38000 - 120000	13 (22)	22	NA	

322141

Table 5.5 (continued)
Summary of Groundwater Analytical Results for Flightline Area Recovery Wells
April 1993 and July 1994
Carswell AFB, Texas

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Organic (µg/L)						
1,2-Dichloroethene	NA	5 - 600	4 (11)	11	NA	
trans-1,2-Dichloroethene	100	<5.0 - 32	4 (15)	5	0	
cis-1,2-Dichloroethene	70	<5.0 - 380	9 (10)	10	10	RW4,5,6,7,8,9,10,11,12
Trichloroethene	5	47 - 5000	9 (10)	11	11	RW1,2,3,4,5,6,7.8.9.10,11,12
Vinyl Chloride	2	10 - 19	5 (6)	3	3	
Methylene Chloride	5	10 - 17	5 (6)	5	5	
Bis(2-ethylhexyl)phthalate	6.08	<10 - 12B	7 (16)	2	2	

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Source: Phase I 1nd II Report (IT, 1993); Phase III Report (IT, 1994)

320142

Table 5.6a
Summary of Groundwater Analytical Results for 1995 Quarterly Sampling (4 Quarters)
Carswell AFB - Landfill 4

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (μg/L)						
Aluminum	NA	<500 - 24800	7 (22)	15	NA	
Barium	2000	74.0 - 290	7 (22)	22	0	
Calcium	NA	106000 - 323000	7 (22)	22	NA	
Iron	NA	65 - 27300	7 (22)	22	NA	
Magnesium	NA	<250 - 10100	7 (22)	20	NA	
Manganese	NA	70 - 9910	7 (22)	22	NA	
Molybdenum	NA	<50.0 - 1250	7 (22)	2	NA	
Nickel	100	<50 - 420	7 (22)	1	1	LF04-4A
Potassium	NA	802 - 5850	7 (22)	22	NA	
Sodium	NA	18000 - 39800	7 (22)	22	NA	
Vanadium	NA	<50 - 63	7 (22)	2	NA	
Zinc	NA	<10 - 275	7 (22)	12	NA	
Lead, AA	15	<5.0 - 12.0	7 (22)	6	0	
Mercury, AA	2	<0.5 - 1.6JL	7 (22)	1	0	

320143

Table 5.6a (continued)
Summary of Groundwater Analytical Results for 1995 Quarterly Sampling (4 Quarters)
Carswell AFB - Landfill 4

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Volatile Organics (µg/L)						
Trichloroethene	5	0.399 - 1950	13 (22)	13	12	LF04-4D, 4E, 4F
cis-1,2-Dichloroethene	70	32.6JQ - 390	13 (13)	13	12	LF04-4D, 4E, 4F
trans-1,2-Dichloroethene	100	1.96JQ - 32.5JQ	13 (13)	9	0	
Chloroform	100	<0.5 - 0.27JQ	9 (9)	1	0	
Methylene Chloride	5	<2.0 - 129	13 (22)	7	6	LF04-4D, 4E, 4F
Semi-Volatiles (µg/L)						
Butylbenzyl Phthalate	NA	2.63JQ - 43.2	5 (22)	12	NA	
Di-n-butylphthalate	3650	0.525JQ - <11.1	5 (22)	5	0	
Bis(2-ethylhexyl)phthalate	6.08	4.21JQ - <11.0	5 (22)	1	0	

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected; JQ=Estimated Quantitation, detected below the Practical Quantitation Limit; JR=Estimated Quantitation, possibly biased high or a false positive based upon blank data; JL=Estimated Quantitation, possibly biased low or false negative based upon QC data.

Sources: First and Second Semi-Annual Base-Wide Sampling Reports (LAW, 1996)

Table 5.6b
Summary of Groundwater Analytical Results for 1995 Quarterly Sampling (4 Quarters)
Carswell AFB - Landfill 5

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals, ICP/SW 6010 (µg/L)						
Aluminum	NA	<500 - 15000J	5 (15)	8	NA	
Barium	2000	150 - 392	5 (15)	15	0	
Calcium	NA	118000 - 350000J	5 (15)	15	NA	
Iron	NA	907 - 19000J	5 (15)	15	NA	
Magnesium	NA	6680 - 17000J	5 (15)	15	NA	
Manganese	NA	124 - 3260	5 (15)	3	NA	
Potassium	NA	1560 - 7700	5 (15)	15	NA	
Sodium	NA	15000 - 111000	5 (15)	15	NA	
Zinc	NA	<10 - 49J	5 (15)	5	NA	
Arsenic, AA	50	<5.0 - 34.6	5 (15)	7	0	
Lead, AA	15	<5.0 - 14.7	5 (15)	2	0	
Mercury, AA	2	<0.5 - 0.651	5 (15)	1	0	
Volatile Organics (µg/L)						
Carbon Disulfide	3650	5.1JQ - <50	5 (12)	1	0	
Methylene Chloride	5	1.6JB - 108	5 (15)	3	2	LF05-5C,5G

Table 5.6b (continued)
Summary of Groundwater Analytical Results for 1995 Quarterly Sampling (4 Quarters)
Carswell AFB - Landfill 5

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
cis-1,2-Dichloroethene	70	14.0 - 604	5 (15)	15	13	LF05-02,18,5C,5D,5E
trans-1,2-Dichloroethene	100	5.21 - 67.8	5 (15)	13	0	
Benzene	5	0.38JQ - <50	1 (3)	2	0	
Chlorobenzene	100	1.3 - 4.57	1 (3)	3	0	
Trichloroethene	5	8.4 - 1110	5 (15)	3	3	LF05-5D
Vinyl Chloride	2	2.65 - 6.77	1 (3)	3	3	LF05-5D
Semi-Volatile Organics (µg/L)						
1,4-Dichlorobenzene	75	2.15JQ - <12	5 (15)	2	0	
Acenaphthene	2190	1.63JQ - <12.0	5 (15)	3	0	
Butylbenzyl Phthalate	NA	2.86JQ - 44.9	5 (15)	11	NA	
Di-n-butylphthalate	3650	0.728JQ - <12.0	5 (15)	2	0	
Diethylphthalate	29200	1.44JQ - <12.0	5 (15)	2	0	
Naphthalene	1460	1.0JQ - <12.0	5 (15)	1	0	
Bis(2-ethylhexyl)phthalate	6.08	6.71 JQ - <12.0	5 (15)	1	1	LF05-5D

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected

Sources: First and Second Semi-Annual Base-Wide Sampling Reports (LAW, 1996)

Table 5.6c
Summary of Groundwater Analytical Results for 1995 Quarterly Sampling (4 Quarters)
Carswell AFB - Waste Burial Area No. 7

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (µg/L)						
Aluminum	NA	<500 - 15000	2 (8)	5	NA	
Barium	2000	94 - 180	2 (8)	8	0	
Calcium	NA	145000 - 270000	2 (8)	8	NA	
Iron	NA	723 - 23000	2 (8)	8	NA	
Magnesium	NA	5910 - 11600	2 (8)	8	NA	
Manganese	NA	63 - 711	2 (8)	8	NA	
Potassium	NA	1230 - 4400	2 (8)	8	NA	
Sodium	NA	16900 - 49300	2 (8)	8	NA	
Vanadium	NA	<50 - 55	2 (8)	1	NA	
Zinc	NA	<10.0 - 41	2 (8)	5	NA	
Arsenic, AA	50	<5.0 - 47.8	2 (8)	3	0	
Lead, AA	15	<5.0 - 14.0	2 (8)	1	0	
Volatile Organics (µg/L)						
Methylene Chloride	5	24JB - 150	2 (8)	3	3	WP07-10B, 10C
Tetrachloroethene	5	9.6JQ - <100	2 (8)	1	1	WP07-10B
Trichloroethene	5	554 - 2550	2 (8)	8	8	WP07-10B, 10C

320147

Table 5.6c (continued)
Summary of Groundwater Analytical Results for 1995 Quarterly Sampling (4 Quarters)
Carswell AFB - Waste Burial Area No. 7

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
cis-1,2-Dichloroethene	70	167 - 268	2 (7)	7	7	WP07-10B, 10C
trans-1,2-Dichloroethene	100	9.9JQ - 24JQ	2 (8)	5	0	
Semi-Volatile Organics (µg/L)						
1,4-Dichlorobenzene	75	1.93JQ - <14.0	2 (8)	2	0	
Butylbenzyl Phthalate	NA	6.62JQ - 41	2 (8)	5	NA	
Di-n-butylphthalate	3650	0.689JQ - <14.0	2 (8)	1	0	
Phenol	NA	2.64JQ - <14.0	2 (8)	1	NA	
Bis(2-ethylhexyl)phthalate	6.08	5.39JQ - 14.9	2 (8)	4	2	WP07-10C

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected; JQ=Estimated Quantitation, detected below the Practical Quantitation Limit.

Sources: First and Second Semi-Annual Base-Wide Sampling Reports (Law, 1996)

320148

Table 5.6d
Summary of Groundwater Analytical Results for 1995 Quarterly Sampling (4 Quarters)
Carswell AFB - Fire Training Area 1

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (μg/L)						
Aluminum	NA	<500 - 2760	2 (8)	5	NA	
Barium	2000	90 - 156	2 (8)	8	0	
Calcium	NA	120000 - 182000	2 (8)	8	NA	
Iron	NA	1800 - 22900	2 (8)	8	NA	
Magnesium	NA	6600 - 10800	2 (8)	8	NA	
Manganese	NA	79 - 1500J	2 (8)	8	NA	
Potassium	NA	642 - 3110	2 (8)	8	NA	
Sodium	NA	18400 - 116000	2 (8)	8	NA	
Arsenic, AA	50	<5.0 - 31.4	2 (8)	4	0	
Lead, AA	15	<5.0 - <25	2 (8)	0	0	
Volatile Organics (μg/L)						
Benzene	5	0.201JQ - <0.5	2 (7)	1	0	
Methylene Chloride	5	1.51JB - 9.4JB	2 (8)	4	1	FT08-11B
Trichloroethene	5	1.3 - 150	2 (8)	8	7	FT08-11A, 11B
cis-1,2-Dichloroethene	70	1.62 - 110	2 (8)	8	1	FT08-11B

320149

Table 5.6d (continued)
Summary of Groundwater Analytical Results for 1995 Quarterly Sampling (4 Quarters)
Carswell AFB - Fire Training Area 1

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
trans-1,2-Dichloroethene	100	<0.5 - 12	2 (8)	6	0	
Semi-Volatile Organics (μg/L)						
Butylbenzyl Phthalate	NA	2.81JQ - 45.6	2 (8)	5	NA	
Di-n-butylphthalate	3650	0.621JH - <12.0	2 (8)	2	0	
Diethylphthalate	29200	<12.0	2 (8)	1	0	
Bis(2-ethylhexyl)phthalate	6.08	<12.0	2 (8)	1	0	

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected
J = Estimated Quantitation based upon QC data
JB = Estimated Quantitation, possibly biased high or a false positive based upon blank data
JH = Estimated Quantitation, possible biased high based upon QC data
JQ = Estimated Quantitation, detected below the Practical Quantitation Limit.

Sources: First and Second Semi-Annual Base-Wide Sampling Reports (Law, 1996)

320150

Table 5.6e
Summary of Groundwater Analytical Results for 1995 Quarterly Sampling (4 Quarters)
Carswell AFB - Fire Training Area 2

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Metals (μg/L)						
Aluminum	NA	<500 - 34200	4 (18)	13	NA	
Barium	2000	110 - 249	4 (18)	18	0	
Beryllium	4	<3.0 - 10100	4 (18)	2	2	P6A
Cadmium	5	<10 - 10	4 (18)	1	1	P6A
Calcium	NA	131000 - 1170000	4 (18)	18	NA	
Iron	NA	1130 - 47400	4 (18)	18	NA	
Magnesium	NA	4400 - 17800	4 (18)	18	NA	
Manganese	NA	86 - 3150	4 (18)	18	NA	
Molybdenum	NA	<50 - 41,400	4 (18)	1	NA	
Nickel	100	<50 - 79	4 (18)	1	0	
Potassium	NA	<600 - 6450	4 (18)	14	NA	
Sodium	NA	<250 - 42800	4 (18)	17	NA	
Vanadium	NA	<50 - 172	4 (18)	3	NA	
Zinc	NA	<10 - 80	4 (18)	11	NA	
Arsenic, AA	50	<5.0 - 12.1	4 (18)	6	0	

320151

Table 5.6e (continued)
Summary of Groundwater Analytical Results for 1995 Quarterly Sampling (4 Quarters)
Carswell AFB - Fire Training Area 2

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Lead, AA	15	<5.0 - 27.8	4 (18)	4	1	P6A
Volatile Organics (µg/L)						
1,1-Dichloroethane	3650	0.254JQ - 0.84	4 (18)	7	0	
1,1-Dichloroethene	7	<0.5 - 0.95	4 (18)	3	0	
Benzene	5	<0.5 - 1.56	4 (18)	7	0	
Chloroform	100	0.369JQ - 0.51	4 (18)	4	0	
Methylene Chloride	5	1.7JB - 2.4JB	4 (18)	3	0	
Tetrachloroethene	5	0.28JQ - 13.7	4 (18)	12	4	FT09-12B
Trichloroethene	5	<0.5 - 37.2	4 (18)	12	4	FT09-12B
Vinyl Chloride	2	<2.0 - 6.08	4 (18)	4	4	FT09-12C
cis-1,2-Dichloroethene	70	0.41JQ - 38	4 (18)	12	0	
trans-1,2-Dichloroethene	100	0.198JQ - 6.07	4 (18)	7	0	

320152

Table 5.6e (continued)
Summary of Groundwater Analytical Results for 1995 Quarterly Sampling (4 Quarters)
Carswell AFB - Fire Training Area 2

Analytical Parameter	TNRCC Risk Reduction Standard #2[1]	Range of Concentrations[2]	Number of Wells Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Number of Samples exceeding Risk Reduction Standard #2	Location of Samples Exceeding RRS#2
Semi-Volatile Organics (μg/L)						
4-Methylphenol=cresol, p-	1830	7.74 - <12.0	4 (18)	1	NA	
Butylbenzyl Phthalate	NA	1.19JQ - 41.7	4 (18)	12	NA	
Di-n-butylphthalate	3650	0.955JQ - <12.0	4 (18)	1	0	
Bis(2-ethylhexyl)phthalate	6.08	5.94JQ - <12.0	4 (18)	2	1 (6.92JQ)	FT109-12A

Notes:

[1]Maximum Concentration in Groundwater for residential exposure conditions (NA = Not Available).
"Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)"
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

[2]ND = Not Detected, JB = Estimated Quantitation; possibly biased high or false positive based upon blank data, JQ = Estimated Quantitation; detected below the Practical Quantitation Limit.

Sources: First and Second Semi-Annual Base-Wide Sampling Reports (Law, 1996)

Table 5.7
Summary of Groundwater Analytical Results for October/November 1995
Carswell AFB - Flightline Area

Parameter	TNRCC Risk Reduction Standard 2[2]	Sampling Location[1]																	
		HM-122	HM-123	LF04-01	LF04-02	LF04-04	LF04-4C	LF04-4C Duplicate	LF04-4G	LF04-10	LF05-01	LF05-02	LF05-5A	LF05-5B	LF05-5E	LF05-14	LF05-18	LF05-19	LF05-19 Duplicate
VOCs, Method E524.2 (µg/L)																			
Trichloroethene	5	(260)	(1400)		(2400)	(1300)	(13.0)	(14)	(1400)			(160)	(200)		(200)	(800)	(1600)	(14.0)	(14.0)
cis-1,2-Dichloroethene	70	(710)	(370)		(220)	(410)	6.7	6.7	(170)		(230)	(350)	44	(640)	(110)	(220)	(450)	8	8.5
trans-1,2-Dichloroethene	100	(110)				(130)		1.4J	11.0J			32				13.0J	26.0J		
Acetone	3650				860										(56.0)	(310)			
Vinyl Chloride	2						(2.7J)	(3.3J)				(18.0J)		(81.0J)					
N-Nitrosodi-n-propylamine	0.0122			(12.0)			(10.0)						(12.0)						
Bis(2-Chloroisopropyl)ether	12.2			(18.0)															
Metals, SW6010 (µg/L)																			
Aluminum	NA	19000	1400	58000	8800	19000	16000	13000	35000	49000	70000	52000	8500	8000	17000	2500	1500	1800	1600
Barium	2000	670	100	510	140	160	780	810	280	420	1200	690	210	490	200	190	180	150	150
Cadmium	5									(10.0)	(7.0)	(8.0)							
Calcium	NA	300000	150000	960000	250000	660000	500000	530000	860000	810000	1200000	1000000	240000	180000	840000	210000	180000	200000	190000
Chromium	100			72					65	82	(130)	57							
Cobalt	NA			68															
Copper	NA			71						96	120	71							
Iron	NA	19000	3000	110000	14000	60000	28000	24000	64000	130000	120000	210000	16000	32000	41000	3700	1900	4600	4200
Lead	15										(310)								
Magnesium	NA	9700	5700	18000	8900	13000	14000	14000	20000	16000	27000	19000	8400	9600	12000	10000	8800	9600	9500
Manganese	NA	2000	76	4400	300	1000	8500	8600	1500	2300	1800	3100	1100	2300	1100	410	35	590	460
Nickel	100										100								
Potassium	NA			10000		5900			9200	9400	14000	8400							
Sodium	NA	18000	21000	20000	20000	26000	39000	40000	21000	22000	23000	19000	19000	25000	26000	40000	45000	38000	38000
Vanadium	NA		210	210		110			170	300	200	180							
Zinc	NA	110	28	200	82	79	56	33	96	350	260	130	48	38	90	24	21	30	43
Lead, Method SW7421 (µg/L)																			
Lead	15	(29.0)		(79.0)	6.9	(17.0)	9.9	(16.0)	(29.0)	61.0	(280)	(45.0)	(19.0)		(30.0)				
Chromium, Method SW6010 (µg/L)																			
Chromium	100	14	6	72	11.0J	38.0J	19.0J	21.0J	65	82	(130)	57	9.0J	13.0J	35.0J		10.0J	8.0J	6.0J

Notes:

[1]Parenthesis ( ) indicates concentration exceeds TNRCC Risk Reduction Standard #2; J = estimated value
[2]Maximum Concentration in Groundwater for residential exposure conditions.
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission

Source: IRP Comprehensive Sampling Letter Report (Jacobs, 1996)

320154

Table 5.8a
Surface Water Sampling Analyses
January and February 1985
Carswell AFB, Texas

Surface Water Sampling Location	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
SW85-LF4	X	X						X	X
SW85-LF5	X	X				X		X	X
SW85-FT2	X	X		X	X	X			

320155

Table 5.8b
Surface Water Sampling Analyses
Spring 1990
Carswell AFB, Texas

Surface Water Sampling Location	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
LF05-S1	X	X			X				
LF05-S2	X	X			X				
LF05-S3	X	X			X				
LF05-S4	X	X			X				
LF05-S5	X	X			X				
LF05-S6	X	X			X				
LF05-S7	X	X			X				

320156

Table 5.8c
Surface Water Sampling Analyses
October and November 1995
Carswell AFB, Texas

Surface Water Sampling Location	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Diesel-range Organics	Pesticides	Herbicides
LF05-S5		X	X		X		X		
LF05-S6		X	X		X		X		
LF05-S7		X	X		X		X		

Table 5.9a
Summary of Surface Water Analytical Results for January and February 1985
Carswell AFB - Flightline Area

Parameters[1]	TSWQS[2] (μg/L)	SW85-LF4		SW85-LF5		SW85-FT2	
		January 1985	February 1985	January 1985	February 1985	January 1985	February 1985
Metals (μg/L)							
Arsenic	50	NA	NA	NA	NA	(160)	<60
Barium	2000	NA	NA	NA	NA	290	150
Cadmium	5	NA	NA	NA	NA	(7.0)	<2.0
Chromium	100	NA	NA	NA	NA	17	<5.0
Lead	5	NA	NA	NA	NA	(81)	<80
Mercury	0.0122	NA	NA	NA	NA	(0.3)	(0.6)
Selenium	50	NA	NA	NA	NA	<80	<80
Silver	-	NA	NA	NA	NA	<2.0	<2.0
Organic Indicators (μg/L)							
Oil & Grease	-	NA	NA	350000	<1000	84000000	1000
Phenols	-	NA	NA	NA	NA	140	NA
COD	-	4000	<1000	8000	12000	NA	NA
TOC	-	2000	3000	5000	9000	50000000	86000
TOX	-	NA	NA	NA	NA	630	<10.0
Pesticides/Herbicides (μg/L)	-	ND	ND	NA	ND	NA	NA

320158

Table 5.9a (continued)
Summary of Surface Water Analytical Results for January and February 1985
Carswell AFB - Flightline Area

Parameters[1]	TSWQS[2] (µg/L)	SW85-LF4		SW85-LF5		SW85-FT2	
		January 1985	February 1985	January 1985	February 1985	January 1985	February 1985
Purgeable Halocarbons (µg/L)							
Vinyl Chloride	2	(2.3)	ND	ND	(38.7)	ND	ND
Methylene Chloride	-	2.7	ND	ND	ND	ND	ND
trans-1,2-Dichloroethene	-	ND	ND	ND	56.9	ND	ND
1,1,1-Trichloroethane	200	ND	5	ND	ND	ND	ND
Trichloroethene	5	1.4	4.3	ND	4.4	ND	ND
Trichlorofluoromethane	-	ND	ND	ND	ND	ND	3.5
Purgeable Aromatics (µg/L)	-	ND	ND	ND	ND	ND	ND

Note:

[1]Parameters shown were detected (ND = not detected, NA = not analyzed, parenthesis ( ) indicate concentration was above TSWQS).

[2]Texas Surface Water Quality Standards (TSWQS) taken from Chapter 307 - Table 3 of Texas Administrative Code - Title 30. Environmental Quality: "-" indicates no TSWQS was found in Table 3.

Source: IRP Phase II, Stage I (Radian, 1986)

320159

Table 5.9b
Summary of Surface Water Analytical Results for Spring 1990
Carswell AFB - Flightline Area[1]

Parameters[2]	TSWQS[3] (µg/L)	Range of Detected Concentrations	Number of Locations Sampled (Number of Samples Analyzed)	Number of Samples with Detectable Concentrations	Constituents Detected Exceeding (TSWQS)
Purgeable Halocarbons (µg/L)					
Trichloroethene	5	1.8 - 1400	7 (8)	8	5
Vinyl Chloride	2	0.56 - 3.7	7 (8)	2	1
cis-1,2-Dichloroethene	-	3.1 - 310	7 (8)	8	-
trans-1,2-Dichloroethene	-	0.46 - 0.66	7 (8)	2	-

Note:

[1]A list of analytical results at each surface water sampling location was not provided in the site characterization report.

[2]No heavy metals were detected in the surface water samples in excess of TSWQS (lab reports were not provided).

[3]Texas Surface Water Quality Standards (TSWQS) taken from Chapter 307 - Table 3 of Texas Administrative Code - Title 30. Environmental Quality: "-" indicates no TSWQS was found in Table 3.

Source: Site Characterization Report (Radian, 1990)

Table 5.9c
Summary of Surface Water Analytical Results for October and November 1995
Carswell AFB - Flightline Area

Parameter[1]	TSWQS[2] (µg/L)	Sampling Location			
		LF05-S5	LF05-S6	LF05-S7	LF05-S7 (Duplicate)
Volatile Organics (µg/L)					
Trichloroethene	5	(13.0)	(86.0)	(507)	(490)
cis-1,2-Dichloroethene	-	2.8 J	34	180	170
trans-1,2-Dichloroethene	-	ND	ND	6.2 J	6.8 J
Acetone	-	ND	ND	96	110
Metals (µg/L)					
Arsenic	50	32 J	(75 J)	45 J	(120 J)
Barium	2000	65 J	73 J	92 J	90 J
Beryllium	-	0.5 J	0.6 J	0.3 J	0.6 J
Calcium	-	67000	90000	150000	140000
Chromium	100	7.0 J	6.0 J	8.0 J	ND
Cobalt	-	7.0 J	ND	ND	ND
Copper	-	9.0 J	10 J	ND	10 J
Iron	-	94	70	14 J	20 J
Lead	5	ND	(32 J)	ND	(37 J)
Magnesium	-	5300	5900	7800	7500
Manganese	-	6.0 J	6.0 J	3.0 J	4.0 J
Molybdenum	-	4.0 J	4.0 J	ND	ND

Table 5.9c (continued)
Summary of Surface Water Analytical Results for October and November 1995
Carswell AFB - Flightline Area

Parameter[1]	TSWQS[2] (μg/L)	Sampling Location			
		LF05-S5	LF05-S6	LF05-S7	LF05-S7 (Duplicate)
Potassium	-	2000 J	1900 J	1900 J	1700 J
Selenium	50	ND	ND	ND	(70 J)
Sodium	-	32000	30000	29000	28000
Zinc	-	30	42	31	32

Note:

[1]Parameters shown were analyzed (ND = not detected, NA = not analyzed, J = denotes an estimated value, parenthesis ( ) indicate concentration was above TSWQS).

[2]Texas Surface Water Quality Standards (TSWQS) taken from Chapter 307 - Table 3 of Texas Administrative Code - Title 30. Environmental Quality: "-" indicates no TSWQS was found in Table 3.

Source: IRP Comprehensive Sampling Letter Report (Jacobs, 1996)

320162

Table 5.10a
Soil Sampling Analyses
January and February 1985
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
FT08-11A		X		X	X	X		X	X
FT08-11B		X		X	X	X		X	X
FT08-11C		X		X	X	X		X	X
HM122									
FT09-12A		X		X	X	X			
FT09-12B		X		X	X	X			
FT09-12C		X		X	X	X			
FT09-12D									
FT09-12E									
FT09-12F		X		X	X	X			
P6A									
LF04-01									
LF04-02									
LF04-03									
LF04-04									
LF04-10									
LF04-4A				X	X				

320163

Table 5.10a (continued)
Soil Sampling Analyses
January and February 1985
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
LF04-4B				X	X				
LF04-4C				X	X				
LF04-4D				X	X				
LF04-4E				X	X				
LF04-4F									
LF04-4G									
LF04-4H									
LF05-01									
LF05-02									
LF05-14									
LF05-18									
LF05-19									
LF05-5A		X		X	X	X			
LF05-5B		X		X	X	X			
LF05-5C		X		X	X	X			
LF05-5D									
LF05-5E									

Table 5.10a (continued)
Soil Sampling Analyses
January and February 1985
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
LF05-5F									
LF05-5G									
LF05-5H									
HM123									
WP07-10A		X				X			
WP07-10B		X				X			
WP07-10C		X				X			
CAR-RW1									
CAR-RW10									
CAR-RW11									
CAR-RW12									
CAR-RW2									
CAR-RW3									
CAR-RW4									
CAR-RW5									
CAR-RW6									
CAR-RW7									

Table 5.10a (continued)
Soil Sampling Analyses
January and February 1985
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
CAR-RW8									
CAR-RW9									
CAR-P1									
CAR-P2									

320166

Table 5.10b
Soil Sampling Analyses
February 1988
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
FT08-11A									
FT08-11B									
HM122									
FT09-12A									
FT09-12B									
FT09-12C									
FT09-12D		X	X		X		X		
FT09-12E		X	X		X		X		
FT09-12G		X	X		X		X		
FT09-12H		X	X		X		X		
FT09-12I		X	X		X		X		
FT09-12J		X	X		X		X		
FT09-12K		X	X		X		X		
P6A									
LF04-01									
LF04-02									

Table 5.10b (continued)
Soil Sampling Analyses
February 1988
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
LF04-04									
LF04-10									
LF04-4A									
LF04-4B									
LF04-4C									
LF04-4D									
LF04-4E									
LF04-4F		X	X		X	X			
LF04-4G		X	X		X	X			
LF04-4H		X	X		X	X			
LF05-01									
LF05-02									
LF05-14									
LF05-18									
LF05-19									
LF05-5A									
LF05-5B									

320168

Table 5.10b (continued)
Soil Sampling Analyses
February 1988
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
LF05-5C									
LF05-5D		X	X		X	X			
LF05-5E		X	X		X	X			
LF05-5F		X	X		X	X			
LF05-5G		X	X		X	X			
LF05-5H		X	X		X	X			
HM123									
WP07-10A									
WP07-10B									
WP07-10C									
WP07-10D		X	X		X	X	X	X	
WP07-10E		X	X		X	X	X	X	
WP07-10F		X	X		X	X	X	X	
CAR-RW1									
CAR-RW10									
CAR-RW11									
CAR-RW12									

Table 5.10b (continued)
Soil Sampling Analyses
February 1988
Carswell AFB, Texas

Well Name	Wet/General Chemistry	Volatile Organics	Semi-Volatile Organics	Total Phenols	Metals	Oil & Grease	Petroleum Hydrocarbons	Pesticides	Herbicides
CAR-RW2									
CAR-RW3									
CAR-RW4									
CAR-RW5									
CAR-RW6									
CAR-RW7									
CAR-RW8									
CAR-RW9									
CAR-P1									
CAR-P2									

320170

Table 5.11a
Summary of Soil Analytical Results - Landfill 4 Area
January 1985
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2[2]	Sample Location[1]									
		LF04-4A (14-15 ft)	LF04-4B (14-15 ft)	LF04-4B (19-20 ft)	LF04-4B Duplicate (19-20 ft)	LF04-4C (19-20 ft)	LF04-4C (29-30 ft)	LF04-4D (19-20 ft)	LF04-4D (29-30 ft)	LF04-4E (24-25 ft)	LF04-4E (28-30 ft) (34-35 ft)
Organic Compounds (mg/Kg)											
Phenols	NA	0.10 U	0.10 U	0.10 U	0.10 U	0.30	0.20	0.40	0.15 U	0.40	0.30
Metals (mg/Kg)											
Arsenic	5.00	(5.70)	(9.40)	5.10 U	5.30 U	(8.50)	(5.90)	5.20 U	5.70 U	5.20 U	5.40 U
Barium	200.00	16.00	50.00	34.00	39.00	18.00	5.50	8.60	6.20	2.60	10.00
Cadmium	0.50	0.32	(0.54)	0.17 U	0.17 U	(0.64)	0.42	0.17 U	0.19 U	0.17 U	0.38
Chromium	10.00	1.70	2.00	1.30	1.60	4.80	3.70	1.50	2.50	0.44	3.20
Mercury	0.20	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U
Lead	1.50	(7.80)	(7.50)	6.80 U	7.00 U	(8.30)	6.30 U	7.00 U	7.60 U	7.00 U	7.20 U
Selenium	5.00	6.10 U	6.60 U	6.80 U	7.00 U	6.00 U	6.30 U	7.00 U	7.60 U	7.00 U	7.20 U
Silver	51.10	2.00	1.40	0.58	0.88	1.90	1.50	0.83	0.19 U	0.21	0.69

Notes:

[1]Parenthesis ( ) indicates the concentration exceeds the TNRCC Risk Reduction Standard #2.
B = Detected in Reagent Blank; background subtraction not performed
BJ = Analyte detected in blank. Estimated value below detection limit
R = Indicates that the matrix spike recovery for this analysis was not within acceptable limits indicating an interferant present
@ = Indicates that the analytical spike recovery for this analysis was not within acceptable limits indicating an interferant present

J = Estimated value (GC test codes)
* = Indicates duplicate analysis is not within control limits
U = Indicated analyte was not detected above the specified limits

[2]Maximum Concentration of Groundwater Protection Standard for Industrial Use (NA=Not Available)
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission

Source: IRP Phase II, Stage I (Radian, 1986)

Table 5.11b
Summary of Soil Analytical Results - Landfill 4 Area
February 1988
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2[2]	Sample Location[1]			
		LF04-4F (20-25 ft)	LF04-4F (20-25 ft)	LF04-4G (14-19 ft)	LF04-4H (14-27 ft)
Metals (mg/Kg)					
Arsenic	5	0.9	0.9	0.7	0.8
Silver	51.1	1.8	1.4	0.83 U	1.9
Aluminum	NA	460	420	470.00 E	600
Barium	200	3.3	3.2	2.9	6.3
Beryllium	0.4	0.2	0.2	0.09 U	0.2
Calcium	NA	13000	13000	360.00 E	3600
Chromium	10	2.50 E	2.50 E	0.83 U	2.60 E
Copper	NA	1.6	1.6	0.92 U	0.99 U
Iron	NA	2700	2400	2300	2200
Potassium	NA	50	70	70	70
Magnesium	NA	130	120	87	100
Manganese	NA	32	29	22	42
Sodium	NA	36.00 E	51.00 E	40	35.00 E
Antimony	0.6	(7.0)	(6.0)	5.50 U	(9.0)
Silicon	NA	290	260	270	260
Vanadium	NA	9.00 E	6.00 E	1.80 U	6.00 E

Table 5.11b (continued)
Summary of Soil Analytical Results - Landfill 4 Area
February 1988
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2[2]	Sample Location[1]			
		LF04-4F (20-25 ft)	LF04-4F (20-25 ft)	LF04-4G (14-19 ft)	LF04-4H (14-27 ft)
Zinc	NA	3.4	3.2	2.6	2.7
VOCs (mg/Kg)					
2-Butanone	NA	0.026 U	0.026 U	0.018 J	0.026 U
Toluene	100.00	0.0041 J	0.0088	0.0062 U	0.001 J
Acetone	1020.00	0.0077 U	0.0077 U	0.023	0.0077 U
Methylene Chloride	0.5	0.012 B	0.0029 U	0.0028 BJ	0.087 B
SVOCs (mg/Kg)					
Bis(2-ethylhexyl)phthalate	2.04	0.44 B	0.25 B	0.16 BJ	0.32 B
di-n-butylphthalate	1020.00	0.21	0.096 J	0.34 B	0.15 J
di-n-octylphthalate	204.00	0.17 U	0.17 J	0.17 U	0.26

Notes:

[1]Parenthesis ( ) indicates the concentration exceeds the TNRCC Risk Reduction Standard #2.
B = Detected in Reagent Blank; background subtraction not performed value (GC test codes)
BJ = Analyte detected in blank. Estimated value below detection limit analysis is not within control limits
R = Indicates that the matrix spike recovery for this analysis was not within acceptable limits indicating an interferant present
@ = Indicates that the analytical spike recovery for this analysis was not within acceptable limits indicating an interferant present

J = Estimated value (GC test codes)
* = Indicates duplicate analysis is not within control limits
U = Indicated analyte was not detected above the specified limits
E = The reported value is estimated

[2]Maximum Concentration of Groundwater Protection Standard for Industrial Use (NA=Not Available)
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission

Source: RI/FS Stage 2 (Radian, 1989)

320173

Table 5.11c
Summary of Soil Analytical Results - Landfill 4 Area
January and February 1985 (Fire Training Area 2)
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2 [2]	Sample Location [1]												
		FT09-12A (19-20 ft)	FT09-12A Duplicate (19-20 ft)	FT09-12B (9-10 ft)	FT09-12B Duplicate (9-10 ft)	FT09-12B (14-15 ft)	FT09-12B (34-35 ft)	FT09-12C (24-25 ft)	FT09-12F (0 ft)	FT09-12F (2 ft)	FT09-12F Duplicate (2 ft)	FT09-12F (4 ft)	FT09-12F (6 ft)	FT09-12F (8 ft)
Metals (mg/kg)														
Arsenic	5.00	<5.9	<5.5	<5.5	<5.0	<5.5	<4.8	<5.2	<3.0	(19.0)	<3.0	<3.0	<3.0	<3.0
Barium	200.00	26.00	30.00	30.00	38.00	2.40	4.40	7.50	20.00	84.00	100.00	74.00	59.00	23.00
Cadmium	0.50	<0.19	0.37	0.37	(0.53)	<0.18	<0.16	<0.17	<0.20	(0.69)	<0.39	<0.39	<0.39	<0.39
Chromium	10.00	4.60	4.60	4.60	5.30	1.40	0.84	2.50	7.60	(15.0)	(11.0)	(14.0)	9.30	8.60
Lead	1.50	(9.60)	(8.20)	(8.20)	(13.0)	<7.3	<6.4	<7.0	(16.0)	(49.0)	(54.0)	(19.0)	(13.0)	<4.0
Mercury	0.20	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.12	<0.05	0.09	0.10	<0.05	(0.21)
Selenium	5.00	<7.8	(9.30)	(9.30)	(15.0)	<7.3	<6.4	<7.0	<4.0	(38.0)	(32.0)	(24.0)	(17.0)	<4.0
Silver	51.10	0.69	0.56	0.56	0.63	0.81	<0.16	<0.17	2.80	2.70	1.60	1.60	1.80	0.46
Organic Indicators (mg/Kg)														
Oil & Grease	NA	<10.0	<10.0	<10.0	<10.0	700.00	<10.0	<10.0	17000.00	13000.00	11000.00	9800.00	8200.00	11000.00
Phenols	NA	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.50	1.30	1.20	2.00	2.40
Purgeable Halocarbons (mg/Kg)														
1,2-Dichlorobenzene	60.00	ND	ND	ND	ND	ND	ND	ND	ND	0.689	0.679	1.659	1.17	0.721
1,3-Dichlorobenzene	60.00	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.464	0.364	0.273
1,1,2,2-Tetrachloroethane	1.43	ND	ND	ND	ND	ND	ND	ND	ND	0.271	0.274	0.327	0.384	1
Trichloroethene	0.50	ND	ND	ND	ND	ND	ND	ND	(256)	0.276	0.278	0.299	0.32	0.395
Trichlorofluoromethane	3070.00	ND	ND	ND	ND	ND	ND	ND	210.00	ND	ND	ND	ND	ND

320174

Table 5.11c (continued)
Summary of Soil Analytical Results - Landfill 4 Area
January and February 1985 (Fire Training Area 2)
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2 [2]	Sample Location [1]												
		FT09-12A (19-20 ft)	FT09-12A Duplicate (19-20 ft)	FT09-12B (9-10 ft)	FT09-12B Duplicate (9-10 ft)	FT09-12B (14-15 ft)	FT09-12B (34-35 ft)	FT09-12C (24-25 ft)	FT09-12F (0 ft)	FT09-12F (2 ft)	FT09-12F Duplicate (2 ft)	FT09-12F (4 ft)	FT09-12F (6 ft)	FT09-12F (8 ft)
Purgeable Aromatics (mg/Kg)														
Benzene	0.50	ND	ND	ND	ND	ND	ND	ND	(6.44)	ND	(752)	ND	ND	ND
Ethylbenzene	70.00	ND	ND	ND	ND	2.90	ND	ND	32.20	ND	23.7	28.4	63.6	(110)
Toluene	100.00	ND	ND	ND	ND	1.40	ND	ND	12.20	ND	27.4	36.1	64.3	(134)

Notes:

[1]B = Detected in Reagant Blank; background subtraction not performed.
BJ = Analyte detected in blank. Estimated value below detection limit.
R = Indicates that the matrix spike recovery for this analysis was not within acceptable limits indicating an interferent present.
@ = Indicates that the analytical spike recovery for this analysis was not within acceptable limits indicating an interferent present.
J = Estimated value (GC test codes).
* = Indicates duplicate analysis is not within control limits.
U = Indicated analyte was not detected above the specified limits.
ND = Not Detected

[2] Parenthesis ( ) indicates concentration exceeds TNRCC Risk Reduction Standard Number 2

[3] Maximum Concentration of Groundwater Protection Standard for Industrial Use (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

Source: IRP Phase II, Stage I (Radian 1986)

320175

Table 5.11d
Summary of Soil Analytical Results - Landfill 4 Area
February 1988 - Fire Training Area 2
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2 [3]	Sample Location [1,2]				
		FT09-12D (15-20 ft)	FT09-12D (25-30 ft)	FT09-12E (4-6 ft)	FT09-12E (14-19 ft)	FT09-12E (24-29 ft)
Metals (mg/Kg)						
Silver	51.1	1.1	ND	ND	1.5	1.4
Aluminum	NA	820 E	740 E	8600	510	2000
Barium	200.0	4.9 E	5.8 E	43.0	2.6	8.6
Beryllium	0.4	0.1	0.1	(0.5)	0.1	0.2
Cadmium	0.5	ND	0.3	ND	(0.5)	ND
Calcium	NA	650	44000	51000	340	5600
Cobalt	NA	ND	ND	3.8	1.9	2.3
Chromium	10.0	2.2	3.0	9.6	2.4	6.4
Copper	NA	1.9	1.3	3.0	ND	2.0
Iron	NA	2700	2600	8800	3200	7800
Potassium	NA	80	80	1200	45	270
Magnesium	NA	120 E	350 E	1700	74	420
Manganese	NA	21 E	41 E	76	21	60
Sodium	NA	70 E	140 E	40	39	43
Nickel	10.0	2.0	ND	9.0	4.0	6.0
Lead	1.5	ND	ND	(13.0)	(6.0)	(11.0)

320176

Table 5.11d (continued)
Summary of Soil Analytical Results - Landfill 4 Area
February 1988 - Fire Training Area 2
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2 [3]	Sample Location [1,2]				
		FT09-12D (15-20 ft)	FT09-12D (25-30 ft)	FT09-12E (4-6 ft)	FT09-12E (14-19 ft)	FT09-12E (24-29 ft)
Antimony	0.6	ND	ND	(7.0)	ND	ND
Selenium	5	ND	ND	ND	ND	ND
Silicon	NA	350 E	440	310	280	330
Thallium	NA	ND	ND	9.0	ND	ND
Vanadium	NA	4.0	7.0	22.0 E	6.0 E	15.0 E
Zinc	NA	3.3 E	3.2 E	17.0	3.7	9.8
Arsenic	5	ND	ND	ND	ND	ND
Petroleum Hydrocarbons (mg/Kg)	NA	ND	ND	ND	14	ND
VOCs (mg/Kg)						
1,1,2-2-Tetrachloroethane	1.43	ND	ND	ND	ND	ND
2-Butanone	NA	ND	ND	ND	ND	ND
4-methyl-2-pentanone	NA	ND	ND	ND	ND	ND
Benzene	0.5	ND	ND	ND	ND	ND
Ethylbenzene	70	ND	ND	ND	ND	ND
Toluene	100	ND	0.029	0.018	0.0019 J	0.0042 J
Acetone	1020	0.011 B	0.014 B	0.012 B	0.015 B	0.029 B

320177

Table 5.11d (continued)
Summary of Soil Analytical Results - Landfill 4 Area
February 1988 - Fire Training Area 2
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2 [3]	Sample Location [1,2]				
		FT09-12D (15-20 ft)	FT09-12D (25-30 ft)	FT09-12E (4-6 ft)	FT09-12E (14-19 ft)	FT09-12E (24-29 ft)
Methylene Chloride	0.5	ND	ND	ND	ND	ND
Total Xylenes	NA	ND	ND	ND	ND	ND
SVOCs (mg/Kg)						
2-Methylnaphthalene	NA	ND	ND	ND	ND	ND
4-Methylphenol	NA	ND	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	2.04	ND	0.150 BJ	0.110 J	0.160 J	0.094 J
di-n-Butylphthalate	1020	0.210	0.096 J	0.150 BJ	0.250 B	0.240 B
di-n-octyl phthalate	204	ND	ND	0.100 J	ND	0.092 J
dibenzofuran	NA	ND	ND	ND	ND	ND
Naphthalene	409	ND	ND	ND	ND	ND
Phenol	6130	ND	ND	ND	ND	ND

Notes:

[1] -B = Detected in Reagant Blank; background subtraction not performed.
BJ = Analyte detected in blank. Estimated value below detection limit.
R = Indicates that the matrix spike recovery for this analysis was not within acceptable limits indicating an interferent present.
@ = Indicates that the analytical spike recovery for this analysis was not within acceptable limits indicating an interferent present.
J = Estimated value (GC test codes).
* = Indicates duplicate analysis is not within control limits.
U = Indicated analyte was not detected above the specified limits.
ND = Not Detected

[2] Parenthesis ( ) indicates concentration exceeds TNRCC Risk Reduction Standard Number 2
[3] Maximum Concentration of Groundwater Protection Standard for Industrial Use (NA = Not Available).

Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

Source: RI/FS Stage 2 (Radian, 1989)

320178

Table 5.12a
Summary of Soil Analytical Results - Landfill 5 Area
January 1985
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2[2]	Sample Location[1]				
		LF05-5A (24-25 ft)	LF05-5A (29-30 ft)	LF05-5B (4-5 ft)	LF05-5C (14-15 ft)	LF05-5C (19-20 ft)
Organic Compounds (mg/Kg)						
Phenols	NA	0.30	0.10 U	0.10 U	0.10 U	0.10 U
Oil & Grease	NA	10.00 U	10.00	10.00 U	10.00 U	10.00 U
Purgeable Halocarbons (mg/Kg)						
trans-1,2-Dichloroethene	10.00	0.024	ND	ND	0.033	0.015
Trichloroethene	0.50	0.287	0.257	ND	0.338	0.277
Purgeable Aromatics (mg/Kg)						
Ethylbenzene	70.00	ND	ND	ND	ND	1.07
Toluene	100.00	ND	ND	ND	0.46	ND
Metals (mg/Kg)						
Arsenic	5.00	(7.10)	5.80 U	5.90 U	(9.40)	5.90 U
Barium	200.00	2.80	19.00	70.00	13.00	4.40
Cadmium	0.50	0.47	0.19 U	0.39	(0.62)	0.20 U
Chromium	10.00	2.00	4.10	(47.00)	3.70	0.74
Lead	1.50	7.80 U	7.80 U	7.90 U	(8.40)	7.90 U
Mercury	0.20	0.09	0.09	(0.21)	0.08	0.05 U

Table 5.12a (continued)
Summary of Soil Analytical Results - Landfill 5 Area
January 1985
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2[2]	Sample Location[1]				
		LF05-5A (24-25 ft)	LF05-5A (29-30 ft)	LF05-5B (4-5 ft)	LF05-5C (14-15 ft)	LF05-5C (19-20 ft)
Selenium	5.00	90 U	7.80 U	7.90 U	7.70 U	7.90 U
Silver	51.10	0.20 U	1.00	0.45	0.54	0.20 U

Notes:

[1]Parenthesis ( ) indicates the concentration exceeds the TNRCC Risk Reduction Standard #2.
B = Detected in Reagent Blank; background subtraction not performed
BJ = Analyte detected in blank. Estimated value below detection limit
R = Indicates that the matrix spike recovery for this analysis was not within acceptable limits indicating an interferant present
@ = Indicates that the analytical spike recovery for this analysis was not within acceptable limits indicating an interferant present
J = Estimated value (GC test codes)
* = Indicates duplicate analysis is not within control limits
U = Indicated analyte was not detected above the specified limits
ND = Not Detected, no detection limit specified

[2]Maximum Concentration of Groundwater Protection Standard for Industrial Use (NA=Not Available)
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission

Source: IRP Phase II, Stage I (Radian, 1986)

320180

Table 5.12b
Summary of Soil Analytical Results - Landfill 5 Area
January - February 1988
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2[2]	Sample Location[1]						
		LF05-5D (14-19 ft)	LF05-5E (9-14 ft)	LF05-5E (29-33 ft)	LF05-5F (4-9 ft)	LF05-5F (19-24 ft)	LF05-5G (8-14 ft)	LF05-5H (9-14 ft)
Metals (mg/Kg)								
Arsenic	5.00	0.40 ^	4.30 R	0.60	(13.00)	0.8	4.3 R	(9.4)
Silver	51.10	0.88 U	0.85 U	0.83 U	1.80	1.3	0.87 U	0.88 U
Aluminum	NA	370.00	4400.00	420.00	10000.00	470	1900	8000
Barium	200.00	2.70	34.00	2.30	51.00	3.1	13	46
Beryllium	0.40	0.098 U	0.2	0.092 U	(0.5)	0.2	0.097 U	0.2
Calcium	NA	7500.00 B	73000.00	9200.00	90000.00	7700	60000	89000
Cobalt	NA	0.98 U	1.90	0.92 U	1.90	0.97 U	0.97 U	1.7
Chromium	10.00	2.10	7.20	1.10	(12.00 E)	2.5 E	5.2 E	(24 E)
Copper	NA	0.98 U	2.10	0.92 U	4.00	0.97 U	1.6	9.8
Iron	NA	2500.00 R	6900.00	2800.00	9200.00	2200	4600	11000
Potassium	NA	50.00	430.00	50.00	1300.00	50	200	950
Magnesium	NA	110.00	1200.00	120.00	2300.00	130	700	1700
Manganese	NA	27.00	140.00 ^	39.00	270.00	34	82	240
Sodium	NA	45.00	150.00 ^	52.00	120.00 E	56 E	70 E	290 E
Nickel	10.00	2.00 U	5.00	1.80 U	8.00	1.9 U	4	9
Lead	1.50	4.90 U	(7.00)	4.60 U	4.90 U	4.9 U	4.9 U	4.9 U
Antimony	0.60	5.90 U	(16.00)	5.50 U	(23.00)	5.8 U	(14)	(25)
Silicon	NA	340.00 B	570.00	420.00	300.00	150	260	240

320181

Table 5.12b (continued)
Summary of Soil Analytical Results - Landfill 5 Area
January - February 1988
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2[2]	Sample Location[1]						
		LF05-5D (14-19 ft)	LF05-5E (9-14 ft)	LF05-5E (29-33 ft)	LF05-5F (4-9 ft)	LF05-5F (19-24 ft)	LF05-5G (8-14 ft)	LF05-5H (9-14 ft)
Thallium	NA	8.80 U	8.50 U	8.30 U	12.00	10	11	12
Vanadium	NA	2.00 U	12.00	1.80 U	22.00 E	8 E	11 E	24 E
Zinc	NA	1.10	10.00	1.80	18.00	2.3	6	12
VOCs (mg/Kg)								
Toluene	100.00	0.031	0.0023 J	0.0071 U	0.01	0.031	0.0062 U	0.0064 J
Trichloroethene	0.5	0.0022 U	0.0022 U	0.022	0.0021 U	0.0022 U	0.002 U	0.0021 U
Acetone	1020.00	0.035	0.012	0.027	0.011	0.018	0.016	0.0094
Methylene Chloride	0.5	0.0081 B	0.0032 U	0.0041 B	0.0071 B	0.017 B	0.0029 U	0.0051 B
trans-1,2-Dichloroethene	10.00	0.0019 U	0.0019 U	0.014	0.0017 U	0.0019 U	0.0016 U	0.0018 U
SVOCs (mg/Kg)								
Bis(2-ethylhexyl)phthalate	2.04	0.18 BJ	0.14 BJ	0.23 B	0.44 B	0.49 B	0.83 B	0.65 B
di-n-butylphthalate	1020.00	0.18 BJ	0.12 BJ	0.11 BJ	0.18 U	0.28	0.17 U	0.18 U
di-n-octylphthalate	204.00	0.084 J	0.35	0.11 J	0.18 J	0.26	0.34	0.18 U

Notes:

[1]Parenthesis ( ) indicates the concentration exceeds the TNRCC Risk Reduction Standard #2.

B = Detected in Reagent Blank; background subtraction not performed
BJ = Analyte detected in blank. Estimated value below detection limit
R = Indicates that the matrix spike recovery for this analysis was not within acceptable limits indicating an interferant present
@ = Indicates that the analytical spike recovery for this analysis was not within acceptable limits indicating an interferant present

J = Estimated value (GC test codes)
* = Indicates duplicate analysis is not within control limits
U = Indicated analyte was not detected above the specified limits

[2]Maximum Concentration of Groundwater Protection Standard for Industrial Use (NA=Not Available)
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission

Source: RI/FS Stage 2 (Radian, 1989)

Table 5.12c
Summary of Soil Analytical Results - Landfill 5 Area
January and February 1985 (Fire Training Area 1)
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2 [2]	Sample Location [1]						
		FT08-11A (9-10 ft)	FT08-11B (9-10 ft)	FT08-11C (0 ft)	FT08-11C (2 ft)	FT08-11C Duplicate (2 ft)	FT08-11C (4 ft)	FT08-11C (6 ft)
Metals (mg/Kg)								
Arsenic	5.00	(14.0)	<3.0	<3.0	<3.0	<3.0	<3.0	<3.00
Barium	200.00	<0.23	<0.23	42.00	47.00	32.00	32.00	20.00
Cadmium	0.50	<0.23	<0.20	<0.39	<0.39	<0.4	<0.4	<0.39
Chromium	10.00	3.00	2.00	6.40	7.90	7.30	6.50	7.10
Mercury	0.20	0.14	(0.21)	0.11	0.08	0.19	0.11	0.15
Lead	1.50	<4.0	<4.0	(8.0)	(13.0)	(12.0)	(13.0)	<4.0
Selenium	5.00	(9.0)	<4.0	(11.0)	(17.0)	(16.0)	(20.0)	(9.0)
Silver	51.10	3.10	<0.18	<0.2	0.20	0.72	1.60	0.74
Organic Indicators (mg/Kg)								
Oil & Grease	NA	<10	<10	100	2200.00	<10	<10	<10
Phenols	NA	<0.1	<0.1	<0.1	<0.1	10	<0.1	<0.1

320183

Table 5.12c (continued)
Summary of Soil Analytical Results - Landfill 5 Area
January and February 1985 (Fire Training Area 1)
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2 [2]	Sample Location [1]						
		FT08-11A (9-10 ft)	FT08-11B (9-10 ft)	FT08-11C (0 ft)	FT08-11C (2 ft)	FT08-11C Duplicate (2 ft)	FT08-11C (4 ft)	FT08-11C (6 ft)
Purgeable Halocarbons (mg/Kg)								
Trichloroethene	0.50	0.251	ND	0.249	ND	ND	ND	0.257

Notes:

[1] - B = Detected in Reagent Blank; background subtraction not performed.
BJ = Analyte detected in blank. Estimated value below detection limit.
R = Indicates that the matrix spike recovery for this analysis was not within acceptable limits indicating an interferent present.
@ = Indicates that the analytical spike recovery for this analysis was not within acceptable limits indicating an interferent present.
J = Estimated value (GC test codes).
^ = Indicates duplicate analysis is not within control limits.
U = Indicated analyte was not detected above the specified limits.
ND = Not Detected.
Parenthesis ( ) indicates concentration exceeds TNRCC Risk Reduction Standard Number 2

[2] Maximum Concentration of Groundwater Protection Standard for Industrial Use (NA = Not Available).
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II) Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission.

Source: IRP Phase II, Stage I (Radian 1986)

320184

Table 5.13a
Summary of Soil Analytical Results - Waste Burial No. 7 Area
January 1985
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2[2]	Sample Location[1]				
		WP07-10A (29-30 ft)	WP07-10B (14-15 ft)	WP07-10B (29-30 ft)	WP07-10C (24-25 ft)	WP07-10C (29-30 ft)
Oil & Grease (mg/Kg)	NA	10 U	10 U	10 U	10 U	10 U
1,1,1-Trichloroethane (mg/Kg)	20.00	ND	ND	0.044	ND	ND
Trichloroethene (mg/Kg)	0.50	0.014	ND	0.067	0.0151	0.021

Notes:

[1]Parenthesis ( ) indicates the concentration exceeds the TNRCC Risk Reduction Standard #2.

B = Detected in Reagent Blank; background subtraction not performed
BJ = Analyte detected in blank. Estimated value below detection limit
R = Indicates that the matrix spike recovery for this analysis was not within acceptable limits indicating an interferant present
@ = Indicates that the analytical spike recovery for this analysis was not within acceptable limits indicating an interferant present
J = Estimated value (GC test codes)
^ = Indicates duplicate analysis is not within control limits
U = Indicated analyte was not detected above the specified limits
ND = Analyte was not detected

[2]Maximum Concentration of Groundwater Protection Standard for Industrial Use (NA=Not Available)
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission

Source: IRP Phase II, Stage I (Radian, 1986)

320185

Table 5.13b
Summary of Soil Analytical Results - Waste Burial No. 7 Area
January 1988
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2[2]	Sample Location[1]				
		WP07-10D 28-Jan-88 (24-29 ft)	WP07-10E 29-Jan-88 (12-19 ft)	WP07-10E 29-Jan-88 (24-29 ft)	WP07-10F 29-Jan-88 (14-19 ft)	WP07-10F 29-Jan-88 (14-19 ft)
Metals (mg/Kg)						
Arsenic	5.00	0.50 ^	0.50 R	0.50	0.80	1.00
Lead	1.50	1.40 ^	(2.40)	1.30	1.60	(2.00 @)
Mercury	0.20	0.05 U	0.08	0.05 U	0.05 U	0.05 U
Aluminum	NA	430.00	400.00	670.00	670.00	640.00
Barium	200.00	2.30	2.90	4.10	4.00	3.50
Calcium	NA	13000.00 B	15000.00 ^	10000.00	8700.00	8200.00
Chromium	10.00	0.83 U	2.20	1.60	1.80	3.20
Iron	NA	1800.00	4900.00	2200.00	3900.00	4300.00
Potassium	NA	60.00	75.00	110.00	80.00	80.00
Magnesium	NA	130.00	170.00	160.00	170.00	150.00
Manganese	NA	22.00	64.00	37.00	51.00	49.00
Sodium	NA	70.00	46.00	56.00	29.00	29.00
Antimony	0.60	(8.00)	5.50 U	5.50 U	5.50 U	5.60 U
Silicon	NA	330.00 R	260.00	300.00	240.00	270.00
Thallium	NA	15.00	8.20 U	8.20 U	8.20 U	8.30 U

Table 5.13b (continued)
Summary of Soil Analytical Results - Waste Burial No. 7 Area
January 1988
Carswell AFB, Texas

Parameters	Risk Reduction Standard #2[2]	Sample Location[1]				
		WP07-10D 28-Jan-88 (24-29 ft)	WP07-10E 29-Jan-88 (12-19 ft)	WP07-10E 29-Jan-88 (24-29 ft)	WP07-10F 29-Jan-88 (14-19 ft)	WP07-10F 29-Jan-88 (14-19 ft)
Vanadium	NA	1.80 U	5.30	1.80 U	2.00	4.00
Zinc	NA	1.00	4.40 ^	2.00	3.00	3.80
VOC's (mg/Kg)						
Toluene	100.00	0.0067 U	0.0061 U	0.0053 J	0.002 J	0.0066 U
Trichloroethene	0.50	0.0021 U	0.0019 U	0.0022 U	0.0021 U	0.0032
Acetone	1020.00	0.013 B	0.0084 B	0.011 B	0.005 BJ	0.0037 BJ
Methylene Chloride	0.50	0.0018 J	0.0028 U	0.0033 U	0.0021 J	0.0022 J
SVOC's (mg/Kg)						
Bis(2-ethylhexyl)phthalate	2.04	0.36	0.27	0.39	0.20	0.23
di-n-butylphthalate	1020.00	0.1 BJ	0.091 BJ	0.19 BJ	0.27 B	0.75 B
di-n-octylphthalate	204.00	0.18 U	0.17 U	0.097 J	0.089 J	0.085 J

[1]Parenthesis ( ) indicates the concentration exceeds the TNRCC Risk Reduction Standard #2.
B = Detected in Reagent Blank; background subtraction not performed
BJ = Analyte detected in blank. Estimated value below detection limit
R = Indicates that the matrix spike recovery for this analysis was not within acceptable limits indicating an interferant present
@ = Indicates that the analytical spike recovery for this analysis was not within acceptable limits indicating an interferant present

J = Estimated value (GC test codes)
^ = Indicates duplicate analysis is not within control limits
U = Indicated analyte was not detected above the specified limits

[2]Maximum Concentration of Groundwater Protection Standard for Industrial Use (NA=Not Available)
Medium-Specific Concentrations, Standards and Criteria for Health-Based Closure/Remediation (Chapter 335.568 Appendix II)
Texas Administrative Code. Tile 30. Environmental Quality Part 1. Texas Natural Resource Conservation Commission

Source: IRP Phase II, Stage 2 (Radian, 1989)

Table 7.1
Technology Types and Process Options for Groundwater
Carswell AFB, Texas

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

Table 7.1 (continued)
Technology Types and Process Options for Groundwater
Carswell AFB, Texas

General Response Action	Technology Type	Process Options	Description	Preliminary Screening Comments
Collection/ Treatment/Disposal (cont)	Treatment technologies: Physical treatment	Air stripping	Remove dissolved volatile organics from groundwater with air	Potentially applicable to the Upper Zone
		Carbon adsorption	Adsorb dissolved organic compounds onto granulated carbon	Potentially applicable to the Upper Zone
		Oil/water separation	Separate emulsified, floating or sinking oils from water	Potentially applicable to the Upper Zone
	Chemical Treatment	UV/oxidation	Use ultraviolet light with ozone or hydrogen peroxide to destroy contaminants	Potentially applicable to the Upper Zone
		Fenton-like chemistry	Use Fenton-like chemistry to generate hydroxyl radicals to cleave organic bonds	New technology. Potentially applicable to Upper Zone
	Biological treatment	Ex-situ bioremediation	Use microorganisms to destroy or alter contaminants	Not reliable for chlorinated compounds, not considered
		In-situ bioremediation	Use microorganisms to destroy or alter contaminants	Not considered because still in the development stage for chlorinated hydrocarbons
		In-situ phytoremediation	Use plants to destroy or alter contaminants	Potentially applicable for Alluvial Terrace Groundwater
	In-situ treatment	Air sparging	Pump air into aquifer, volatilize dissolved organics	Difficult to control in heterogeneous media, could spread contamination, not considered
	Discharge technologies: On-site Discharge	Discharge to surface water	Discharge treated water to local surface water	Potentially applicable for the Upper Zone
	Off-site Discharge	POTW	Send water to an off-site treatment facility	Potentially acceptable

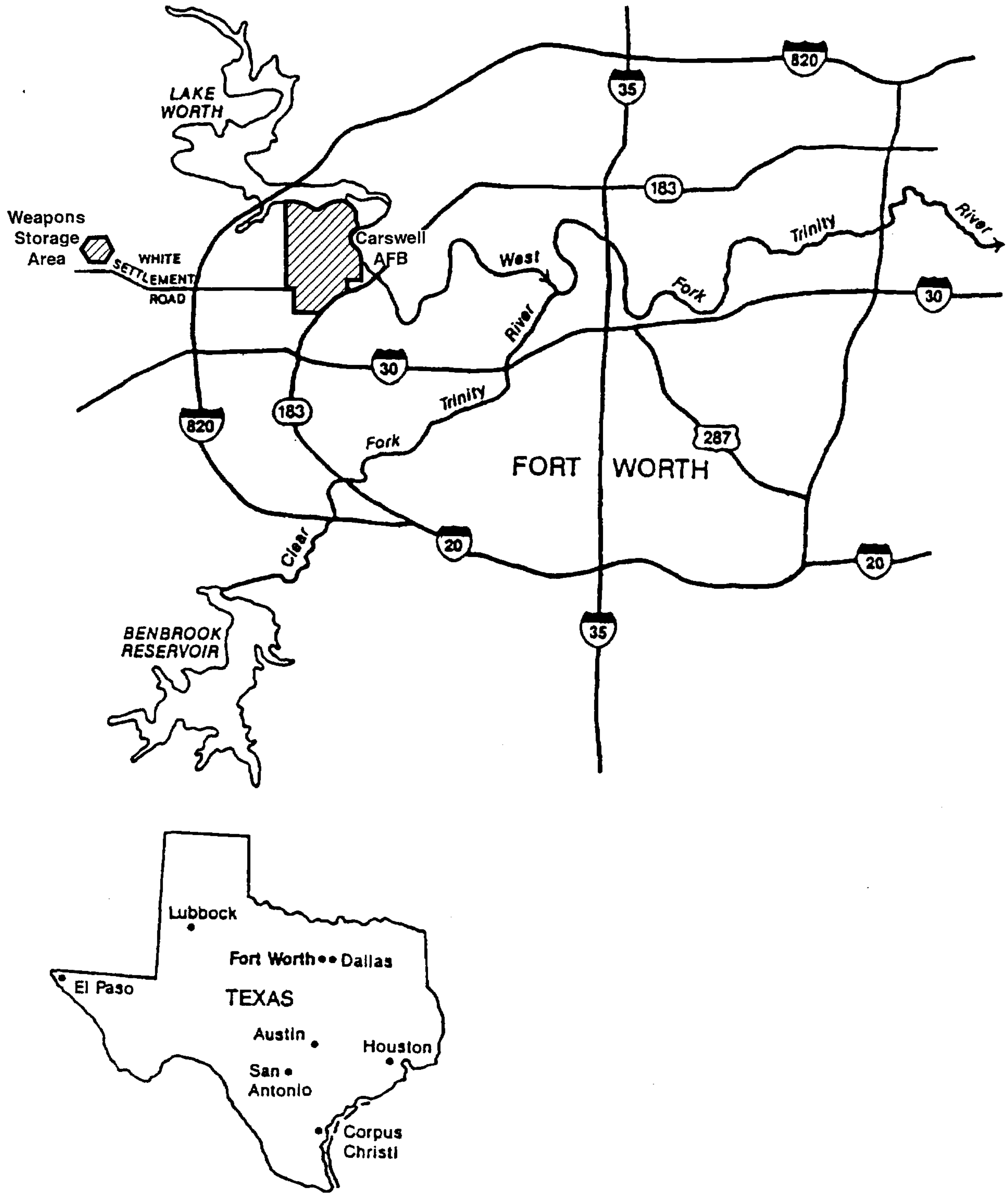
Table 7.2
Technology Types and Process Options for Soil/Sediment
Carswell AFB, Texas

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

Table 7.2 (continued)
Technology Types and Process Options for Soil/Sediment
Carswell AFB, Texas

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

320191



HYDRO GeoLogic INC.

Legend

Site

0 2 4
MILES

N

Figure 1.1
Site Location Map
Carswell Air Force Base
[From Radian, 1989]

320192

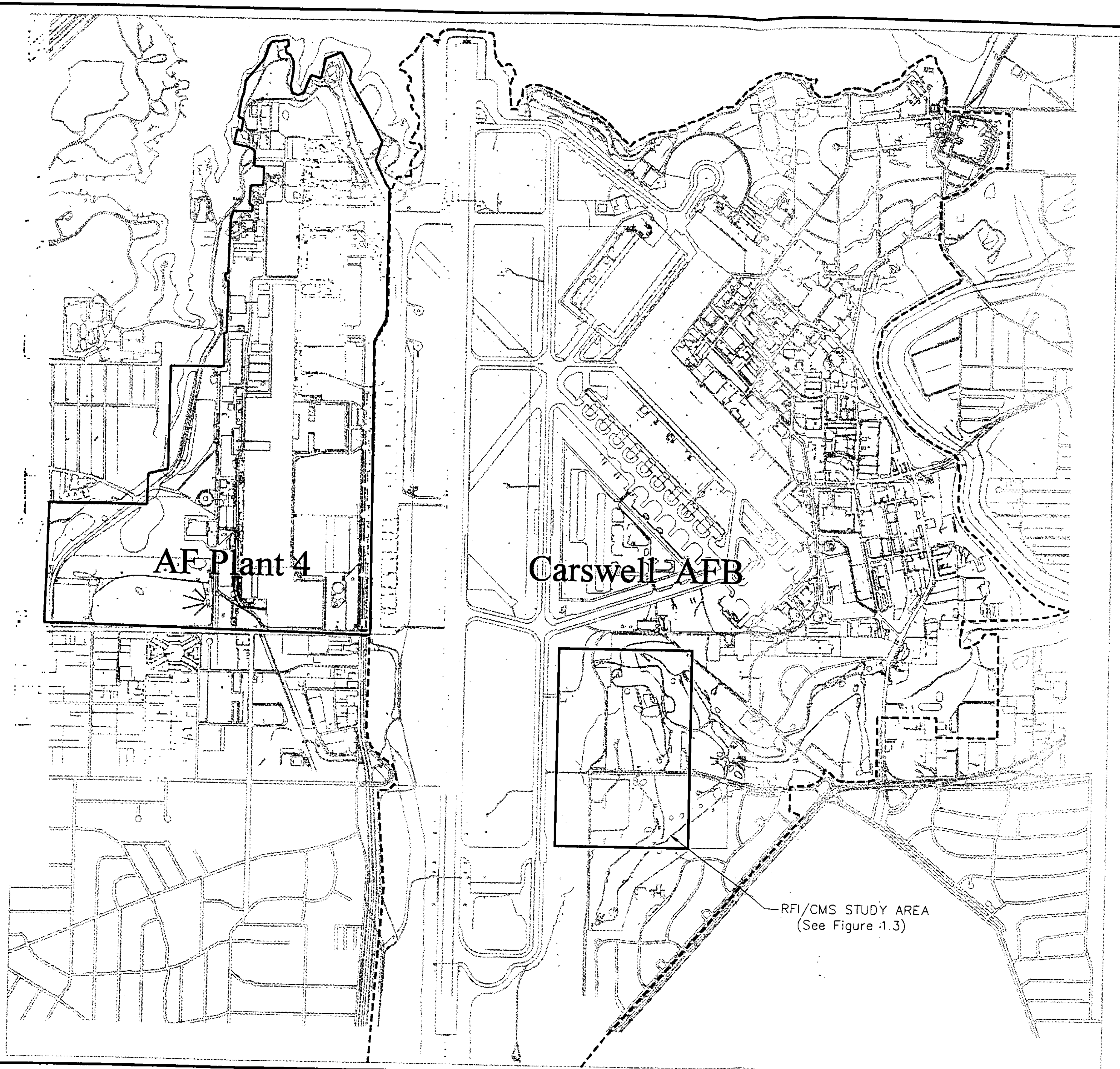


Figure 1.2

CAFB/AFP-4
Base Boundaries

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- - - - - - Former Property Boundary of Carswell AFB

——— Property Boundary of AF Plant 4

HYDRO GeoLogic INC.

Map Source:
JACOBS, 1996

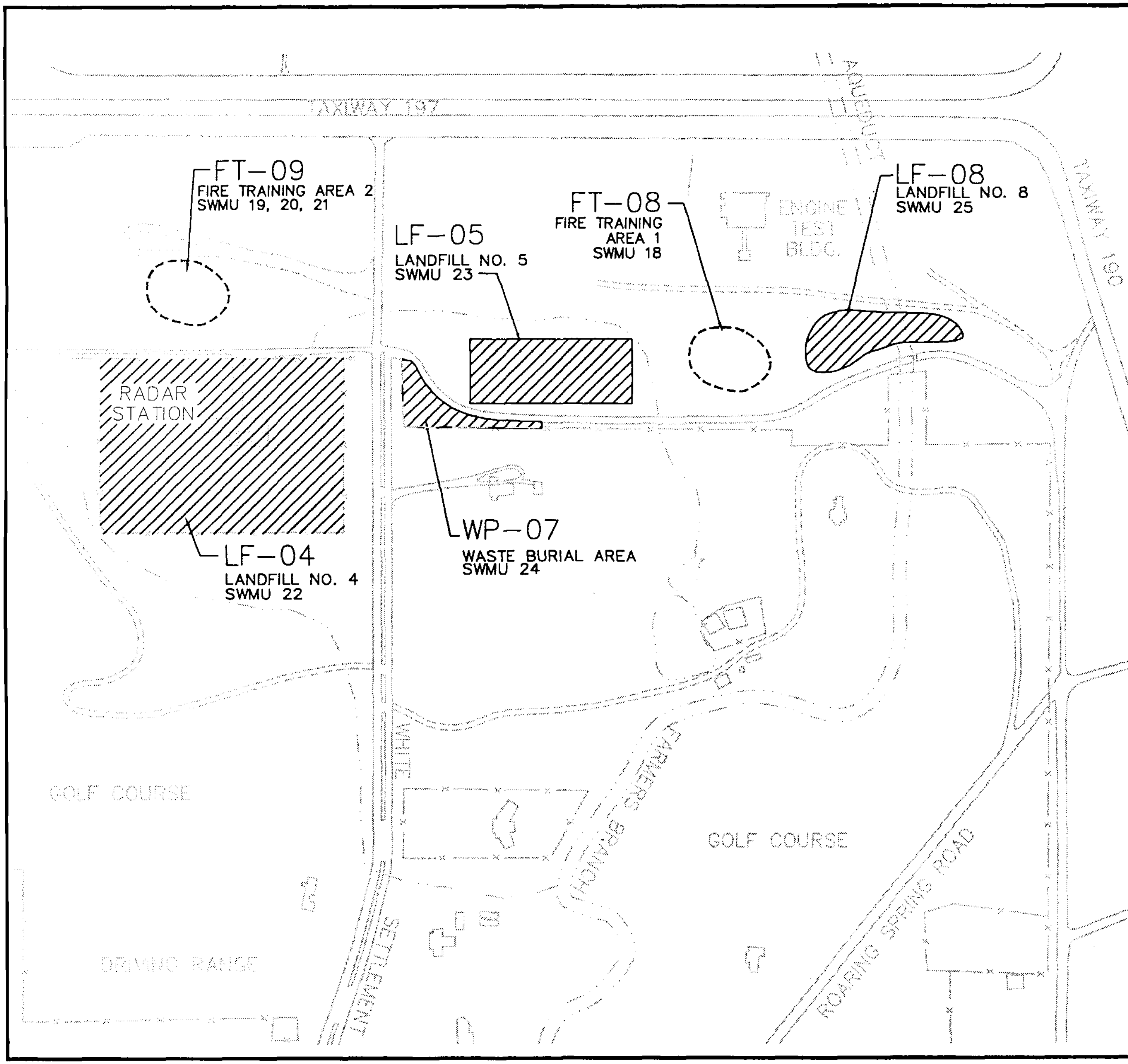


Figure 1.3

Location of SWMU In Flightline Area

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

ROAD
STREAM
FENCE
SWMU TO BE INVESTIGATED
SWMU NOT IN CURRENT RFI/CMS

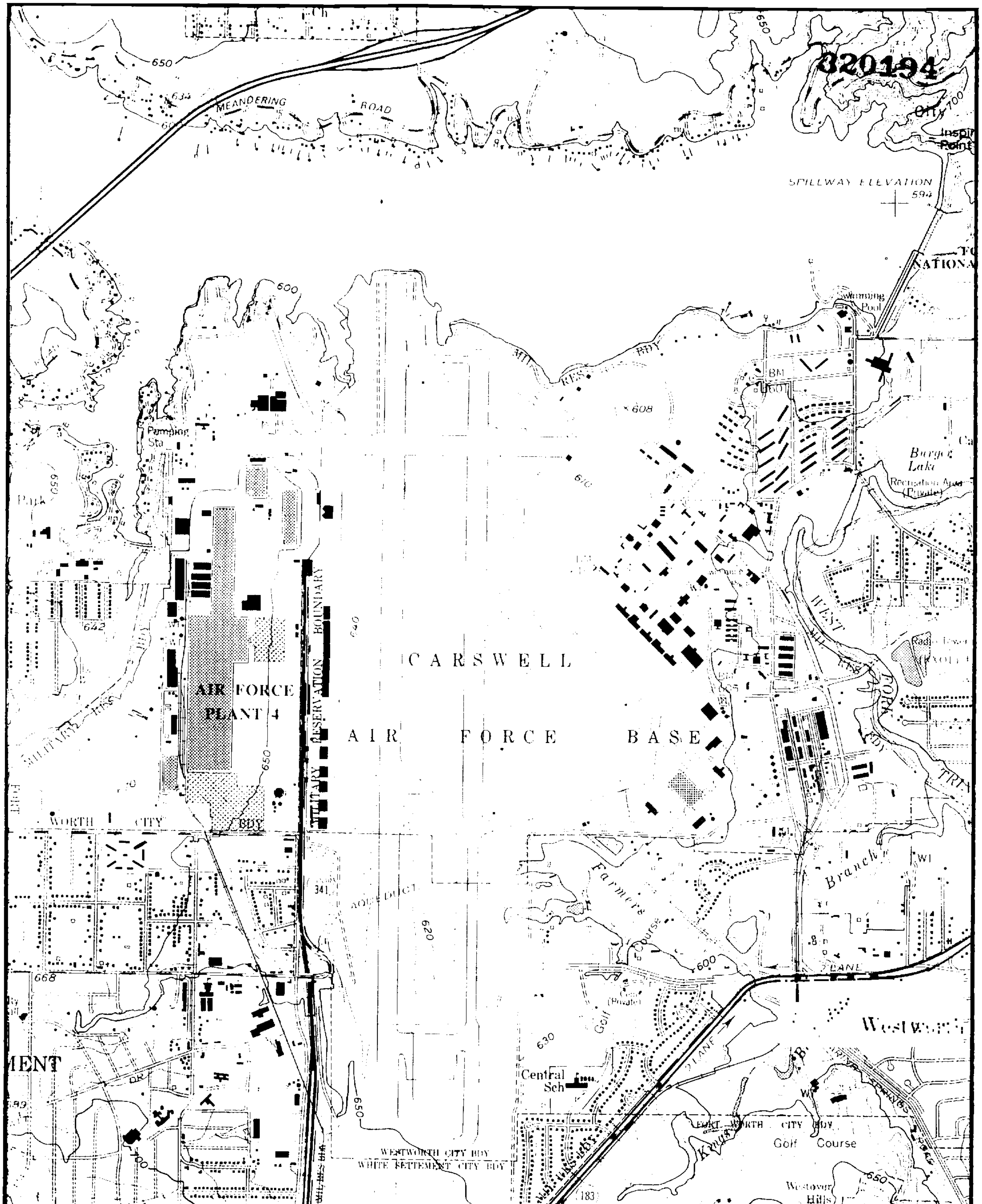
N

SCALE
0 300 600

HYDRO GeoLogic INC.

320193

Map Source:
IT CORP., 1993



Legend

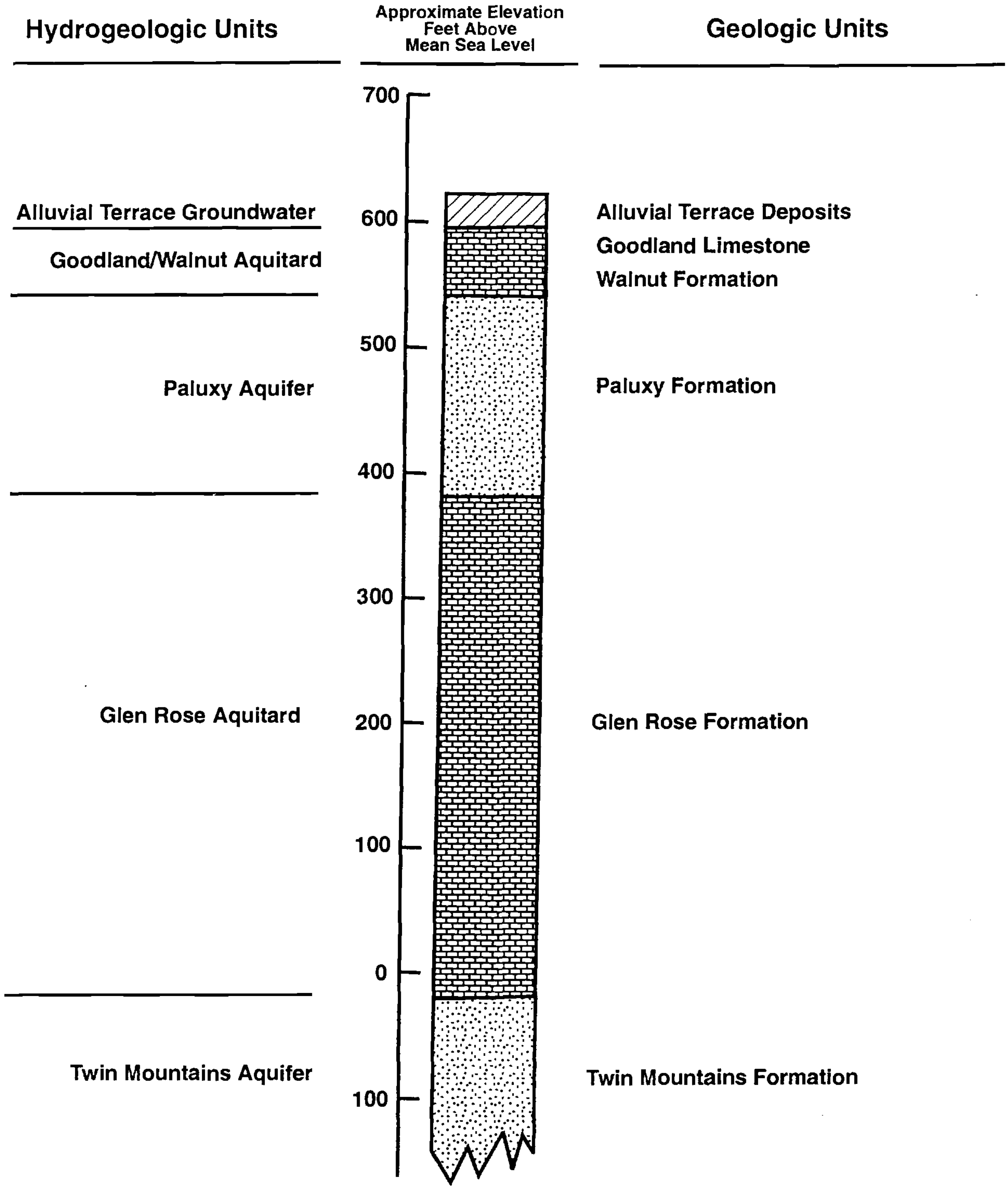
Contour Interval 10 feet

Scale 1:24,000

N

Figure 2.1
Topographic Map of CAFB

320195



HYDROGEOLOGIC INC.

