

N83447.AR.000066  
NAS FORT WORTH  
5090.3a

RCRA PERMIT PART B NUMBER HW50289 RCRA FACILITY INVESTIGATION  
REMEDATION WORK PLANS FOR SOLID WASTE MANAGEMENT UNITS 18, 19, 20, 21, 22,  
23, 24, 28, 53, 64, 65, 67, 68 VOLUME 1 NAS FORT WORTH TX  
5/7/1991  
ARMY CORP OF ENGINEERS



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

---

**ADMINISTRATIVE RECORD  
COVER SHEET**

AR File Number 77

**CARSWELL AIR FORCE BASE, TEXAS**  
**RCRA Permit, Part B, Number HW50289**

**Volume 1**

**RFI WORK PLANS**

**Purpose**  
**Work Plan**  
**Quality Assurance Project Plan**  
**Health and Safety Plan**

**7 May 1991**

## TABLE OF CONTENTS

| ITEM                                  | LOCATION |
|---------------------------------------|----------|
| Volume 1                              |          |
| Purpose                               | Pg. 1    |
| Work Plan                             | App. A   |
| Quality Assurance Project Plan        | App. B   |
| Health and Safety Plan                | App. C   |
| Volume 2                              |          |
| Flightline Area Site Characterization | App. D   |
| Flightline Area Feasibility Study     | App. E   |
| Volume 3                              |          |
| East Area Remedial Investigation      | App. F   |
| Weapons Storage Area                  | App. G   |
| Other (Non-IRP) Site Investigations   | App. H   |

**PURPOSE:**

This report is prepared in response to the RCRA Permit, part B, Number HW50289, issued to Carswell Air Force Base on February 7, 1991. It includes RFI plans for all sites addressed in the permit.

Carswell Air Force Base is currently engaged in an intensive environmental program by identifying and remediating contaminated sites under the Air Force's Installation Restoration Program (IRP). The IRP individual sites have been grouped together into two areas, these being the flightline area and the east area. The IRP has progressed from the initial records search conducted in 1984 thru identification of remediation alternatives of the sites located at the flightline area and completion of the remedial investigation at the east area.

The IRP program identified sites by a different numbering sequence than those used in the permit. IRP site numbers are used throughout this report and correspond to the following permit solid waste management unit (SWMU) numbers:

| Site Name                       | IRP No. | SWMU No. |
|---------------------------------|---------|----------|
| Landfill 1                      | 1       | 28       |
| Landfill 4                      | 4       | 22       |
| Landfill 5                      | 5       | 23       |
| Waste Burial Area               | 10      | 24       |
| Fire Department Training Area 1 | 11      | 18       |
| Fire Department Training Area 2 | 12      | 19,20,21 |
| Flightline Drainage Ditch       | 13      | 53       |
| Entomology Dry Well             | 15      | 63       |
| Unnamed Stream                  | 16      | 64,67    |
| POL Tank Farm                   | 17      | 68       |
| Weapons Storage Area            | WSA     | 65       |

This report will be organized as follows:

| Item                                  | Appendix |
|---------------------------------------|----------|
| Work Plan                             | A        |
| Quality Assurance Project Plan        | B        |
| Health and Safety Plan                | C        |
| Flightline Area Site Characterization | D        |
| Flightline Area Feasibility Study     | E        |
| East Area Remedial Investigation      | F        |
| Weapons Storage Area Site Assessment  | G        |
| Other (Non-IRP) Site Investigations   | H        |

The Flightline Area consists of the following SWMU's:

- 18 Fire Training Area No. 1
- 19 Fire Training Area No. 2
- 20 Waste Fuel Storage Tank
- 21 Waste Oil Tank
- 22 Landfill No. 4
- 23 Landfill No. 5
- 24 Waste Burial Area

The East Area consists of the following SWMU's:

- 28 Landfill No.1
- 53 Storm Water Drainage System
- 63 Entomology Dry Well
- 64 French Underdrain System
- 67 Bldg 1340 - Oil/Water Separator
- 68 POL Tank Farm

The Weapons Storage Area has the following SWMU:

- 65 Weapons Storage Area Disposal Site

The Non-IRP SWMU's are:

- 16 Bldg 1060 - Waste Accumulation Area
- 32 Bldg 1410 - Waste Accumulation Area
- 35 Oil/Water Separation System
- 36 Bldg 1191 - Waste Accumulation Area
- 61 Bldg 1320 - Power Production Maintenance Facility Waste Accumulation Area

# APPENDIX A

## Work Plan



INSTALLATION RESTORATION PROGRAM  
PHASE II - CONFIRMATION/QUANTIFICATION  
STAGE 2  
CARSWELL AIR FORCE BASE

WORK PLAN

HEADQUARTERS, STRATEGIC AIR COMMAND  
COMMAND SURGEON'S OFFICE (HQSAC/SGPB)  
JANUARY 1988

PREPARED BY  
RADIANT CORPORATION  
8501 MO-PAC BOULEVARD  
POST OFFICE BOX 201088  
AUSTIN, TEXAS 78729-1088

USAF CONTRACT NO. F-33615-87-D-4023, DELIVERY ORDER NO. 0004  
RADIANT CONTRACT NUMBER 227-005-04

USAFOEHL TECHNICAL PROGRAM MANAGER  
MR. KARL RATZLAFF  
TECHNICAL SERVICES DIVISION (TS)

USAF OCCUPATIONAL & ENVIRONMENTAL HEALTH LABORATORY (USAFOEHL)  
TECHNICAL SERVICES DIVISION (TS)  
BROOKS AIR FORCE BASE, TEXAS 78235-5501