Legend

Alluvium

Limestone

Sandstone

Figure 2.2
Stratigraphic Column at CAFB

[From Radian, 1989]

320196

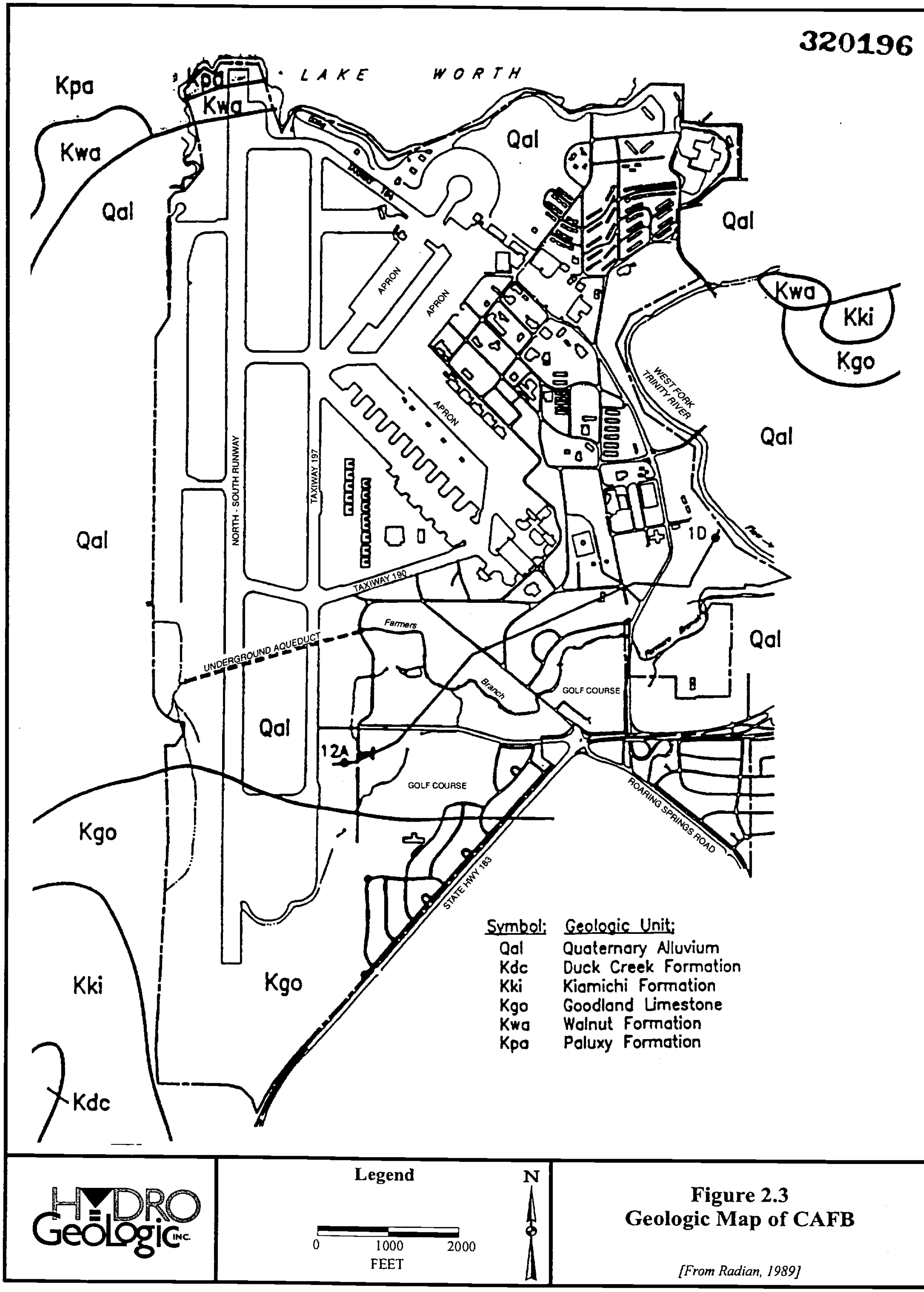
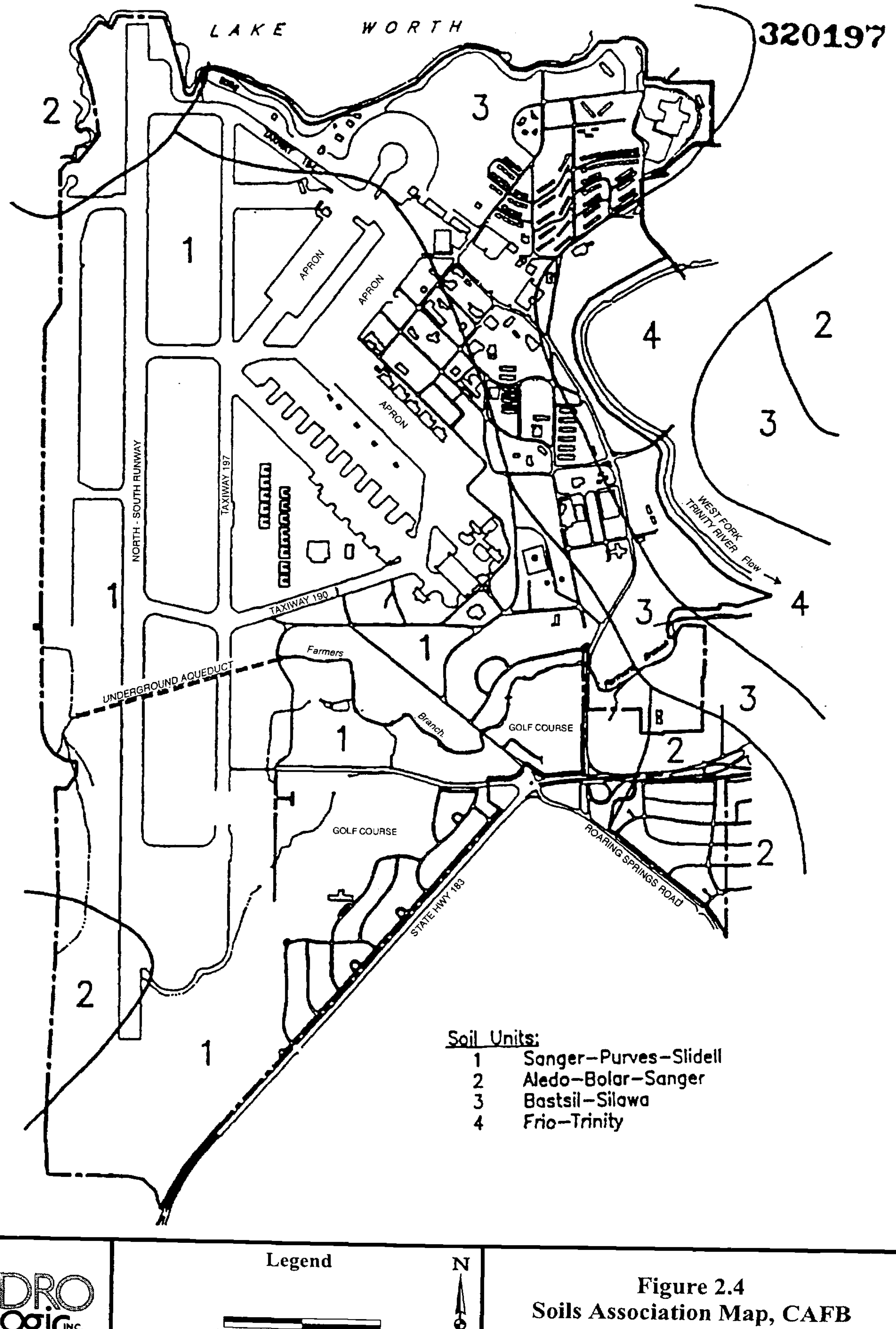


Figure 2.3
Geologic Map of CAFB

[From Radian, 1989]

320197



HYDRO GeoLogic INC.

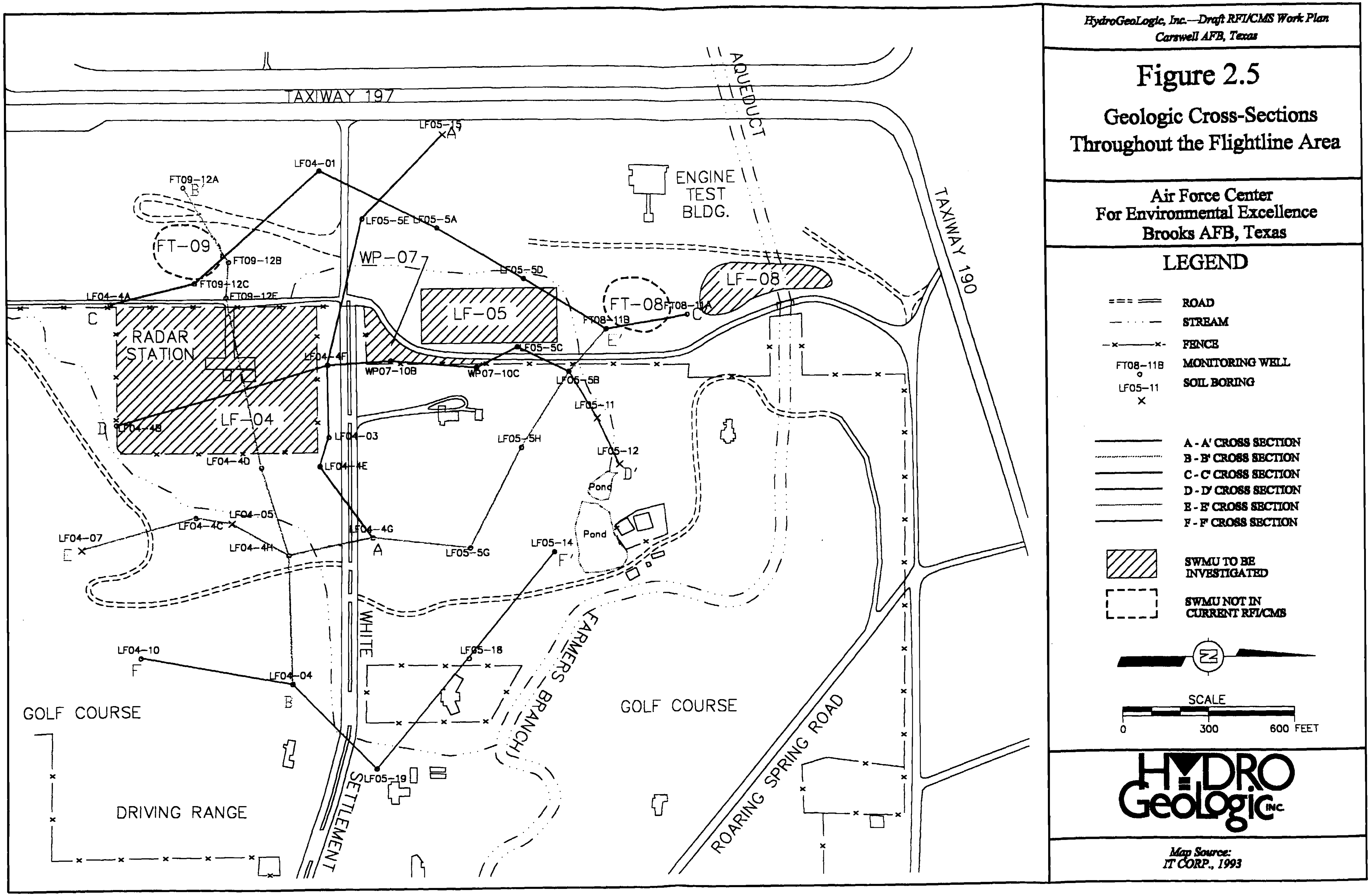
Figure 2.4
Soils Association Map, CAFB

[From Radian, 1989]

Figure 2.5

Geologic Cross-Sections Throughout the Flightline Area

Air Force Center
For Environmental Excellence
Brooks AFB, Texas



HYDRO GeoLogic INC.

Map Source:
IT CORP., 1993

320199

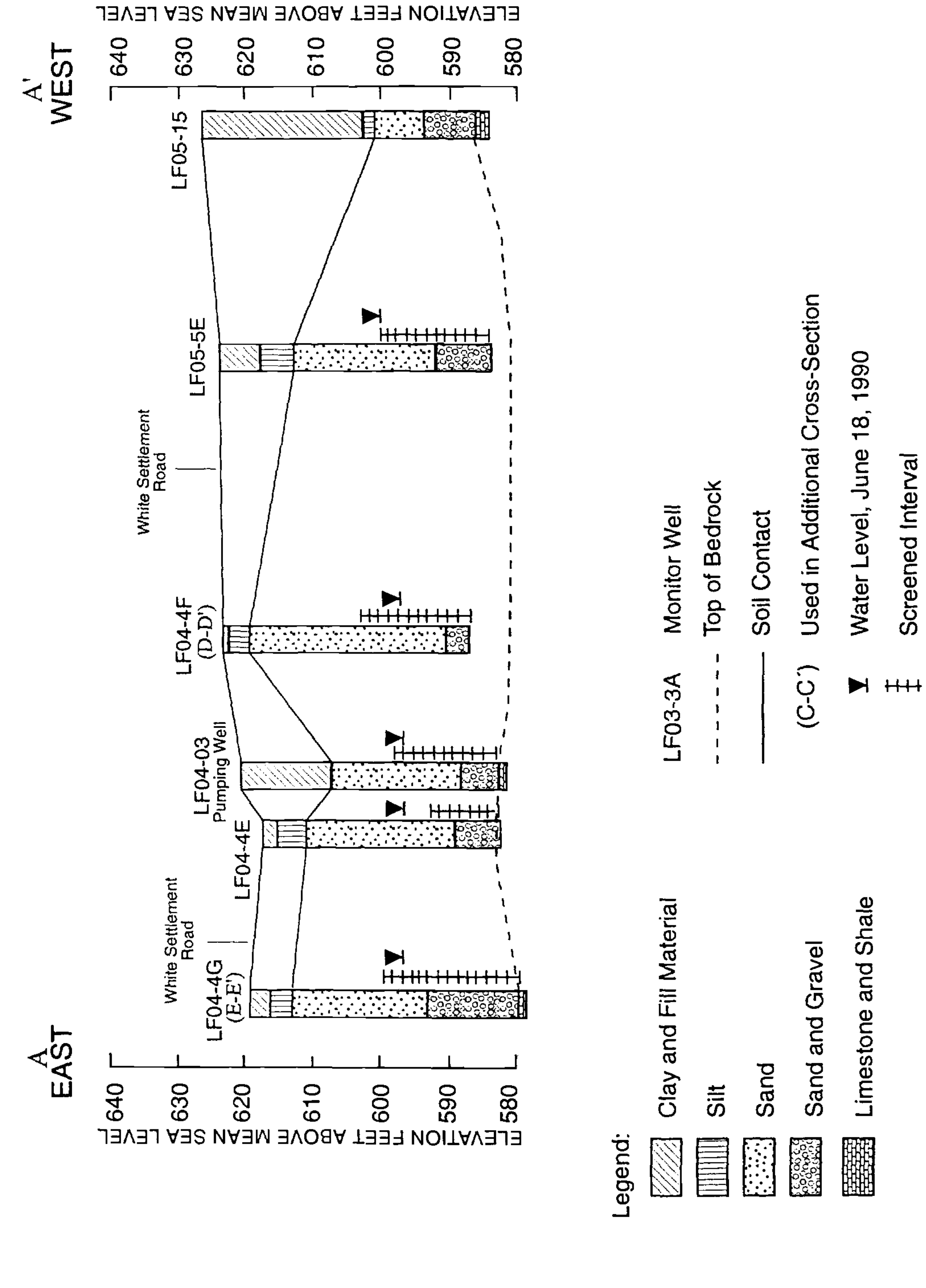
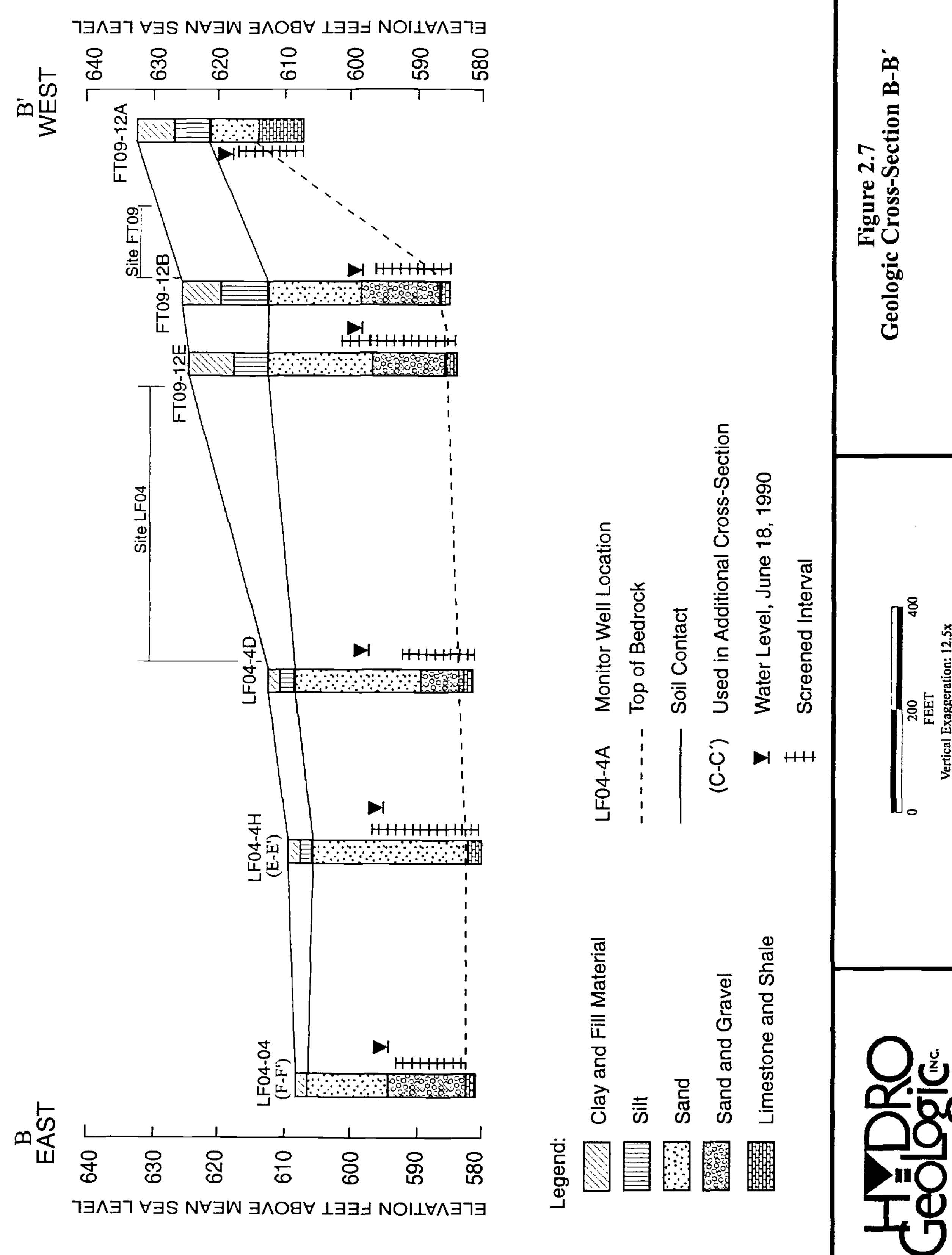


Figure 2.6
Geologic Cross-Section A-A´

[From Radian, 1991]

HYDRO GEOLOGIC INC.

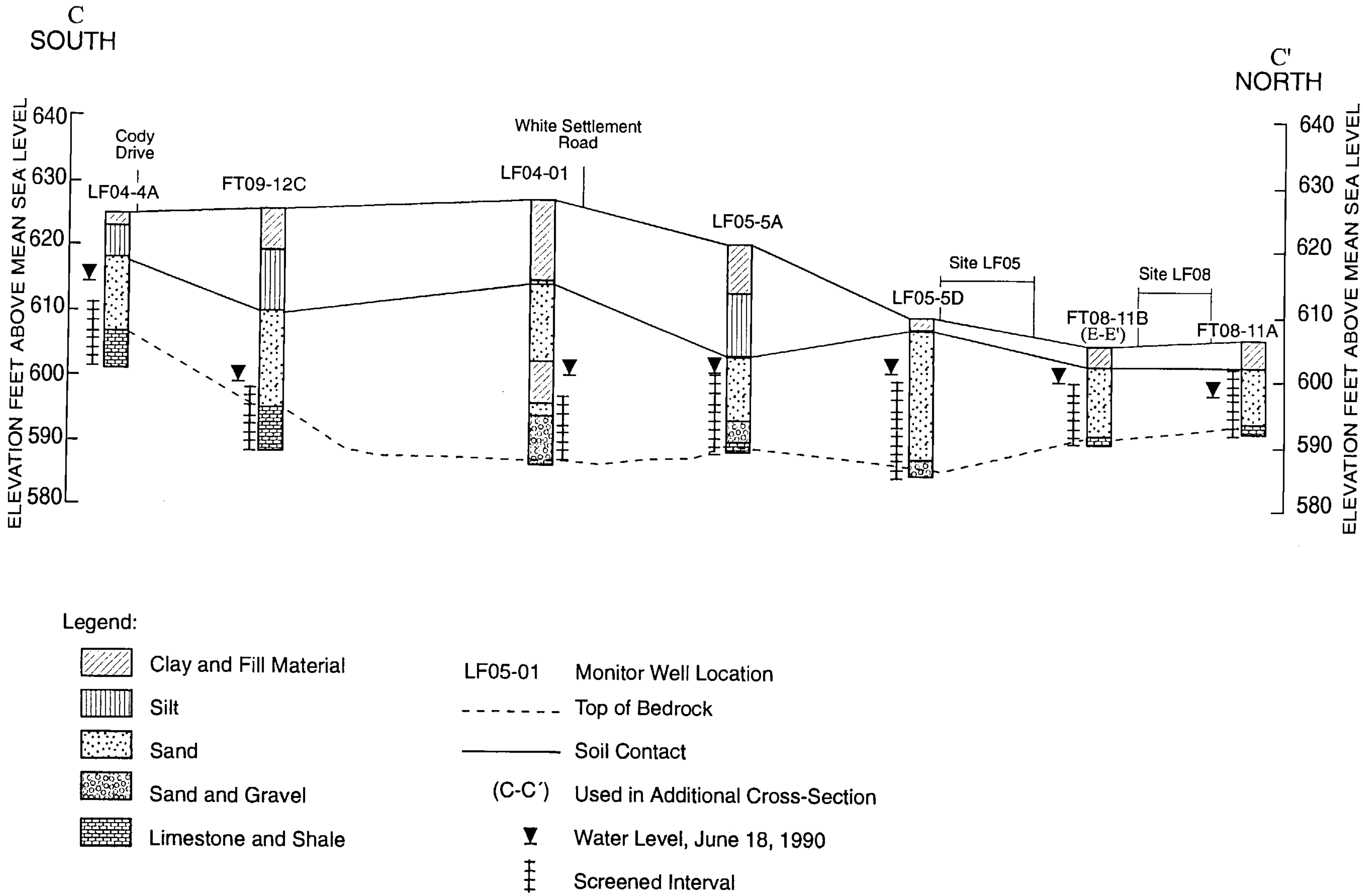
320200



HYDRO GeoLogic INC.

Figure 2.7
Geologic Cross-Section B-B′

[From Radian, 1991]



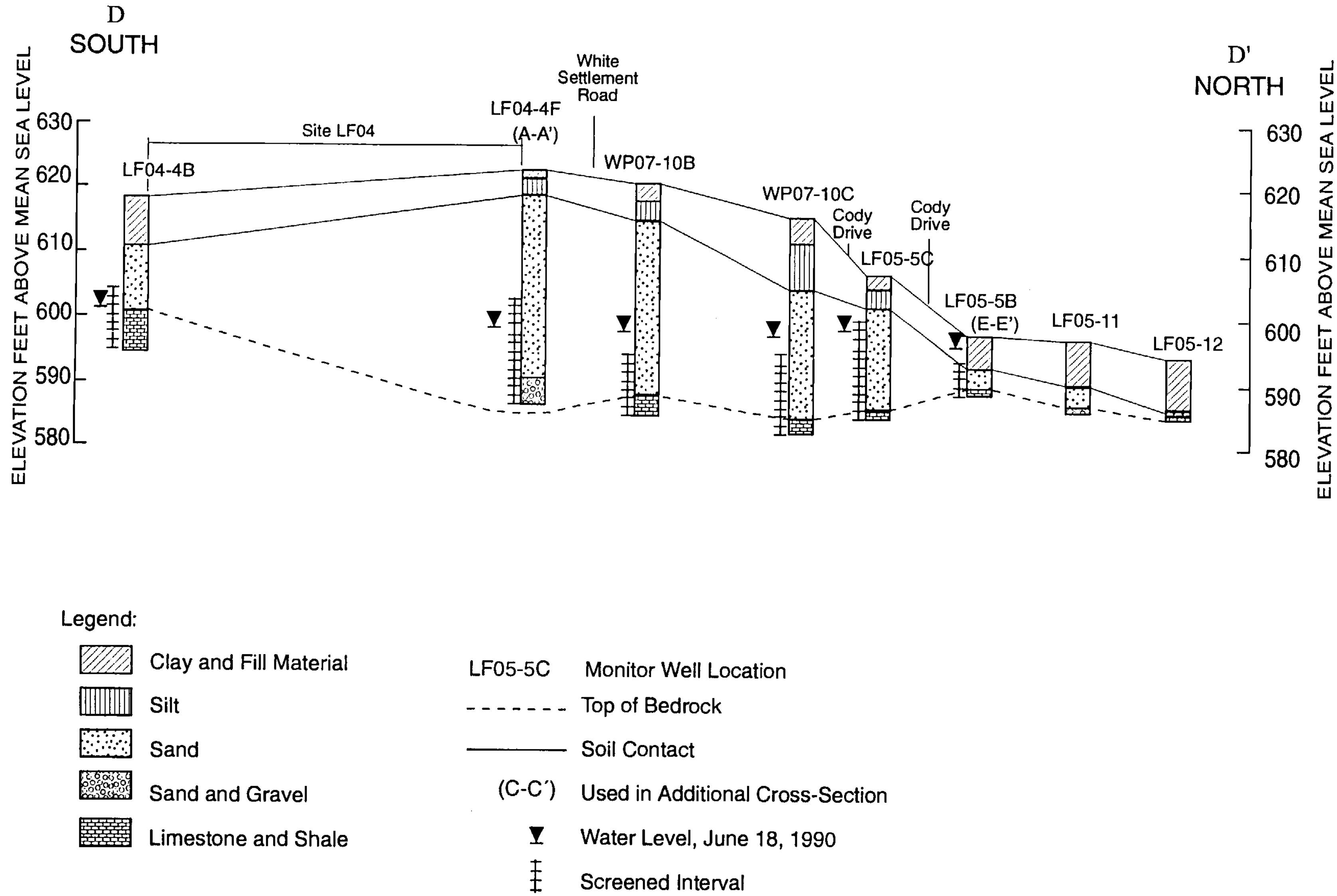
HYDRO GeoLogic INC.

0 200 400
FEET
Vertical Exaggeration: 12.5x

Figure 2.8
Geologic Cross-Section C-C′

[From Radian, 1991]

320201



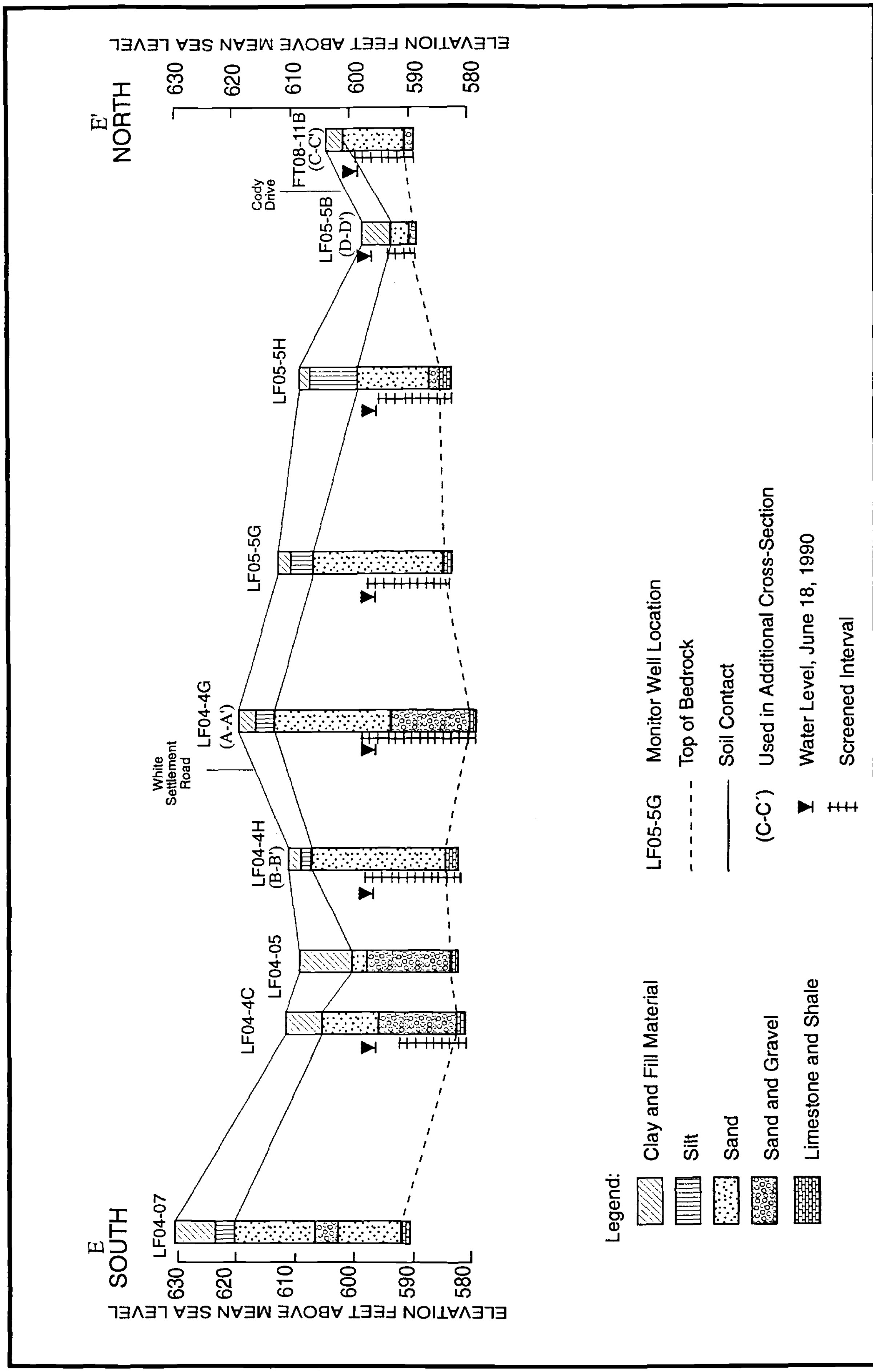
HYDRO GeoLogic INC.

0 200 400
FEET
Vertical Exaggeration: 12.5x

Figure 2.9
Geologic Cross-Section D-D′

[From Radian, 1991]

320202



320203

Figure 2.10
Geologic Cross-Section E-E′

[From Radian, 1991]

HydroGeoLogic INC.

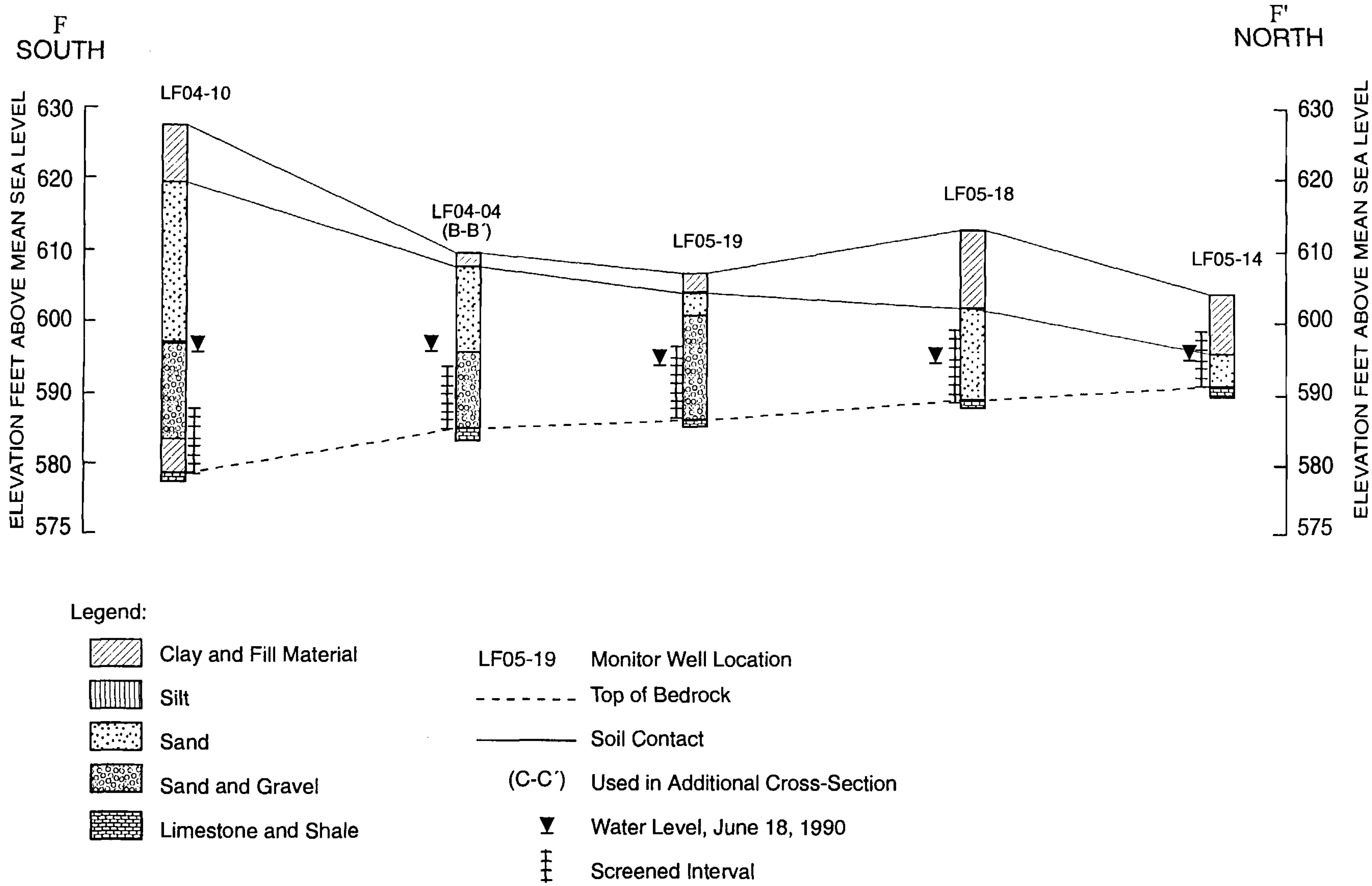
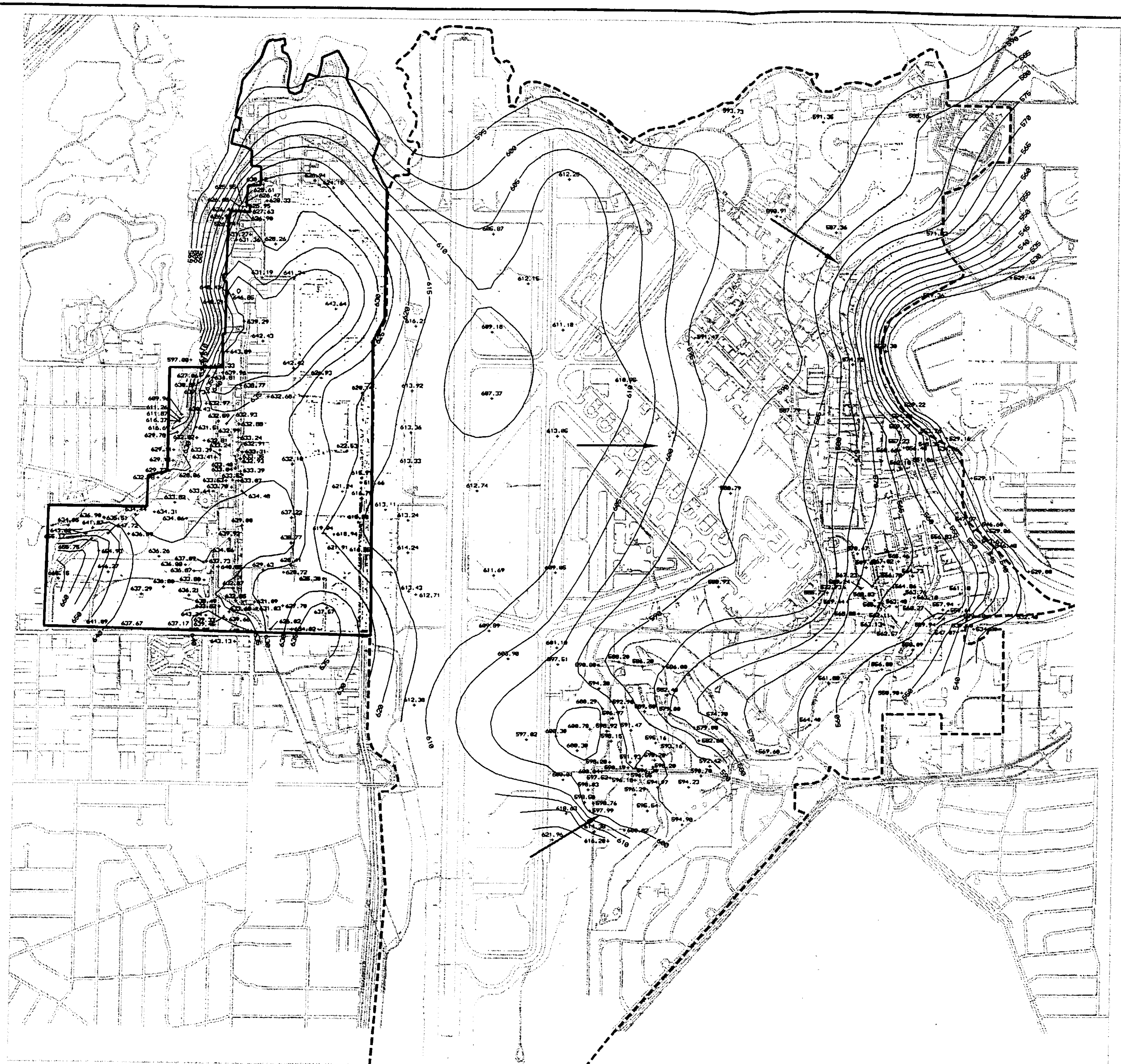


Figure 2.11
Geologic Cross-Section F-F'

[From Radian, 1991]

320204

320205



HydroGeoLogic, Inc. — Draft RFI/CMS Work Plan
Carswell AFB, Texas

Figure 2.12

CAFB / AF Plant 4

Alluvial Terrace Groundwater

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

Former Property Boundary of Carswell AFB

Property Boundary of AF Plant 4

Groundwater Flow Direction

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

Water Level Contour

0 500 1000 2000
SCALE IN FEET

N

HYDRO GeoLogic INC.

Map Source:
JACOBS, 1996

HydroGeoLogic, Inc.—Draft RFI/CMS Work Plan
Carswell AFB, Texas

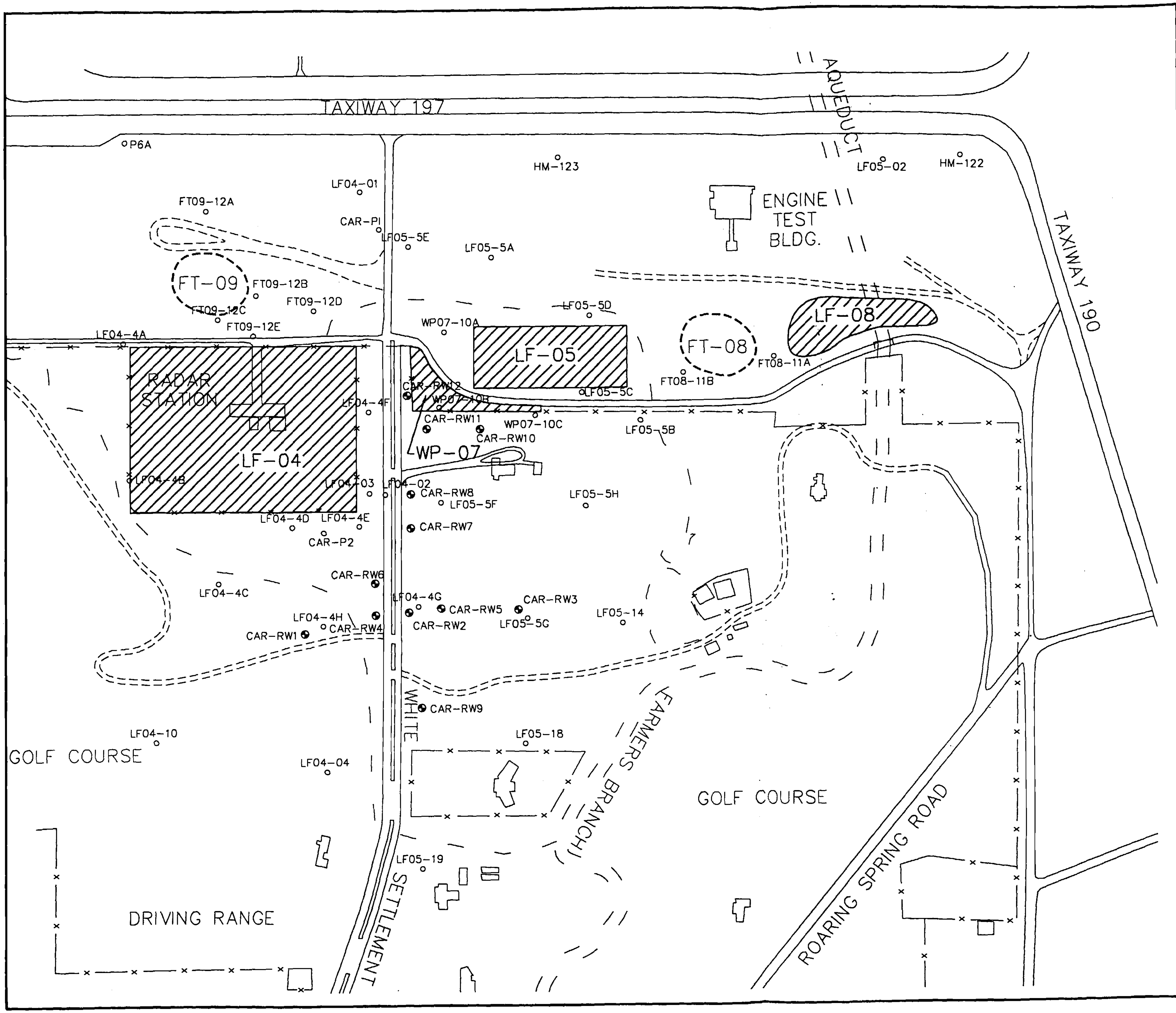
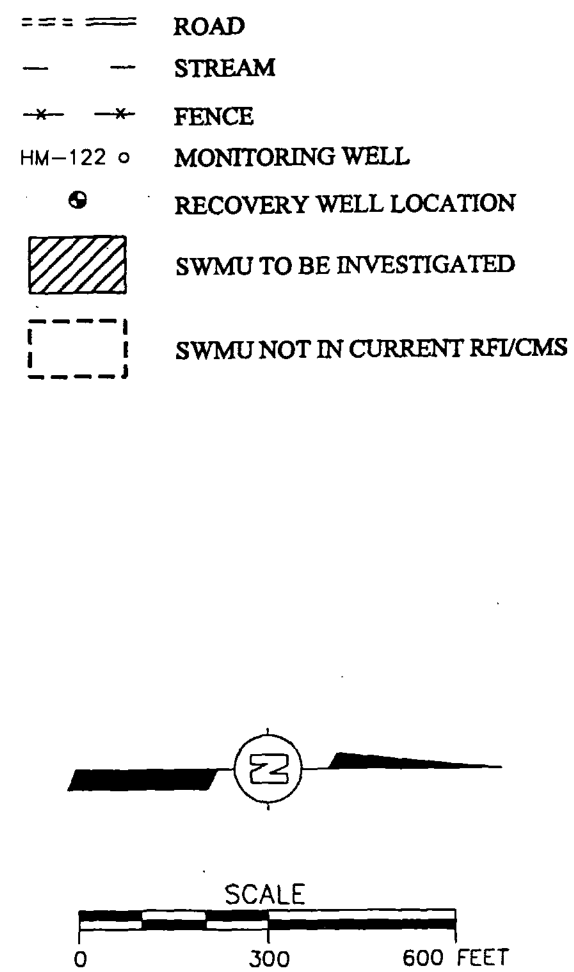


Figure 2.13

Well Locations in the Flightline Area

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND



HYDRO GeoLogic INC.

Map Source:
IT CORP., 1993

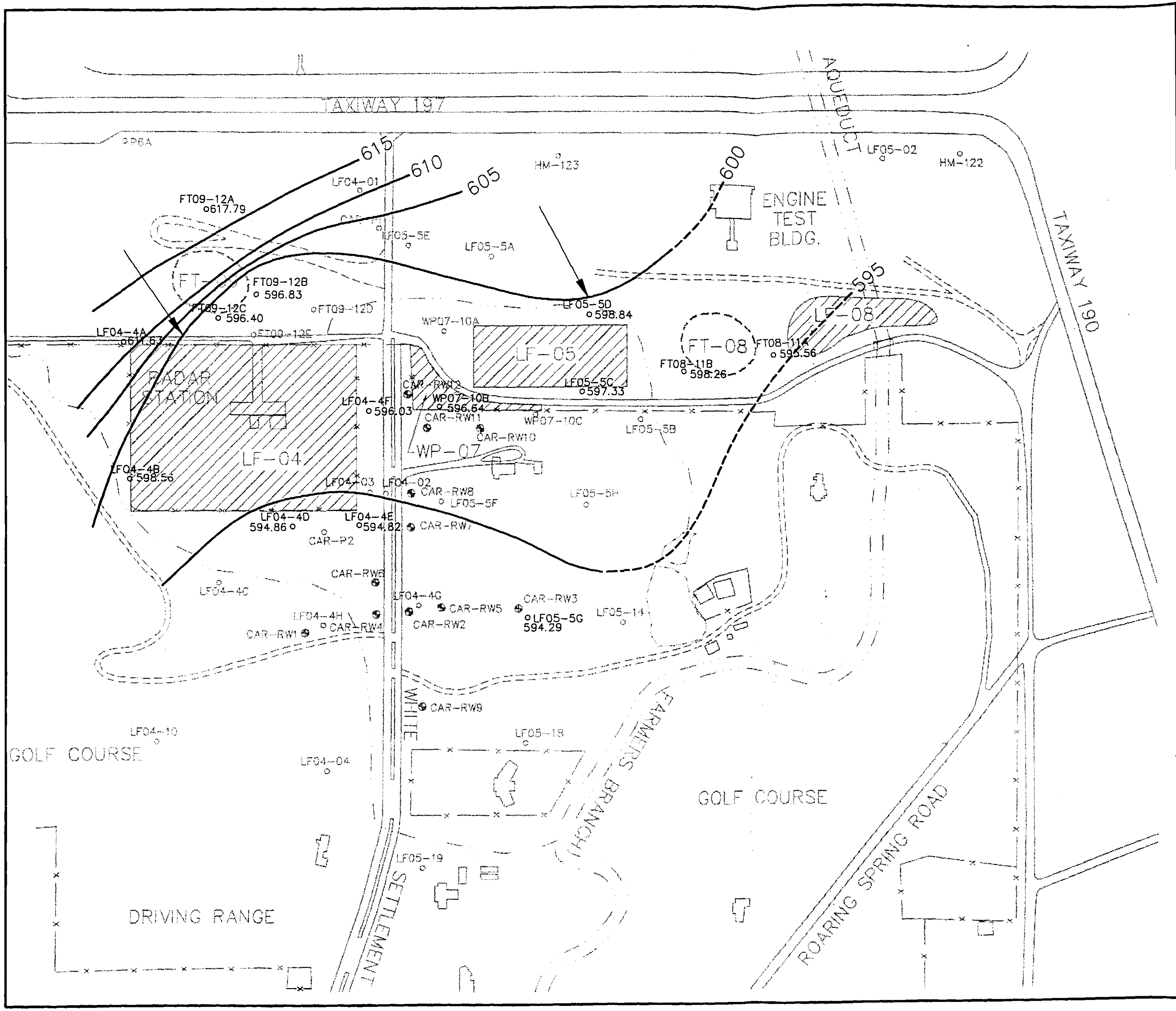


Figure 2.14

Alluvial Terrace Groundwater Elevation Contours (October, 1995)

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

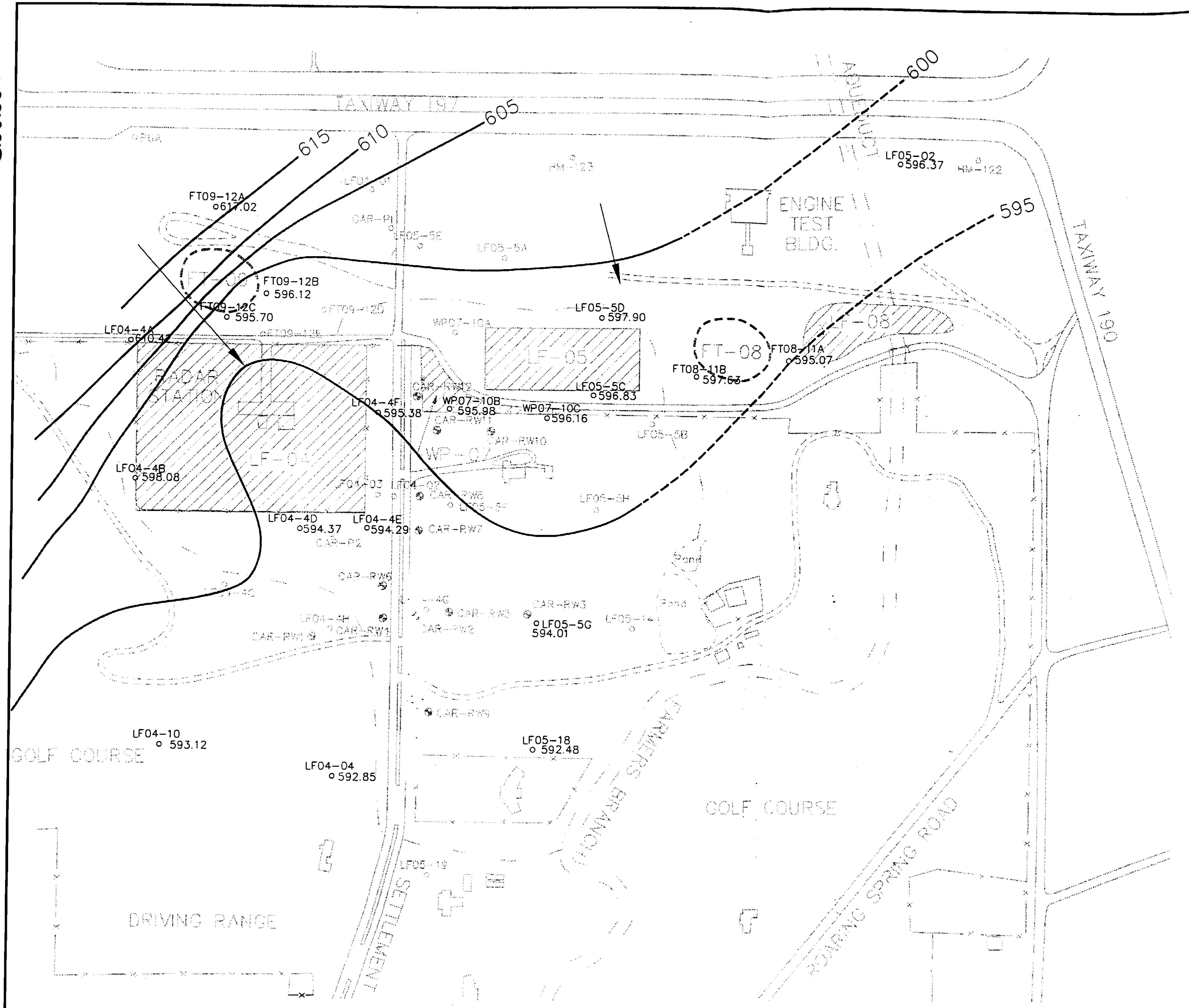
ROAD
STREAM
FENCE
MONITORING WELL
RECOVERY WELL LOCATION
SWMU TO BE INVESTIGATED
SWMU NOT IN CURRENT RFI/CMS
600 WATER LEVEL CONTOURS
GROUNDWATER FLOW DIRECTION

N

SCALE
0 300 600 FEET

HYDRO GeoLogic INC.

Map Source:
IT CORP., 1993



HydroGeoLogic, Inc.—Draft RFI/CMS Work Plan
Carswell AFB, Texas

Figure 2.15

Alluvial Terrace Groundwater Elevation Contours (January, 1996)

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

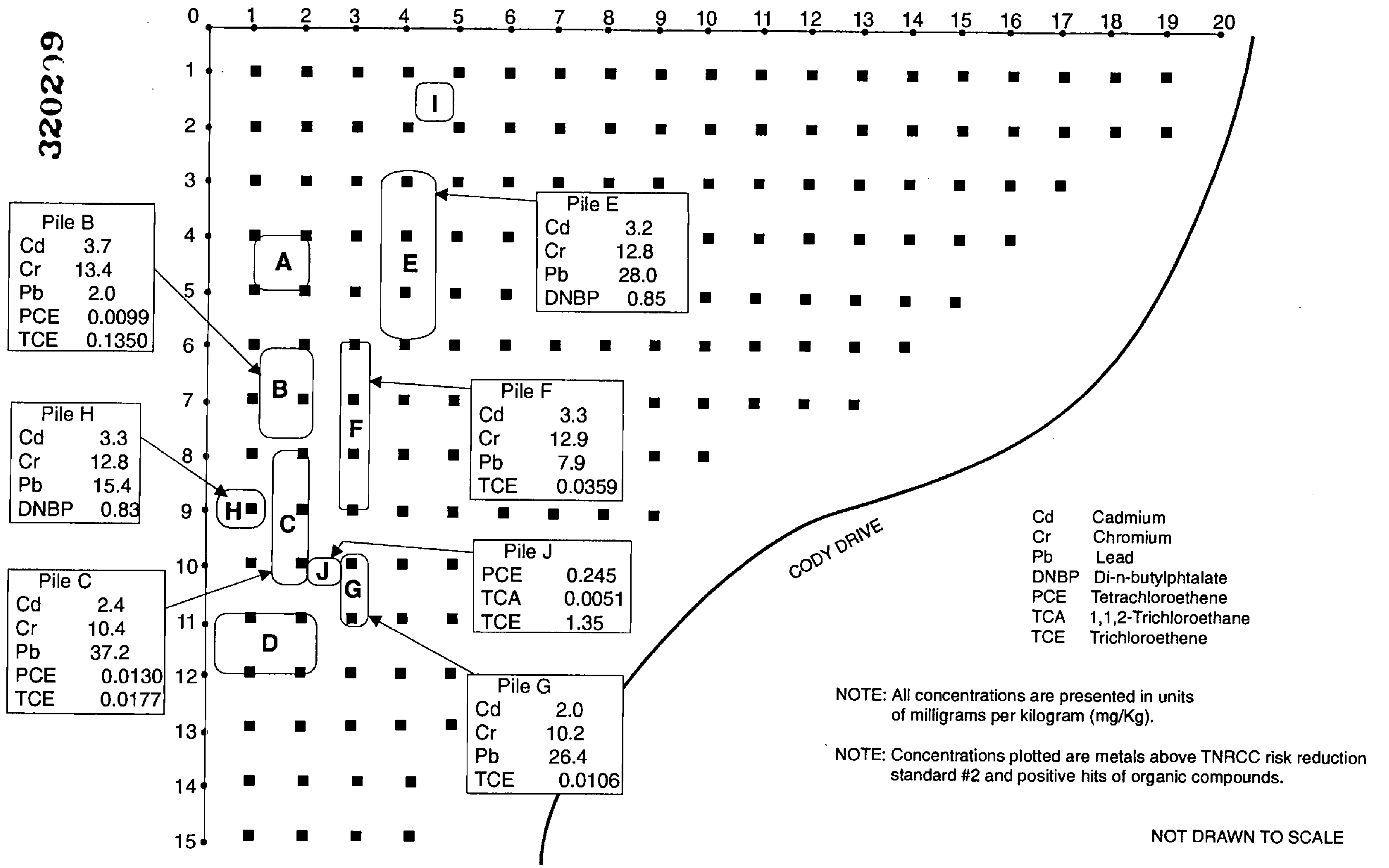
- ROAD
- STREAM
- FENCE
- MONITORING WELL
- RECOVERY WELL LOCATION
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RFI/CMS
- 600 WATER LEVEL CONTOURS
- GROUNDWATER FLOW DIRECTION

SCALE
0 300 600 FEET

HYDRO GeoLogic INC.

Map Source:
IT CORP., 1993

320209



Cd Cadmium
Cr Chromium
Pb Lead
DNBP Di-n-butylphtalate
PCE Tetrachloroethene
TCA 1,1,2-Trichloroethane
TCE Trichloroethene

NOTE: All concentrations are presented in units of milligrams per kilogram (mg/Kg).

NOTE: Concentrations plotted are metals above TNRCC risk reduction standard #2 and positive hits of organic compounds.

NOT DRAWN TO SCALE

HYDRO GeoLogic INC.

Legend

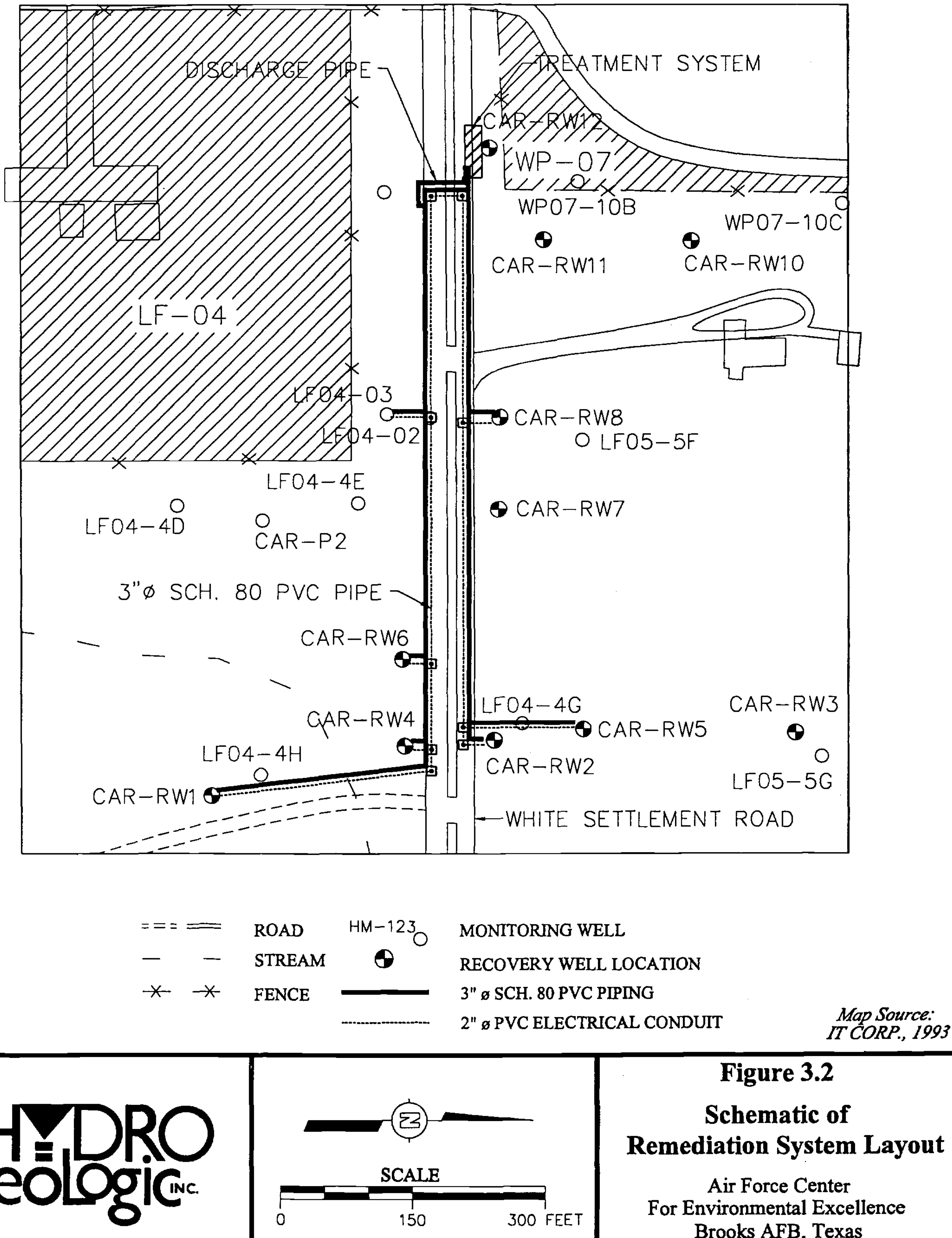
- GEOPHSICAL SURVEY POINTS (E&E)
- CHAIN-LINK FENCE
- H SUSPECTED BURIAL SITE

N

Figure 3.1
Summary of Analytical Results from Soil or Fill in Drum Removal Locations.

Sources: Ecology and Environment, Inc., February 1991
USACE, 1992

320210



HYDRO GeoLogic INC.

Figure 3.2

Schematic of Remediation System Layout

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

320211

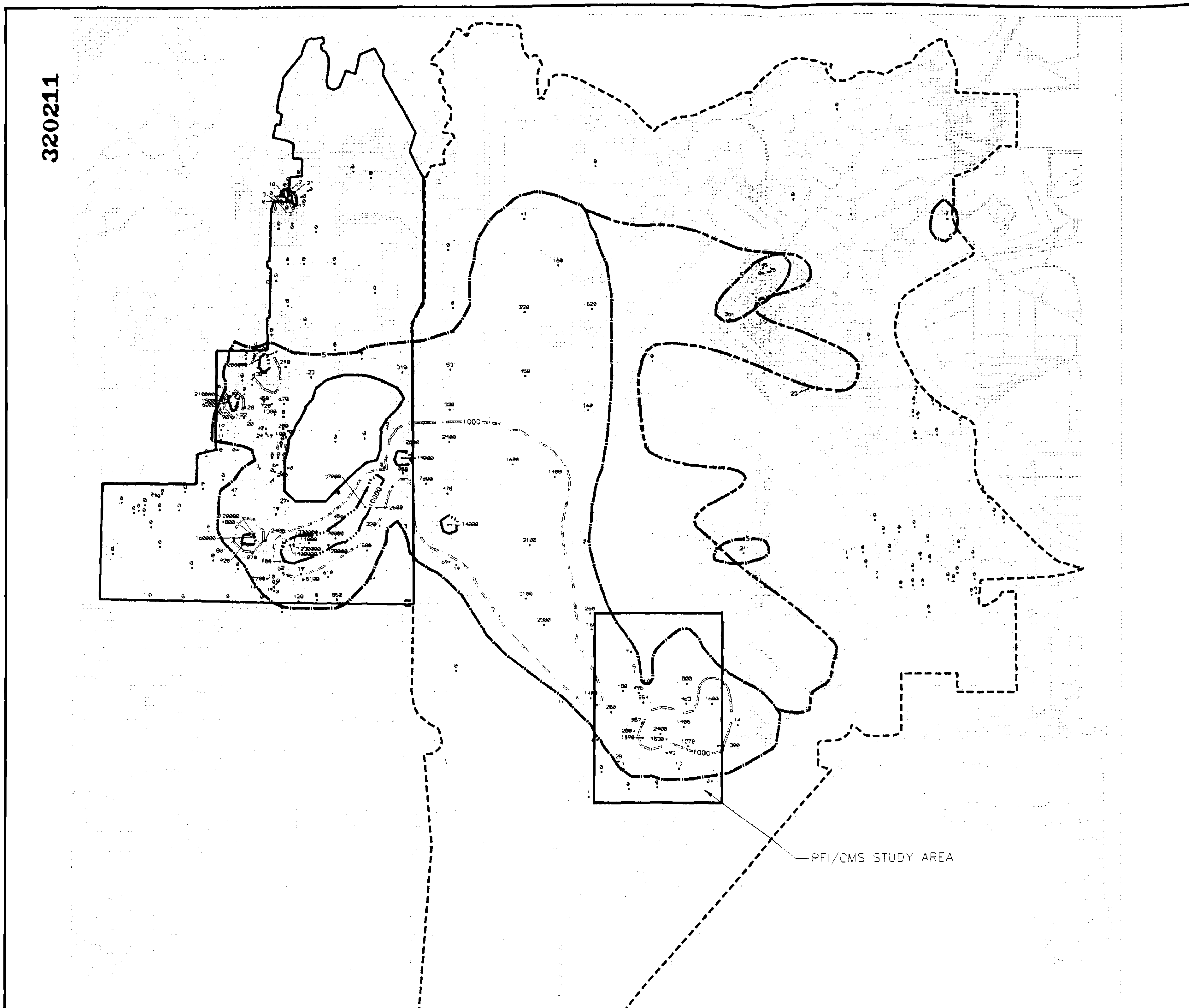


Figure 5.1
CAFB/AFP-4
TCE Plume Map
October/November 1995

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

Former Property Boundary of Carswell AFB

Property Boundary of AF Plant 4

1200 TCE concentration in μg/L

Approximate extent of TCE contamination as defined by Geomarine Hydropunch data and mapped by Rust-Geotech

References:
Geomarine 1992
Geomarine 1993
Geomarine 1994
Geotech 1995

Contour Interval Key μg/L TCE

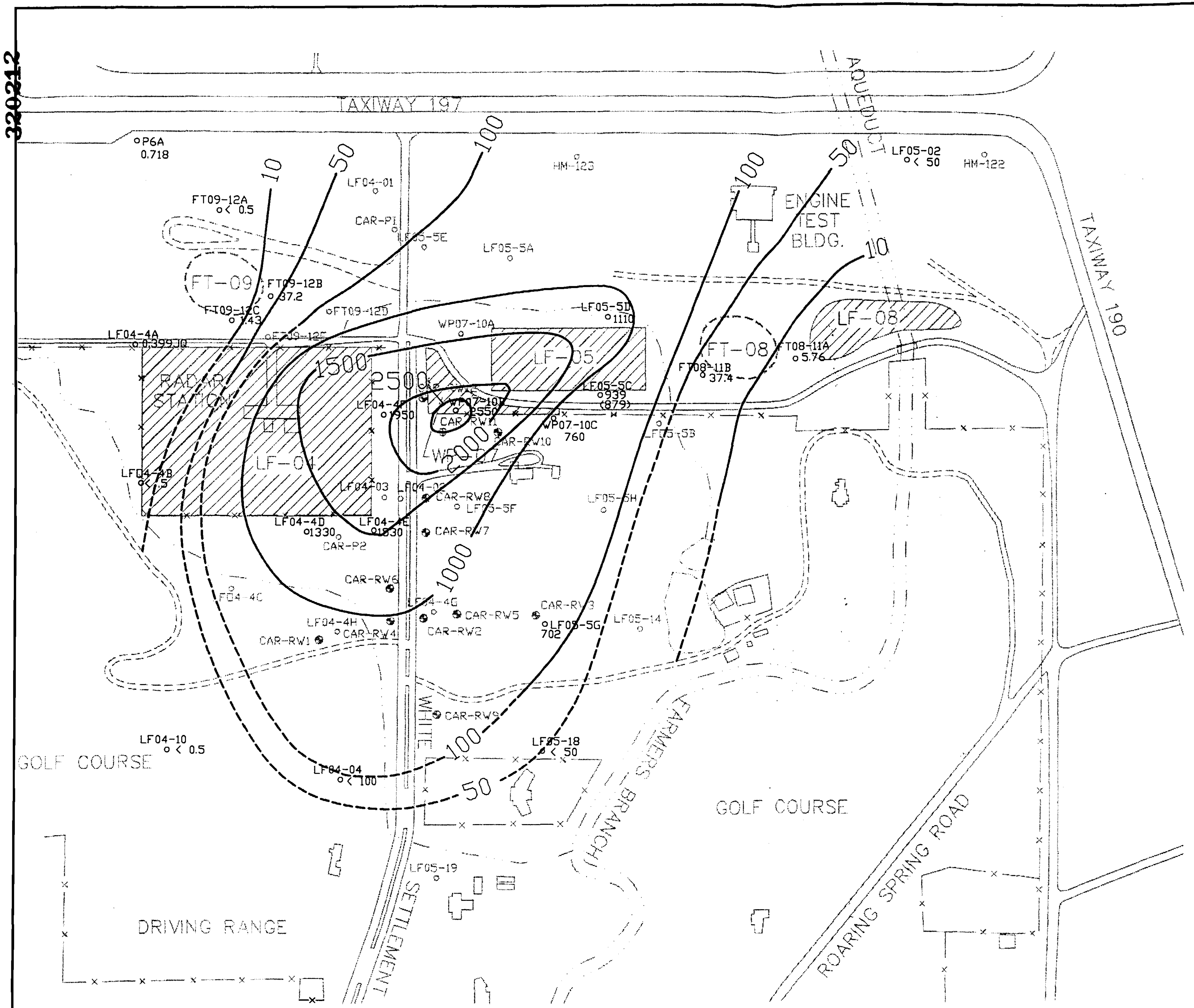
+10,000
1,000-10,000
1-1,000
0

0 500 1000 2000
SCALE IN FEET

N

HYDRO GeoLogic INC.

Map Source:
JACOBS, 1996



HydroGeoLogic, Inc.—Draft RFI/CMS Work Plan
Carswell AFB, Texas

Figure 5.2

Flightline Area TCE Plume Map (January 1996)

Air Force Center
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Brooks AFB, Texas

LEGEND

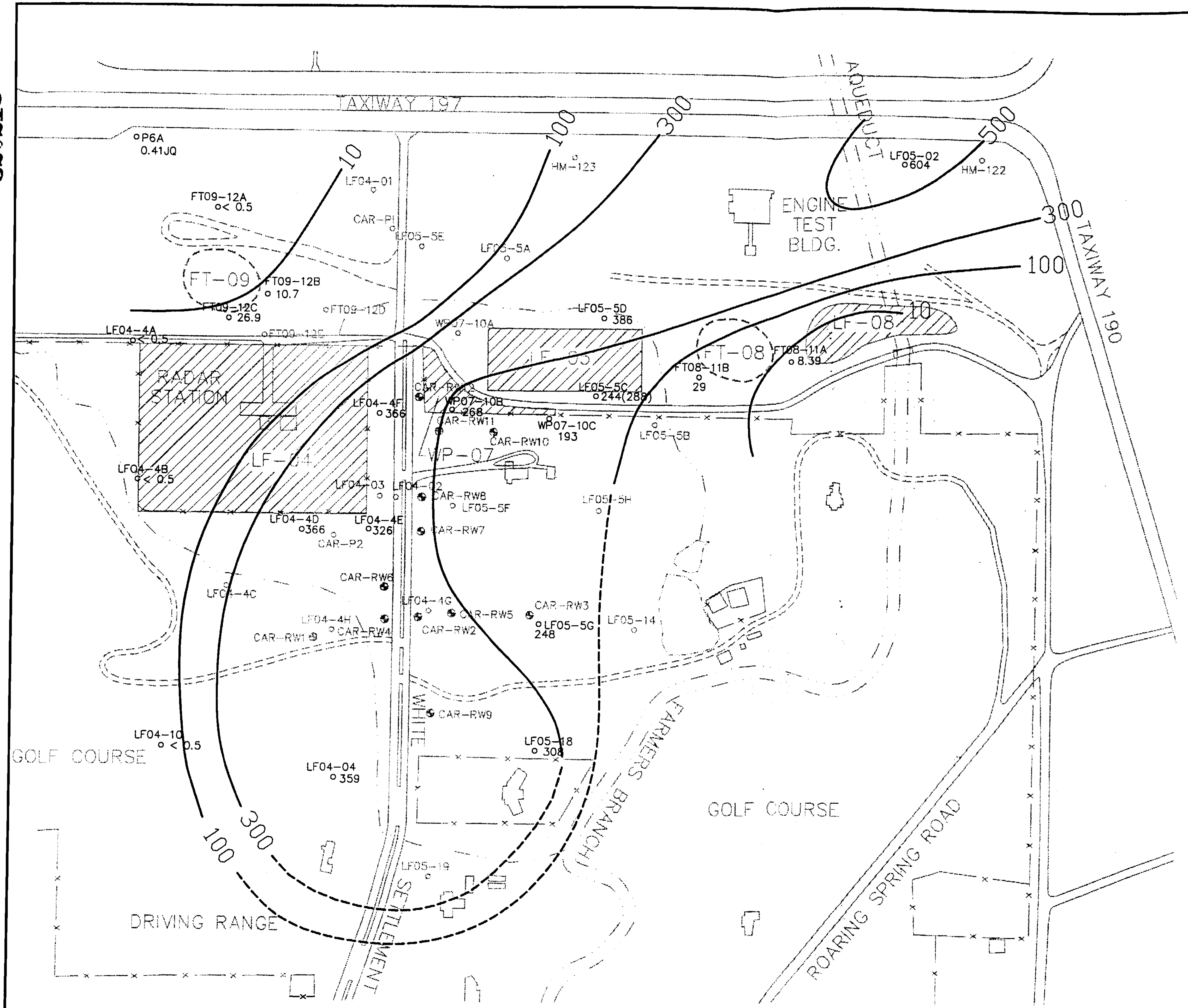
- ROAD
- STREAM
- FENCE
- MONITORING WELL
- RECOVERY WELL LOCATION
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RFI/CMS
- TCE CONCENTRATIONS CONTOUR (ug/L)
- ESTIMATED TCE CONCENTRATIONS CONTOUR (ug/L)
- JQ ESTIMATED QUANTITATION DETECTED BELOW THE PRACTICAL QUANTITATION LIMIT

SCALE
0 300 600 FEET

HYDRO GeoLogic INC.

Map Source:
IT CORP., 1993

320213



HydroGeoLogic, Inc.—Draft RFI/CMS Work Plan
Carswell AFB, Texas

Figure 5.3

Flightline Area
Cis-1, 2 - DCE Plume Map
(January 1996)

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- ROAD
- STREAM
- FENCE
- HM-123 MONITORING WELL
- RECOVERY WELL LOCATION
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RFI/CMS
- 50 CIS - 1, 2 - DCE CONCENTRATION CONTOUR (µg/L)
- 50 ESTIMATED CIS - 1, 2 - DCE CONCENTRATION CONTOUR (µg/L)
- JQ ESTIMATED QUANTITATION DETECTED BELOW PRACTICAL QUANTITATION LIMIT

N

SCALE

0 300 600 FEET

HYDRO GeoLogic INC.

Map Source: IT CORP., 1993

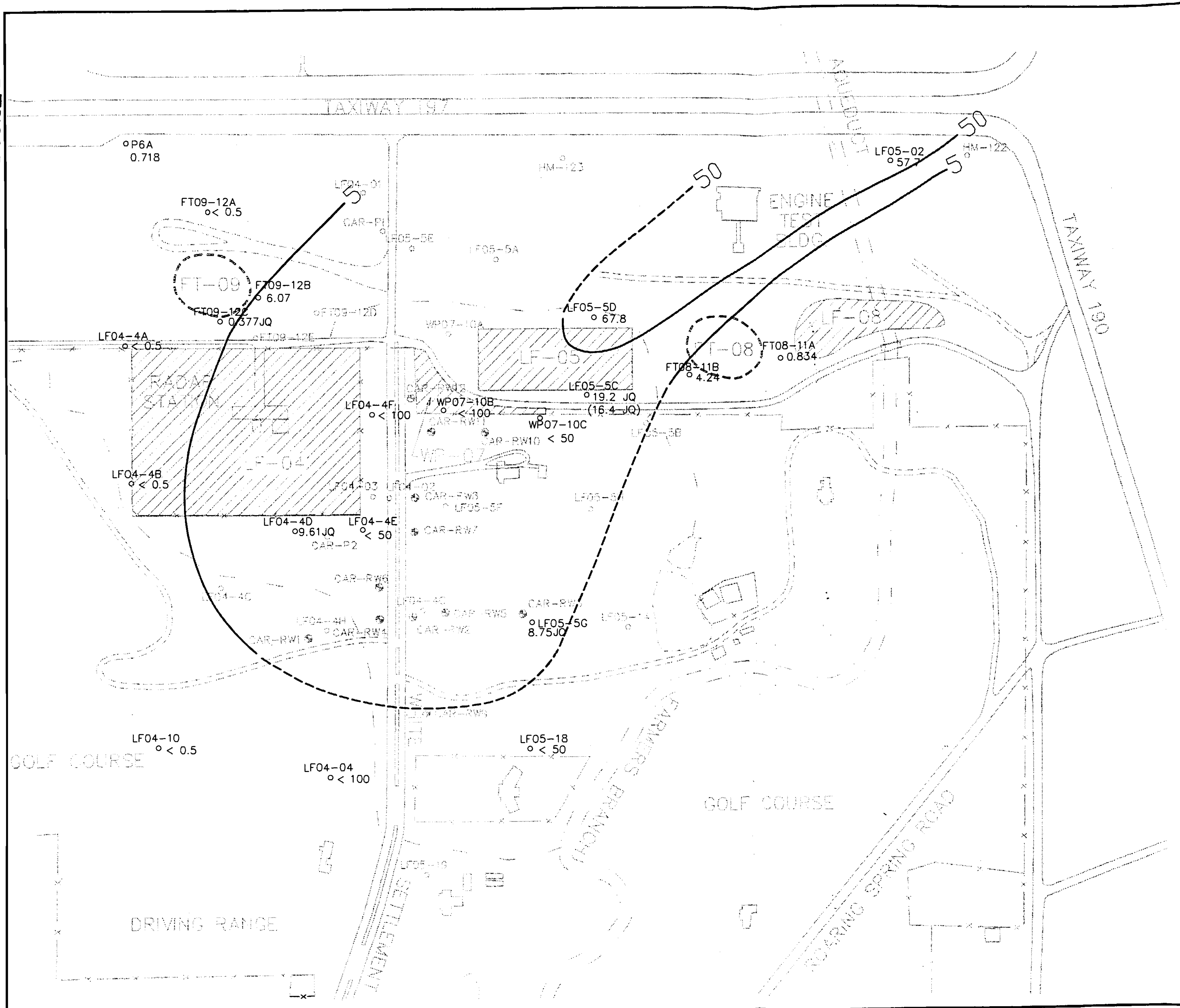


Figure 5.4

Flightline Area
Trans-1, 2 - DCE Plume Map
(January 1996)

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

ROAD
STREAM
FENCE
MONITORING WELL
RECOVERY WELL LOCATION
SWMU TO BE INVESTIGATED
SWMU NOT IN CURRENT RFI/CMS
TRANS - 1, 2 - DCE CONCENTRATIONS CONTOUR (ug/L)
ESTIMATED TRANS - 1, 2 - DCE CONCENTRATIONS CONTOUR (ug/L)
JQ ESTIMATED QUANTITATION DETECTED BELOW PRACTICAL QUANTITATION LIMIT

N

SCALE
0 300 600 FEET

HYDRO GeoLogic INC.

Map Source:
IT CORP., 1993

320215

Figure 5.5

Proposed Alluvial Terrace Groundwater Sampling Locations

Air Force Center
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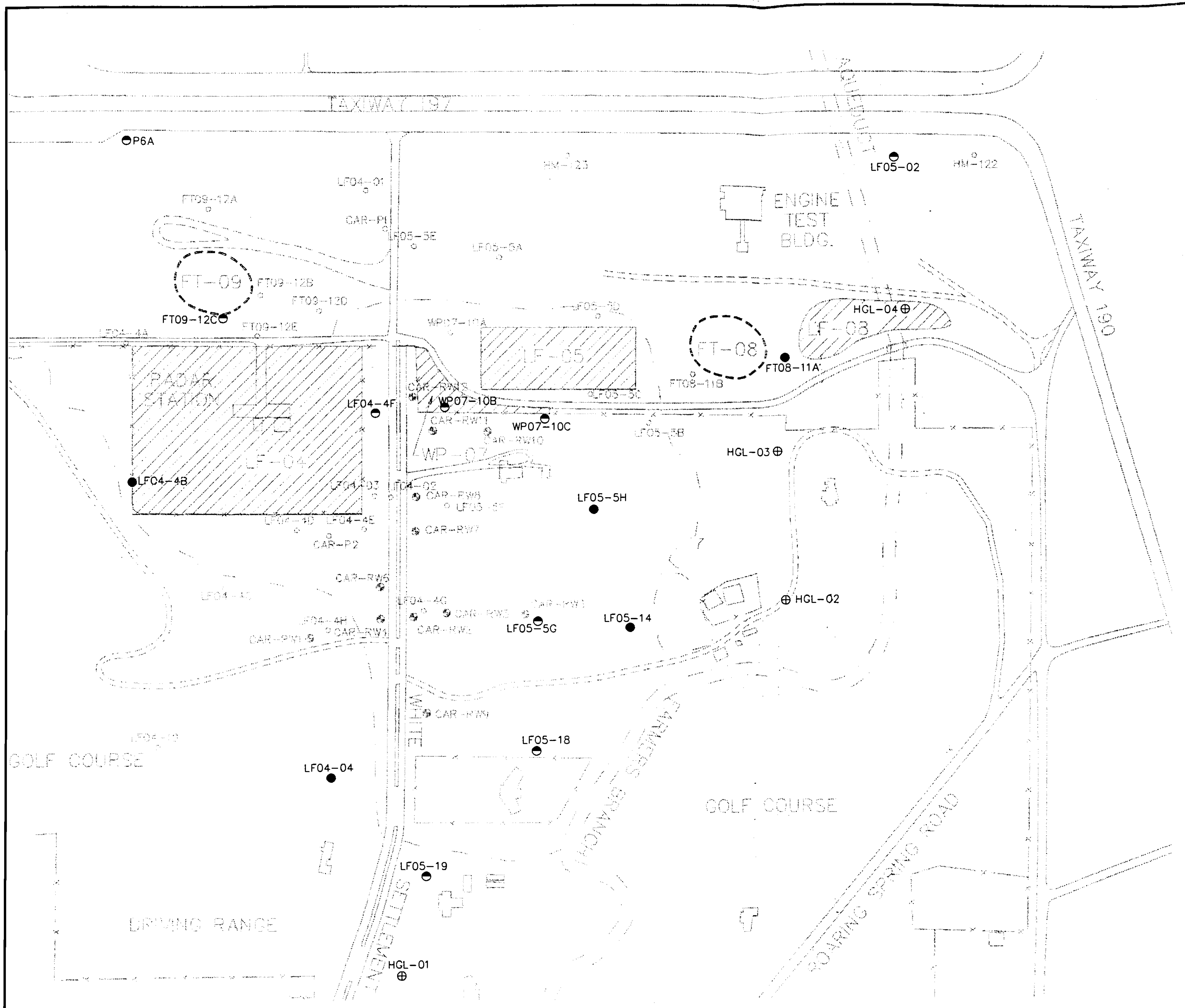
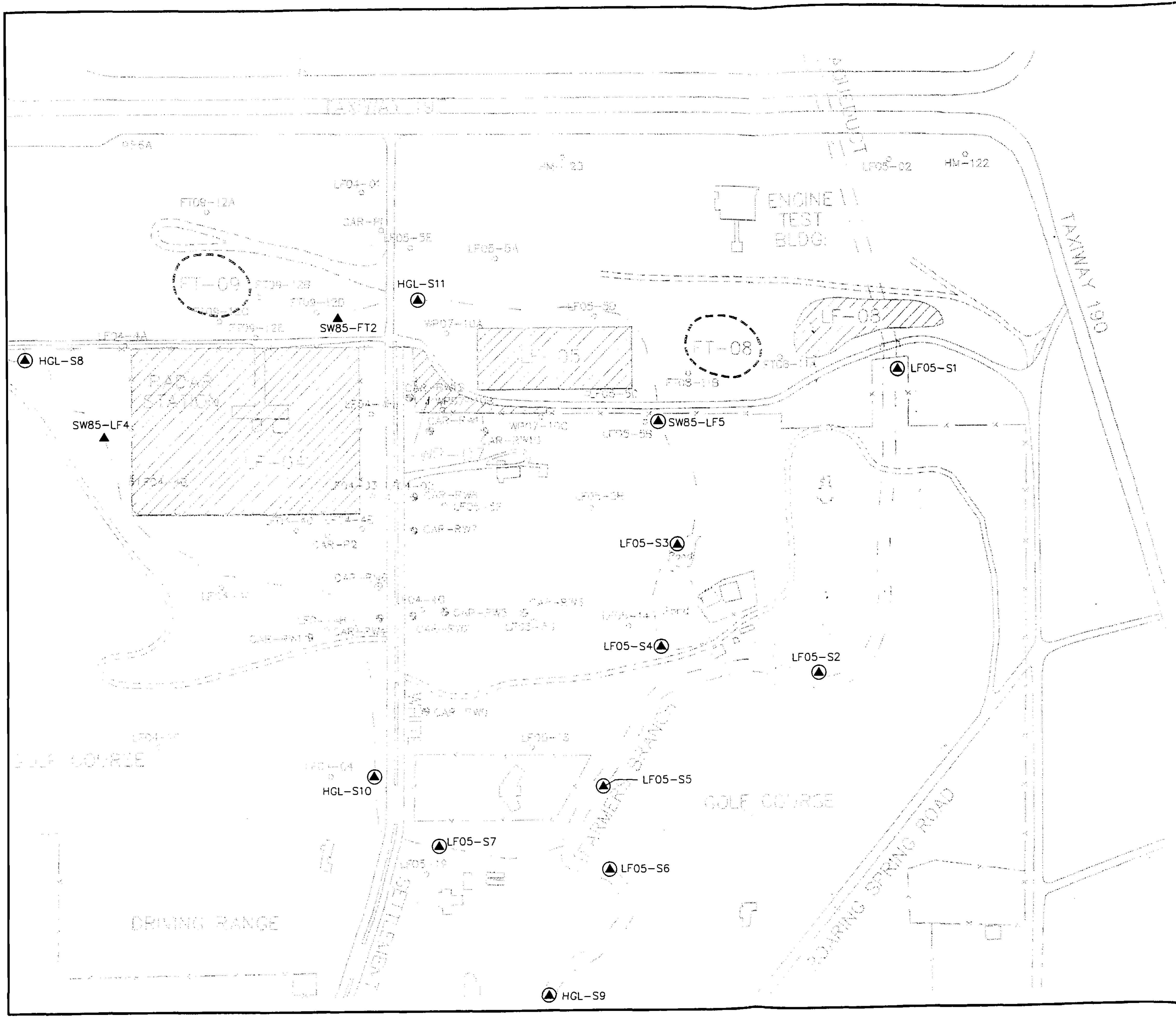
Brooks AFB, Texas



Map Source:
IT CORP., 1993



HydroGeoLogic, Inc.—Draft RFI/CMS Work Plan
Carswell AFB, Texas

Figure 5.6

Surface Water Sampling Locations in the Flightline Area

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

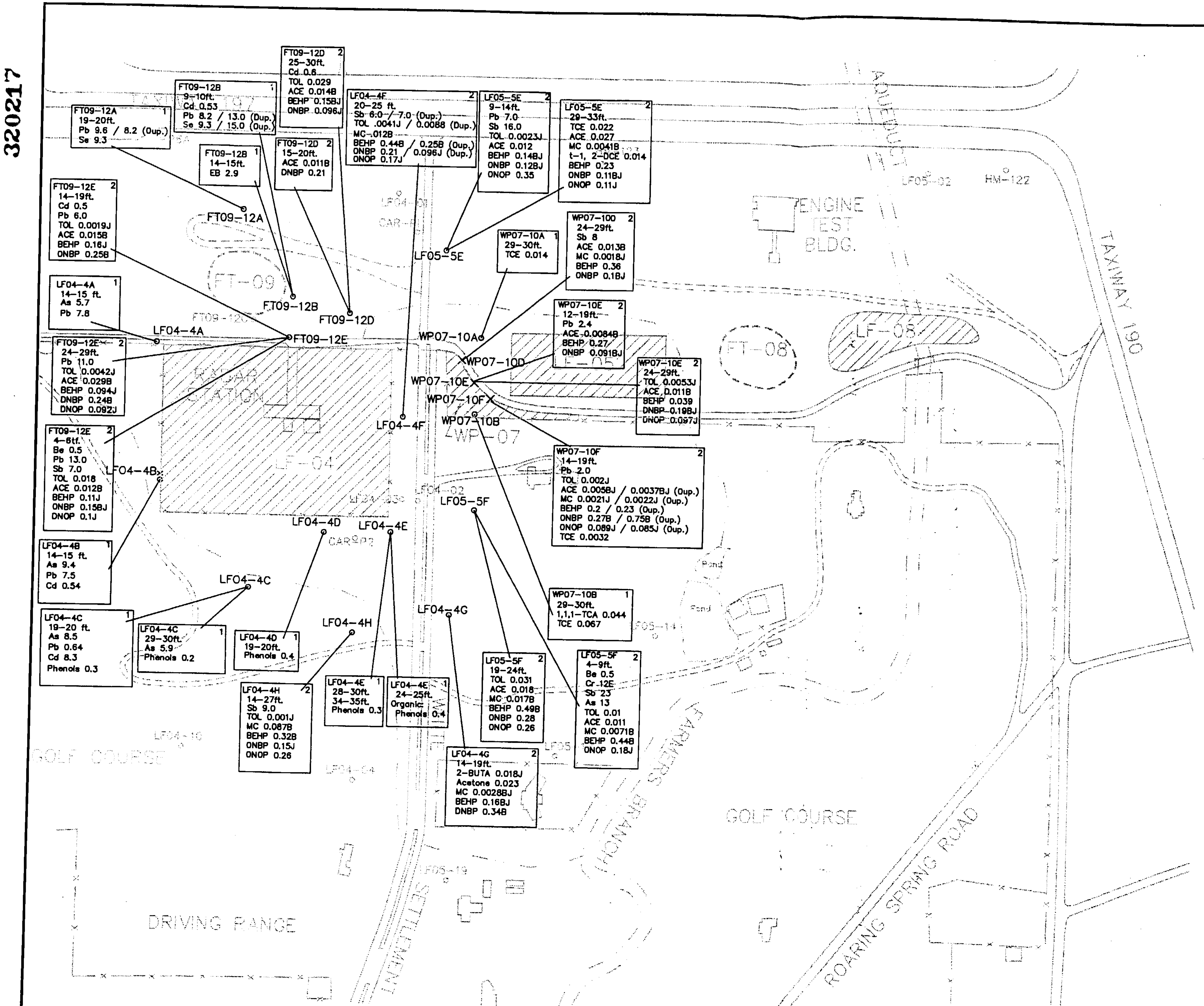
LEGEND

- ROAD
- STREAM
- FENCE
- MONITORING WELL
- RECOVERY WELL LOCATION
- SURFACE WATER SAMPLING LOCATION (APPROXIMATE)
- PROPOSED SURFACE WATER SAMPLING LOCATION
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RFI/CMS

SCALE
0 300 600 FEET

HYDRO GeoLogic INC.