TABLE OF CONTENTS

| <u>SECTION</u> |  | <u>PAGE</u> |
|----------------|--|-------------|
| 1.0            | INTRODUCTION . . . . .   | 1-1         |
| 1.1            | U.S. Air Force Installation Restoration Program . . . . .                | 1-1         |
|                | 1.1.1 Program Origins . . . . .  | 1-1         |
|                | 1.1.2 Program Objectives . . . . .                                       | 1-2         |
|                | 1.1.3 Program Organization . . . . .                                     | 1-2         |
|                | 1.1.4 Program Documents . . . . .  | 1-3         |
| 1.2            | Current Study Objectives . . . . .                                       | 1-6         |
| 2.0            | BACKGROUND . . . . .   | 2-1         |
| 2.1            | Background of Base Activities . . . . .                                  | 2-1         |
|                | 2.1.1 Description of Installation . . . . .                              | 2-2         |
|                | 2.1.2 Past Waste Management Practices . . . . .                          | 2-2         |
| 2.2            | Site-Specific Background Information (By Site) . . . . .                 | 2-5         |
|                | 2.2.1 Description of Site Setting and Location . . . . .                 | 2-7         |
|                | 2.2.2 Types of Wastes and Concentrations . . . . .                       | 2-11        |
|                | 2.2.3 Pathways Affected . . . . .  | 2-16        |
| 3.0            | ENVIRONMENTAL SETTING . . . . .  | 3-1         |
| 3.1            | Geophysical Setting . . . . .  | 3-1         |
|                | 3.1.1 Physiography . . . . .   | 3-1         |
|                | 3.1.2 Topography . . . . .   | 3-4         |
| 3.2            | Geology . . . . .  | 3-4         |
| 3.3            | Hydrogeology . . . . .   | 3-12        |
|                | 3.3.1 Surface Water . . . . .  | 3-12        |
|                | 3.3.2 Groundwater . . . . .  | 3-12        |
| 3.4            | Climatology/Air . . . . .  | 3-18        |
| 3.5            | Human Environment . . . . .  | 3-20        |
|                | 3.5.1 Population . . . . .   | 3-20        |
|                | 3.5.2 Demographics . . . . .   | 3-20        |
|                | 3.5.3 Land Use . . . . .   | 3-21        |
| 4.0            | BASIS FOR PROGRAM APPROACH . . . . .                                     | 4-1         |
| 4.1            | Physiochemical Properties of Contaminants . . . . .                      | 4-1         |
| 4.2            | Pathways and Receptors . . . . .   | 4-2         |
| 4.3            | Environmental/Health Effects . . . . .                                   | 4-2         |
| 4.4            | Preliminary Technologies . . . . .                                       | 4-3         |
| 4.5            | Applicable or Relevant and Appropriate Requirements<br>(ARARs) . . . . . | 4-3         |
| 4.6            | Data Requirements . . . . .  | 4-4         |
| 5.0            | SCOPE OF WORK . . . . .  | 5-1         |
| 5.1            | Organization of Effort . . . . .   | 5-1         |
|                | 5.1.1 Operable Units . . . . .   | 5-1         |
|                | 5.1.2 Combined Site Investigations . . . . .                             | 5-2         |

TABLE OF CONTENTS (cont.)

| <u>SECTION</u>   | <u>PAGE</u> |
|--|-------------|
| 5.2 General Discussion of Integrated IRP Tasks . . . . .                   | 5-2         |
| 5.2.1 Field Related Tasks . . . . .  | 5-2         |
| 5.2.1.1 Soil Gas Survey . . . . .  | 5-4         |
| 5.2.1.2 Geophysical Surveys . . . . .                                      | 5-4         |
| 5.2.1.3 Subsurface Soil Surveys . . . . .                                  | 5-4         |
| 5.2.1.4 Borehole Geophysical Surveys . . . . .                             | 5-7         |
| 5.2.1.5 Monitoring Wells . . . . .   | 5-7         |
| 5.2.1.6 Aquifer Tests . . . . .  | 5-11        |
| 5.2.1.7 Groundwater Samples . . . . .                                      | 5-11        |
| 5.2.1.8 Trenching . . . . .  | 5-13        |
| 5.2.1.9 Drum Sampling . . . . .  | 5-15        |
| 5.2.2 Evaluation-Related Tasks . . . . .                                   | 5-15        |
| 5.2.2.1 Data Management . . . . .  | 5-15        |
| 5.2.2.2 Hydrogeologic Assessment . . . . .                                 | 5-17        |
| 5.2.2.3 Demographic Survey . . . . .                                       | 5-17        |
| 5.2.2.4 Evaluation and Screening of Data. . . . .                          | 5-18        |
| 5.2.2.5 Endangerment Assessment . . . . .                                  | 5-15        |
| 5.2.2.6 Map Preparation . . . . .  | 5-19        |
| 5.2.2.7 Treatability Studies . . . . .                                     | 5-20        |
| 5.2.2.8 IRP Reports . . . . .  | 5-20        |
| 5.2.3 Feasibility Study Tasks . . . . .                                    | 5-21        |
| 5.2.3.1 Identification of General Response<br>Actions . . . . .            | 5-21        |
| 5.2.3.2 Identification and Screening of<br>Remedial Technologies . . . . . | 5-22        |
| 5.2.3.3 Development of Alternatives . . . . .                              | 5-22        |
| 5.2.3.4 Screening of Alternatives . . . . .                                | 5-24        |
| 5.2.3.5 Technical Evaluation of Alterna-<br>tives . . . . .                | 5-25        |
| 5.2.3.6 Institutional Requirements Evalua-<br>tion . . . . .               | 5-26        |
| 5.2.3.7 Exposure Assessment . . . . .                                      | 5-26        |
| 5.2.3.8 Environmental Impact Evaluation . . . . .                          | 5-26        |
| 5.2.3.9 Cost Analysis of Selected Alterna-<br>tives . . . . .              | 5-26        |
| 5.3 Site-Specific Discussion . . . . .                                     | 5-27        |
| 5.3.1 Field Investigation . . . . .  | 5-27        |
| 5.3.2 Evaluation of Alternatives . . . . .                                 | 5-36        |
| 6.0 REPORTING REQUIREMENTS . . . . .                                       | 6-1         |
| 6.1 Monthly Research and Development (R&D) Status<br>Report . . . . .      | 6-1         |
| 6.2 Informal Technical Information Report (ITIR) . . . . .                 | 6-1         |
| 6.3 RI/FS Reports . . . . .  | 6-1         |
| 7.0 SCHEDULE . . . . .   | 7-1         |

LIST OF FIGURES

| <u>FIGURE</u> |   | <u>PAGE</u> |
|---------------|---|-------------|
| 2-1           | Location of Phase II, Stage 2 Sites, Carswell, AFB<br>Texas . . . . . | 2-6         |
| 3-1           | Regional Setting of Carswell AFB, Texas . . . . .                     | 3-2         |
| 3-2           | Area Location Map of Carswell AFB, Texas . . . . .                    | 3-3         |
| 3-3           | Soils Association Map, Carswell AFB, Texas . . . . .                  | 3-6         |
| 3-4           | Stratigraphic Column at Carswell AFB, Texas . . . . .                 | 3-8         |
| 3-5           | Geologic Map of Carswell AFB, Texas . . . . .                         | 3-10        |
| 3-6           | Geologic Cross Section A-A', Carswell AFB, Texas . . . . .            | 3-11        |
| 3-7           | Areal Extent of the Paluxy Aquifer, North Texas . . . . .             | 3-14        |

1.0 INTRODUCTION

1.1 U.S. Air Force Installation Restoration Program

The Department of Defense (DOD) is conducting a nationwide program to evaluate waste disposal practices on DOD property, to control the migration of hazardous contaminants, and to control hazards that may result from these waste disposal practices. This program, the Installation Restoration Program (IRP), consists of four phases: Phase I, Problem Identification/Records Search; Phase II, Problem Confirmation and Quantification; Phase III, Technology Base Development; and Phase IV, Remedial Actions in support to the program. The United States Air Force has initiated an IRP investigation at Carswell Air Force Base near Fort Worth, Texas. Phase I and Phase II Stage 1 have been completed. Radian Corporation will perform the Phase II Stage 2 Field Evaluation under USAF Contract No. F336615-87-D-4023, Delivery Order 4.

1.1.1 Program Origins

In 1976, the U.S. Department of Defense (DOD) developed the comprehensive Installation Restoration Program (IRP), in response to the Resource Conservation and Recovery Act of 1976 (RCRA), and in anticipation of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA, the legislation that authorizes the U.S. EPA "Superfund" program). DOD issued a Defense Environmental Quality Program Policy Memorandum (DEQPPM) dated June 1980 (DEQPPM 80-6), that requires the identification of past hazardous waste disposal sites at DOD agency installations. The Air Force implemented the DEQPPM in December of 1980. The program was revised by DEQPPM 81-5, dated December 1981, which reissued and amplified all previous directives and memoranda on the IRP. The Air Force implemented DEQPPM 81-5 in January of 1982.

The IRP has been developed as the following four-phase program:

- Phase I - Problem Identification/Records Search
- Phase II - Problem Confirmation and Quantification
- Phase III - Technology Base Development
- Phase IV - Corrective Action

Since the initiation of the IRP, experience has been gained in all phases of the program, and the approaches used in the IRP have evolved accordingly. Based on experience at Air Force bases nationwide, the Air Force has adopted an approach that streamlines and integrates the elements of the program.

1.1.2 Program Objectives

The long-range objectives of the Carswell AFB IRP activities are to assess the extent and magnitude of contamination at past hazardous waste disposal and spill sites and to develop remedies consistent with the National Contingency Plan (NCP) for those sites that pose a threat to human health or welfare or the environment. Further, the IRP is to assess and control the migration of environmental contamination that may have resulted from past operations and disposal practices at DOD facilities. The program is designed to conduct remedial investigations and feasibility studies in parallel rather than serial fashion.

1.1.3 Program Organization

This subsection presents a description of the organization of the current IRP. It is the intent of the Air Force that the IRP will be equivalent to the NCP process in accordance with CERCLA procedures. Therefore, the NCP nomenclature is used throughout. Phases I, II/IVA, III, and IVB are briefly described below:

Phase I - The objectives of this phase are to identify and assess past disposal sites. This assessment considers whether or not each site poses a hazard to human health or the environment as a result of direct contact, contamination migration, or contaminant persistence.

Phase II/IVA (RI/FS) - The integration of these phases corresponds to the Remedial Investigation/Feasibility Study (RI/FS) programs described in the National Oil and Hazardous Substances Contingency Plan, also referred to as the National Contingency Plan (NCP) (40 CFR 300, November 20, 1985), and in the Superfund Amendment and Reauthorization Act of 1986 (SARA). Data collection and subsequent site characterization are the main objectives of Phase II, which will be conducted concurrently with Phase IVA. Development, screening, and detailed analysis of remediation alternatives form the main portion of Phase IVA, which leads to selection of the recommended remedial action alternative.

Phase III - This phase is the implementation of the research and technology development required for objective assessment of environmental effects or remedial technologies.

Phase IVB - Phase IVB involves the construction and implementation of the remedial alternatives.

1.1.4 Program Documents

The USAF Installation Restoration Program has been designed and is being conducted under guidance from the following applicable documents:

Public Laws

United States Code

PL 96-510

Comprehensive Environmental Response  
Compensation, and Liability Act  
(CERCLA) of 1980

PL 99-499

Superfund Amendments and Reauthoriza-  
tion Act (SARA) of 1986

Regulations

Code of Federal Regulations

40 CFR 136.3e,  
Table II

Required Containers, Preservation  
Techniques, and Holding Times

40 CFR 136,  
Appendix A

Methods for Organic Chemical Analysis  
of Municipal and Industrial Wastewater

40 CFR 136,  
Appendix B

Definition and Procedure for the Deter-  
mination of the Method Detection Limit

40 CFR 136,  
Appendix C

Inductively Coupled Plasma - Atomic  
Emission Spectrometric Method for Trace  
Element Analysis of Water and Wastes  
Method 200.7

40 CFR 300.61 -  
300.71 (Subpart F)

National Contingency Plan

Federal Register

Vol. 51, No. 114,  
13 June 1986

Toxicity Characteristic Leaching  
Procedure (TCLP)

Residential Documents

Executive Orders

EO 12088

Federal Compliance with Pollution  
Control Standards (13 October 1978)

EO 12580

Superfund Implementation (23 January  
1987)

Environmental Protection Agency

EPA-330/9-51-002

MEIC Manual for Groundwater/Subsurface Investigations of Hazardous Waste Sites

Superfund Exposure Assessment Manual (January 1986)

EPA-600/4-79-020

Methods for Chemical Analysis of Water and Wastes (1983)

SW-846

Test Methods for Evaluating Solid Waste, Third Edition (1986)

American Public Health Association (APHA, AWWA, & WPCF)

Standards Methods for the Examination of Water and Wastes (16th Edition)

American Society for Testing and Materials

D-1452

Soil Investigation and Sampling by Auger Boring

D-1586

Penetration Test and Split-Barrel Sampling of Soils

D-2487

Unified Soil Classification System

D-2488

Recommended Practices for Visual-Manual Description of Soils

Annual Book of ASTM Standards

Section 11, Water and Environmental Technology

Handbooks

Environmental Protection Agency

EPA-540/G-85-002

Guidance on Remedial Investigations under CERCLA

EPA-540/G-85-003

Guidance on Feasibility Studies under CERCLA

Analytical Chemistry

Vol. 55, Pages 2210  
2218, December 83

Principles of Environmental Analysis

64-77

For a base-specific investigation, IRP reports that document Phase I or II activities will be the prime source documents for conducting current investigations at Carswell. The principal documents for the Carswell AFB IRP Phase II Stage 2 investigations will be:

- Installation Restoration Phase I Records Search for Carswell AFB, Texas, February 1984; and
- Installation Restoration Program Phase II - Confirmation/Quantification, Stage 1 - Final Report, Carswell AFB, Texas, October 1986.

1.2 Current Study Objectives

The primary objective of the Carswell AFB IRP Stage 2 work is to integrate the past and present remedial investigations of the sites at the base in order to provide the information that is necessary and sufficient to conduct feasibility studies. This integration involves determining which sites pose a threat to human health and the environment and which sites do not. In order to complete this integration, the following efforts will be performed:

- Review previous Phase I and Phase II Stage 1 work and assess its adequacy for use in the current effort;
- Prepare the necessary procedural and administrative plans to control the quality and flow of information collected during Stage 2;
- Conduct follow-on field investigations at incompletely characterized sites;
- Conduct pathway characterization studies;

- Identify and screen remedial technologies;
- Define ARARs and develop an approach for public health evaluation;
- Evaluate and prioritize sites; and
- Develop and screen appropriate remedial alternatives;

2  
7  
4  
7

2.0 BACKGROUND

2.1 Background of Base Activities

The United States Air Force (USAF) in August, 1983, initiated an IRP investigation at Carswell Air Force Base near Fort Worth, Texas. Subsequent to that time, a Phase I and II Stage 1 investigation have been completed. USAF contracted with Radian Corporation to conduct the Phase II Stage 2 Field Evaluation for Carswell Air Force Base (AFB) under Contract No. F33615-87-D-4023, Delivery Order 4.

Phase I studies for the Carswell AFB Installation Restoration Program were completed in February 1984. The purpose of the Phase I study was to conduct a records search for the identification of past waste disposal activities which may have caused groundwater contamination and the migration of contaminants off site.