Map Source:
IT CORP., 1993



HydroGeoLogic, Inc. — Draft RFI/CMS Work Plan
Carswell AFB, Texas

Figure 5.7
Soil Concentrations Above TNRCC Standards Site LF-04

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- ROAD
- STREAM
- FENCE
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RFI/CMS
- HM-122 MONITORING WELL
- WP07-10D SOIL BORING

As	Arsenic	MC	Methylene Chloride
TOL	Toluene	Sb	Antimony
ACE	Acetone	t-1,2-DCE	Trans-1, 2-Dichloroethylene
BEHP	Bis(2-Ethylhexyl) Phthalate	Be	Beryllium
ONBP	Di-n-Butyl Phthalate	1,1,1-TCA	1,1,1 Trichloroethane
ONOP	Di-n-Octyl Phthalate	EB	Ethyl Benzene
Cd	Cadmium	Hg	Mercury
Pb	Lead	TCE	Trichloroethylene
Se	Selenium	2-BUTA	2-Butanon

NOTE: All analytical results are in units of mg/Kg.

B: Detected in reagent blank; background subtraction not performed.
J: Estimated value (GC Test Codes)
BJ: Analyte detected in blank; estimated value below detection limit.

[1] IRP Phase II, Stage 1 (Radian, 1986)
[2] RI/FS, Stage 2 (Radian, 1989)

SCALE
0 300 600 FEET

HYDRO GeoLogic INC.

Map Source:
IT CORP., 1993

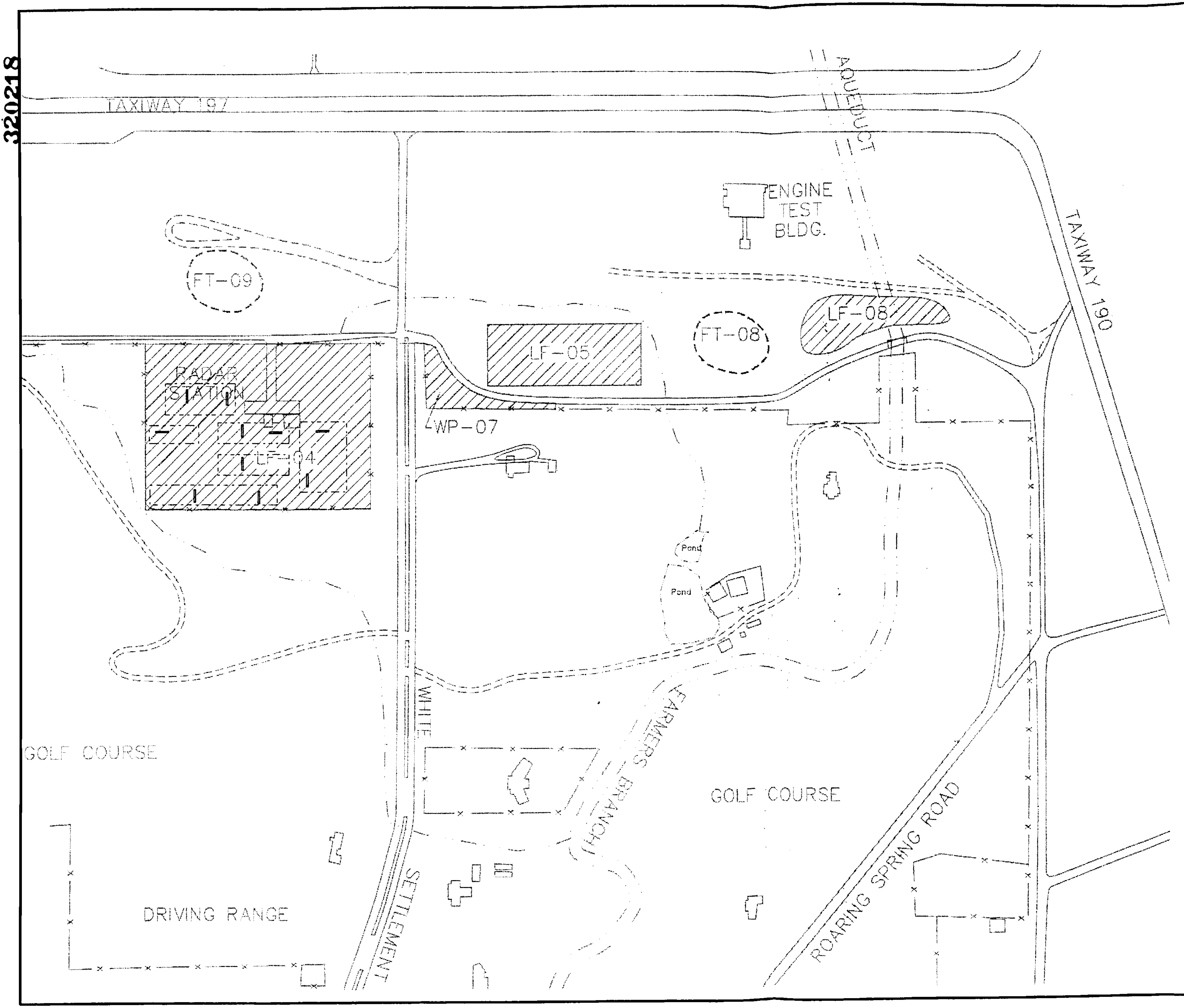


Figure 5.8

Proposal Test Pit Locations LF-04

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- ROAD
- STREAM
- FENCE
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RFI/CMS
- FORMER BURIAL PIT LOCATION FROM 1 SEP 64 AERIAL PHOTOGRAPH
- PROPOSED TEST PIT LOCATION

SCALE
0 300 600 FEET

HYDRO GeoLogic INC.

Map Source:
IT CORP., 1993

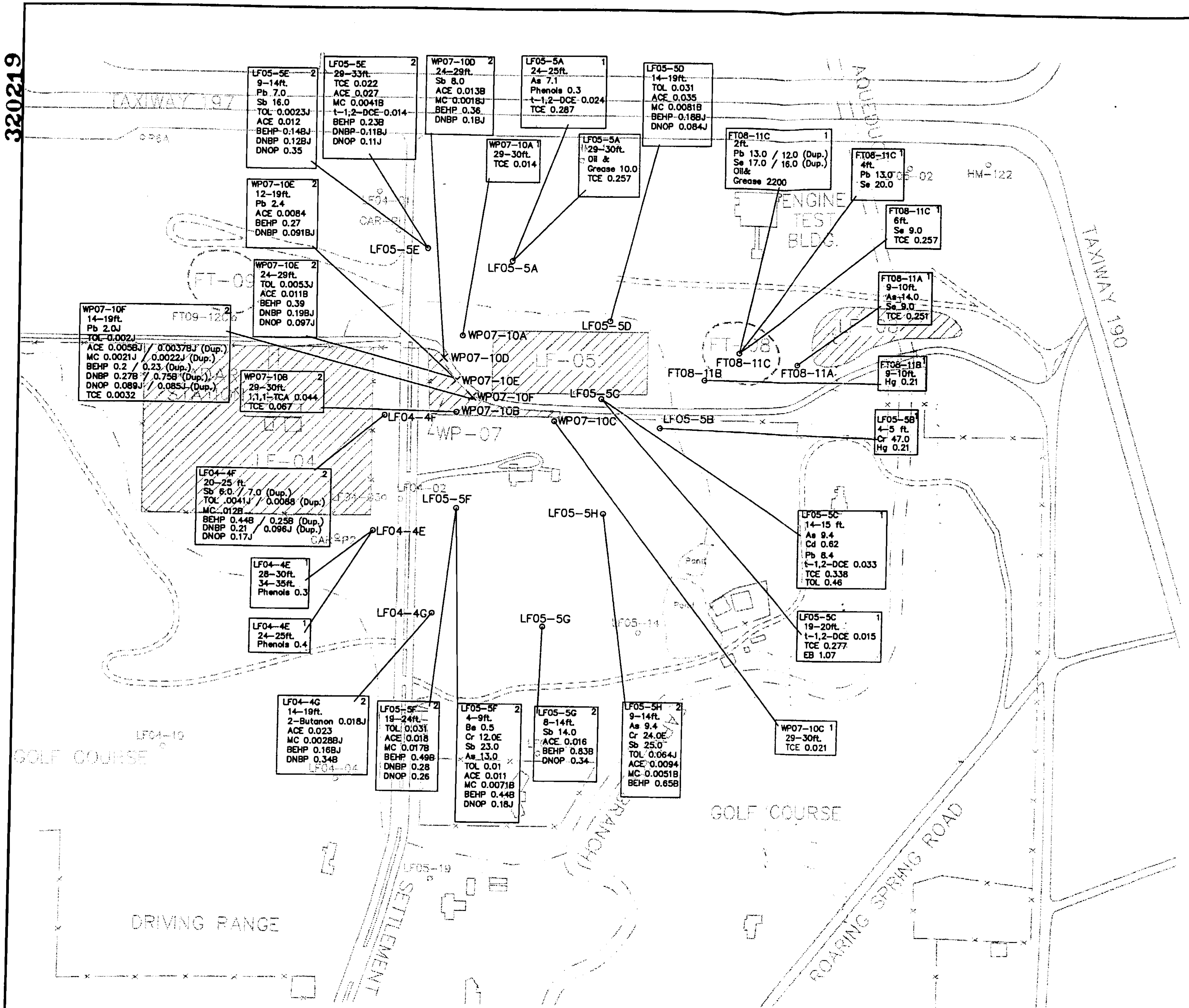


Figure 5.9
Soil Concentrations Above TNRCC Standards Sites WP-07 and LF-05

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

- ROAD
- STREAM
- FENCE
- SWMU TO BE INVESTIGATED
- SWMU NOT IN CURRENT RFI/CMS
- HM-122 MONITORING WELL
- WP07-10D SOIL BORING

As	Arsenic	MC	Methylene Chloride
TOL	Toluene	Sb	Antimony
ACE	Acetone	t-1,2-DCE	Trans-1,2-Dichloroethylene
BEHP	Bis(2-Ethylhexyl) Phthalate	Be	Beryllium
DNBP	Di-n-Butyl Phthalate	1,1,1-TCA	1,1,1 Trichloroethane
DNOP	Di-n-Octyl Phthalate	EB	Ethyl Benzene
Cd	Cadmium	Hg	Mercury
Pb	Lead	TCE	Trichloroethylene
Se	Selenium	2-BUTA	2-Butanon
Cr	Cromium		

NOTE: All analytical results are in units of mg/Kg.

B: Detected in reagent blank; background subtraction not performed.
J: Estimated value (GC Test Codes)
BJ: Analyte detected in blank; estimated value below detection limit.

1 IRP Phase II, Stage 1 (Radian, 1986)
2 RI/FS, Stage 2 (Radian, 1989)

SCALE
0 300 600 FEET

HYDRO GeoLogic INC.

Map Source:
IT CORP., 1993

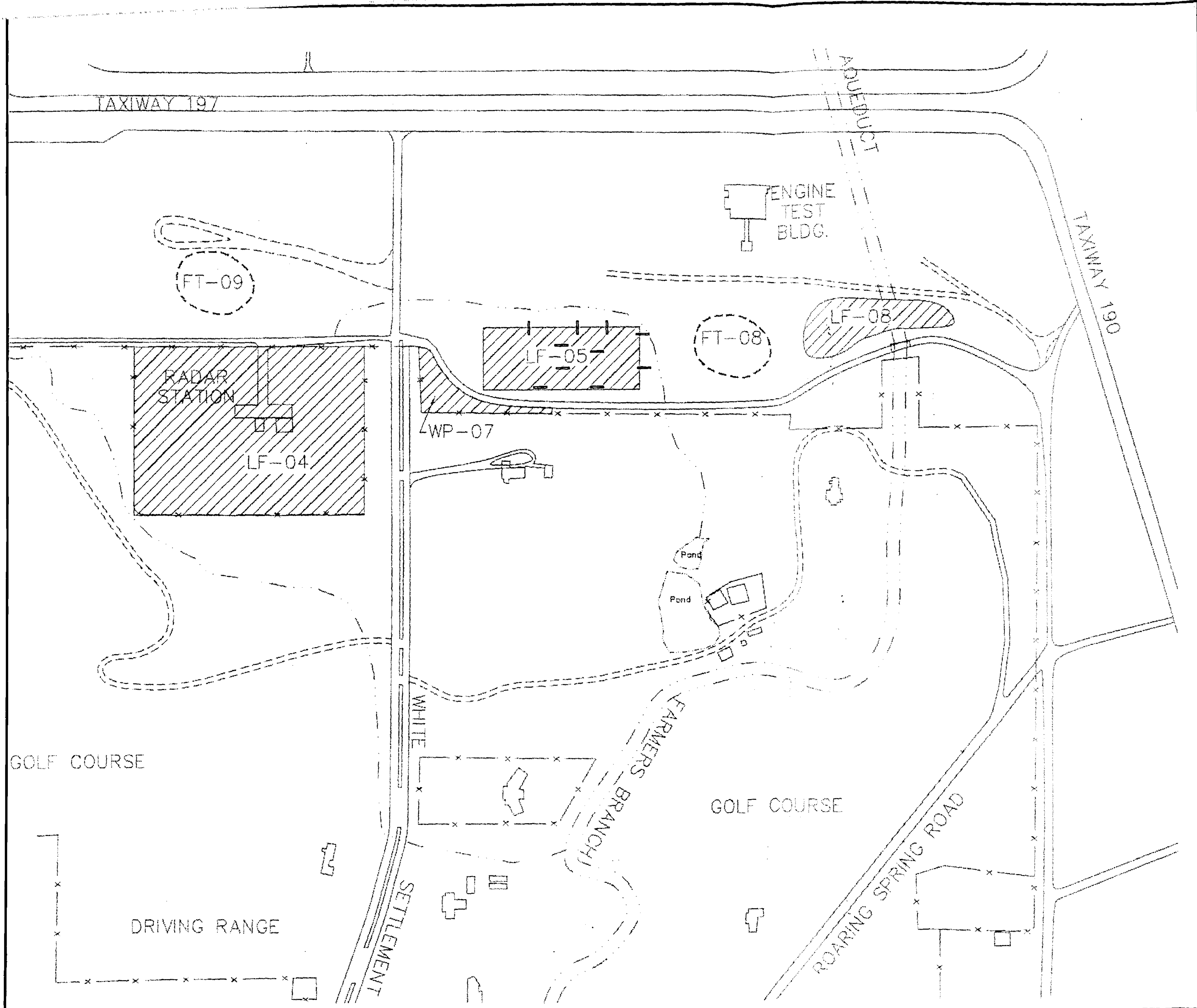


Figure 5.10

Proposal Test Pit Locations
LF-05

Air Force Center
For Environmental Excellence
Brooks AFB, Texas

LEGEND

ROAD
STREAM
FENCE
SWMU TO BE INVESTIGATED
SWMU NOT IN CURRENT RFI/CMS
PROPOSED TEST PIT LOCATION

SCALE
0 300 600 FEET

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Map Source:
IT CORP., 1993

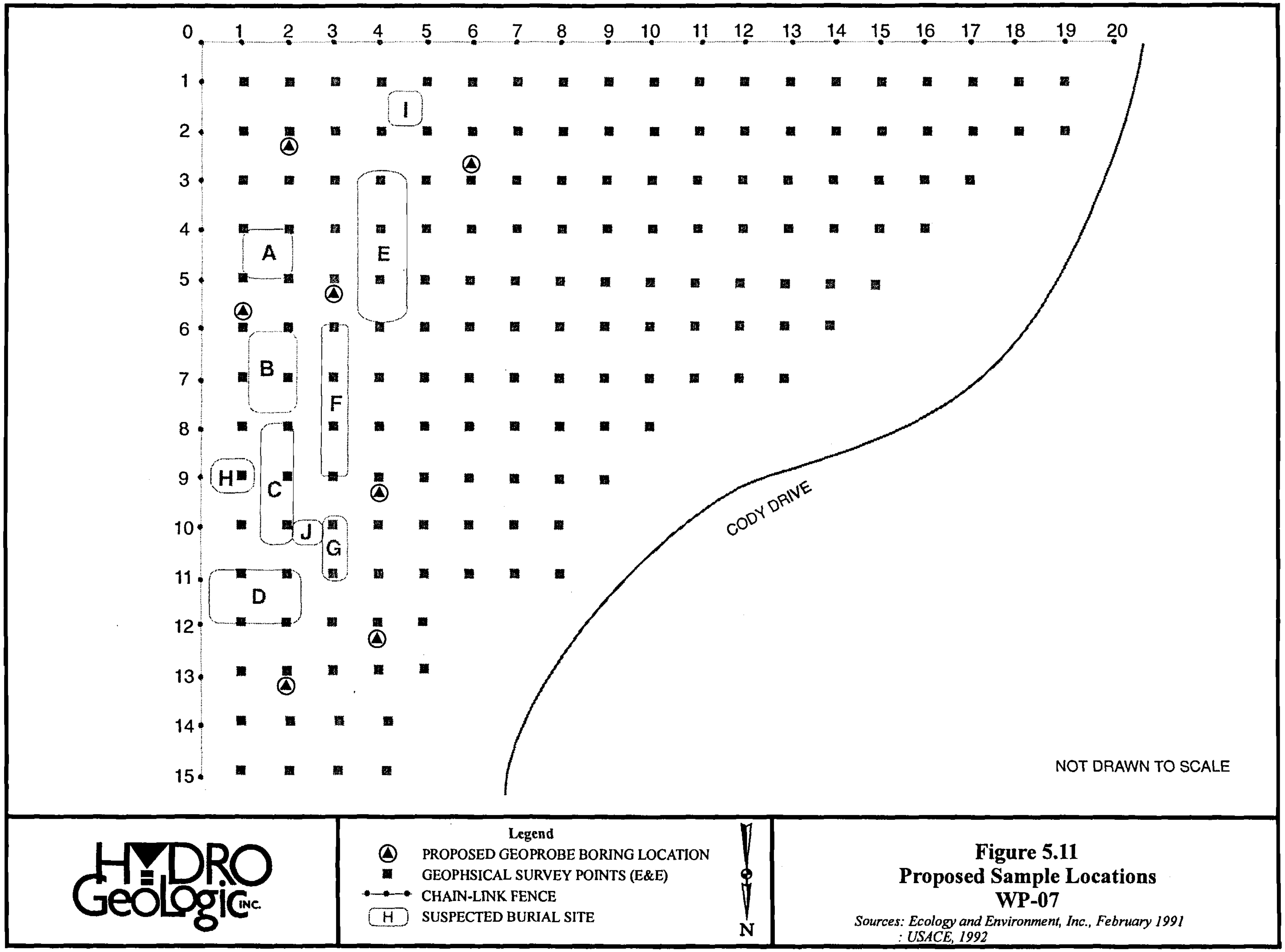

Figure 5.11
Proposed Sample Locations
WP-07

Sources: Ecology and Environment, Inc., February 1991
: USACE, 1992

320221

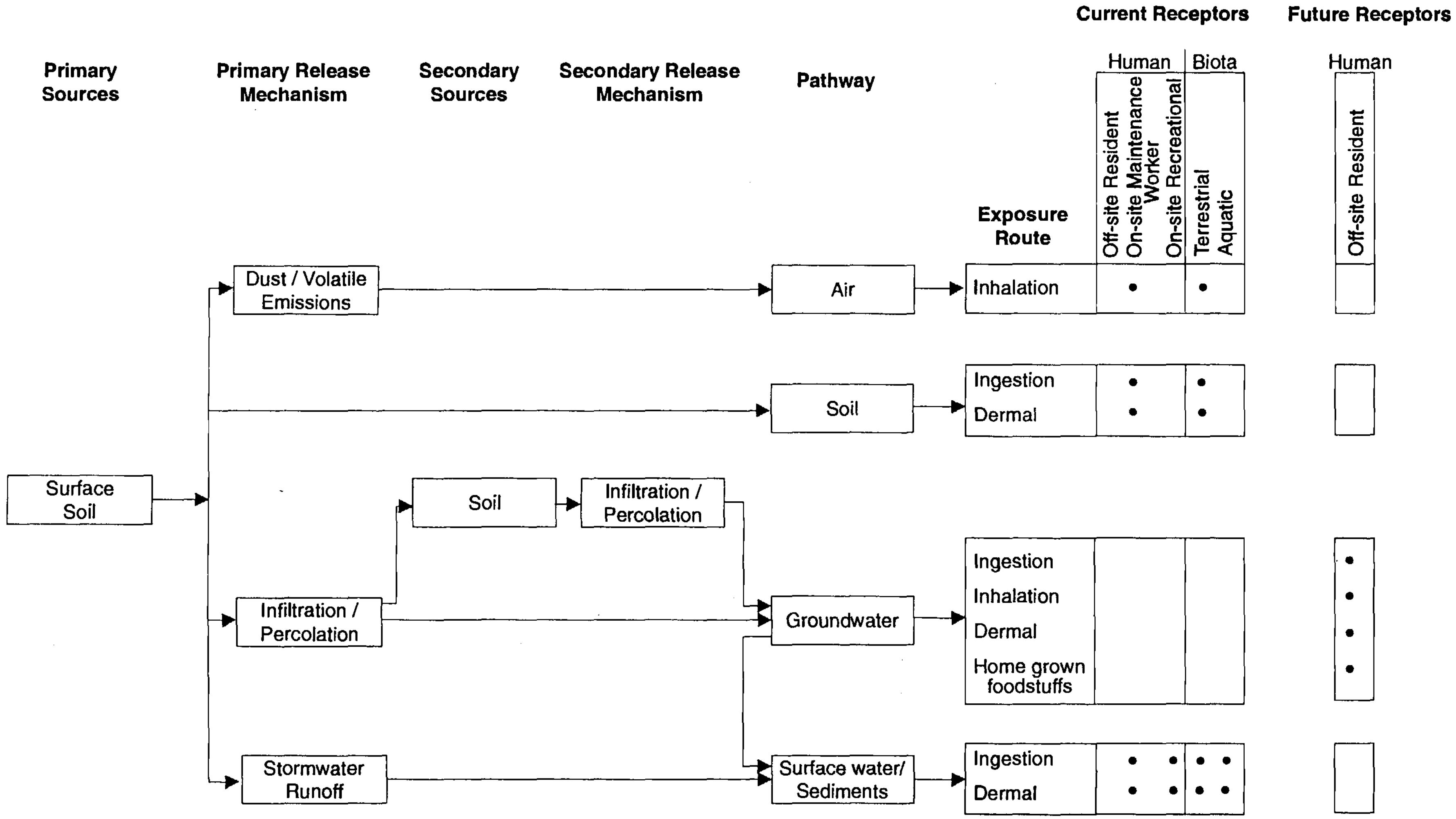

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Figure 6.1
Conceptual Exposure Pathway Model
for Surface Soil
Carlswell AFB, Texas

320222

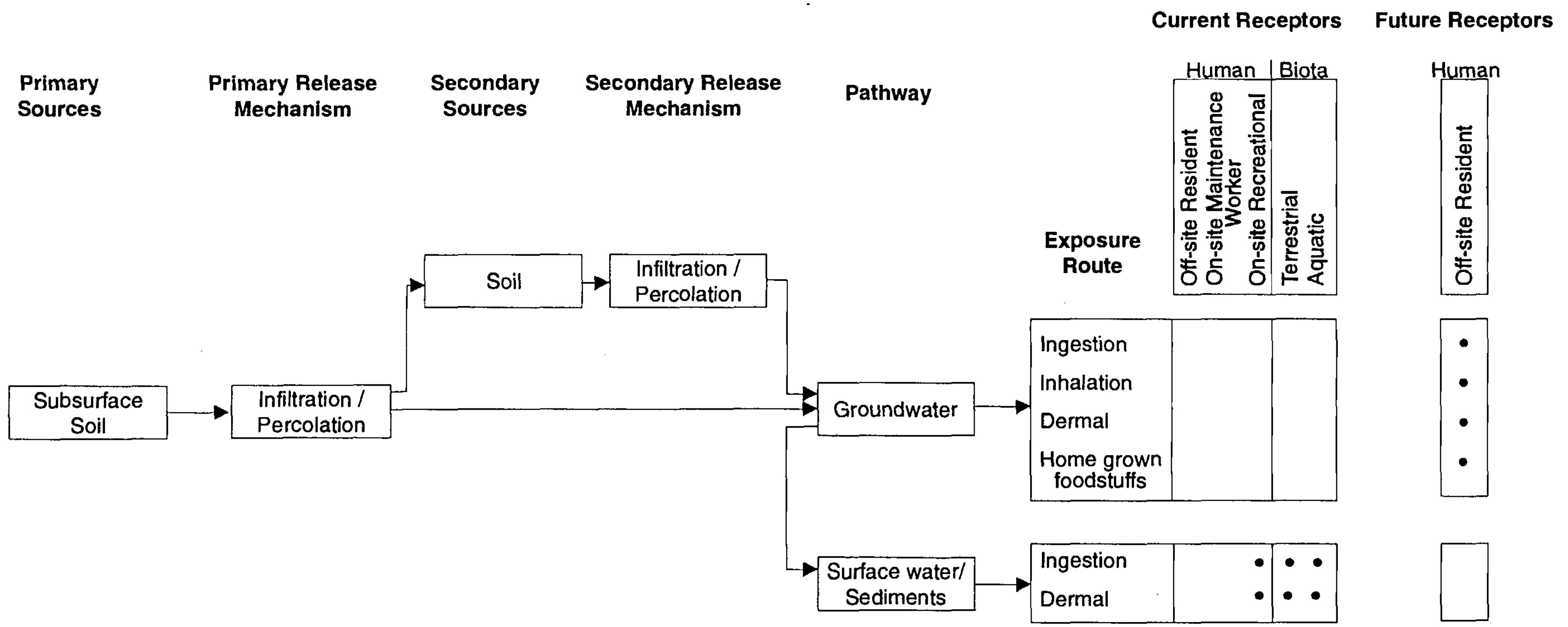

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Figure 6.2
Conceptual Exposure Pathway Model
for Subsurface Soil
Carlswell AFB, Texas

320223

320224

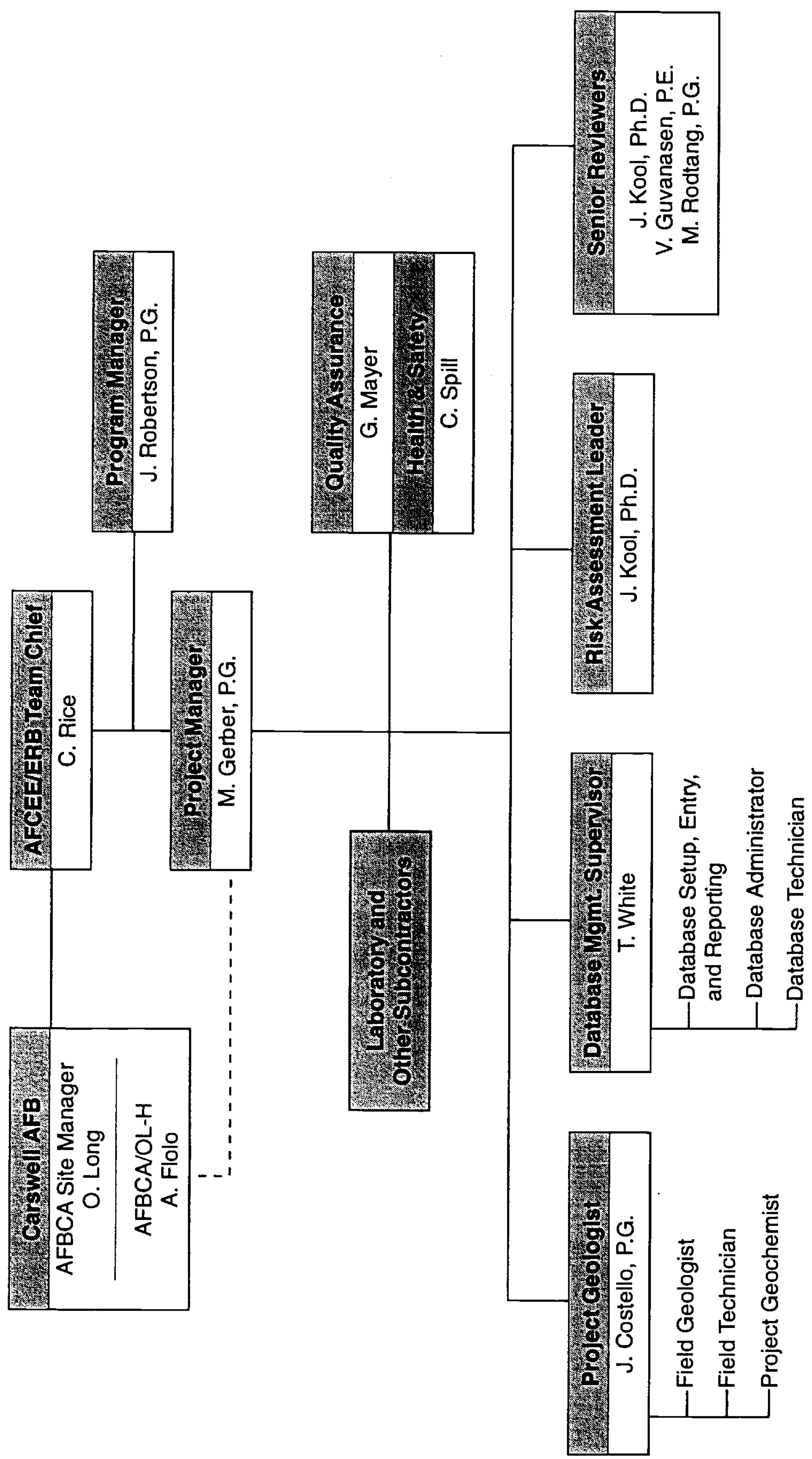
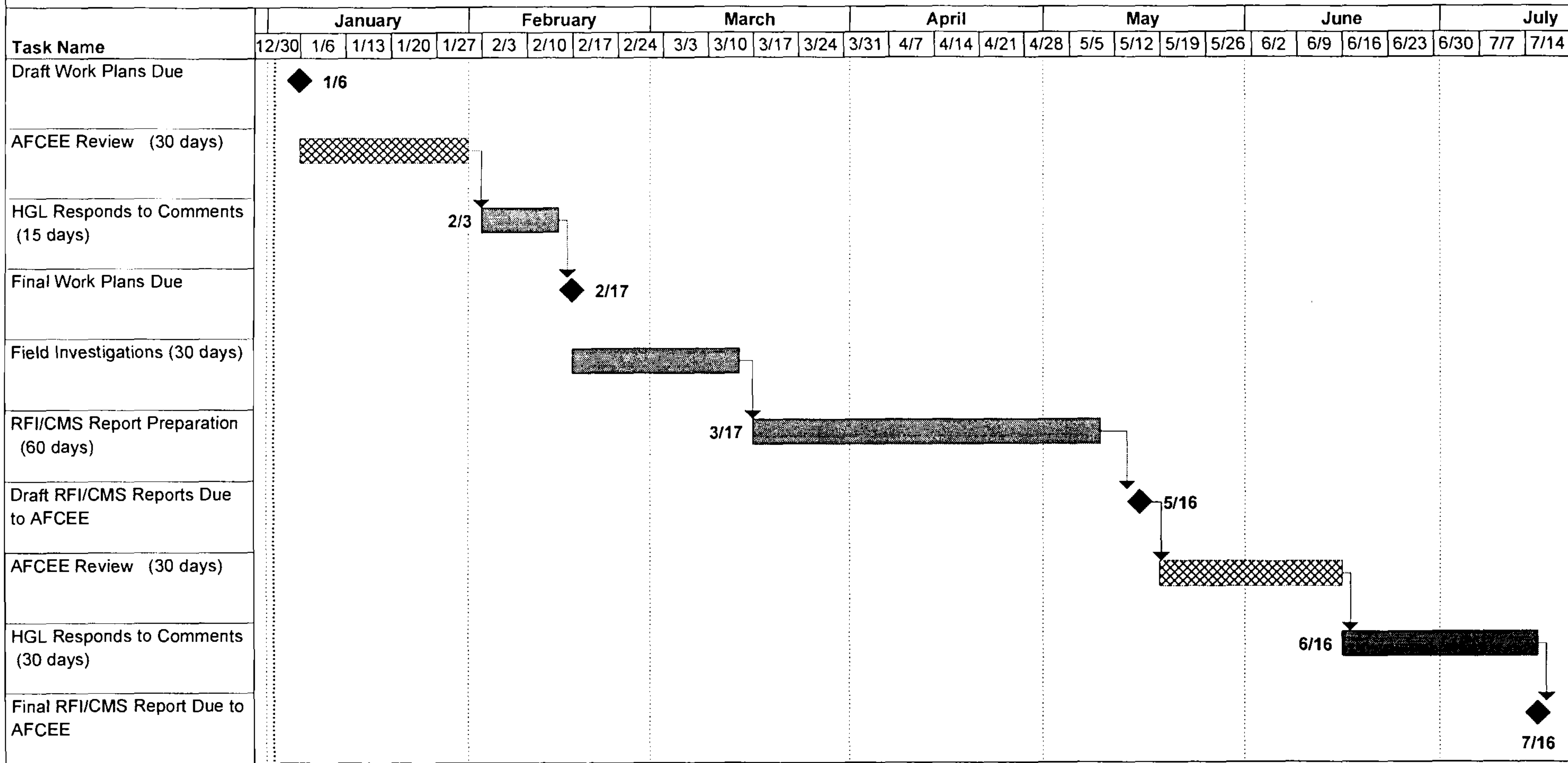


Figure 8.1

Project Organization
Carswell AFB

FIGURE 12.1
REVISED SCHEDULE
CARSWELL AFB RFI/CMS PROJECT



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DRAFT
FIELD SAMPLING PLAN

RCRA FACILITY INVESTIGATION/ CORRECTIVE MEASURES STUDY CARSWELL AFB, TEXAS

Contract Number F41624-95-D-8005

Prepared for:

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

Prepared by:

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

January 1997

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1.0 INTRODUCTION

This document is part of the Work Plans for a Resource Conservation Recovery Act (RCRA) Facility Investigation (RFI) at the former Carswell Air Force Base (CAFB, the Base). The investigation is being conducted as part of the United States Air Force Installation Restoration Program. This work is authorized as Delivery Order 0002 under Air Force Center for Environmental Excellence (AFCEE) Contract No. F41624-95-D-8005. For this investigation, the Work Plans consist of a Work Plan (WP), a Sampling and Analysis (SAP), and a Health and Safety Plan (HSP). The SAP consists of a Field Sampling Plan (FSP) and a Quality Assurance Project Plan (QAPP). The FSP describes in detail the proposed sampling and analysis and the specific procedures, measurements, and record keeping requirements for the field effort.

RFI data collection activities include test pit excavation and soil sampling; sampling of soil borings using hand auger and direct push technology; installation of groundwater monitoring wells with hollow-stem auger drilling equipment; sampling of groundwater wells; surface water and sediment sampling. Table 1.1 of this FSP provides a summary of planned field data collection activities. The FSP describes in detail the proposed sampling and analysis program, specific field procedures, field measurements, and record keeping requirements for the field effort. Field investigation procedures are described in the following sections.

This FSP has been prepared according to AFCEE's *Model Field Sampling Plan* (March 1996), the AFCEE *Handbook for the Installation Restoration Program (IRP) for Remedial Investigations and Feasibility Studies* (September 1993), and follows guidelines defined in the *Data Quality Objectives Process for Superfund, Interim Final Guidance* (U.S. EPA, 1993).

This FSP is required reading for all staff participating in the work effort. The FSP will be in the possession of the field teams collecting the samples.