Twenty-two disposal or spill sites at Carswell AFB and the Weapons Storage Area were identified as possibly containing hazardous waste during the Phase I study. Of these sites, fourteen were selected for environmental rating. The potential for adverse environmental consequences at each site was then evaluated and rated using the USAF Hazard Assessment Rating Methodology (HARM). The rating was based on the potential environmental contamination and migration of contaminants. The system took into account such factors as the site environmental setting, the nature of the wastes present, past waste disposal practices, and the potential for contaminant migration.

Twelve of the fourteen Phase I sites were selected for Phase II (Stage 1) studies. The IRP Phase II studies are for contaminant confirmation and quantification, which is executed in a staged approach. Stage 1 was the initial part of the investigation designed to confirm a contamination problem. Based upon the results of the Stage 1 activities completed in October 1986, additional investigations were deemed necessary for quantification of contaminants at all sites, which will require one or more successive stages.

2.1.1 Description of Installation

Carswell AFB is located on 2,751 acres of land in Tarrant County, Texas, 6 miles west of the center of Fort Worth and lies between the communities of White Settlement and River Oaks. Carswell AFB lies within a bend of the West Fork of the Trinity River which flows along the northern and eastern boundaries of the base. The river is dammed to form Lake Worth, a drinking water supply and recreation reservoir bordering Carswell AFB to the north. To the west, Carswell AFB is neighbored by AF Plant 4, an Air Force-owned, General Dynamics Corporation-operated, aircraft production plant that shares the runway and several facilities with Carswell AFB. To the south Carswell AFB is bordered by urban areas. Off-base facilities include the ILS Marker Beacon west of Carswell AFB and the Weapons Storage Area (WSA), 4 miles west of Carswell AFB.

Carswell AFB is the home of the Strategic Air Command's (SAC) 7th Bombardment Wing. As such, the mission of Carswell AFB is to maintain the capability of strategic warfare and air refueling operations. Assigned weapon systems include the Boeing B-52 "H" model bomber and the KC-135A tanker.

As host unit, the 7th Bombardment Wing oversees aircraft operations and maintenance agencies. In addition to maintaining bombers, tankers, and combat crews capable of strategic warfare, Carswell AFB also houses an extensive air training effort which includes the air training requirements of three tactical squadrons. The 7th combat Support Group and the USAF Regional Hospital Support the combat mission of the Wing. The total work force at Carswell AFB (as of 1984) was approximately 5,100 military and 1,000 civilian personnel.

2.1.2 Past Waste Management Practices

The Phase I report (CH<sub>2</sub>M-Hill, 1984) has an account of the history of waste generation and disposal activities. The following paragraphs describing the waste disposal history are from the Phase I report.

Wastes have been generated and disposed of at Carswell AFB since the beginning of industrial operations in 1942. The major industrial operations at Carswell AFB now include: maintenance of jet engines, aerospace ground equipment (AGE), fuel systems, weapons systems, and pneudraulic systems; maintenance of general and special purpose vehicles; aircraft corrosion control; and non-destructive inspection (NDI) activities. All of these operations generate wastes such as primarily oils, recoverable fuels, spent solvents, and cleaners.

The total quantity of waste oils, recoverable fuels, spent solvents, and cleaners generated at Carswell AFB was estimated in 1984 to be approximately 55,000 gallons/year. This estimate was derived from a review of shop files and the best recollection of interviewees and is considered to be representative of the 1970s to 1983. Prior to the 1970s, the waste quantities were probably less because fewer aircraft were maintained at the base.

Prior to about 1970, some of the liquid waste oil, recovered fuels and possibly solvents were burned at two fire training areas at the Base. Both sites have been described as "gravel-lined," with one being used from 1942 to 1963. It is estimated that up to 156,000 gallons per year of waste oils, fuels, solvents and cleaners have gone to the fire training area before 1970. After 1970, the training exercises have been conducted about 2 to 3 times per month using an average of 1,300 gallons per month of clean or recovered JP-4 fuel.

Smaller amounts of liquid wastes are associated with pest and weed control activities at the Base. The pesticides have been stored at two locations, one at Facility 1338 before 1981, and thereafter at Facility 1217. Some of the chemicals in use are anticoagulant, Baygon, diazinon, malathion organophosphate and monosodium arenate. Used containers are triple rinsed, punctured and disposed of in dumpsters along with the empty bags. Rinse waters from container and equipment rinsing is discharged to a tank outside Facility 1217. The full tank is pumped out for proper disposal. Before 1981,

the rinse waters were discharged into a "dry well" sump located outside Facility 1338. This "dry well" sump has been identified as a potentially contaminated site (Site 15).

Practices for past and present industrial waste disposal are summarized below:

- 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 wash-racks. In 1955, an oil/water separator (Facility 1190) was installed to recover waste materials discharged from the wash-racks. Materials from the oil/water separators were pumped out and disposed of through contractor removal. Discharge from the oil/water separator was and still is into the sanitary sewers.
- 1970-1975: 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 department training area and burned in practice exercises. Recovered JP-4 was also reused by AGE. 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 drains. This primarily occurred at the washracks that discharge to the Facility

1190 oil/water separator. This oil/water separator was routinely pumped out by a private contractor and the recovered materials removed from the base by the contractor.

- 1975-1982: 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 by AGE. PD-680 used at the washracks was discharged to the Facility 1190 oil/water separator which discharges to the sanitary sewers.
- 1982-Present: Waste oils, solvents, and cleaners are collected in 55-gallon drums and temporarily (less than 90 days) stored at 12 hazardous waste accumulation points located throughout the flightline area. 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 by AGE. Removal of waste oils and PD-680 (Type II) from oil/water separators is also handled by an off-base contractor through DRMO.

## 2.2 Site-Specific Background Information (By Site)

Phase II (Stage 2) work at Carswell AFB will focus on eleven sites on base shown on Figure 2-1 and the WSA, located four (4) miles west of the base. These sites consist of landfills, fire training areas, industrial areas, and spill sites. The following paragraphs provide brief descriptions of the locations and features of the Phase II sites. All of the information provided was obtained from the Installation Restoration Program Phase I record search report (CH<sub>2</sub>M-Hill, 1984).

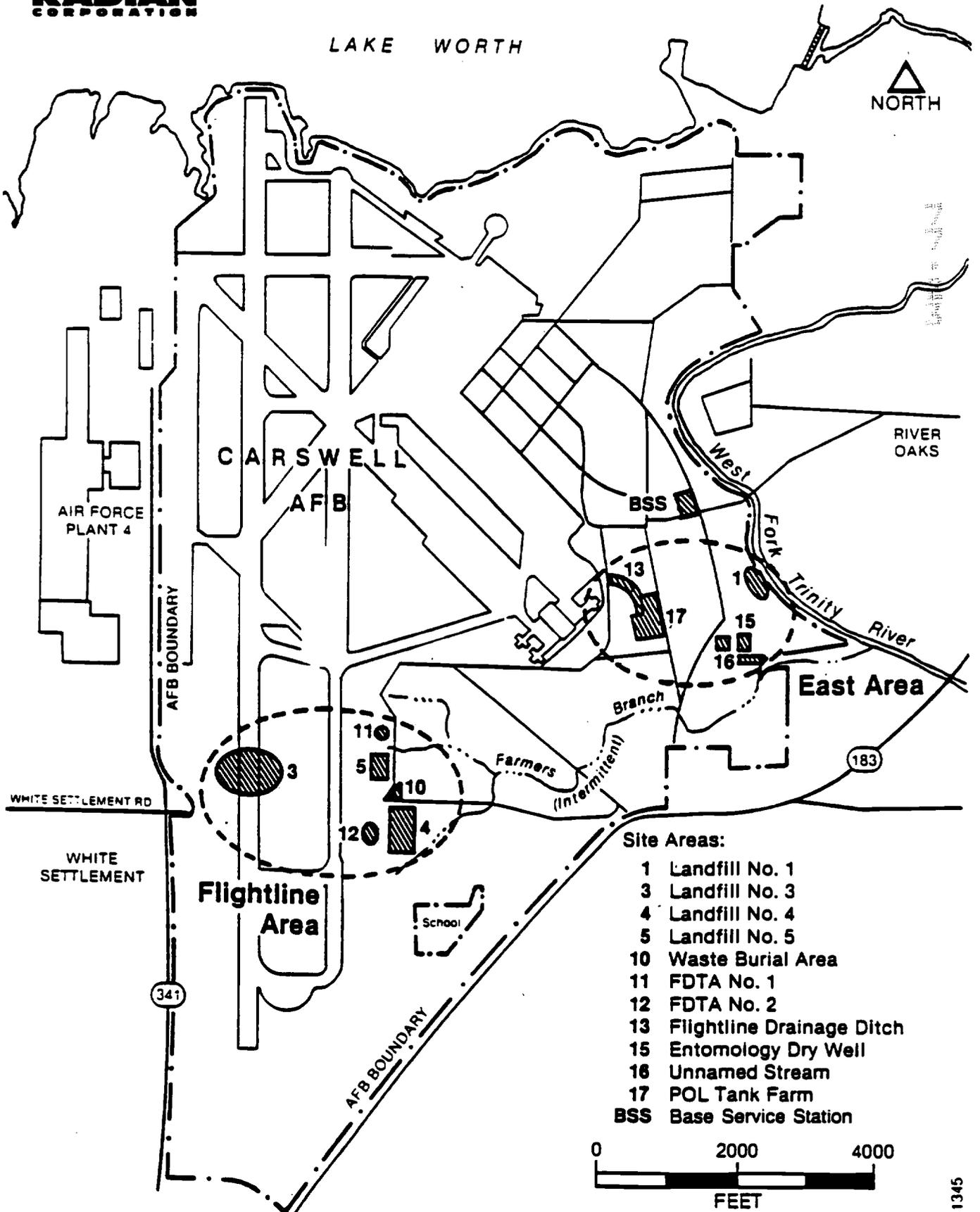


Figure 2-1. Location of Phase II, Stage 2 Sites, Carswell AFB, Texas

C1345

2.2.1 Description of Site Setting and Location

Site 1. Landfill 1

Landfill 1 was reported to be the original base landfill and was operated during the 1940s. This site is located adjacent to the Trinity River levee at the current DRMO storage yard. Due to the time elapsed since this site was closed, no information was available concerning past waste disposal practices at this location.

Site 3. Landfill 3

Landfill 3 is located under the main runway, immediately south of the culvert carrying the flow of Farmers Branch. During the period from 1950 until 1952, Site 3 was used for burial of all types of waste, but primarily construction rubble. During that period, the runway ended north of Farmers Branch, and a ravine present at this site was used as a fill area.

Site 4. Landfill 4

Landfill 4 was operated from approximately 1956 until 1975. This site, which includes 10 acres of land east of the runway and is currently the location of the radar site, was the main landfill during much of the history of Carswell AFB. All base refuse was buried here and burning was a regular practice. At least six large pits, approximately 12 feet deep were filled with refuse which was burned and buried. Various materials suspected of being hazardous were reportedly disposed at this site, including drums of waste liquids, partially full paint cans, and cadmium batteries. Written records indicate that routine disposal of waste paints, thinners, and strippers; oil containing adsorbent materials; PD-680 (a safety cleaning solvent) and oils may have been practiced at this location.

Site 5. Landfill 5

Landfill 5 was reportedly used between 1963 and 1975. This site is located northwest of Landfill 4 and was constructed adjacent to a small tributary to Farmers Branch. The landfill site was constructed by building a clay berm adjacent to the creek and then filling the area behind the berm up to its existing level. This fill site received all types of flightline wastes and refuse, and was regularly burned prior to covering.

Site 10. Waste Burial Area

Site 10, located adjacent to and south of White Settlement Road, where it dead-ends at the taxiway, 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 reported disposed of at this site. Reportedly, these materials were buried in a natural clay strata. The site is currently identified by several signs reporting the presence of buried tetraethyl lead sludge.

Site 11. Fire Department Training Area 1

Site 11 is located north of Landfill 5 adjacent to a small tributary to Farmers Branch. This training area was the primary fire pit prior to 1963. The pit reportedly was gravel-lined and had a low concrete curb around its perimeter. Several fire training exercises are reported to have taken place at this site each month, with waste oils and contaminated fuels being the primary flammable liquids used in the exercises. Small quantities of solvents are also reported to have been used in these exercises.

Site 12. Fire Department Training Area 2

Site 12 is located between the north-south taxiway and the radar facility. This site, with only slight modifications, has been used as a fire department training area since 1963. The fire ring is gravel-lined with a low

berm around its perimeter. In the past, a pit was present at the site to collect runoff from training exercises, but this pit has been filled. At the beginning of Phase II, Stage 1 field work the berm had been breached by erosion and some runoff had collected outside the northeast corner of the ring. By the conclusion of field work, the breach had been repaired.

Two tanks located at the site have been used for storage of flammable liquids prior to training exercises. An 8,500-gallon aboveground tank is used to store clean or contaminated fuels, which are delivered to the ring via a pump and various pipes. An underground tank of approximately 9,500 gallons has been used for storage of waste oils and solvents from the flightline shops. Although normal disposition of the underground tank contents has been to off-base contractors, it is possible that contents of this tank have also been used for training exercises in the past.

#### Site 13. Flightline Drainage Ditch

Site 13 is located east of Haile Drive, directly east of the main base washrack (Pad 29) and Hangars 1049 and 1048. The ditch is unlined from Haile Drive to where it intersects at the POL tank farm, at which point it enters a concrete-lined channel. Contamination was visible at Site 13 during the base visit (1983) in the form of a white liquid (aircraft soap) originating at the washrack and entering the ditch through a small pipe; the presence of petroleum products on the surface of the water further downstream; and the presence of a dark zone of fuel or oil saturation along the banks of the ditch at least 10 inches above the surface of the water.

In addition to normal storm drainage, this ditch receives discharges from the aircraft washracks (18 and 29) and discharges from the Fuel Systems Shop (Building 1048). Washrack wastes (PD-680, a cleaning solvent, and soap) can be discharged directly to the Facility 1190 oil/water separator, located adjacent to the flightline drainage ditch, or into the drainage ditch via an

overflow pipe in the drain line between the washracks and the oil/water separator. Discharge to the oil/water separator or to the drainage ditch is controlled by a valve in the drain line just upstream of the separator.