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Table 1.1
Proposed RFI/CMS Sampling Locations
Carswell AFB, Texas

Site	Matrix	Sample Collection Method	Depth	Number of Locations	Analyses	Rationale
Site-wide	Groundwater	Submersible Pump	Shallow Groundwater	9	VOC[1], SVOC[2], PP Metals[3]	Delineate the northern and eastern extents of the TCE plume. Install/ sample four new wells. Sample five existing wells.
Site-wide	Surface Water	Grab Samples	Top six inches of surface water	12	VOC, SVOC, PP Metals	Determine the nature and extent of the surface water contamination
Site-wide	Sediment	Grab Samples	Top four inches of sediments	12	VOC, SVOC, PP Metals	Determine the nature and extent of sediment contamination
LF-04	Surface Soil	Hand Auger	Top two feet of soil	10	VOC, SVOC, PP Metals	Evaluate the chemical characteristics of surface soil at LF-04
LF-05	Surface Soil	Hand Auger	Top two feet of soil	10	VOC, SVOC, PP Metals	Evaluate the chemical characteristics of surface soil at LF-05
WP-07	Surface Soil	Hand Auger	Top two feet of soil	7	VOC, SVOC, PP Metals	Evaluate the chemical characteristics of surface soil at WP-07
LF-08	Surface Soil	Hand Auger	Top two feet of soil	8	VOC, SVOC, PP Metals	Evaluate the chemical characteristics of surface soil at LF-08
LF-04	Subsurface Soil	Test Pit	Top of undisturbed soil	10	VOC, SVOC, PP Metals	Determine the chemical characteristics of the undisturbed soil beneath the unit
LF-05	Subsurface Soil	Test Pit	Top of undisturbed soil	10	VOC, SVOC, PP Metals	Determine the chemical characteristics of the undisturbed soil beneath the unit
LF-08	Subsurface Soil	Test Pit	Top of undisturbed soil	8	VOC, SVOC, PP Metals	Determine the chemical characteristics of the undisturbed soil beneath the unit
WP-07	Subsurface Soil	Geoprobe Boring	Soil above top of water	7	VOC, SVOC, PP Metals	Determine the chemical characteristics of the soil above the water table

Notes:

[1] Analytical method for SVOCs are SW846 Method 8260.
[2] Analytical method for SVOCs are SW846 Method 8270.
[3] Analytical method for Priority Pollutant Metals are SW846 Methods 6010 and 70000.

2.0 PROJECT BACKGROUND

2.1 THE U.S. AIR FORCE INSTALLATION RESTORATION PROGRAM

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

The 1976 RCRA is one of the primary federal laws governing the disposal of hazardous wastes. Sections 6001 and 6003 of RCRA require federal agencies to comply with local and state environmental regulations and provide information to the EPA concerning past disposal practices at federal sites. RCRA Section 3012 requires state agencies to inventory past hazardous waste disposal sites and provide information to the EPA concerning those sites.

In 1980, Congress enacted CERCLA (Superfund). CERCLA outlines the responsibility for identifying and remediating contaminated sites in the United States and its possessions. The CERCLA legislation identifies the EPA as the primary policy and enforcement agency regarding contaminated sites.

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

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

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

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

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

2.2 PROJECT PURPOSE AND SCOPE

The purpose and scope of this project have been defined in Section 1.0 of the Work Plan. Please refer to the Work Plan for this information.

2.3 PROJECT SITE DESCRIPTION

A detailed description of the sites to be investigated (i.e, Landfills 4, 5, and 8, and WP-07) is provided in the Work Plan. Please refer to the Work Plan for project site descriptions.

2.4 PROJECT SITE CONTAMINATION HISTORY

Section 5.0 of the Work Plan provides the history of environmental investigations conducted at each site and documents subsequent contamination present at each site. Please refer to this section for the contamination history of the sites.

3.0 PROJECT SCOPE AND OBJECTIVES

The scope and objectives of the project are presented in the Work Plan. A summary of the objectives, the samples to be analyzed and the field activities planned for the RFI/CMS are presented in the following sub-sections.

3.1 OBJECTIVES

The data quality objectives (DQOs) are determined based on the end use of the data collected. The DQOs for this RFI/CMS are intended to provide data of sufficient quality to achieve the following objectives:

- ***Site-wide Alluvial Terrace Groundwater.*** Determine the nature and extent, and evaluate the fate and transport of the alluvial terrace groundwater contamination beneath the Flightline Area. Conduct a baseline risk assessment (BLRA) for the alluvial terrace groundwater beneath the Flightline Area. Complete a corrective measures study to evaluate the remediation alternatives if the BLRA shows excess risk present at the site.

- ***Site-wide Surface Water and Sediment.*** Determine the nature and extent of the surface water and sediment contamination in the Flightline Area. Conduct a BLRA and a qualitative ecological risk assessment. Complete a corrective measures study, if necessary.

- ***Sites LF-04 and LF-05.*** Determine the source of the contamination present in the groundwater beneath the units. Determine the nature and extent of any contamination discovered in the vadose zone. Conduct a BLRA if surface or subsurface soil contamination is identified. Complete a corrective measures study, if necessary.

- ***Site WP-07.*** Determine the nature and extent of the soil contamination identified during the source removal action. Conduct a BLRA if surface or subsurface soil contamination is identified. Complete a corrective measures study, if necessary.

- ***Site LF-08.*** Conduct a geophysical survey to identify the location of the former landfill. Determine if a source a contamination is present through the use of test pits. Conduct a BLRA if surface or subsurface soil contamination is identified. Complete a corrective measures study, if necessary.

3.2 SAMPLE ANALYSIS AND FIELD ACTIVITY SUMMARY

Section 5.0 of the Work Plan provides a discussion of the field activities proposed, number of sampling locations proposed, the number of samples to be collected from each location, and the types of laboratory analyses. Table 3.1 provides a list of all samples proposed for the RFI/CMS field investigation. Table 3.2 is a summary of the field activities to be conducted during the

RFI/CMS. Table 3.3 is a summary of the DQOs for all of the analyses for samples to be collected during the RFI/CMS.

Table 3.1
Sample Analysis Summary

Site	Method	Matrix	# Samples	# Equipment Blanks	# Ambient Blanks	# Trip Blanks	# Field Duplicates	# MS/MSD	Total # Samples
Site-wide	8260	Groundwater	9	4	1	1	1	2	18
Site-wide	8270	Groundwater	9	4	0	0	1	2	16
Site-wide	PP Metals[1]	Groundwater	9	4	0	0	1	2	16
LF-04	8260	Soil	20	5	0	1	2	2	30
LF-04	8270	Soil	20	5	0	0	2	2	29
LF-04	PP Metals	Soil	20	5	0	0	2	2	29
LF-05	8260	Soil	20	5	0	1	2	2	30
LF-05	8270	Soil	20	5	0	0	2	2	29
LF-05	PP Metals	Soil	20	5	0	0	2	2	29
WP-07	8260	Soil	14	3	0	1	2	2	22
WP-07	8270	Soil	14	3	0	0	2	2	21
WP-07	PP Metals	Soil	14	3	0	0	2	2	21
LF-08	8260	Soil	16	5	0	1	2	2	26
LF-08	8270	Soil	16	5	0	0	2	2	25
LF-08	PP Metals	Soil	16	5	0	0	2	2	25
Site-wide	8260	Surface water	12	1	0	1	2	2	18
Site-wide	8270	Surface water	12	1	0	0	2	2	17
Site-wide	PP Metals	Surface water	12	1	0	0	2	2	17
Site-wide	8260	Sediments	12	1	0	0	2	2	17
Site-wide	8270	Sediments	12	1	0	0	2	2	17
Site-wide	PP Metals	Sediments	12	1	0	0	2	2	17

Notes:

[1] Priority Pollutant metals by 6010, Mercury by 7000.

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Table 3.2
Field Activities Summary

Site	Activity	#
Site-wide	Install Alluvial Terrace Monitoring Wells	4
Site-wide	Sample Existing Alluvial Terrace Monitoring Wells	5
Site-wide	Surface Water Sample Locations	12
Site-wide	Sediment Sample Locations	12
LF-04	Test Pits	10
LF-05	Test Pits	10
WP-07	Soil Borings	7
LF-08	Test Pits	8
LF-08	Geophysical Study	1

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Table 3.3
Data Quality Levels and Intended Use for Field and Laboratory Data
Carswell AFB

Sampling Matrix/Location	Parameters[a]	Analytical Method	Field/Lab Analysis	Data Quality Level	Intended Use
Soil, all locations	VOCs	PID	Field	I	Field screening
Groundwater, all locations	Temperature, pH, EC, turbidity	NA	Field	II	Field screening for well purging/ development
Surface water	Temperature, pH, EC, turbidity	NA	Field	II	Field screening
Surface water and sediment	Priority Pollutant metals VOCs SVOCs	6010A, 7000 8260A 8270B	Lab Lab Lab	IV IV IV	Characterize conditions, risk assessment, corrective measures study
Groundwater	Priority Pollutant metals VOCs SVOCs	6010A, 7000 8260A 8270B	Lab Lab Lab	IV IV IV	Nature/extent of contaminants, risk assessment, corrective measures study
Soil LF-04, LF-05, LF-07, LF-08	Priority Pollutant metals VOCs SVOCs	6010A/7000 8260A 8270B	Lab Lab Lab	IV IV IV	Nature/extent of contaminants, risk assessment, corrective measures study

Notes:

[a] VOCs = Volatile Organic Compounds
EC = Electrical Conductivity
SVOCs = Semivolatile Organic Compounds
NA = Not Applicable

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4.0 PROJECT ORGANIZATION AND RESPONSIBILITY

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The individuals and their respective responsibilities for this project are outlined in Section 8.0 of the Work Plan. Please refer to Section 8.0 of the Work Plan.

4.1 SUBCONTRACTORS

HydroGeoLogic's subcontractors for this project will be determined by past performance and cost effectiveness. The Base point of contact (POC) and AFCEE will have final approval of all subcontractors. Subcontractors necessary for this project will include: drillers, backhoe/trackhoe operators, and surveyors.

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5.0 FIELD OPERATIONS

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The overall project field logistics and activities necessary to complete the project sampling objectives described in the WP are presented in this section. All field work will be conducted in accordance with the site HSP. HydroGeoLogic will be the prime contractor for the field investigation. The POC at the Base will be Mr. Olen Long. HydroGeoLogic's Field Coordinator will be Ms. Miquette Gerber.

5.1 GEOLOGIC STANDARDS

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

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

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

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

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

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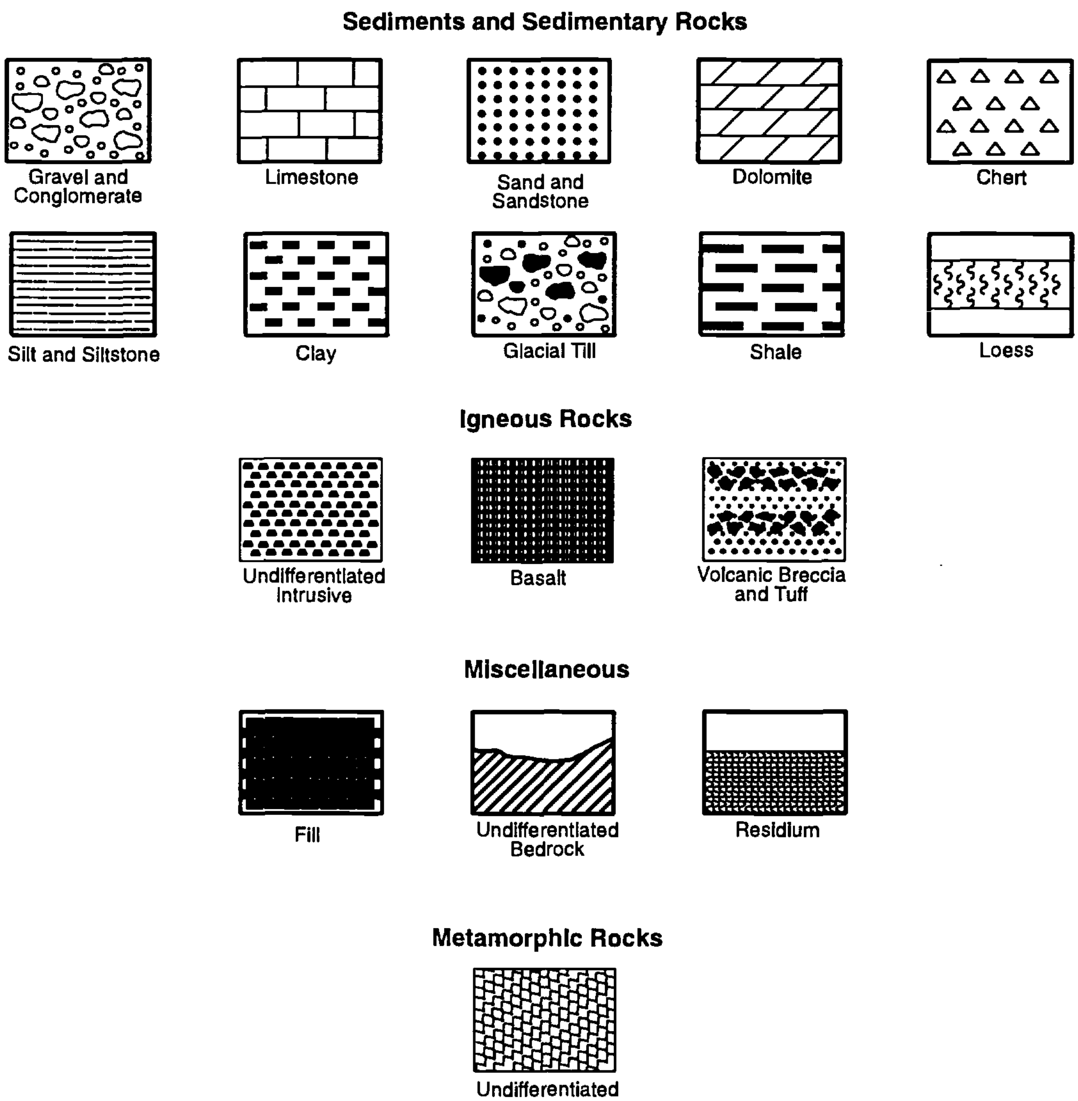

Figure 5.1 Lithologic Patterns for Illustration

5.2 SITE RECONNAISSANCE, PREPARATION, AND RESTORATION PROCEDURES

Areas designated for intrusive sampling will be surveyed for the presence of underground utilities. Utility locations are determined using existing utility maps, and in the field, are verified using a hand-held magnetometer or utility probe. Prior to commencement of drilling activities, the Base civil engineer will be contacted to verify that selected locations are free of underground utilities. Those locations not clear of underground utilities will be relocated to achieve clearance and verified for clearance a second time. Vehicle access routes to sampling locations will be determined by the Base representative prior to any field activity.

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

The field office and the primary staging area for field equipment and supplies will be located in the building adjacent to the west side of the Air Force Base Conversion Agency office at 6550 White Settlement Road. This location is in close proximity to the four SWMUs under investigation.

Each work site or sampling location will be returned to its original condition when possible. Efforts will be made to minimize impacts to work sites and sampling locations, particularly those in or near sensitive environments such as wetlands. Following the completion of work at a site, all drums, trash, and other waste will be removed. Decontamination and/or purge water and soil cuttings will be transported to the designated locations as described in Section 5.12. At the completion of field activities, all capital equipment and consumable materials will be removed or turned over to Base personnel in accordance with AFCEE procedures. A final site walk will be conducted with the Base representative, at his/her discretion, to ensure that all sampling locations have been restored satisfactorily before final demobilization from the site.

5.3 GEOPHYSICAL SURVEYS

Two geophysical surveys, Electromagnetic Induction (EM) and a magnetometer survey will be utilized to evaluate the extent of the landfill and any "hot spots" that may be present at LF-08. The EM survey will be used to initially identify and pin point areas with conductivity contrasts, i.e., "hot spots." The grid will then be resurveyed, including the "hot spots" using the cesium (Cs) magnetic gradiometer as a confirmatory tool. The data gathered from these surveys will help identify areas of buried wastes and provide indications on the depths of groundwater, bedrock, and stratigraphy. This information will be used to assure that optimal trenching and soil sampling locations are selected.

5.3.1 General Requirements For Geophysical Surveys

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A HydroGeoLogic professional geologist or engineer will supervise geophysical surveying activities. The final results of the geophysical survey will be presented in plain views and cross sections and contours will be used where appropriate. The interpretation of results will discuss positive and negative results as well as limitations of the method and data and the interpretation of the data will be incorporated into the conceptual site model.

5.3.2 Surface Geophysical Surveys

The survey procedure will begin by creating a grid over an approximately 4 acre area (950 feet [N-S] by 175 feet [E-W]) that will overlay the area suspected to be the landfill. Although the lateral extent of the landfill is not expected to be this large, a fringe surrounding the landfill is desired and will serve as a background data set for comparison. Station locations will be placed on 10 foot centers using a tape measure for distance and a transit for trueness. The chain link fence, across from Cody Drive will be used as the base line from which all perpendicular lines originate. However, the survey will not be conducted east of Cody Drive. The base station for this grid will be a corner of the fence located approximately 1,130 feet north of White Settlement, where the fence bends east at a 90° angle and continues for approximately 50 feet. Figure 1.3 of the Work Plan shows the location of the fence and its relation to LF-08. All distances on the geophysical site maps will be measured in feet from this monument.

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

5.3.2.1 Electromagnetic Methods

An electromagnetic survey measures the electrical conductivity of a subsurface volume, which is a function of the soil or rock type, porosity/permeability, and fluid content. The measured values, referred to as terrain conductivity, are obtained without direct ground contact through electromagnetic induction. Data collected during an electromagnetic survey can be used to map the location of buried metallic objects; depth or thickness determinations cannot be made solely by this method. The electromagnetic technique can also detect chemicals or contaminant plumes (e.g., hydrocarbons in high concentrations or other conductive or resistive chemicals).

A ground conductivity meter (e.g., Geonics Ltd. EM-31DL®) will be used to obtain terrain conductivity data. The transmitting and receiving coils on this instrument are mounted at the ends of 4-foot tubes that project horizontally from either end of the instrument console. The 8-foot coil separation results in a depth of penetration of approximately 15 to 18 feet. A data logger records quadrature and in-phase data at each measuring station.

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

5.3.2.2 Magnetometry

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

Magnetometer surveys are conducted using a magnetometer/gradiometer or equivalent equipment (e.g., Geometrics model 856AG® proton precession magnetometer/gradiometer). The magnetometer has two sensors and an electronics package and can collect both total field data and vertical gradient data and can discriminate to 0.2 gammas (g) in a total field of 40,000 to 60,000 g. Magnetic readings are stored in memory with the time of day, station numbers, and line numbers of the readings. A base station for magnetic readings is established at the start of each day's measurements. Magnetic readings will be collected and recorded in the morning, at noon, and at the end of day to evaluate instrument drift.

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

5.4 BOREHOLE DRILLING, LITHOLOGIC SAMPLING, LOGGING, AND ABANDONMENT

5.4.1 General Drilling Procedures

All drilling activities will conform with state and local regulations and will be supervised by a HydroGeoLogic licensed professional geologist or engineer. HydroGeoLogic will obtain all necessary permits, applications, and other documents required by state and local authorities. The location of all borings will be coordinated, in writing, with the base civil engineer or equivalent before drilling commences.

The drill rig will be cleaned and decontaminated in accordance with the procedure in Section 5.11. The drill rig will not leak any fluids that may enter the borehole or contaminate equipment placed in the hole. Rags or other absorbent materials to absorb leaking fluids will not be used.

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

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

5.4.2 Logging

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

Unconsolidated samples for lithologic description will be obtained at each change in lithology or every five (5) foot interval, whichever is less. Lithologic descriptions of unconsolidated materials encountered in the boreholes will generally be described in accordance with American Society for Testing and Materials (ASTM) D-2488-90 Standard Practice for Description and Identification of Soils (Visual-Manual Procedure) (ASTM, 1990). Descriptive information to be recorded in the field will include: (1) identification of the predominant particles size and range of particle sizes, (2) percent of gravel, sand, fines, or all three, (3) description of grading and sorting of coarse particles, (4) particle angularity and shape, and (5) maximum particle size or dimension. Plasticity of fines description include: (1) color using Munsell Color System, (2) moisture (dry, wet, or moist), (3) consistency of fine grained soils, (4) structure of consolidated materials, and (4) cementation (weak, moderate, or strong).

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

Lithologic descriptions of consolidated materials encountered in the boreholes will generally be described in accordance with Section 5.1. Consolidated samples for lithologic description will be obtained at each change in lithology or at five-foot intervals, whichever is less, or as specified in the SOW. All samples will be monitored with an organic vapor monitor (e.g., PID, OVA). The samples will be handled in such a way as to minimize the loss of volatiles, and these procedures will be described in Section 6.0. Cuttings will be examined for their hazardous characteristics. Materials that are suspected to be hazardous because of abnormal color, odor, or organic vapor monitor readings will be containerized in conformance with the RCRA and the state and local requirements. Lithologic descriptions of consolidated materials will follow the specifications in Section 5.1.

5.4.3 Abandonment

Boreholes that are not converted to monitoring wells will be abandoned in accordance with applicable federal, state or local requirements. If a slurry is used, a mud balance and/or Marsh Funnel will be used to ensure the density (lbs/gal) of the abandonment mud mixture conforms with the manufacturer's specifications. The slurry will be emplaced from the bottom to the top of the hole using a tremie pipe.

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

5.5 MONITORING WELL CONSTRUCTION

The on-site field manager will supervise the drilling, soil boring, geophysical surveys, lithologic sampling, and monitoring well construction and will be a licensed professional geologist or engineer. The supervising field manager will affix his/her signature and registration/certification seal to all drilling logs, as-built well construction diagrams, lithologic logs, sampling records, and similar documents. Although floating petroleum products are not anticipated to be encountered, monitoring wells will be screened across the water table if they are encountered.

5.5.1 Drilling Requirements

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

The rig will be cleaned and decontaminated according to the guidelines described in Section 5.11 The rig will not leak any fluids that may enter the borehole or contaminate equipment that is placed in the hole. Rags or absorbent materials will not be used to absorb leaking fluids.

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

5.5.2 Borehole Requirements

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

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

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

The documentation record and forms, Appendix A, will document the following information for each boring: (1) boring or well identification (this identification will be unique; HydroGeoLogic will ensure that it has not been used previously at the installation.), (2) purpose of the boring (e.g., soil sampling, monitoring well), (3) location in relation to an easily identifiable landmark, (4) names of drilling contractor and logger, (5) start and finish dates and times, (6) drilling method, (7) types of drilling fluids and depths at which they were used, (8) diameters of surface casing, casing type, and methods of installation, (9) depth at which saturated conditions were first encountered, (10) lithologic descriptions and depths of lithologic boundaries, (11) sampling-interval depths, (12) zones of caving or heaving, (13) depth at which drilling fluid was lost and the amount lost, (14) changes in drilling fluid properties, (15) drilling rate, and (16) drilling rig reactions, such as chatter, rod drops, and bouncing.

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

5.5.3 Casing Requirements

The casing requirements that will be followed are: (1) all casing will be new, unused, and decontaminated according to the specifications of Section 5.11, (2) glue will not be used to join casing, and casings will be joined only with compatible welds or couplings that will not interfere with the planned use of the well, (3) all polyvinyl chloride will conform to the ASTM Standard F-480-88A or the National Sanitation Foundation Standard 14 (Plastic Pipe System), (4) the casing will be straight and plumb within the tolerance stated for the borehole, and (5) the driller will cut a notch in the top of the casing to be used as a measuring point for water levels.

The monitoring wells will be constructed using flush-threaded two-inch diameter Schedule 40 Polyvinyl Chloride (PVC) casing.

5.5.4 Well Screen Requirements

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

The monitoring wells will be constructed using flush-threaded two-inch diameter Schedule 40 PVC casing and screen. The well screen will be ten feet long with 0.010 inch continuous slotted PVC screen placed in the lowest portion of the alluvial terrace groundwater zone. The bottom of the screen will be capped.

5.5.5 Annular Space Requirements

The annular space requirements are the following: (1) the annular space will be filled with a filter pack, a bentonite seal, and casing grout between the well string and the borehole wall, (2) any drilling fluids will be thinned with potable water of known acceptable quality to a density less than 1.2 g/cm^3 (10 lb/gal) before the annular space is filled, and a mud balance or Marsh Funnel will be kept on site to allow measurement of drilling fluid density, and (3) as the annular space is being filled, the well string will be centered and suspended such that it does not rest on the bottom of the hole, and for wells greater than 50 feet deep, at least two centralizers will be used, one at the bottom and one at the top of the screen. Additional centralizers will be used as needed.

Annular space will be filled with clean silica sand to approximately 3 feet above the top of the screen followed by approximately two feet of bentonite pellet seal. During placement of the sand, the 6-inch drive casing will be vibrated to insure that no bridging of the sand occurs. After the filter pack is emplaced, the well will be surged with a surge block for ten minutes. Following the verification of the top of the sand pack, a bentonite seal will be placed. The remaining annulus will be grouted to the surface using a 100% bentonite grout.

5.5.6 Filter Pack Requirements

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

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

The filter pack will have a grain size distribution and uniformity coefficient compatible with the formation materials and the screen, as described in Chapter 12, *Ground Water and Wells*, 2nd Edition, 1986. The filter pack will not extend across more than one water-bearing unit. In all wells, the filter pack will be emplaced with a bottom-discharge tremie pipe of at least 1-1/2 inches in diameter. The tremie pipe will be lifted from the bottom of the hole at the same rate the filter pack is set. The contractor will record the volume of the filter pack emplaced in the well. Potable water may be used to emplace the filter pack so long as no contaminants are introduced. The contractor may use formation materials as a filter pack when they are compatible with the slot size of the screen, such as in glacial outwash gravel deposits.

5.5.7 Bentonite Seal Requirements

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

5.5.8 Casing Grout Requirements

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

5.5.9 Surface Completion Requirements

For flush-mounted completions, cut the casing about three inches below the land surface and provide a water-tight casing cap to prevent surface water from entering the well. To allow for escape of gas, a small diameter (e.g., 1/4-inch) vent hole will be placed in the upper portion of the casing, or a ventilated well cap will be used. A freely draining valve box with a locking cover will be placed over the casing. The top of the casing will be at least one foot above the bottom of the box. The valve box lid will be centered in a three-foot diameter, four-inch thick concrete pad that slopes away from the box at 1/4 inch per foot. The identity of the well will be permanently marked on the valve box lid and the casing cap. Where heavy traffic may pass over the well or for other reasons, the concrete pad and valve box/lid assembly will be constructed to meet the strength requirements of surrounding surfaces.

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

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

5.6 MONITORING WELL DEVELOPMENT

The monitoring well development requirements are: (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 and bailers or pumps (prior approval for any alternate method will be obtained, in writing, from AFCEE before well construction begins), and wells will be developed until the turbidity is $\leq$ 10 nephelometric turbidity units (NTU), and when the stabilization of pH, temperature, and specific conductance has occurred. Stabilization is defined in the AFCEE Handbook (Section 2.1.3.2) as pH within 0.1 unit, temperature within 1 degree centigrade, and specific conductance within 5 percent. In some instances, collection of non-turbid samples are difficult or unattainable. If a well does not provide a sediment-free sample, development will stop when:

- A maximum of 10 well volumes have been removed, in addition to any volume of water or fluid that may have entered the well and formation during construction and/or

- Temperature, conductivity, and pH have stabilized to ± 10 percent over at least three successive well volumes and the turbidity remains within a 10 NTU range for at least 30 minutes.

No detergents, soaps, acids, bleaches, or other additives will be used to develop a well. All development equipment will be decontaminated according to the specifications documented in Section 5.11. A Monitoring Well Development Log will be completed for each well (Appendix A).

5.7 ABANDONING MONITORING WELLS

All abandonment of monitoring wells, when necessary, will be performed in accordance with state and local laws and regulations. If slurry is used, a mud balance and/or Marsh Funnel will be used to ensure that the density (lbs/gal) of the abandonment mud mixture conforms with the manufacturer's specification. All abandoned 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. Abandonment of monitoring wells is not anticipated as an RFI/CMS activity.

5.8 TEST PIT EXCAVATION

A test pit is an opening in soil, unconsolidated deposit, or bedrock having at least one lateral dimension greater than the depth of the opening, which is used for scientific purposes. The location of each test pit will be coordinated in writing with the base civil engineer before digging begins. Test pit efforts will follow Occupational Safety and Health Administration (OSHA) rules for excavation and confined space entry. The excavated material will be screened for volatile organic compounds using an organic vapor monitor (e.g., PID, OVA). Excavated material will be backfilled immediately after the required information has been recorded unless the PID/OVA readings indicate that the soil is excessively contaminated. The first soils out will be the last in when filling the pit. No test pit will be left open overnight unless adequate safety precautions are employed. In vegetated areas, backfilled test pits will be reseeded with native grasses. The following will be recorded for each test pit: (1) the total depth, length, and width, (2) the depth and thickness of distinct soil or lithologic units, (3) a lithologic description of each unit, and (4) a description of any man-made materials or apparent contamination encountered. An example Test Pit Classification Log is included in Appendix A.

Excavation will occur by using a backhoe/trackhoe. Decontamination of all equipment will occur after an excavation is completed or daily following the procedures described in Section 5.11. Any shoring that is required will be described and documented.

A total of 28 test pits will be excavated as part of this work effort and will be completed according to specification outlined in Section 2.1.2.11 of the AFCEE Handbook. A backhoe/trackhoe will be used to excavate each test pit. Each pit will be 40 feet long and a maximum of 15 feet deep. The maximum depth of each pit will be 15 feet, the depth at which virgin soil beneath the debris is reached, depth at which bedrock is reached, or the depth at which groundwater is encountered, whichever occurs first. All excavated material will be used to backfill the test pits immediately after sampling unless the material is contaminated. Contamination will be determined by screening with a PID and visual observations. If the material is contaminated, it will be containerized and disposed of as IDW.

5.9 SURVEYING

All surveying locations of field activities will be measured by a certified land surveyor as the distance in feet from a reference location that is tied to the state plane system. The surveys will be third order (cf. Urquhart, L.C., *1962 Civil Engineering Handbook*, 4th Edition, p. 96 and 97).

An XY-coordinate system will be used to identify locations. The X-coordinate will be the East-West axis; the Y-coordinate will be the North-South axis. The reference location is the origin. All surveyed locations will be reported using the state plane coordinate system. The surveyed control information for all data collection points will be recorded and displayed in a table. The table will give the X and Y coordinates in state plane coordinate values, the ground elevation, and the measuring point elevation if the location is a ground-water monitoring well. The elevation of all newly installed wells and piezometers will be surveyed at the water level measuring point (notch) on the riser pipe. Include the elevation of the ground surface in the survey.

5.10 EQUIPMENT DECONTAMINATION

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

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

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

Reagent-Grade II Water, methanol, and hexane will be purchased, stored, and dispensed only in glass, stainless steel, or Teflon containers. These containers will have Teflon caps or cap liners. It is the contractor's responsibility to assure these materials remain free of contaminants. If any question of purity exists, new materials will be used.

Prior to commencement of field activities a decontamination area will be established at a suitable area determined by the CAFB representative. All sampling equipment that may directly or indirectly contact samples will be decontaminated before use. Drilling equipment will be steam cleaned prior to drilling each boring, installation of each monitoring well, and before leaving the site. Monitoring well casing material that arrives on-site sealed in factory supplied packaging will not be decontaminated prior to using in the well. Any casing material or well screen that is not sealed when it arrives at the wellhead will be steam cleaned and allowed to air dry prior to use in the monitoring well. Sampling equipment will be decontaminated in the following sequential steps:

- Wash and scrub equipment with a solution of potable water and laboratory-grade nonphosphate detergent.
- Rinse several times with potable water.
- Rinse plastic or Teflon-coated equipment with 10% nitric acid solution.
- Rinse with Reagent Grade-II Water (deionized water).
- Rinse with pesticide-grade methanol (if oily waste encountered).
- Rinse with pesticide-grade hexane (if oily waste encountered).
- Rinse with Reagent Grade-II Water (deionized water).
- Allow equipment to air dry.
- Wrap in aluminum foil, shiny side out.

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

5.11 WASTE HANDLING

5.11.1 General Waste Handling Procedures

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

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

Investigation derived waste will be properly containerized and temporarily stored at each site, prior to transportation. Depending on the constituents of concern, fencing or other special

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marking may be required. The number of containers will be estimated on an as-needed basis. Acceptable containers will be sealed, U.S. Department of Transportation (DOT)-approved steel 55-gallon drums or small dumping bins with lids. The containers will be transported in such a manner to prevent spillage or particulate loss to the atmosphere. To facilitate handling, the containers will be no more than half full when moved.

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

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

5.12 HYDROGEOLOGICAL CONCEPTUAL MODEL

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

5.12.1 Analytical or Numerical Model Representations of the Hydrogeological Conceptual Model

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

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

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6.0 ENVIRONMENTAL SAMPLING

6.1 SAMPLING PROCEDURES

All purging and sampling equipment shall be decontaminated according to the specifications in Section 5.11 prior to any sampling activities and will be protected from contamination until ready for use.

6.1.1 Groundwater Sampling

Groundwater sampling field procedures will follow those procedures outlined in the *Groundwater Sampling and Analysis Plan* created by CH2MHILL on behalf of AFCEE (August 1996).

6.1.2 Subsurface Soil Sampling

Soil samples will be collected based on odors, discoloration, organic vapor meter readings and any other field screening method.

6.1.2.1 Split-Spoon Samples

During monitoring well installation using hollow-stem auger methods, soil samples will be collected using stainless steel, continuous drive, California modified split-spoon samplers, or equivalent. These samplers are 24 inches in length and have an outside diameter (OD) of 3 inches to accommodate four 2-inch diameter brass/stainless steel rings, each of which is 6 inches in length. Soil samples during monitoring well installation will be field screened for VOCs. Samples will not be collected for laboratory analytical testing.

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

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

6.1.2.2 Sampling by Hand Auger

Hand augering will be used to collect soil samples from depths up to 2 feet bgs. Each hand auger boring will be advanced by manually turning a hand auger, equipped with 3-inch diameter cylindrical stainless steel bits, until the auger head fills with cuttings. The hand auger will then be pulled from the boring and the cuttings will be deposited on plastic sheeting. The hand augering will be continued until the sampling depth reaches two feet.

6.1.2.3 Direct Push Sampling

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

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

6.1.3 Surface Water Sampling

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

The sample collection sequence is as follows: (1) if sampling both water and sediment or just sediment, sampling will begin with the most downstream point and proceed upstream,(2) if sampling water only and the sample can be taken without disturbing the river or stream bottom, obtain any background samples first, then the farthest downstream sample, and then move upstream toward the source or discharge point,(3) if sampling water only and the stream or river bottom must be disturbed, start at the most downstream point and proceed upstream.

Samples will be taken from the active portion of the stream on the side nearest the source of contamination or suspected plume. Water samples are collected using a Van Dorn Sampler or Kemmerer Sampler when grab samples are required, or using an autosampler (discrete or composite samples) with the inlet line located at the desired sampling depth.

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

6.1.4 Sediment Sampling

Sediment samples for all parameters except VOCs will be collected using a stainless steel spoon to transfer sediments into a stainless steel bowl. The VOC samples will be transferred directly from the stainless steel spoon to sample containers. Organic material and cobbles will be discarded and the remaining sediments will be homogenized. The spoon will be used to transfer samples to the appropriate sample container.

6.2 SAMPLE HANDLING

6.2.1 Sample Containers

Sample containers are purchased precleaned and treated according to EPA specifications for the methods. Sampling containers that are reused are decontaminated between uses by the EPA-recommended procedures (i.e., EPA 540/R-93/051). Containers are stored in clean areas to prevent exposure to fuels, solvents, and other contaminants. Amber glass bottles are used routinely where glass containers are specified in the sampling protocol.

6.2.2 Sample Volumes, Container Types, and Preservation Requirements

Sample volumes, container types, and preservation requirements for the analytical methods performed on AFCEE samples are listed in Table 6.1. Sample holding time tracking begins with the collection of samples and continues until the analysis is complete. Holding times for methods required routinely for AFCEE work are specified in Table 6.1.

6.2.3 Sample Identification

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

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

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

xxxxyyyyzaa

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Table 6.1
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
Alkalinity	E310.1	P, G	4°C	50 mL	14 days
Common anions	SW9056	P, G	None required	50 mL	28 days for Br^-, F^-, Cl^-, and SO_4^{-2}; 48 hours for NO_3^-, NO_2^- and PO_4^{-3}
Cyanide, total and amenable to chlorination	SW9010A SW9012	P, G, T	4°C; NaOH to pH > 12, 0.6 g ascorbic acid	500 mL or 4 ounces	14 days (water and soil)
Filterable residue	E160.1	P, G	4°C	100 mL	7 days
Nonfilterable residue	E160.2	P, G	4°C	100 mL	7 days
Hydrogen ion (pH) (W, S)	SW9040/ SW9045	P, G	None required	N/A	Analyze immediately
Nitrogen, nitrate+nitrite	E353.1	P, G	4°C, H_2SO_4 to pH < 2	500 mL	28 days
Conductance	SW9050	P, G	None required	N/A	Analyze immediately
Temperature	E170.1	P, G	None required	N/A	Analyze immediately
Dissolved oxygen	E360.1	G	None required	500 mL	Analyze immediately
Turbidity	E180.1	P, G	4°C	N/A	48 hours
Total organic carbon	SW9060	P, G, T	4°C, HCl or H_2SO_4 to pH < 2	500 mL or 4 ounces	28 days (water and soil)
Chromium (VI)	SW7196A	P, G, T	4°C	500 mL or 8 ounces	24 hours (water and soil)[d]
Mercury	SW7470 SW7471	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	28 days (water and soil)
Metals (except chromium (VI) and mercury)	SW6010A SW6020 and SW-846 AA methods	P, G, T	HNO_3 to pH < 2, 4°C	500 mL or 8 ounces	180 days (water and soil)
Total petroleum hydrocarbons (TPH)-volatile	SW8015 (modified)	G, Teflon-lined septum, T	4°C, HCl to pH < 2	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid
Total petroleum hydrocarbons (TPH)-extractable	SW8015 (modified)	G, amber, 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)
Volatile aromatics	SW8020A	G, Teflon-lined septum, T	4°C, HCl to pH < 2, 0.008% $Na_2S_2O_3$	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid

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Table 6.1 (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
Halogenated volatiles	SW8021A	G, Teflon-lined septum, T	4°C, HCl to pH < 2, 0.008% $Na_2S_2O_3$	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid
Nitrosamines	SW8070	G, Teflon-lined cap, T	4°C	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Chlorinated herbicides	SW8150B SW8151	G, Teflon-lined cap, T	4°C, pH 5-9	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Organochlorine pesticides and polychlorinated biphenyls (PCBs)	SW8080A, SW8081,	G, Teflon-lined cap, T	4°C, pH 5-9	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Organophosphorus pesticides/ compounds	SW8140 SW8141A	G, Teflon-lined cap, T	4°C, pH 5-9	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Semivolatile organics	SW8270B	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Volatile organics	SW8240B, SW8010B, SW8260A	G, Teflon-lined septum, T	4°C, 0.008% $Na_2S_2O_3$ (HCl to pH < 2 for volatile aromatics by SW8240 and SW8260)[b]	2 x 40 mL or 4 ounces	14 days (water and soil); 7 days if unpreserved by acid
Polynuclear aromatic hydrocarbons (PAHs)	SW8310	G, Teflon-lined cap, T	4°C, store in dark, 0.008% $Na_2S_2O_3$	1 liter or 8 ounces	7 days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Dioxins and furans	SW8280	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$	1 liter or 8 ounces	30 days until extraction and 45 days after extraction (water and soil)
Ethylene dibromide (EDB)	SW8011	G, Teflon-lined cap, T	4°C, 0.008% $Na_2S_2O_3$	2 x 40 mL	28 days (water)

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Table 6.1 (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
Explosive residues	SW8330	P, G, T	Cool, 4°C	1 liter or 8 ounces	7 days to extraction (water); 14 days to extraction (soil); analyze within 40 days after extraction
TCLP	SW1311	G, Teflon-lined cap, T	Cool, 4°C	1 liter or 8 ounces	14 days to TCLP extraction and 14 days after extraction (volatiles); 14 days to TCLP extraction and 40 days after extraction (semivolatiles); 28 days to TCLP extraction and 28 days after extraction (mercury); 180 days to TCLP extraction and 180 days after extraction (metals)

[a] Polyethylene (P); glass (G); brass sleeves in the sample barrel, sometimes called California brass (T).
[b] No pH adjustment for soil.
[c] Preservation with 0.008 percent $Na_2S_2O_3$ 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 will be analyzed within 24 hours of completion of extraction.

where:

xxxx represents the site identification (e.g., LF04, LF05, WP07, LF08)

yyyy represents the location number (e.g., 04, 4F)

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

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

For example, the second soil sample of soil boring 02 collected from LF04 would be identified as "LF04-SB02-SO-02". A duplicate groundwater sample collected from MW04 at LF04 would be identified as "LF04-MW04-GW-52", and sent to the laboratory as a blind sample. However, proper notes will be entered into the field sampling logbook to track this sample as a field duplicate.

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

xxyyyyyyzz

where:

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

yyyyyy represents date (day, month, year)

zz represents sample number from 01 to 99

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

6.3 SAMPLE CUSTODY

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

Chain-of-custody records will be maintained for all field and field Quality Control (QC) samples. A sample is defined as being under a person's custody if any of the following conditions exist: (1)

it is in their possession, (2) it is in their view, after being in their possession, (3) it was in their possession and they locked it up or, (4) it is in a designated secure area. All sample containers will be sealed in a manner that will prevent or detect tampering if it occurs. In no instance will tape be used to seal sample containers. Appendix A contains a sample chain-of-custody form (COC).

The following minimum information concerning the sample will be documented on the COC form (as illustrated in Section 8):

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

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

6.4 FIELD QUALITY CONTROL SAMPLES

6.4.1 Ambient Blank

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

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

6.4.2 Equipment Blank

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

6.4.3 Trip Blank

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

6.4.4 Field Duplicates

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

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

6.4.5 Field Replicates

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

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7.0 FIELD MEASUREMENTS

7.1 PARAMETERS

7.1.1 Field Screening of Soils

RFI field activities will utilize field screening of soil samples for volatile organic compounds to determine the depth from which the laboratory analytical samples will be collected. During hand auguring, hollow-stem auger drilling, and direct push soil boring activities, head space readings will be recorded from collected soils. Headspace analysis will be performed on each lithologic and analytical soil sample collected. A portion of the recovered soil sample will be placed into a quart-size Ziploc-type plastic bag, and the bag will be labeled, sealed, and shaken to mix the sample. The sample will be allowed to volatilize in a shaded area for approximately 15 minutes after which a headspace reading will be taken by punching through the bag with an OVA or PID sampling tip. The sampling tip will not be placed in the soil, but in the headspace of the bag. A background headspace value will be obtained from empty Ziploc-type plastic bag handled in manner identical to the plastic bag containing the headspace sample. The headspace reading and the background reading will be recorded on the Soil Boring Log.