Discharges from the Fuel Systems Shop consists of JP-4 fuel drained from fuel tanks. Prior to 1978, this fuel was piped via gravity to the Facility 1190 oil/water separator. The pipe was routed through the much larger stormwater culvert that begins the flightline drainage ditch. Approximately 5 years ago (1979), the pipe ruptured and JP-4 was allowed to enter the stormwater culvert and thus the ditch. The pipe was repaired in March 1984.

Site 15. Entomology Dry Well

Site 15 is located immediately west of the old entomology shed (Building 1338) in the present Civil Engineering Compound, east of Rogner Drive. A dry well at the site was used for disposal of insecticide rinsate between 1965 and 1981. The site is currently vacant; Building 1338 has been demolished and the site has been regraded. Building 1338 was used for the storage and mixing of insecticides including malathion, diazinon, dursban, and chlordane, and for storage and cleaning of spray equipment. Chlordane has been reported in samples taken from the well next to Building 1338, although no documented analytical results could be found during the records search to substantiate this report.

Site 16. Unnamed Stream

Site 16 is a small tributary of Farmers Branch, located south of the old entomology shed, and near the confluence of Farmers Branch and the Trinity River. This small stream is the discharge from an oil/water separator located immediately south of the fenced civil engineering yard, and receives its perennial flow from groundwater entering the separator. The separator is connected to a french underdrain system which was reportedly build in 1965 to capture POL leaking from the POL Tank Farm (see below) into the sewer pipes. This separator has not been routinely cleaned for a number of years and contained

hydrocarbon constituents. Overflow from this separator is apparently contributing POL and iron to the stream. The discharge has a petroleum odor, an oil sheen, and is reddish brown with extensive growths of what appears to be iron-reducing bacteria. Previous analyses completed on the stream have detected trace quantities of trichlorethylene.

#### Site 17. POL Tank Farm

Site 17 is located on the eastern side of Carswell AFB, adjacent to Knight's Lake Road. Currently, from above-ground tanks are located at this location; formerly, three additional tanks were also located here. During the early 1960s, fuels were discovered in the ground in this area, and also downgradient (southeast) from this site. A french drain was installed downgradient from this area to collect fuels in the ground. The french drain discharged through the oil/water separator mentioned above (Site 16). At that same time, the underground leaking POL pipes were reportedly located and replaced. No additional loss of POL to the ground is suspected to have occurred in this area since 1965. The french drain system is still continuing to collect POL as evidenced by the contents of the Unnamed Stream observed during the site visit. As a result, fuel is still suspected to be present in the ground in the area of the POL tank farm and downgradient (southeast and east) from it.

#### 2.2.2 Types of Wastes and Concentrations

The Phase II Stage 1 investigation (Radian, 1986) documented the presence of organic contamination, mostly trichloroethylene (TCE), in the upper zone soil and groundwater at several sites. Concentrations of heavy metals were typically at background levels. No groundwater contamination was observed in the Paluxy aquifer. In addition, low levels of organic compounds were detected in small tributaries of Farmers Branch in the vicinity of several sites at the flightline. A summary of the analytical data for organic contaminants in upper zone groundwater is provided in Table 2-1. Results of analyses of surface water are provided in Table 2-2, and results of soil analyses are given in Table 2-3.

TABLE 2-1. SUMMARY OF ORGANIC COMPOUNDS IN UPPER ZONE GROUNDWATER, CARSWELL AFB, TEXAS

| Parameter                           | Location    |            |             |           |           |             |         |             |            |  |  |
|-------------------------------------|-------------|------------|-------------|-----------|-----------|-------------|---------|-------------|------------|--|--|
|                                     | Site 1      | Site 4     | Site 5      | Site 10   | Site 11   | Site 12     | Site 15 | Site 16     | Site 17    |  |  |
| <b>ORGANIC INDICATORS (ug/L)</b>    |             |            |             |           |           |             |         |             |            |  |  |
| Oil and Grease                      | <1-190      | <1-23      | <1-220      | <1-310    | <1-200    | <1-49       | <1-4    | <1-7,100    | <1-31,000  |  |  |
| Phenols                             | 0.005-0.074 | <0.005-0.1 | 0.005-0.012 | NA        | 0.005     | 0.005-0.021 | NA      | NA          | NA         |  |  |
| TOC                                 | 3-8         | 1-20       | 1-6         | 1-5       | 1-15      | <1-5        | NA      | 1-420       | 44-190     |  |  |
| TOX                                 | <0.01       | NA         | 0.03-1.5    | 0.03-0.16 | 0.01-0.14 | <0.01-0.38  | NA      | <0.01-0.04  | <0.01-0.12 |  |  |
| <b>PESTICIDES/HERBICIDES (ug/L)</b> |             |            |             |           |           |             |         |             |            |  |  |
| 2,4,5-TP                            | ND-0.2      | ND         | NA          | ND        | ND-0.2    | NA          | ND      | NA          | NA         |  |  |
| Lindene                             | ND          | ND         | NA          | ND        | ND        | NA          | ND-<0.1 | NA          | NA         |  |  |
| Endrin                              | ND          | ND         | NA          | ND        | ND        | NA          | ND-<0.1 | NA          | NA         |  |  |
| <b>FURCABLE HALOCARBONS (ug/L)</b>  |             |            |             |           |           |             |         |             |            |  |  |
| Vinyl Chloride                      | ND          | ND-12.5    | ND-178      | ND-8.6    | ND        | ND-9.4      | NA      | ND          | NA         |  |  |
| Chloroethane                        | ND          | ND-7.6     | ND          | ND        | ND        | ND          | NA      | ND          | NA         |  |  |
| Methylene Chloride                  | ND          | ND         | ND          | ND        | ND        | ND          | NA      | ND          | NA         |  |  |
| Trichlorofluoroethane               | ND-3.8      | ND-6.8     | ND          | ND-5.3    | ND-3.7    | ND-15.7     | NA      | ND-4.2      | NA         |  |  |
| 1,1-Dichloroethane                  | ND          | ND-0.1     | ND-7.5      | ND        | ND        | ND-2.5      | NA      | ND          | NA         |  |  |
| 1,1-Dichloroethane                  | ND          | ND-4.4     | ND          | ND-6.8    | ND        | ND-5.9      | NA      | ND          | NA         |  |  |
| 1,1,1-Trichloroethane               | ND          | ND-23.1    | ND          | ND        | ND        | ND-2.9      | NA      | ND          | NA         |  |  |
| 1,2-Dichloropropane                 | ND          | ND-2.3     | ND-2.6      | ND        | ND        | ND          | NA      | ND-2.9      | NA         |  |  |
| Trichloroethylene                   | ND-1.4      | ND-4298    | ND-3208     | 1870-5008 | ND-1.8    | ND-342      | NA      | ND          | NA         |  |  |
| Tetrachloroethylene                 | ND          | ND-16.3    | ND          | ND-182    | ND        | ND-164      | NA      | ND          | NA         |  |  |
| Chloroethene                        | ND          | ND-3.7     | ND          | ND        | ND        | ND          | NA      | ND          | NA         |  |  |
| Trans-1,2-Dichloroethane            | ND-1.4      | ND         | ND          | ND        | ND        | ND          | NA      | ND-0.1      | NA         |  |  |
| <b>FURCABLE AROMATICS (ug/L)</b>    |             |            |             |           |           |             |         |             |            |  |  |
| 1,4-Dichlorobenzene                 | ND          | ND-9.1     | ND          | ND        | ND        | ND-3.9      | NA      | (very high) | ND         |  |  |
| 1,2-Dichlorobenzene                 | ND          | ND         | ND          | ND        | ND        | ND-4.1      | NA      | (very high) | ND         |  |  |