7.1.2 Field Parameters for Water Samples

Temperature, pH, EC, and turbidity will be measured during monitoring well development and purging.

The temperature of each water sample will be measured by either a pH meter/temperature probe, conductivity meter/temperature probe, or a mercury thermometer. This measurement will also be used to calibrate the pH meter.

The pH of each water aliquot will be measured by a portable pH meter. The pH meter will be calibrated with buffer solutions of the appropriate range for the expected values of pH. The meter will be recalibrated daily.

The EC of each water sample will be measured with a portable field conductivity meter. A standard potassium chloride solution will be used to calibrate the instrument before it is used. The meter will also be recalibrated daily. All measurements will be entered on the Sampling Collection Log (Appendix A).

The turbidity of each water aliquot will be measured using a portable nephelometer. A standard 0.2 NTU solution will be used to calibrate the instrument before it is used. The meter will also be recalibrated daily. All measurements will be recorded on the Groundwater Well Development/ Purge Log (Appendix A).

7.2 EQUIPMENT CALIBRATION AND QUALITY CONTROL

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

7.3 EQUIPMENT MAINTENANCE AND DECONTAMINATION

7.3.1 Equipment Maintenance

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

7.3.2 Decontamination of Field Instruments

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

7.4 FIELD MONITORING MEASUREMENTS

7.4.1 Groundwater Level Measurements

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

Water-level measurements shall be taken with electric sounders, air lines, pressure transducers, or water-level recorders (e.g., Stevens recorder). Devices that may alter sample composition shall not be used. Pressure gauges, manometers, or equivalent devices shall be used for flowing wells to measure the elevation of the piezometric surface. All measuring equipment shall be decontaminated according to the specifications in Section 7.3 and 5.11. Groundwater level shall be measured to the nearest 0.01 foot.

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

7.4.2 Floating Hydrocarbon Measurements

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

7.5 FIELD PERFORMANCE AND SYSTEM AUDITS

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

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

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

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8.0 RECORD KEEPING

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

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

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

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

8.1 FIELD LOGBOOK

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

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

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

8.2 FIELD EQUIPMENT LOGBOOK

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

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

8.2.1 Sample Collection Log

A sample collection log form will be completed for each sample collected during the investigation (Appendix A). Information to be included on the form includes:

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

APPENDIX A

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HYDRO GeoLogic INC.

LOG OF DAILY TIME AND MATERIALS

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Project Name: ____________________

Project Number: ____________________

Subcontractor: ____________________

Boring or Well No: ____________________

Date: ____________________

ITEM	NO. UNITS
Drilling /ft	
______-inch augerhole	/ft
______-inch mud rotary hole	/ft
______-inch air rotary	/ft
Split spoon samples	
Shelby tube samples	
______-rock coring	/ft
Driven casing ______-inch	/ft
Well Materials	
______-inch stainless steel riser pipe	/ft
______-inch stainless steel screen	/ft
______-inch PVC riser pipe	/ft
______-inch PVC screen	/ft
Couplings	
Bottom caps	
Top caps	
Protective casings /w locking caps	
Well installation	/ft
Revert (bags)	
Bentonite powder (bags)	
Bentonite pellets (buckets)	
Sand (bags)	
Cement (bags)	
Other Charges	
Standby	/hr
Decontamination	/hr
Well development	/hr
Spoil Disposal (barrels)	

Other____

____

HydroGeoLogic Site Representative: ____________________________

Subcontractor Site Representative: ____________________________

HYDRO GeoLogic INC.

BORING LOG

Borehole No. 320278
Sheet _____ of ____

Location					
Project Name	Project Number	LTCCODE (IRPIMS)	Site ID	LPRCODE (IRPIMS)	
Drilling Company	Driller	Ground Elevation	Total Drilled Depth		
Drilling Equipment	Drilling Method	Borehole Diameter	Date/Time Drilling Started	Date/Time Total Depth Reached	
Type of Sampling Device			Water Level (bgs) First Final		
Sample Hammer Type Driving Wt. Drop			Hydrogeologist	Checked by/Date	
Location Description (include sketch in field logbook)					

Depth	Interval	Recovery	Blow Counts	Description (Include lithology, grain size, sorting, angularity, Munsell color name & notation, minerology, bedding, plasticity, density, consistency, etc., as applicable)	USCS Symbol	Lithology	Water Content	Remarks (Include all sample types & depth, odor, organic vapor measurements, etc.)

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WELL CONSTRUCTION DETAILS AND ABANDONMENT FORM

FIELD REPRESENTATIVE: ____________________

DRILLING CONTRACTOR: ____________________

DRILLING TECHNIQUE: ____________________
AUGER SIZE AND TYPE: ____________________

BOREHOLE IDENTIFICATION: ____________________
BOREHOLE DIAMETER: ____________________
WELL IDENTIFICATION: ____________________

WELL CONSTRUCTION START DATE: ____________
WELL CONSTRUCTION COMPLETE DATE: ________

SCREEN MATERIAL: ____________________
SCREEN DIAMETER: ____________________
STRATUM-SCREENED INTERVAL (FT): __________

CASING MATERIAL: ____________________
CASING DIAMETER: ____________________

TYPE OF FILTER PACK: ____________________
GRADIATION: ____________________
AMOUNT OF FILTER PACK USED: ____________

TYPE OF BENTONITE: ____________________
AMOUNT BENTONITE USED: ____________________

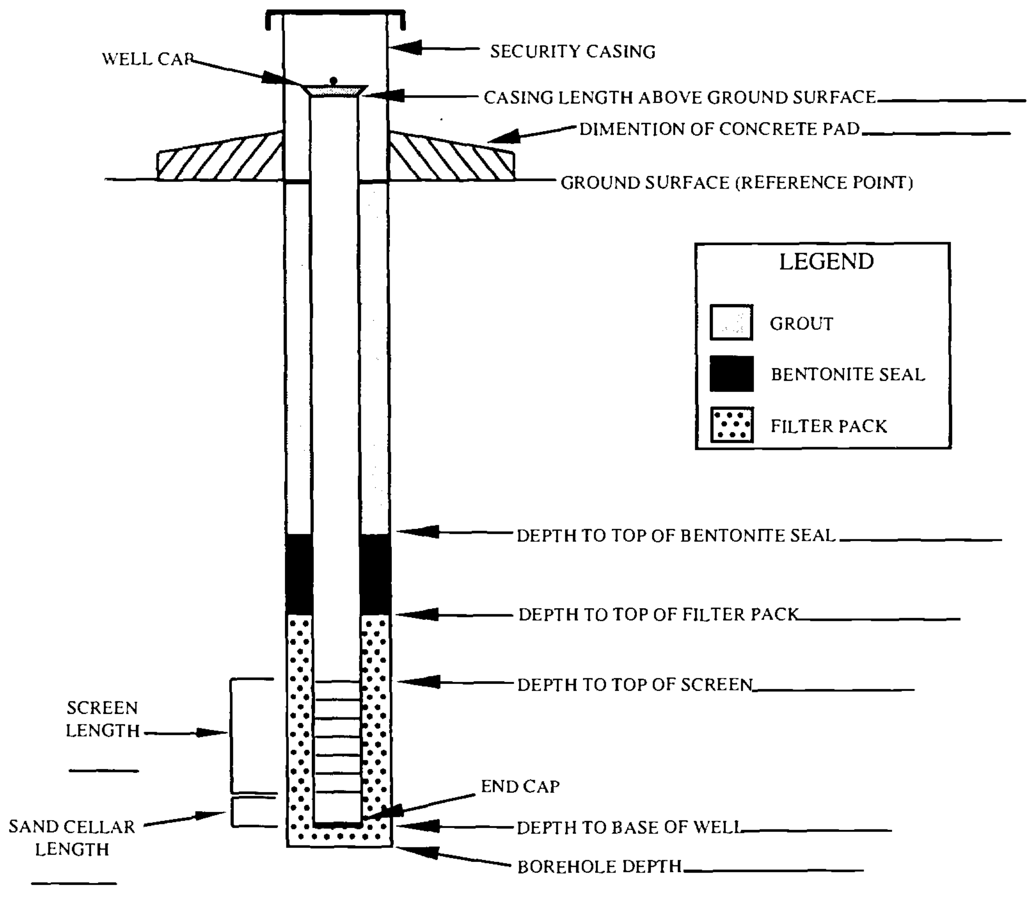
TYPE OF CEMENT: ____________________
AMOUNT CEMENT USED: ____________________
GROUT MATERIALS USED: ____________________

DIMENSIONS OF SECURITY CASING: ____________

TYPE OF WELL CAP: ____________________
TYPE OF END CAP: ____________________

COMMENTS:

SPECIAL CONDITIONS
(describe and draw)



NOT TO SCALE

INSTALLED BY: ____________________ INSTALLATION OBSERVED BY: ____________________

DISCREPANCIES: ____

AFCEE FORM WAA.0

HYDRO GeoLogic INC.

WELL DEVELOPMENT RECORD

WELL/PIEZOMETER ID 320280
SHEET ______ of ______

PROJECT NAME: ________________ PROJECT NO. : __________________________ DATE: ____________________

LOCATION: ____________________ DATE INSTALLED: ____

TOTAL DEPTH (FTOC) ___________ CASING DIAMETER ____

METHODS OF DEVELOPMENT

☐ Swabbing ☐ Bailing ☐ Pumping ☐ Describe ______________________________

Equipment decomtaminated prior to development ☐ Yes ☐ NO

Describe____

EQUIPMENT NUMBERS:

pH Meter _______________ EC Meter _______________ Turbidity Meter _______________ Thermometer _______________

CASING VOLUME INFORMATION:

Casing ID (inch)	1.0	1.5	2.0	2.2	3.0	4.0	4.3	5.0	6.0	7.0	8.0
Unit Casing Volume (A) (gal/ft)	0.04	0.09	0.16	0.2	0.37	0.65	0.75	1.0	1.5	2.0	2.6

PURGING INFORMATION:

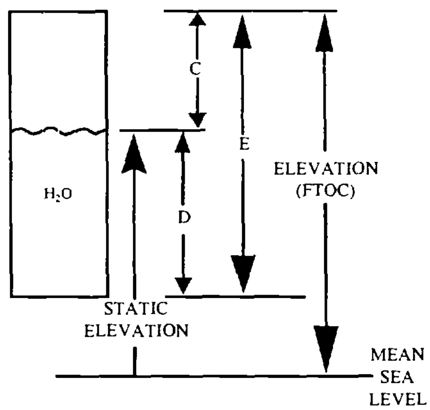
Measured Well Depth (B) ______________________ft.

Measured Water Level Depth (C) ____________________ft.

Length of Static Water Column (D) _______ - _______ = _________ ft.
(B) (C)

Casing Water Volume (E) + _______ x _______ = _________ gal
(A) (D)

Total Purge Volume = ________ (gal)



Date	Time	Water Level (FTOC)	Volume Removed (gal)	pH	EC	Temperature F or C	Turbidity/ Sand (ppm)	Comments

AFCEE FORM WD.0

HydroGeoLogic Inc.

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Test Pit Classification Log

Project Name: ______________________ Test Pit No.: __________ Page ____ of ____

Project Number: ______________________ Approx. Elev.: __________ Date: __________

Field Geo./Eng.: ______________________

Location: ______________________

Equipment Used: ______________________

Pit Dimensions: ______ x ______ x ______ = ______
LENGTH WIDTH DEPTH VOLUME

GROUNDWATER LEVEL DATA		
DATE	ACTUAL TIME	DEPTH
	NOT ENCOUNTERED	

DEPTH (FT)	SAMPLE NO. AND TYPE	DESCRIPTION	USCU SYMBOL	REMARKS
1				
2				
3				
4				

WASTE INVENTORY TRACKING FORM

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LOCATION : ______________________________

PROJECT NAME: ______________________________

ACTIVITIES: ______________________________

Date Waste Generated	Activity Generating Waste (borehole # / well #)	Description of Waste	Field Evidence of Contamination	Estimated Volume	Type of Container (storage ID#)	Location of Container	Waste Characterization	Comments

Note: Describe whether soil or water samples have been collected for waste characterization, include date, if known.

Signature: ______________________________

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MONITOR WELL STATIC WATER LEVEL FORM

PROJECT NAME: ______________________ DATE: ______________

WATER LEVEL INDICATOR ID # __________ FIELD BOOK # __________

LOCATION: __________________________ PAGE # ______________

Monitor Well Number	Time	Depth to Static Water Level (from T.O.C.)	Total Well Depth (ft)	Explosimeter Reading (above background)	PID Reading (above background)

Note: Total well depth to be measured at time of gauging.

Comments: ____

____

____

Sampler ______________________ Observer ______________________

AFCEE FORM WL.0

MONITOR WELL PURGING FORM

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PROJECT : ______________________________ DATE: ________________

LOCATION: ______________________________ EXPLOSIMETER BOREHOLE READING ________

WELL ID: ______________________________ PURGE VOLUME
(3 WELLBORE VOLUMES): ______________ (gal)

WELL DEPTH: ______________________________

Time	Depth to Water (ft)	Flow Meter Reading	Volume Purged (gal)	Temp. (°C)	pH	Electrical Conductivity (mmho)	Turbidity N.T.U	Comments

Note: Condition of the well: ______________________________

pH - Calibrate at start and before last reading.

Sampler ______________________________ Observer ______________________________

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HYDRO GeoLogic INC.

FIELD SAMPLING REPORT

LOCATION: ______________________ PROJECT : ______________________

SITE: ______________________

SAMPLE INFORMATION

MATRIX ______________________ SAMPLE ID: ______________________

SAMPLING METHOD ______________ DUP./REP. OF : ______________________

BEGINNING DEPTH ______________ MATRIX SPIKE/MATRIX SPIKE DUPLICATE YES ( ) NO ( )

END DEPTH ______________________

GRAB ( ) COMPOSITE ( ) DATE: ____________ TIME: __________

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

NOTABLE OBSERVATIONS

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

GENERAL INFORMATION

WEATHER: SUN/CLEAR _____ OVERCAST/RAIN _____ WIND DRIECTION _______ AMBIENT TEMP ______

SHIPMENT VIA: FED-X _____ HAND DELIVER ______ COURIER _______ OTHER _______

SHIPPED TO: ____

COMMENTS: ____

SAMPLER: ______________________ OBSERVER: ______________________

MATRIX TYPE CODES

DC=DRILL CUTTINGS
WG=GROUND WATER
LH=HAZARDOUS LIQUID WASTE
SH=HAZARDOUS SOLID WASTE
SE=SEDIMENT
SL=SLUDGE
SO=SOIL
GS=SOIL GAS
WS=SURFACE WATER
SW=SWAP\WIPE

SAMPLING METHOD CODES

B=BAILER
BR=BRASS RING
CS=COMPOSITE SAMPLE
C=CONTINUOUS FLIGHT AUGER
DT=DRIVEN TUBE
W=SWAB\WIPE
G=GRAB
HA=HAND AUGER
H=HOLLOW STEM AUGER
HP=HYDRO PUNCH
SS=SPLIT SPOON
SP=SUBMERSIBLE PUMP

HYDRO GeoLogic INC.

CALIBRATION LOG

Project Name: ______________________ By: ______________________

Project No.: ______________________ Page ______ of ______

Date/Time	Instrument	STD	STD CONC ppm	Meter Reading	Comments

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CHAIN OF CUSTODY RECORD

HYDRO GeoLogic INC.
1155 Herndon Parkway
Suite 900
Herndon, VA 20170

Client: ____________________

Project Name/No.: ____________________

Project Manager: ____________________

Sampler: ____________________

Phone: (703) 478-5186 Fax: (703) 471-4180

APPLICABLE REGULATION
- ☐ RCRA
- ☐ ECRA
- ☐ CERCLA
- ☐ NPDES
- ☐ CWA
- ☐ SDWA
- ☐ OTHER

SAMPLE IDENTIFICATION	DATE COLL.	TIME COLL.	GRAB	COMPOSITE	MATRIX: SOIL	MATRIX: WATER	MATRIX: OTHER	TOTAL NO. OF CONTAINERS	ANALYSIS REQUIRED								REMARKS OR SAMPLE LOCATION

Special Instructions

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return to Client ☐ Disposal by Lab ☐ Archive for ______ Months

Turn Around Time Required ☐ Normal ☐ Rush

QC Level ☐ I. ☐ II. ☐ III.

Project Specific (specify)

1. Relinquished by	Date	Time	1. Received by	Date	Time
2. Relinquished by	Date	Time	2. Received by	Date	Time
3. Relinquished by	Date	Time	3. Received by	Date	Time

Comments

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DRAFT
QUALITY ASSURANCE PROJECT PLAN

RCRA FACILITY INVESTIGATION/ CORRECTIVE MEASURES STUDY CARSWELL AIR FORCE BASE, TEXAS

Contract Number F41624-95-D-8005

Prepared for:

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

Prepared by:

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

January 1997

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TABLE OF CONTENTS

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1.0 INTRODUCTION

The Quality Assurance Project Plan (QAPP) presents in specific terms the policies, organization, functions, and Quality Assurance/Quality Control (QA/QC) requirements designed to achieve the data quality goals described in the Work Plan (WP) for the project. This detailed QAPP, (1) has been prepared to ensure the data are scientifically valid and defensible, and (2) establishes the analytical protocols and documentation requirements to ensure the data are collected, reviewed, and analyzed in a consistent manner. This QAPP and a site specific Field Sampling Plan (FSP) shall constitute, by definition, an AFCEE Sampling and Analysis Plan (SAP).

CH2M Hill has been contracted by AFCEE to conduct a basewide groundwater monitoring program at CAFB. To support this sampling effort, CH2M Hill has completed a SAP and a QAPP using current AFCEE guidance documents (CH2M Hill 1996a, CH2M Hill 1996b). Sections 4.0 through 12.0 of the CH2M Hill QAPP are applicable to the RFI/CMS field and laboratory analytical program and are incorporated in their entirety in this QAPP by reference.

The National Contingency Plan (NCP) specifies circumstances under which a QAPP is necessary for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions. For cleanup actions at the remedial investigation/feasibility study (RI/FS) stage, the NCP requires lead agents to develop sampling and analysis plans which provide a process for obtaining data of sufficient quality and quantity to satisfy data needs. Such sampling and analysis plans must include a QAPP "which describes policy, organization, and functional activities and the data quality objectives and measures necessary to achieve adequate data for use in selecting the appropriate remedy." 40 CFR 300.430 (b)(8)(ii).

The U.S. Environmental Protection Agency (EPA) QA policy requires a QAPP for every monitoring and measurement project mandated or supported by the EPA through regulations, contracts, or other formalized means not currently covered by regulation. Guidelines followed in the preparation of this plan are set out in *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans* (U.S. EPA, 1983a) and *U.S. EPA Region IX QAPP: Guidance for Preparing QAPPs for Superfund Remedial Projects* (U.S. EPA, 1989). Other documents that have been referenced for this plan include *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final* (U.S. EPA, 1988); *EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations, Draft Final, EPA QA/R-5* (U.S. EPA, 1993), *Compendium of Superfund Field Operations Methods* (U.S. EPA, 1987a); *Data Quality Objectives Process for Superfund, Interim Final Guidance* (U.S. EPA, 1993); *U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (U.S. EPA, 1994), *U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review* (U.S. EPA, 1994), *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods* (U.S. EPA SW-846, Third Edition and its first and second update), and the *Handbook for Installation Restoration Program (IRP) Remedial Investigations and Feasibility Studies (RI/FS)* (Handbook), September 1993.

This QAPP is required reading for all staff participating in the work effort. The QAPP shall be in the possession of the field teams and in the laboratories performing all analytical methods. All

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subcontractors shall be required to comply with the procedures documented in this QAPP in order to maintain comparability and representativeness of the data produced.

2.0 PROJECT DESCRIPTION

2.1 THE U.S. AIR FORCE INSTALLATION RESTORATION PROGRAM

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

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

In 1980, Congress enacted CERCLA (Superfund). CERCLA outlines the responsibility for identifying and remediating contaminated sites in the United States and its possessions. The CERCLA legislation identifies the EPA as the primary policy and enforcement agency regarding contaminated sites.

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

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

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

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

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

2.2 PURPOSE AND SCOPE

The purpose, scope, and use of this work effort is discussed in Section 1.0 of the WP.

2.3 PROJECT BACKGROUND

A project background description, including (1) the locations of sites at the base or facility, (2) a summary of the contamination history at each site, and (3) the findings from previous investigations are included in Section 1.0 of the WP.

2.4 PROJECT SCOPE AND OBJECTIVES

A summary of the objectives and the proposed work for each site are included in the WP. The intended use of the data acquired during this project, the data quality objective process, and a discussion of how the process specific decision rules were derived are described in the WP and the FSP.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The project organization and responsibility discussion including (1) a project organizational chart identifying task managers and individuals responsible for performance of the project, (2) a list of names of all key participants, including organization names and telephone numbers for project, field, and laboratory QA officers, (3) a description of the authority given to each key participant with an emphasis on the authority of the key individuals to initiate and approve corrective actions, and (4) the role of regulatory representatives is included in Section 8.0 of the WP.

All subcontractors shall be identified and the scope of their performance in the project shall be clearly defined prior to initiating the field investigation. Subcontractors proposed to provide backup services shall be identified prior to initiating the field investigation. An organizational chart, a list of key personnel, and the previously described descriptive text shall be included for each subcontractor prior to initiating the field investigation.

4.0 QUALITY PROGRAM AND DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) specify the data type, quality, quantity, and uses needed to make decisions and are the basis for designing data collection activities. The DQOs for the project are specified in the WP and Section 3.0 of the FSP.

4.1 DATA CATEGORIES

The two general categories of data used by the Air Force Center for Environmental Excellence (AFCEE) are defined as: (1) screening data and (2) definitive data.

Screening data are generated by rapid methods of analysis with less rigorous sample preparation, calibration and/or QC requirements than are necessary to produce definitive data. Sample preparation steps may be restricted to simple procedures such as dilution with a solvent, instead of elaborate extraction/digestion and cleanup. Screening data may provide analyte identification and quantitation, although the quantitation may be relatively imprecise. Physical test methods, e.g., dissolved oxygen measurements, temperature and pH measurements, moisture content, turbidity, conductance, etc., have been designated by definition as screening methods (see Section 6.0).

Screening methods shall be confirmed, as required, by analyses that generate definitive data. Confirmation samples shall be selected to include both detected and nondetected results from the screening method.

Definitive data are generated using rigorous analytical methods (see Section 7.0), such as approved EPA reference methods. The data can be generated in a mobile or off-site laboratory. Data are analyte-specific, and both identification and quantitation are confirmed. These methods have standardized QC and documentation requirements (Sections 7.0 and 8.0). Definitive data are not restricted in their use unless quality problems require data qualification.

Sections 4.2 through 4.5 from the CH2M Hill QAPP are applicable to the sampling and laboratory analyses for this RFI/CMS (CH2M Hill, 1996b). The subject sections from the CH2M Hill QAPP are included in their entirety by reference.

5.0 SAMPLING PROCEDURES

Section 5.0 of the CH2M Hill QAPP is applicable to the sampling and laboratory analyses to be conducted under this RFI/CMS. Section 5.0 of the CH2M Hill is incorporated in this QAPP in its entirety by reference (CH2M Hill, 1996b).

6.0 SCREENING ANALYTICAL METHODS

Section 6.0 of the CH2M Hill QAPP is applicable to the sampling and laboratory analyses to be conducted under this RFI/CMS. Section 6.0 of the CH2M Hill is incorporated in this QAPP in its entirety by reference (CH2M Hill, 1996b).

7.0 ANALYTICAL PREPARATION METHODS AND PROCEDURES FOR DEFINITIVE DATA

Section 7.0 of the CH2M Hill QAPP is applicable to the sampling and laboratory analyses to be conducted under this RFI/CMS. Section 7.0 of the CH2M Hill is incorporated in this QAPP in its entirety by reference (CH2M Hill, 1996b).

8.0 DATA REDUCTION, REVIEW, VERIFICATION, REPORTING, VALIDATION, AND RECORD KEEPING

Section 8.0 of the CH2M Hill QAPP is applicable to the sampling and laboratory analyses to be conducted under this RFI/CMS. Section 8.0 of the CH2M Hill is incorporated in this QAPP in its entirety by reference (CH2M Hill, 1996b).

9.0 SYSTEMS AND PERFORMANCE AUDITS, PERFORMANCE EVALUATION PROGRAMS, MAGNETIC TAPE AUDITS, AND CERTIFICATIONS

Section 9.0 of the CH2M Hill QAPP is applicable to the sampling and laboratory analyses to be conducted under this RFI/CMS. Section 9.0 of the CH2M Hill is incorporated in this QAPP in its entirety by reference (CH2M Hill, 1996b).

10.0 PREVENTIVE MAINTENANCE

Section 10.0 of the CH2M Hill QAPP is applicable to the sampling and laboratory analyses to be conducted under this RFI/CMS. Section 10.0 of the CH2M Hill is incorporated in this QAPP in its entirety by reference (CH2M Hill, 1996b).

11.0 CORRECTIVE ACTION

Section 11.0 of the CH2M Hill QAPP is applicable to the sampling and laboratory analyses to be conducted under this RFI/CMS. Section 11.0 of the CH2M Hill is incorporated in this QAPP in its entirety by reference (CH2M Hill, 1996b).

12.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT 320298

Section 12.0 of the CH2M Hill QAPP is applicable to the sampling and laboratory analyses to be conducted under this RFI/CMS. Section 12.0 of the CH2M Hill is incorporated in this QAPP in its entirety by reference (CH2M Hill, 1996b).

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DRAFT
HEALTH AND SAFETY PLAN

RCRA FACILITY INVESTIGATION/ CORRECTIVE MEASURES STUDY CARSWELL AFB, TEXAS

Contract Number F41624-95-D-8005

Prepared for:

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

Prepared by:

HydroGeoLogic, Inc.
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January 1997

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DRAFT
HEALTH AND SAFETY PLAN
RCRA FACILITY INVESTIGATION/
CORRECTIVE MEASURES STUDY
CARSWELL AIR FORCE BASE, TEXAS

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PROJECT:	U.S. Air Force Center for Environmental Excellence
PROJECT NUMBER:	Contract No. F41624-95-D-8005 HydroGeoLogic Project No. AFC001
PROJECT SITE LOCATION:	Carswell Air Force Base, Texas
PROJECT MANAGER:	Miquette Gerber, P.G.
HEALTH AND SAFETY OFFICER:	Christopher Spill
SITE SAFETY OFFICER:	TBA
PLAN PREPARERS:	Christopher Spill
PLAN REVIEWER:	Dewey Cubit, CIH
PREPARATION DATE:	January 3, 1997

APPROVED BY:

Dewey Cubit, CIH — Date
HydroGeoLogic, Inc.
Certified Industrial Hygienist

Christopher Spill — Date
HydroGeoLogic, Inc.
Health and Safety Officer

Miquette Gerber — Date
HydroGeoLogic, Inc.
Project Manager

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1.0 INTRODUCTION

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1.1 PURPOSE

This Health and Safety Plan (HSP) is designed to assign responsibilities, establish personnel protection standards, specify mandatory operating procedures, and provide for emergency contingencies with respect to health and safety issues that may arise while HydroGeoLogic, Inc. (HydroGeoLogic) personnel and subcontractor personnel are engaged in Resource Conversation and Recovery Act (RCRA) Facility Investigation (RFI) activities at WP-07 and Landfills LF- 04, LF-05 and LF-08 of the Former Carswell Air Force Base (CAFB) located in Texas. The request for RFI activities was identified in the statement of work (SOW) dated July 31, 1996 under the authorization of the U.S. Air Force Center for Environmental Excellence (AFCEE) Contract Number F41624-95-D-8005, Delivery Order Number 0002. This HSP conforms to the requirements of the Occupational Safety and Health Administration (OSHA) Standard 29 CFR 1910 and 1926. Detailed OSHA requirements for hazardous waste operations are contained in OSHA Standard 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response." Additional guidance for hazardous waste operations may be found in the Environmental Protection Agency (EPA) publication, "Standard Operating Safety Guides" (November 1987), the National Institute of Occupational Safety and Health (NIOSH)/OSHA/U.S.Coast Guard (USCG)/EPA publication, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities" (October 1985), and the Federal Acquisition Regulation (FAR) clause 52.236-13: Accident Prevention.

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

1.2 APPLICABILITY

The provisions of the HSP are mandatory for all official visitors, HydroGeoLogic employees, and subcontractors while investigations are being conducted at CAFB. These investigations will include: the installation of approximately 28 test pits at LF-04, LF-05, and LF-08 with associated surface and subsurface soil sampling; surface water and sediment sampling along Farmer's Branch Creek; geophysical survey at LF-08; the use of geoprobes at WP-07 with associated surface and subsurface soil sampling; and the installation of four groundwater monitoring wells. 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 hazard area.

1.3 PROJECT ORGANIZATION, PERSONNEL, AND RESPONSIBILITIES

This section provides HydroGeoLogic's personnel organization for this project as presented in Figure 8.1 of the Work Plan and establishes the roles and responsibilities of various project personnel in regard to site health and safety. The authority and responsibilities of each HydroGeoLogic individual utilized for this project are presented in the following sections.

1.3.1 Responsible Corporate Officer (RCO)

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

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

1.3.2 Health and Safety Officer (HSO)

The HSO for this project will be Christopher Spill. He will be assisted by Dewey Cubit, HydroGeoLogic's Certified Industrial Hygienist (CIH). The HSO has the authority to:

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

The HSO responsibilities for this project will include:

- Interface with Project Manager (PM) in matters of health and safety.
- Keep the RCO and PM informed on the status of the site health and safety plan.
- Develop or review and approve project health and safety plans prior to submittal.
- Conduct staff training and orientation on health and safety related activities.
- Appoint or approve Site Safety Officer (SSO).
- Monitor compliance with health and safety plans and conducts site audits.
- Assist in obtaining required health and safety equipment.

- Approve personnel to work on hazardous waste management projects with regard to medical examinations and health and safety training.

- Maintain records pertaining to medical surveillance, training, fit testing, chemical exposure, and accidents/incidents.

- Provide industrial hygiene/chemical safety guidance.

1.3.3 Project Manager (PM)

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

- Coordinate with the HSO on health and safety matters.

- Assign HSO-approved SSO to project and, if necessary, assign a suitably qualified replacement.

- Temporarily suspend field activities if health and safety of personnel are endangered, pending an evaluation by the HSO.

- Temporarily suspend an individual from field activities for infractions of the health and safety plan, pending an evaluation by the HSO.

The PM responsibilities for this project will include:

- Assure that the project is performed in a manner consistent with the health and safety program.

- Assure that the project health and safety plan is prepared, approved, and properly implemented.

- Provide the HSO with the information needed to develop health and safety plans.

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

1.3.4 Site Safety Officer (SSO)

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

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

- Directing health and safety activities on a site.
- Assuring that appropriate personal protective equipment (PPE) is available and properly utilized by HydroGeoLogic personnel, visitors, and subcontractor personnel.
- Assuring that personnel are aware of the provisions of this plan, are instructed in the work practices necessary to ensure safety, and are aware of planned procedures for dealing with emergencies.
- Assuring that personnel are aware of the potential hazards associated with investigation activities.
- Monitoring the safety performance of all personnel to ensure that required work practices are followed.
- Correcting any work practices or conditions that may result in injury or exposure to hazardous substances.
- Assuring the completion of the site-specific HSP forms presented in Section 14.1 (i.e., Compliance Agreement, Accident/Incident Reports, Site Safety Briefing Form, etc.).
- Assuring that a copy of the HSP is maintained on the site during all investigation activities.
- Assuring that all air monitoring and equipment calibrations required by the HSP are preformed and recorded, and that logs/forms that include these activities are maintained (Section 14.1).
- Assuring that official site visitors and subcontractors provide the proper certifications (i.e., medical clearance and 40-Hour Health and Safety training) in accordance with OSHA Standard 29 CFR 1910.120 and this document.

1.3.5 Project Field Personnel

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

- Taking all reasonable precautions to prevent injury to themselves and to their fellow employees.
- Implementing the HSP and reporting any deviations from the anticipated conditions described in the plans to the SSO.

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

1.3.6 Subcontractor Responsibilities

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

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2.0 SITE DESCRIPTION INFORMATION

A description of the CAFB sites under investigation is presented in Section 1.0 of the Work Plan. Please refer to this section for site description information.

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3.0 RCRA FACILITY INVESTIGATION ACTIVITIES

The RFI activities to be conducted at the CAFB over a one month period will include:

- Installation of approximately 28 test pits at LF-04, LF-05, and LF-08 requiring a field geologist, field technician, and backhoe subcontractor to characterize surface and subsurface soil and type of wastes associated with the landfills.

- Installation of monitoring wells site-wide requiring a field geologist, field technician, and drilling subcontractor to characterize the groundwater associated with the landfills.

- Groundwater sampling at nine locations site-wide using a submersible pump.

- Surface water and sediment sampling at approximately twelve locations along Farmer's Branch Creek.

- Geophysical survey at LF-08 utilizing a electromagnetic conductivity meter and magnetometer.

- Characterization of soil and subsurface soil at approximately 7 locations of WP-07 utilizing a Geoprobe/Hydropunch sampler.

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4.0 HAZARD ASSESSMENT

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

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

4.1 CHEMICAL HAZARDS

Based upon the information obtained from previous site investigations (groundwater, soil, and surface water), the primary chemicals of concern at CAFB have been listed in Table 4.1.

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

4.2 DECONTAMINATION SOLUTIONS AND PRESERVATIVES

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

- Nitric Acid
- Hydrochloric Acid
- Methanol
- Hexane

The acute and chronic symptoms of overexposure to these chemical contaminants and first aid procedures are also presented in Table 4.2.

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Table 4.1
Exposure Limits and Recognition Qualities

Compound	Permissible Exposure Limit (PEL)[a]	IDLH Level[b]	Recognition Qualities			Odor Warning Concentration (ppm)	LEL[c] (%)	UEL[d] (%)	Ionization Potential (eV)
			Color	Odor	State				
Arsenic Compounds	0.010 mg/m^3	100 mg/m^3[e]	silver gray to tin-white	odorless	solid	NA	NA	NA	NA
Lead	0.050 mg/m^3	700 mg/m^3	gray	odorless	solid	NA	NA	NA	NA
Mercury	0.050 mg/m^3	28 mg/m^3	silver-white	odorless	liquid	NA	NA	NA	NA
Benzene	1.0 ppm	3000 ppm[e]	colorless to light yellow	aromatic	liquid	1.5 - 5.0	1.3	7.9	9.24
Toluene	100 ppm	2000 ppm	colorless	aromatic	liquid	0.17 - 40	1.2	7.1	8.82
Ethylbenzene	100 ppm	2000 ppm	colorless	aromatic	liquid	4.7 - 5.0	1.0	6.7	8.76
Total Xylene	100 ppm	1000 ppm	colorless	aromatic	liquid	1.0 - 1.5	1.0	7.0	8.56
Trichloroethylene	50 ppm	1000 ppm[e]	colorless	chloroform-like	liquid	NA	8.0	10.5	9.45
Tetrachloroethylene	25 ppm	500 ppm[e]	colorless	chloroform-like	liquid	NA	NA	NA	9.32
Vinyl Chloride	1 ppm	Unknown[e]	colorless	pleasant	liquid or gas	NA	3.6	33	9.99
Chloroethane	1000 ppm	20000 ppm	colorless	ether-like	liquid or gas	NA	3.8	15.4	10.97
1,1-Dichloroethane	100 ppm	4000 ppm	colorless	chloroform-like	liquid	NA	5.6	NA	11.06
bis-(2-ethylhexyl)phthalate	5 mg/m^3	Unknown[e]	colorless	slight	liquid	NA	0.3	NA	NA
1,2-Dichloroethene	200 ppm	4000 ppm	colorless	slightly acrid, chloroform-like	liquid	NA	5.6	12.8	9.65

[a] OSHA permissible exposure limit or American Conference of Governmental Industrial Hygienists Threshold Limit Value - Time Weighted Average
[b] Immediately Dangerous to Life or Health
[c] Lower explosive limit
[d] Upper explosive limit
[e] To be treated as a carcinogen
NA Not Applicable

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

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

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

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

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

4.3 PHYSICAL HAZARDS

The physical hazards which could be encountered by site personnel 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)
- Flammable/Explosive Atmospheres (Section 6.0)
- Heavy Equipment/Vehicular Activity (Section 11.0)

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

4.3.1 Heat Stress

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

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

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

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

- Heat stroke is the most serious form of heat stress. Temperature regulation fails, and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury or death occurs. Competent medical help must be obtained. 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.
- Shelter (air-conditioners and other cooling devices, if possible) or shaded areas should be provided to protect personnel during rest periods.
- Worker's body fluids should be maintained at normal levels to ensure that the cardiovascular system functions adequately. Daily fluid intake must approximately equal the amount of water in sweat. The normal thirst mechanism is not sensitive enough to ensure that enough water will be drunk to replace lost sweat. When heavy sweating occurs, the worker should be encouraged to drink more. Have workers drink fluid (preferably water or diluted drinks) before beginning work. Urge workers to drink a cup or two at each scheduled break. A total of 1 to 1.6 gallons (4 to 6 liters) of fluid per day are recommended, but more may be necessary to maintain body weight.
- The drinking water temperature should be maintained at 50°F to 60°F (10°C to 15.6°C).
- Small disposable cups that hold about 4 ounces (0.1 liter) 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.

4.3.2 Cold Stress

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

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

- Incipient frostbite is a mild form of cold stress characterized by sudden blanching or whitening of the skin.
- Chilblain is an inflammation of the hands and feet caused by exposure to cold moisture. It is characterized by a recurrent localized itching, swelling, and painful inflammation of the fingers, toes, or ears. Such a sequence produces severe spasms, accompanied by pain.
- Second-degree frostbite is manifested by skin with a white, waxy appearance and the skin is firm to the touch. Individuals with this condition are generally not aware of its

seriousness, because the underlying nerves are frozen and unable to transmit signals to warm the body. Immediate first aid and medical treatment are required.

- Third-degree frostbite will appear as blue, blotchy skin. The tissue is cold, pale, and solid. Immediate medical attention is required.

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

4.3.3 Noise Hazards

The SSO or designee will monitor high noise levels when equipment or machinery (e.g. backhoe, geoprobe, drill rig, etc.) is being used on-site. Field personnel working in areas where noise levels can be expected to reach or exceed 85 decibels (dBA) will be issued hearing protection to reduce the level below the 85 dBA threshold.

4.3.4 Materials Handling

The most common type of materials handling accident is when fingers or toes of field personnel get caught between two objects. Special precautions must be implemented during the moving, shifting, or rolling of materials and should never be attempted by a single individual.

4.3.5 Utility Hazards

The locations of all underground utilities must be identified and marked prior to initiating any subsurface investigations. In addition, drilling within 20 feet in any direction of overhead powerlines will not be permitted.

4.4 BIOLOGICAL HAZARDS

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

- Poisonous snakes and spiders
- Stinging insects
- Ticks and chiggers
- Poisonous plants (e.g., poison sumac, poison ivy, poison oak)

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

4.4.1 Poisonous Snakes and Spiders

Reactions from a snakebite are aggravated by acute fear and anxiety. Other factors that affect the severity of local and general reaction from a poisonous snakebite include: the amount of venom injected and the speed of absorption of venom into the victim's circulation; the size of the victim; protection from clothing, including shoes and gloves; quick anti-venom therapy; and location of the bite.

Spiders in the United States are generally harmless, with two notable exceptions: the Black Widow spider (Latrodectus Mactans) and the Brown Recluse or violin spider (Lox Osceles Reclusa). The symptoms of a Black Widow spider bite are: slight local reaction, severe pain produced by nerve toxin, profuse sweating, nausea, painful cramps in abdominal muscles, and difficulty in breathing and speaking. Victims recover in almost all cases, but an occasional death is reported.

Field personnel should exercise caution when lifting logs, rocks, covers to manholes, sumps, etc.

4.4.1.1 First Aid Procedures (Snakebite)

The objective of first aid is to reduce the circulation of blood through the bite area, to delay absorption of venom, to prevent aggravation of the local wound, and to sustain respiration. Several steps are listed to properly care for a snakebite victim. The most important step is to get the snakebite victim to the hospital quickly. Since all investigation activities will be performed at CAFB, the base hospital will be within reasonable travel time. Meanwhile, take the following first aid measures:

- Keep the victim from moving around.

- Keep the victim as calm as possible and preferably in a lying position.

- Immobilize the bitten extremity and keep it at or below heart level. If the victim can reach a hospital within 4 to 5 hours and if no symptoms develop, no further first aid measures need to be applied.

- If mild-to-moderate symptoms develop, apply a constricting band 2 to 4 inches above the bite, but not around a joint (the elbow, knee, wrist, or ankle) and not around the head, neck, or trunk. The band should be ¾ to 1½ inches wide, not thin like a rubber band. The band should be snug but loose enough for a finger to be slipped underneath. Watch for swelling and loosen the band if it becomes too tight, but do not remove it. Periodically check the pulse in the extremity beyond the bite to insure that the blood flow has not stopped.

Several other factors must be considered in cases of snakebite:

- Shock. Keep the victim lying down and comfortable, and maintain his or her body temperature.

- Breathing and heartbeat. If breathing stops, give mouth-to-mouth resuscitation. If breathing stops and there is no pulse, perform cardiopulmonary resuscitation (CPR) if you have been trained to do so.

- Identifying the snake. If you can kill the snake without risk or delay, bring it to the hospital for identification, but exercise extreme caution in handling the snake.

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

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

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

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

4.4.1.2 General First Aid for Poisonous Insect Bites

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

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

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

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

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

- Give home medicine, such as aspirin, for pain.

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

- In case of a bee sting, remove and discard the stinging apparatus and venom sac.

4.4.2 Ticks and Chiggers

Field personnel should be aware of the presence of ticks (i.e., deer tick) and chiggers at the site. Common carriers of ticks and chiggers are the white-footed mouse and white-tailed deer which are prevalent in the area. The deer tick is about the size of a sesame seed, as distinguished from the dog tick, which is significantly larger. The deer tick is principally found along the Atlantic coast, living in grassy and wooded areas, and feeds on mammals such as mice, shrews, birds, raccoons, opossums, deer, and humans. Common diseases caused by ticks are presented in the following subsections.

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

When in an area suspected of harboring ticks (grassy, bushy, or woodland area) the following precautions can minimize the changes of being bitten by a tick:

- Wear long pants and long-sleeved shirts that fit tightly at the ankles and wrists.
- Wear light colored clothing so ticks can be easily spotted.
- Wearing tick repellents may be useful.
- Inspect clothing frequently while in tick habitat.
- Inspect your head and body thoroughly when you return from the field.
- Remove any attached ticks by tugging with tweezers where the tick's mouth parts enter the skin. Do not squeeze or crush it.

4.4.2.1 Lyme Disease

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

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

4.4.2.2 Rocky Mountain Spotted Fever

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In the eastern and southern United States this tickborne disease is transmitted by the infected Dog Tick (Dermacentor Variabilis). It is important to note that the Dog Tick is significantly larger than the Deer Tick. Nearly all cases of infection occur in the spring and summer, generally several days after exposure to infected ticks. The onset of illness is abrupt and often accompanied by high fever, headache, chills, and severe weakness. After the fourth day of fever, victims develop a spotted pink rash that usually starts on the hands and feet and gradually extends to most of the body. As with Lyme disease, early detection and treatment significantly reduces the severity of illness. The disease responds to antibiotic therapy with tetracycline or chloramphenicol.

4.4.2.3 Other Diseases

Ticks transmit several other diseases, most of which are rare and occur only in specific areas. Babesiosis occurs mainly in the Cape Cod area and eastern Long Island. Colorado tick fever is similarly regional and occurs only among those who live or work at altitudes above 4,000 feet.

4.4.3 Poisonous Plants

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

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

4.4.3.1 First Aid Procedure

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

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5.0 HAZARD COMMUNICATION

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The HydroGeoLogic Hazard Communication Program complies with the OSHA Hazard Communication Standard (HCS) found in OSHA Standard 29 CFR 1910.1200 and 1926.59, which applies to any chemical present in the workplace in such a manner that employees may be exposed to under normal conditions of use in a foreseeable emergency. Although waste materials are excluded from the OSHA requirements, decontamination chemicals for sampling equipment or protective clothing and calibration standards require MSDSs.

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

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

- All containers of hazardous chemicals must be appropriately labeled or tagged to identify the hazard and provide information on effects and appropriate protective measures.

- Labels, tags, or signs must be properly affixed and visible at all times while a hazard is present and removed promptly when the hazard no longer exists.

- Written information (i.e., MSDSs) on hazardous chemicals in the workplace must be available to employees working with the substances.

- Appropriate MSDSs will be available to any contractor or subcontractor employee working on projects under HydroGeoLogic control.

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6.0 AIR MONITORING

This section presents requirements for the use of real-time air monitoring instruments during site activities involving potential for exposure to site contaminants. It establishes the types of instruments to be used, the frequency of which they are to be used, techniques for their use, action levels for upgrading/downgrading levels of protection, and methods for instrument maintenance and calibration.

6.1 INSTRUMENTS AND USE

A Photo-ionization Detector (PID) equipped with a lamp appropriate will be utilized for detecting the presence of emissions from chemicals of concern. A Draeger pump and trichloroethylene colorimetric tubes will be used to confirm any significant detections observed with the PID. Additionally, an LEL/O_2 meter will be used during certain drilling and excavation activities to detect the presence of flammable/explosive atmospheres. Visual observation will be used to detect the presence of airborne particulates.

The PID/Draeger pump will be used throughout the execution of these activities:

- Test pit excavations.
- Monitoring well installation.
- Soil sampling during drilling/geoprobe activities.
- Well development.
- Groundwater sampling.
- Sampling equipment decontamination/equipment (heavy) decontamination.
- Surface water and sediment sampling.
- Waste characterization and disposal.

LEL/O_2 meter will be used throughout the execution of these activities if flammable contaminants are anticipated:

- Test pit excavations.
- Monitoring well installation.

6.2 AIR MONITORING REQUIREMENTS

6.2.1 Photo Ionization Detector (PID)

Air monitoring with the PID will be initiated at potential sources of vapor emissions (source monitoring) at specified frequencies. The following potential sources and monitoring frequencies are anticipated:

Bore holes	Every 5-foot depth
Test Pits	Every 5-foot depth and length
Open well heads	Upon initial opening
Environmental sampling	Every sample set
Surface/subsurface soil sampling	Every 5-foot depth
RFI waste characterization	Every container to be sampled

If source monitoring indicates the presence of airborne emissions, air monitoring will then be initiated in the breathing zones of those workers who could be affected by the emissions. The presence of elevated readings in the worker's breathing zone requires that personnel don pressure-demand supplied-air respirators until readings subside. Air-purifying respirators are not acceptable due to the fact that the contaminants of concern have poor warning properties and/or are unable to be filtered from inspired air with chemical cartridges. Elevated readings will be based on confirmation sampling using a Draeger pump and colorimetric tubes.

6.2.2 Drager Pump and Tubes

A hand operated Draeger pump with TCE colorimetric tubes will be used to confirm the results of PID testing. If the results of the PID tests show concentrations greater than 10 ppm above background concentrations in the breathing zone, then the Draeger tubes will be used to determine the concentration of TCE in the breathing zone.

6.2.3 LEL/O_2 Meter

Air monitoring with the LEL/O_2 meter will be conducted during all drilling and excavation activities within bore holes, test pits, and immediately over drill cuttings at every 5-foot depth interval. If elevated (above background) LEL readings are observed, personnel must be advised of the potential explosive nature of the bore hole and must initiate the use of spark proof tools. LEL readings in excess of 20 percent requires cessation of drilling activities or abandonment of the drilling location until readings subside.

6.2.4 Visual Observations

If airborne particulates are perceived, personnel must don air-purifying respirators equipped with organic vapor cartridges and high efficiency particulate air (HEPA) filters. If such an observation is coupled with elevated PID readings, confirmed by Draeger tubes, in the worker's breathing zone, personnel must don pressure-demand supplied-air respirators.

6.3 MODIFICATION OF AIR MONITORING REQUIREMENTS

The action levels and protection measures presented in Table 6.1 are based upon the assumption that the contaminants listed in Table 4.1 are the only contaminants which pose a reasonable health risk to site workers covered by this HSP. In the event that this assumption is found to be invalid through analysis of samples collected, or by some other means, the action levels will be modified as necessary.

6.4 INSTRUMENT MAINTENANCE AND CALIBRATION

Air monitoring instruments are maintained and prefield-calibrated at the HydroGeoLogic office in Herndon, Virginia. Field maintenance will consist of daily cleaning of the instruments using a damp towel or rag to wipe off the instrument's outer casing, overnight battery recharging, and cleaning or replacing of the lamp whenever calibration cannot be attained. Procedures for accomplishing instrument maintenance is contained in the PID User's Manual which will be provided with each instrument. The User's Manual provided with each instrument will be followed to field calibrate the instruments prior to each day of use under the environmental conditions (temperature and humidity) that sampling will occur.

6.5 RECORDKEEPING

Instrument calibrations and readings will be recorded on the Air Monitoring Log Sheet provided in Section 14.1 of this HSP. Copies of these log sheets will be maintained on site until field activities covered by this HSP have been completed at which time the log sheets will be transmitted to the HydroGeoLogic HSO and to the project file.

LEL/O_2 readings will not be recorded unless flammable/explosive or oxygen deficient/enriched atmospheres are detected in which case entries will be made in the field log book.

LEL/O_2 and the PID will undergo daily operational checks. These checks will be recorded in the field log book and Equipment Calibration Log (Section 14.1).

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Table 6.1
Hazard Monitoring Methods, Action Levels, and Protection Measures

Hazard	Monitoring Method	Action Level	Protective Measures	Monitoring Schedule
Toxic Vapors	PID	Measurable Above Background Based on Judgment of SSO up to 10 ppm	Level D (see Table 7.1)	• Continue with regular monitoring of breathing zone • Confirm readings with Draeger tubes
	PID	Measurable Above Background Based on Judgment of SSO > 10 ppm and < 50 ppm	Level D (see Table 7.1)	• Continue with regular monitoring of breathing zone • Confirm readings with Draeger tubes
	PID	Measurable Above Background Based on Judgment of SSO > 50 ppm and < 100 ppm	Don full-face respirator with organic vapor cartridge and high-efficiency dust and mist filters Level C (see Table 7.1)	• Continue with regular monitoring of breathing zone
	PID	Measurable Above Background Based on Judgment of SSO > 100 ppm	STOP WORK EVACUATE AREA NOTIFY PROJECT MANAGER	• Level C protection will be required to continue work under these conditions
Flammable Gas/Vapor	Explosive Gas Meter	> 10 percent LEL	STOP WORK NOTIFY SSO	• Prior to sampling, monitor air spaces, containers, sumps, etc. suspected of containing flammable gases or liquids

7.0 PERSONAL PROTECTIVE EQUIPMENT (PPE)

This section presents requirements for the use of personal protective equipment (PPE) for each of the activities being conducted. This section includes anticipated levels of protection for each of the activities, the criteria used for selecting various levels of protection, and criteria for modifying levels of protection based on monitoring instrument readings and personal observations.

7.1 ANTICIPATED LEVELS OF PROTECTION

All work is anticipated to be performed in Level D protection, as defined in Appendix B of OSHA Standard 29 CFR 1910.120. Many activities may require the use of chemical resistant coveralls, gloves, and boot covers as presented in Table 7.1. Additionally, it is possible that work will be upgraded to Level B protection (pressure-demand, supplied-air respirators) depending on the results of air monitoring as discussed in Section 6.0 of this HSP. If Level B protection is warranted, work activities will be suspended until the project HSP is re-evaluated and the HSP Amendments Form completed (Section 14.1). The amended HSP will require the review and signature of the project HSO, PM, and the CIH.

The items of PPE anticipated to be used for each activity are presented in Table 7.1. Where overlap in activities occur, the more protective requirement will apply.

Table 7.1
Protective Equipment for On-site Activities

Activity	Level	Protective Equipment
Test Pits MW Installation Groundwater Sampling Surface Soil Sampling Subsurface Soil Sampling Surface Water Sampling Geoprobe	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, latex)
	D (modified)	• Rubber boots; chemically-resistant with steel toe • Gloves (nitrile, neoprene, latex) • Hard hat (if hazard to head exists) • Safety glasses/goggles (if hazard to eyes exists) • Uncoated tyvek or equivalent
	C	• Coated tyvek or equivalent • Rubber boots; chemically-resistant with steel toe • Rubber boot covers • Latex inner gloves • Chemical resistant outer gloves (nitrile, neoprene) • Full-face respirator (organic vapor cartridges) • Additional items may be required (site-specific)

7.2 PPE SELECTION CRITERIA

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Respiratory protection was not selected for use during initial stages of work due to the detectability of site contaminants with monitoring instruments and warning properties. See Section 7.3 for modification criteria of respiratory protection. Basic requirements of field personnel prior to using respiratory protection include:

- All field personnel will be medically certified to wear a full face respirator and have the proper fit test documentation within the past 12 months prior to assignment.
- Only NIOSH approved respirators are to be used on site. The respirators are to be properly cleaned, inspected, and maintained prior to and at the conclusion of the work day.
- Cartridges to air-purifying respirators will be disposed of at the end of each work day and when load-up or breakthrough occurs.
- Field personnel will be clean shaven in areas which might prevent the seal of the respirator to the face and contact lenses will not be permitted while wearing a respirator.

Hard hats, safety glasses, and steel-toe work boots were selected as minimum protection to reduce the potential for injury resulting from exposure to the physical hazards associated with onsite investigations.

Boot covers, nitrile gloves, and Tyvek coveralls were selected to minimize contamination of work clothes and to prevent direct skin contact with low level contamination. Viton gloves were selected for activities that may involve direct contact with appreciable concentrations of solvents thought to be present as site contaminants.

PVC or Saranex coveralls, hoods, and/or splash shields were selected to prevent saturation of work clothes during activities involving large volumes of liquids and/or saturated soils/equipment.

7.3 PPE MODIFICATION CRITERIA

This section presents criteria for upgrading and downgrading chemical protective clothing (CPC) and/or respiratory protection. Where uncertainties arise, the more protective requirement will apply.

7.3.1 CPC Modification Criteria

Tyvek coveralls and boot covers must be worn anytime there is a reasonable potential for contamination of street clothes.

Nitrile gloves must be worn anytime there is a reasonable potential for contact with unsaturated soils or equipment which may contain trace contamination.

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Viton gloves must be worn anytime there is a reasonable potential for contact with groundwater, saturated soils, and/or soils producing elevated PID readings.

Polyvinyl chloride (PVC) or Saranex coveralls must be worn anytime there is a reasonable potential for saturation of work clothes.

7.3.2 Respiratory Protection Modification Criteria

A pressure-demand, supplied-air respirator must be worn whenever any one or a combination of the following conditions prevail:

- Elevated PID readings in the worker's breathing zone, including intermittent readings that persist for greater than 15 minutes.
- Chemical odors present in the work space, including intermittent odors that persist for greater than 15 minutes.
- Worker complaints of adverse health effects that indicate possible overexposure.

Air-purifying respirators must be worn when both of the following criteria exist:

- If dusty conditions become evident and cannot be controlled via other methods (e.g., wetting down areas of concern).
- None of the criteria for the use of air-supplied respirators are met.

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8.0 DECONTAMINATION

This section describes the steps site personnel will follow to prevent the spread of site contaminants into areas that may affect unprotected, unsuspecting site personnel or the public. It includes requirements for decontamination of personnel, sampling equipment, and augering/ drilling equipment.

8.1 PERSONNEL DECONTAMINATION

The decontamination of personnel and their protective clothing will be performed within the decontamination zone. The following are the three stages of decontamination for Level D protection.

- Stage 1 includes removing contamination from reusable protective clothing and/or clothing that will be disposed of.

- Stage 2 will include removal of protective clothings, discarding disposable clothing and storing reusable protective clothing.

- Stage 3 will consist of workers washing their hands with potable water and soap each time they leave the work zone.

The decontamination of personnel and their protective clothing will be performed in 18 stages for Level C & B protection, if necessary. The 18 stages are presented in Table 8.1 below.

Table 8.1
18 Stages for Decontamination in Level B & 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.

Table 8.1 (Cont.)
18 Stages for Decontamination in Level B & C Protection 320340

Stage	Procedure
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.
Stage 15: Inner Glove Removal	Remove inner gloves and deposit in lined container.
Stage 16: Inner Clothing Removal	Remove clothing soaked with perspiration and place in lined container. Do not wear inner clothing off site since there is a possibility that small amounts of contaminants might have been transferred when removing the disposal coveralls.
Stage 17: Field Wash	Shower if highly toxic, skin-corrosive, or skin-absorbable materials are known or suspected to be present. Wash hands and face if shower is not available.
Stage 18: Redress	Put on clean clothes.

All decontamination fluids generated will be contained and disposed of as specified in the Work Plan. The decontamination area will be physically identified with rope or flagging and will be sufficiently equipped to be conducive for completion of the stages listed above.

8.1.1 Closure of the Personnel Decontamination Station

All disposable clothing and plastic sheeting used during the operation will be double-bagged and contained on site prior to removal to an approved off-site disposal facility as identified in the Work Plan. Decontamination and rinse solution will be contained on site prior to disposal. Reusable rubber clothing will be dried and prepared for future use. If contamination of non-disposable clothing has occurred, the item will be discarded. All wash tubs, pail containers, etc., will be thoroughly washed, rinsed, and dried prior to removal from the site.

8.1.2 Disposal of Decontamination and Other Wastes

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All PPE, polyethylene sheeting and sampling support materials (e.g. paper towers, ziplock baggies) will be collected at the end of each work day, placed in plastic trash bags and left at the site overnight. The following day, the air within the plastic trash bag will be tested using the PID. If the air within the bag does not show significant concentrations of organic vapors (greater than 10 ppm above background), the plastic trash bag will be double-bagged and placed in the municipal waste dumpster for disposal.

All other wastes generated during decontamination other than decontamination fluids will be placed into 55-gallon drums; the drums will be fully-opening with a top cover bung (type 17E/H) as identified in the Work Plan. 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 the site for disposal after the analyses of the samples have been obtained.

8.2 SAMPLING EQUIPMENT DECONTAMINATION

All sampling equipment will be decontaminated prior to use, between sampling locations, and at the end of sampling activities to avoid cross-contamination, and to decrease personnel contact with contaminated materials and the probability of removing contamination from the site.

8.2.1 Augering\Drilling and Soil Sampling Equipment

Downhole equipment will be decontaminated between sampling locations. The procedures for decontaminating equipment is presented in the FSP.

8.2.2 Monitoring Well Sampling/Development Equipment

Equipment used to surge and purge the monitoring well during development and the probe used for water level measurements will be decontaminated using the procedures presented in the FSP.

Methanol/hexane will only be used outdoors and personnel will position themselves such that they can avoid breathing vapor and/or mist. MSDSs for the decontamination solutions will be present during site specific training and maintained on site for reference upon request.

8.3 HEAVY EQUIPMENT DECONTAMINATION

Decontamination of augering/drilling tools and other heavy equipment will be accomplished through the use of a high pressure low volume steam system. The HydroGeoLogic field leader will inspect all heavy equipment prior to the equipment being released from the site. All decontamination fluids generated will be contained and disposed of as described in the Work Plan.

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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 physician, preferably an occupational physician. The examination will include the tests, procedures, and frequencies which comply with the requirements of OSHA Standard 29 CFR 1910.120 (f) and ANSI Z-88.2 and will be medically qualified to perform hazardous waste site work under respiratory protection. Medical surveillance documents confirming the worker's fitness to perform hazardous waste operations on this project are on file at the HydroGeoLogic headquarters in Herndon, Virginia, and can be made available upon request.

9.2 REQUIREMENTS FOR SUBCONTRACTORS

Subcontractors are also required to obtain a certificate of their ability to perform hazardous waste operations work and to wear respiratory protection. Subcontractors, who have a company medical surveillance program meeting the requirements of the OSHA Standard 29 CFR 1910.120 (f) will be required to submit a letter, on company letterhead, confirming all on-site workers to be utilized for this project are medically qualified to perform the investigation activities. In addition, medical surveillance documents for personnel assigned to this project must be made available upon request.

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10.0 TRAINING REQUIREMENTS

10.1 INITIAL TRAINING

10.1.1 Requirements for HydroGeoLogic Personnel

All investigation personnel to be utilized are currently enrolled in the HydroGeoLogic continuous training program in accordance with OSHA Standard 29 CFR 1910.120. Individuals working on a site have successfully completed an approved 40-hour Hazardous Waste Site Operations (HAZWOPER) Course including 24-hours of actual field experience under the direction of a trained supervisor, and any subsequent annual 8-hour refresher courses. In addition, the on-site field leader will have completed an 8-hour supervisory course. In addition, a majority of HydroGeoLogic field investigation personnel are also current in first aid/CPR training requirements. HydroGeoLogic employee records are on file in the employee's home office in Herndon, Virginia.

10.1.2 Requirements for Subcontractors

All HydroGeoLogic subcontractor personnel must also have completed 40 hours HAZWOPER training course or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120(e) prior to performing work at the site. In addition, subcontractor personnel must also have successfully completed any subsequent annual 8-hour refresher training.

HydroGeoLogic subcontractors must certify that each subcontractor employee, who will perform work at the site, has had training meeting the requirements of OSHA Standard 29 CFR 1910.120(e). This certification can be accomplished by submitting a letter to HydroGeoLogic, on company letterhead, containing such information.

10.1.3 Requirements for Site Visitors

No person will be allowed in the work zones (exclusion and decontamination) unless they have completed the necessary health and safety training as required by OSHA Standard 29 CFR 1910.120(e) and are wearing the necessary protective equipment as required by this HSP.

10.2 SITE-SPECIFIC TRAINING

HydroGeoLogic will provide site-specific training to all HydroGeoLogic employees and subcontractor personnel who will perform work at the site. Any personnel who does not participate in training will not be permitted to perform work at the site. Site-specific training will include:

- The contents of the HSP.
- Names of personnel and alternates responsible for site health and safety.
- Safety, health, and other hazards present on the site.

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- Use of personal protective equipment.
- Work practices by which the employees can minimize risks from hazards.
- Safe use of engineering controls and equipment on the site.
- Medical surveillance requirements, including recognition of symptoms and signs which might indicate overexposure to hazards.
- Decontamination procedures.
- Emergency response procedures.

HydroGeoLogic and subcontractor personnel will be required to sign a statement indicating receipt of site-specific training and understanding of site hazards and control measures. This form is presented in Section 14.1.

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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.
- Upon leaving the exclusion zone, hands and face must be thoroughly washed. Any protective outer clothing is to be decontaminated and removed as specified in this HSP, and left at a designated area prior to entering the clean area.
- Contact with potentially contaminated substances must be avoided. Contact with the ground or with contaminated equipment must also be avoided. Air monitoring equipment must not be placed on potentially contaminated surfaces.
- No facial hair, which interferes with a satisfactory fit of the mask-to-face seal, is permitted on personnel required to wear respiratory protective equipment.
- All personnel must satisfy medical monitoring procedures.
- No flames or open fires will be permitted on site.
- All personnel must be aware of and follow the action levels presented in this HSP for upgrading respiratory protection.
- Any new analytical data must be promptly conveyed via telephone to the project HSO by the laboratory technician or field leader.
- Personnel must develop hand signals with users of heavy equipment (i.e., drillers, geoprobe operators, etc.).
- A copy of the OSHA "Job Safety and Health Protection" poster must be prominently posted at each site.

- Only equipment which has been approved by the manufacturer may be used in conjunction with site equipment.

- Medicine and alcohol can potentate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel on operations where the potential for absorption, inhalation, or ingestion of toxic substances exists unless specifically approved by a qualified physician. Alcoholic beverage intake will not be allowed at anytime, including during breaks.

- No person will enter the exclusion zone alone.

- Safety devices on equipment must be left intact and used as designed.

- Equipment and tools will be kept clean and in good repair and used only for their intended purpose.

- Eye protection must be worn when any hammering or pounding is performed that may product flying particles or slivers.

- Field personnel are not allowed to lift more than 60 pounds.

- Leather gloves must be worn when handling objects that may product slivers (e.g., driving wood stakes).

- No person shall climb the drill mast without the use of ANSI approved fall protection (i.e., approved belts, lanyards, and a fall protection slide rail) or portable ladder which meets the requirements of OSHA standards.

- The SSO must make an entry into the site field logbook at least daily, to include:

    - Weather conditions
    - Site Personnel
    - New arrivals and their clearance for site work
    - Air monitoring data summary
    - Monitoring instrument calibration
    - Indications of inhalation exposure
    - PPE used per task
    - Deviations from HSP
    - Inspection and cleaning of respiratory equipment
    - General health and safety problems/corrective actions

- If personnel note any warning properties of chemicals (irritation, odors, symptoms, etc.) or even remotely suspect the occurrence of exposure, they must immediately notify the SSO for further direction.

11.2 DRILLING AND GEOPROBE ACTIVITIES

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Prior to the commencement of drilling or geoprobe activities, all locations will be surveyed and marked for underground utilities. In addition, a hand auger or probe will be used to a depth of three feet to assure the absence of underground utilities at the location of interest. If any uncertainties exist, the location will be moved to a nearby adjacent area.

The following general drilling practices must be adhered to during investigation activites:

- All drilling equipment (i.e., rigging, derrick, hoists, augers, etc.) must be inspected by the drilling crew and SSO prior to starting work. Defective equipment will be removed from service and replaced.

- No drilling within 20 feet in any direction of overhead power lines will be permitted. The locations of all underground utilities must be identified and marked prior to initiating any subsurface activities.

- All drill rigs and other machinery with exposed moving parts must be equipped with an operational emergency stop device. Drillers and geologists must be aware of the location of this device. This device must be tested prior to job initiation, and periodically thereafter. The driller and helper shall not simultaneously handle moving augers or flights unless there is a standby person to activate the emergency stop.

- The driller must never leave the controls while the tools are rotating unless all personnel are clear of the rotating equipment.

- Drillers must wear hearing protection unless the employer can provide documentation that noise exposures are less than a dose of 50 percent as required by OSHA Standard 29 CFR 1910.95.

- A long-handled shovel or equivalent must be used to clear drill cuttings away from the hole and from rotating tools. Hands and/or feet are not to be used for this purpose.

- A remote sampling device must be used to sample drill cuttings if the tools are rotating. Samplers must not reach into or near the rotating equipment. If personnel must work near any tools which could rotate, the driller must shut down the rig prior to initiating such work.

- Drillers, helpers, and samplers must secure all loose clothing when in the vicinity of drilling operations.

- Only equipment which has been approved by the manufacturer may be used in conjunction with site equipment and specifically to attach sections of drilling tools together. Pins that protrude from augers shall not be allowed.

A variety of additional work practices (i.e., hoisting, cat line, pipe and auger handling, etc.) are to be adhered to by the drilling crew, which will not be addressed in this HSP. If the on-site field team leader or site supervisor observe any operations or actions that are perceived as threatening to the health and safety of site personnel, drilling or geoprobe operations will be temporarily suspended until a mutual understand of the action(s) in question are addressed and/or corrected.

11.3 TEST PITS

- No personnel, under any circumstances, will enter a test pit. Personnel must use remote sampling equipment to collect samples from test pits or collect the samples from the backhoe bucket.

- No sampling of drums is to occur during test pit operations without prior approval and written procedures form the HSO.

- Personnel must stand a minimum of two feet from the edge of any test pit and are prohibited from leaning over the edge of any test pits. Unstable pits must be sloped at the sides to prevent cave-ins.

- Personnel must develop hand signals with the backhoe operator prior to digging.

- No open pits will be left unattended under any circumstances.

- The backhoe operator will not undermine the excavation.

- Personnel must stand upwind from the test pits and away from the reach of the backhoe, tires, and outrigging.

- The SSO will inspect the test pits for slide or cave-in potential on several occasions during the excavation.

11.4 HOUSEKEEPING

Housekeeping is a very important aspect of an investigation program and will be strongly stressed in all aspects of field work. Good housekeeping plays a key role in occupational health protection and is a way of preventing dispersion of dangerous contaminants. All work areas will be kept as clean as possible at all time and spills will be cleaned up immediately. Housekeeping will be the responsibility of all employees.

HydroGeoLogic will implement a housekeeping program for the field activities to minimize the spread of contamination beyond the work site. The program will include:

- Daily scheduling to police the area of debris including paper products, cans, and other materials brought on site.

- Changing of wash and rinse water for hands, face, and equipment as needed.

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- Periodic (daily minimum) removal of all garbage bags and containers used to dispose of food products, plastic inner gloves, and contaminated disposable clothing.

11.5 WORK LIMITATIONS

All investigation activities will be performed during normal daylight hours.

11.6 CONFINED SPACE ENTRY

Site personnel are not to undertake any activity which could be considered a confined-space entry.

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12.0 SITE CONTROL

12.1 WORK ZONES

Each investigation location will be physically barricaded with rope, flagging, or cones to control entry and exit into and from the area. These barricaded areas will be referred to as the exclusion zones. The exclusion zone will be identified by the site supervisor and consist of a twenty foot radius surrounding the drilling, geoprobe, or test pit location. Each person leaving an exclusion zone will proceed directly to the decontamination zone which will be located adjacent to the exclusion zone and also identified by physical barriers. The decontamination zone will consist of a low-lying area covered with a plastic sheeting. At the completion of decontamination procedures at each location, the debris will be enclosed in the plastic sheeting and deposited into 55-gallon type 17 E/H drums for later disposal as identified in the Work Plan. 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 away from 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 CAFB in emergency situations.

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13.0 EMERGENCY RESPONSE

This HSP has been develop in an attempt to prevent the occurrence of situations that may jeopardize the health and safety of on-site personnel. However, supplemental emergency procedures must be identified in the event that an unforeseen health and safety accident or incident occurs. In general, HydroGeoLogic will evacuate their employees and subcontractors from the workplace if an emergency involving chemical spills, chemical fires, chemical exposure, and/or chemical emissions occurs. For this reason, Emergency Response planning will be in accordance with OSHA Standard 29 CFR 1910.38(a).

13.1 PREPLANNING

Upon initial arrival at the site, the HydroGeoLogic field leader and SSO will visit the AFB's fire department to determine the status of emergency response services. This meeting will include a determination as to the need for further coordination with local rescue and police services.

Another aspect of preplanning for emergencies includes completion of the medical data sheet (Section 14.1). This sheet must be completed by all HydroGeoLogic personnel and subcontractors so that, in the event of personal injury or illness, the examining physician has background information readily available on the injured/ill party.

13.2 EMERGENCY PROCEDURES AND ASSIGNMENTS

Upon notification of a site emergency requiring evacuation, all HydroGeoLogic personnel and subcontractors will proceed directly to the support zone (i.e., trailer, office). If personnel cannot reach the support zone without endangering life or health, an alternate meeting point will be specified by the HydroGeoLogic SSO.

In the event of an emergency, the following procedures will be implemented:

- The site supervisor will evaluate the incident, assess the need for assistance, and call the appropriate contacts, if necessary.
- The site supervisor will act as the point of contact for outside emergency personnel and on site personnel.
- The site supervisor will ensure that the SSO promptly notifies the HydroGeoLogic PM and HSO of the incident.

13.2.1 Chemical Inhalation

It is nor anticipated that chemicals of concern are present at the site in concentrations to cause immediate danger to life and health. However, any field personnel exhibiting or complaining of symptoms of chemical exposure as described in Section 4.1 will be removed from the work zone and transported to the designated medical facility for examination and treatment.

13.2.2 Eye and Skin Contact

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Field personnel who have come into contact with contaminants while in the exclusion zone will immediately proceed to the decontamination zone, where an eyewash station will be located. Do not decontaminate prior to using the eyewash. Remove necessary PPE to perform the eyewash procedures. Flush the eye with the clean water for at least 15 minutes and arrange for prompt transport to the designated medical facility.

Unless skin contact with contaminants is severe proceed through the decontamination zone. Field personnel should remove any contaminated PPE and wash the affected area for at least 15 minutes. If the personnel show signs of skin irritation, they will be transported to the designated facility.

13.3 PROCEDURES FOR PERSONNEL REMAINING ON SITE

No HydroGeoLogic or subcontractor personnel will remain on site to operate critical site emergency operations.

13.4 PROCEDURES TO ACCOUNT FOR SITE PERSONNEL

The HydroGeoLogic and subcontractor work force will be small enough so that accounting for site personnel will not be a problem. The HydroGeoLogic field leader and SSO will ensure that the whereabouts of all personnel are known.

13.5 RESCUE AND MEDICAL DUTIES

Only those persons who have been trained by the American Red Cross, or equivalent, will be permitted to perform rescue, first aid, and/or CPR treatment. Outside emergency services and medical facilities will be the primary providers of such services. A "physicians approved" first aid kit, an ANSI approved eye wash station, and a Class ABC fire extinguisher will be readily available on site.

Any HydroGeoLogic employee who shows signs of symptoms of overexposure must immediately be examined by a licensed physician. Subcontractor personnel who show signs or symptoms of overexposure will be encouraged to visit a licensed physician as well. Figure 13.1 describes the directions to the nearest medical facility.

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.

13.7 ACCIDENT/INCIDENT FOLLOW-UP AND REPORTING

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On receiving a report of incident (or near-incident) occurrence the SSO shall immediately investigate the circumstances and shall make appropriate recommendations to prevent recurrence. The HSO shall also be immediately notified by telephone on occurrence of a serious accident or incident. At his discretion, he may also participate in the investigation.

Details of the incident shall be documented on the Accident/Incident Report form (Section 14.1) within 24 hours of the incident and shall be distributed to the Project Manager and the HSO. 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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Table 13.1
Emergency Telephone Numbers, Contacts, and Directions to Nearest Medical Facility

HydroGeoLogic Personnel	Number
Miquette Gerber - Project Manager Christopher Spill - Health and Safety Officer Dewey Cubit - Certified Industrial Hygienist John Robertson - Executive Vice President	(703) 736-4511 (703) 736-4529 (301) 696-8501 (703) 736-4560
Emergency Phones Numbers	
Ambulance - Fire Department - Poison Control Hospital - Harris Methodist - Fort Worth 1301 Pennsylvania Avenue	911 911 911 911 or (817) 882-2000
Directions to Nearest Medical Facility (Figure 13.1)	
Exit CAFB 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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14.0 DOCUMENTATION AND EQUIPMENT

This section summarizes the documentation and equipment needs for the project as specified in the HSP. Its purpose is to serve as a partial checklist to help ensure all of the necessary resources are available to carry out the requirements of the HSP.

14.1 DOCUMENTATION AND FORMS

The following documents are presented in the following pages for use during site operations:

- Site Safety Briefing Forms
- HSP Compliance Agreement Forms
- HSP Amendments Forms
- Accident/Incident Report Forms
- Personnel Medical Data Sheets
- Equipment Calibration Logs
- Air Monitoring Logs

In addition, the following documentation will be present on-site during site operations:

- Approved HSP (Signed copy)
- OSHA poster
- MSDSs
- Employee training and medical surveillance certificates
- Subcontractor training and medical surveillance certificates

14.2 EMERGENCY, HEALTH AND SAFETY EQUIPMENT

- First aid kit
- Eye wash
- Viton and/or Silvershield gloves
- Inner gloves
- Nitrile gloves
- Boot covers
- Hard hats and safety glasses
- Tyvek
- PVC and/or Saranex (with hoods)
- SCBAs
- Decontamination kit
- Fire extinguisher
- Fall protection devices (body harness and lanyard)
- Duct tape
- LEL/O_2 meters
- PID

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SITE SAFETY BRIEFING FORM

Project ____

Date ____________________ Time ______________ Job No. ____________

Location ____

Type of Work ____

____

____

SAFETY TOPICS PRESENTED

Protective Clothing/Equipment ____

____

Chemical Hazards ____

____

Physical Hazards ____

____

Emergency Procedures ____

____

Hospital/Clinic ______________________________ Phone ____________

Hospital Address ____

Special Equipment ____

____

Other ____

____

____

____

ATTENDEES

Name (Printed)	Signature

Meeting Conducted by: ______________________

Site Safety Officer: ______________________

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HEALTH AND SAFETY PLAN

COMPLIANCE AGREEMENT FORM

PROJECT: RCRA Facility Investigations

CLIENT: U.S. Air Force Center for Environmental Excellence

LOCATION: Carswell Air Force Base, Texas

PROJECT NO: AFC001

I, ______________________________, have received a copy of the Health and Safety Plan for the above-referenced project. I have read the plan, understand it, and agree to comply with all its provisions. I understand that I can be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Signed:

______________________________ ______________________________

Signature Date

____

Company

HEALTH AND SAFETY PLAN AMENDMENTS FORM

Change in field activities or hazards: ______________________________

____

____

____

____

____

____

Proposed Amendments: ______________________________

____

____

____

____

____

____

Proposed by: ______________________ Date: ____________

Approved by: ______________________________

Accented: __________ Declined: __________ Date: ____________

Amendment Number: ____________

Amendment Effective Date: ____________

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HYDROGEOLOGIC, INC.
Accident/Incident/Near Miss Investigation Form

Employee's Name:____

Address:____

________________________________ SS#______________

Job Title:________________ Supervisor's Name:________________

Office Location:____________________________________

Location at Time of Incident:____________________________

Date/Time of Incident:________________________________

Describe clearly how the accident occurred:________________________

____

____

____

Was incident: Physical____________________ Chemical______________

Parts of body affected ____________________ Exposure: Dermal__________

right left

Inhalation__________

Ingestion__________

Witnesses: 1)____________________ 2)________________________

Conditions/acts contributing to this incident________________________

____

____

Managers must complete this section:

Explain specifically the corrective action you have taken to prevent a recurrence:__________

____

____

Did injured go to doctor:________________ Where:____________________

____________________________ When:____________________

Did injured go to hospital:________________ Where:____________________

____________________________ When:____________________

Signatures:

________________	________________	________________
Employee	Reporting Manager	Health & Safety Officer
________________	________________	________________
Date	Date	Date

Accidents must be reported immediately; this form must be completed and returned to the Health and Safety Officer within **24 hours.**

MEDICAL DATA SHEET

This brief Medical Data Sheet will be completed by all onsite personnel and will be kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project ____________________

Name ____________________ Home Telephone ____________________

Address ____________________

Age ____________ Height ____________ Weight ____________

Name of Next of Kin ____________________

Drug or other Allergies ____________________

Particular Sensitivities ____________________

Do You Wear Contacts? ____________________

Provide a Checklist of Previous Illnesses or Exposure to Hazardous Chemicals.

____

____

What medications are you presently using? ____________________

____

____

Do you have any medical restrictions? ____________________

____

____

Name, Address, and Phone Number of personal physician: ____________________

____

____

____

____

I am the individual described above. I have read and understand this HSP:

____________________ ____________________

Signature Date

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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)

15.0 REFERENCES

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Federal Acquisition Regulation, FAR Clause 52.236-13: Accident Prevention.

NIOSH/OSHA/USGC/EPA, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985. (DHHS (NIOSH) Publication No. 85-115); EPA "Standard Operating Safety Guides," June 1992. (NTIS Publication No. 9285.1-03).

Occupational Safety and Health Administration (OSHA) General Industry Standards, 29 CFR 1910, and Construction Industry Standards, 29 CFR 1926; especially 29 CFR 1910.120/29 CFR 1926.65, " Hazardous Waste Site Operations and Emergency Response."

U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health (NIOSH), Pocket Guide to Chemical Hazards, June 1990.

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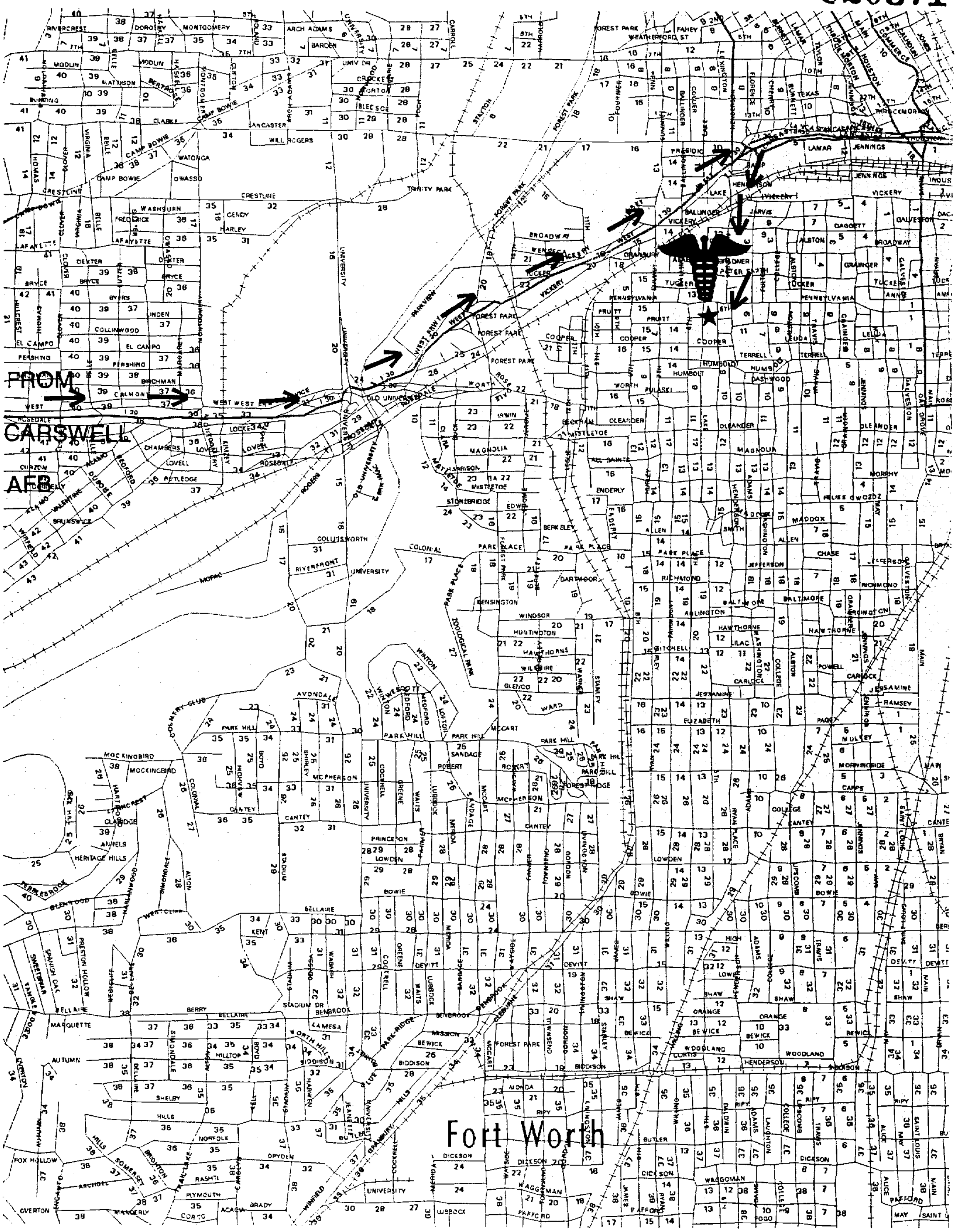

Legend

HOSPITAL

ROUTE TO HOSPITAL

N

Figure 13.1

Nearest Medical Facility to Carswell AFB

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FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE

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FINAL PAGE

ADMINISTRATIVE RECORD

FINAL PAGE