NA = not analyzed  
ND = not detected

00114

TABLE 2-2. SUMMARY OF ORGANIC AND INORGANIC COMPOUNDS IN SURFACE-WATER SAMPLES, CARSWELL AFB, TEXAS

| Parameter                             | Site 4    | Site 5    | Site 12         | Site 16 Oil/Water Separator | Site 16 Unnamed Stream |
|---------------------------------------|-----------|-----------|-----------------|-----------------------------|------------------------|
| <b>ORGANIC INDICATORS (ug/L)</b>      |           |           |                 |                             |                        |
| Oil and Grease                        | NA        | <1 - 350  | 1 - 64,000      | 1 - 640                     | <1                     |
| Phenols                               | NA        | NA        | 0.14            | NA                          | NA                     |
| TOC                                   | 2 - 3     | 8 - 12    | 86 - 50,000     | 4 - 200                     | 4                      |
| TOX                                   | NA        | NA        | <0.01 - 0.63    | 0.01                        | 0.04                   |
| COD                                   | <1 - 4    | 5 - 9     | NA              | NA                          | NA                     |
| <b>INSECTICIDES/HERBICIDES (ug/L)</b> |           |           |                 |                             |                        |
|                                       | ND        | ND        | NA              | NA                          | NA                     |
| <b>PURGEABLE HALOCARBONS (ug/L)</b>   |           |           |                 |                             |                        |
| Vinyl Chloride                        | ND - 2.3  | ND - 38.7 | ND              | ND                          | ND                     |
| Methylene Chloride                    | ND - 2.7  | ND        | ND              | ND                          | ND                     |
| Trichlorofluoromethane                | ND        | ND        | ND - 3.5        | ND - 2.9                    | ND - 3.3               |
| 1,1,1 Trichloroethane                 | ND - 5.0  | ND        | ND              | ND                          | ND                     |
| Trichloroethylene                     | 1.4 - 4.3 | ND - 4.4  | ND              | ND                          | ND                     |
| Tetrachloroethylene                   | ND        | ND        | ND              | ND                          | ND - 3.4               |
| Trans-1,2-Dichloroethane              | ND        | ND - 56.9 | ND              | ND                          | ND                     |
| <b>PURGEABLE AROMATICS (ug/L)</b>     |           |           |                 |                             |                        |
|                                       | ND        | ND        | ND              | ND                          | ND                     |
| <b>METALS (mg/l)</b>                  |           |           |                 |                             |                        |
| Arsenic                               | NA        | NA        | <0.06 - 0.16    | <0.06 - 0.16                | <0.06                  |
| Barium                                | NA        | NA        | 0.15 - 0.29     | 0.28 - 0.29                 | 0.25                   |
| Cadmium                               | NA        | NA        | <0.002 - 0.007  | <0.002 - 0.007              | <0.002                 |
| Chromium                              | NA        | NA        | <0.005 - 0.017  | <0.005 - 0.017              | <0.005                 |
| Lead                                  | NA        | NA        | <0.08 - 0.081   | <0.08 - 0.081               | <0.08                  |
| Mercury                               | NA        | NA        | 0.0003 - 0.0006 | 0.0003 - 0.0004             | 0.0004 - 0.0005        |
| Selenium                              | NA        | NA        | <0.08           | <0.08                       | <0.08                  |
| Silver                                | NA        | NA        | <0.002          | <0.002                      | <0.002                 |

NA - Not analysed  
ND - Not detected

Continued on next page

TABLE 2-3. SUMMARY OF ORGANIC AND INORGANIC COMPOUNDS IN SOIL SAMPLES, CARSWELL AFB, TEXAS

| Parameter                           | Site 1        | Site 4       | Site 5       | Site 10    | Site 11     | Site 12      | Site 13        | Site 16     | Site 17     | Site USA |
|-------------------------------------|---------------|--------------|--------------|------------|-------------|--------------|----------------|-------------|-------------|----------|
| <b>ORGANIC INDICATORS (ug/g)</b>    |               |              |              |            |             |              |                |             |             |          |
| Oil and Grease                      | <10 - 210     | MA           | <10 - 10     | <10        | <10 - 2200  | <10 - 13,000 | <10 - 2,000    | <10 - 240   | <10 - 1,300 | <10 - 14 |
| Phenols                             | <0.1          | <0.1 - 0.4   | <0.1 - 0.3   | MA         | <0.1 - <10  | <0.1 - 2.4   | MA             | MA          | MA          | MA       |
| <b>HERBICIDES (ug/g)</b>            |               |              |              |            |             |              |                |             |             |          |
| 2,4-D                               | MD - 0.00053  | MA           | MD           | MA         | MD          | MA           | MA             | MA          | MA          | MA       |
| <b>INSECTICIDES (ug/g)</b>          |               |              |              |            |             |              |                |             |             |          |
| MD                                  | MD            | MA           | MD           | MA         | MD          | MA           | MA             | MA          | MA          | MA       |
| <b>PURGEABLE HALOCARBONS (ug/g)</b> |               |              |              |            |             |              |                |             |             |          |
| Trichloroethene                     | MD            | MA           | MD           | MD         | MD          | MD - 0.210   | MA             | MD          | MA          | MD       |
| 1,1,1 Trichloroethane               | MD            | MA           | MD           | MD - 0.044 | MD          | MD           | MA             | MD          | MA          | MD       |
| Trichloroethylene                   | MD            | MA           | MD           | MD - 0.067 | MD - 0.237  | MD - 0.395   | MA             | MD          | MA          | MD       |
| Tetrachloroethylene                 | MD            | MA           | MD           | MD         | MD          | MD           | MA             | MD          | MA          | MD       |
| Trans-1,2-Dichloroethene            | MD            | MA           | MD           | MD         | MD          | MD           | MA             | MD          | MA          | MD       |
| 1,2-Dichlorobenzene                 | MD            | MA           | MD           | MD         | MD          | MD - 1.659   | MA             | MD          | MA          | MD       |
| 1,3-Dichlorobenzene                 | MD            | MA           | MD           | MD         | MD          | MD - 0.464   | MA             | MD          | MA          | MD       |
| 1,1,2,2-tetrachloroethane           | MD            | MA           | MD           | MD         | MD          | MD - 1.000   | MA             | MD          | MA          | MD       |
| <b>PURGEABLE AROMATICS (ug/g)</b>   |               |              |              |            |             |              |                |             |             |          |
| Benzene                             | MD            | MA           | MD           | MD         | MD          | MD - 732.0   | MA             | MD          | MA          | MD       |
| Ethyl Benzene                       | MD            | MA           | MD - 1.070   | MD         | MD          | MD - 110.0   | MA             | MD          | MA          | MD       |
| Toluene                             | MD            | MA           | MD - 0.460   | MD         | MD          | MD - 134.0   | MA             | MD - 0.54   | MA          | MD       |
| <b>METALS (ug/g)</b>                |               |              |              |            |             |              |                |             |             |          |
| Arsenic                             | <3 - 11       | <5.1 - 9.4   | <5.8 - 9.4   | MA         | <3 - 14     | <3 - 19      | <0.06 - 0.19   | <5.0 - 11   | MA          | MA       |
| Barium                              | 16 - 48       | 2.6 - 50     | 2.8 - 70     | MA         | <0.23 - 47  | 4.4 - 100    | 0.37 - 1.2     | 45 - 85     | MA          | MA       |
| Cadmium                             | <0.39 - <0.40 | <0.17 - 0.64 | <0.19 - 0.62 | MA         | <0.2 - <0.4 | <0.16 - 0.69 | <0.002 - 0.031 | <0.2 - 0.89 | MA          | MA       |
| Chromium                            | 1.8 - 22      | 0.44 - 4.8   | 0.74 - 47    | MA         | 2.8 - 7.9   | 1.4 - 15     | <0.005 - 0.022 | 5.1 - 13    | MA          | MA       |
| Lead                                | <4.0 - 10     | <6.3 - 0.3   | <7.8 - 0.4   | MA         | <4 - 13     | <4 - 54      | <0.08 - 0.12   | 3.6 - 20    | MA          | MA       |
| Mercury                             | <0.05 - 0.17  | <0.04        | <0.05 - 0.21 | MA         | 0.08 - 0.21 | <0.04 - 0.21 | 0.0003 - 0.13  | 0.05 - 0.18 | MA          | MA       |
| Selenium                            | <4.0 - 17     | <6.0 - <7.6  | <7.7 - <7.9  | MA         | <4 - 20     | <4 - 38      | <0.08 - 0.18   | 9.1 - 41    | MA          | MA       |
| Silver                              | 1.0 - 2.1     | <0.19 - 2.0  | <0.20 - 1.0  | MA         | <0.18 - 3.1 | <0.16 - 2.8  | <0.002 - 0.037 | 0.82 - 1.2  | MA          | MA       |

MA - Not analyzed  
MD - Not detected

Handwritten signature or initials.

Site 1: Groundwater at Landfill 1 contains some elevated levels of oil and grease (not detected to 190 mg/L) and heavy metals, as well as some purgeable halocarbons in low concentrations. Groundwater movement is toward the Trinity River, adjacent to the site.

Sites 4, 5, 10: Groundwater in the vicinity of these sites was found to contain elevated levels of TCE. The occurrence of TCE was generally in the range of not-detected to 5,000 ug/L in the affected areas both upgradient and downgradient of the landfills. Results of soil analyses also indicated TCE (range from not detected to 0.338 ug/g) contamination at some areas near these sites. Most of the contamination is centered east of these sites at the golf course; however, the high levels of TCE were also discovered in the groundwater upgradient of Landfill 5 near the flightline.

Site 11: Low levels of TCE in soil (range from not detected to 0.249 ug/g) were detected at one location at Site 11, located just north of Landfill 5. In addition, TCE (range from not detected to 0.257 ug/g) was also detected in soil from a hand-augered boring at the center of the site and at the upgradient well.

Site 12: Results of analyses at Site 12 indicate that halogenated and aromatic organic compounds are present in soil (range from not detected to 752 ug/g) and groundwater (range from none detected to 362 ug/L). The highest levels of contamination occur in the center of the site, where benzene, toluene, and ethyl benzene were detected (from not detected to 752 ug/g, 134 ug/g and 110 ug/g, respectively) in soil. TCE also occurs in groundwater downgradient (north and east) of the site, but in lower concentrations (range from not detected to 362 ug/L) than at Sites 4, 5 and 10. The operations at this site have also affected the quality of surface water draining the area. Water samples from a drainage ditch near the site had oil and grease (range from 1 to 84,000 mg/L) and TOC (range 86 to 50,000 mg/L).

Site 13: Soil at the Flightline Drainage Ditch are contaminated with jet fuel, detergents, or both. It was observed that the distribution of

contaminants is somewhat erratic, suggesting that contaminant mobility and infiltration are controlled by local variations in soil composition and texture.

Site 15: Insecticides and herbicides from the former Entomology Building and Entomology Dry Well have not been released in significant quantities into the soil and water. Lindane and endrine were detectable, but not quantitatively measurable in one downgradient well.

Site 16: Hydrocarbon fuels (gasoline or JP-4) were observable (range of oil and grease was <1 to 7,100 mg/L, with high levels of aromatic compounds) in the groundwater at Site 16. The source of the contamination is either a former gasoline station at the site or the POL Tank Farm. Results of analyses at the Unnamed Stream suggest that the oil/water separator does not always ensure that oil and grease are not released to the stream.

Site 17: Organic compounds were observed in the groundwater (<1 to 31,000 mg/L) and soil (<1 to 1,300 ug/g) underlying the POL Tank Farm. The organic compounds are most likely fuel hydrocarbons from the storage and handling of fuels. One water sample from borehole 17D suggests that organic solvents (based on TOX levels) may be present in the groundwater.

WSA Site: Groundwater from the potable supply well was found to contain total radium (8.5 pCi/L) in excess of federal standards for drinking water. In addition, analysis of soil west of the Inspection Shop site revealed the presence of TCE (range from none detected to 0.0619 ug/g).

### 2.2.3 Pathways Affected

Three pathways of possible contaminant movement were investigated during the Phase II Stage 1 work at Carswell AFB. Each of these pathways-- groundwater, surface water, and soil--were discovered to have contamination as summarized in Section 2.2.2. An investigation of air quality was not performed during the Stage 1 effort.

3.0 ENVIRONMENTAL SETTING

The following discussion of the Carswell AFB environmental setting is derived primarily from the Installation Restoration Program Phase I Records Search Report (CH2M Hill, 1984). Information from that report is supplemented by information from the literature and from the general findings of this study. The following sections describe the environmental setting of Carswell AFB. Basic features and history of the sites investigated in this study are also discussed below.

3.1 Geophysical Setting

Carswell AFB is located in northeastern Texas in Tarrant County, six miles west of downtown Fort Worth (Figure 3-1). The base is bordered by Lake Worth to the north, the West Fork of the Trinity River and the community of Westworth to the east and southeast, the community of White Settlement to the south and southwest and Air Force (AF) Plant 4 to the west. The location of Carswell AFB is shown in Figure 3-2. One off-base facility, the Weapons Storage Area (WSA), is included in this study. The WSA location, four miles west of Carswell AFB on White Settlement Road, is also shown in Figure 3-1.

The base lies within an area of primarily residential, recreational, and industrial/commercial land use. The principal industrial use of the area is AF Plant 4, an aircraft production plant that borders Carswell AFB to the west and shares the runway with the base. Recreational land use includes the Y.M.C.A.'s Camp Carter, and various parks on the shores of Lake Worth.

3.1.1 Physiography

The majority of Carswell AFB is located within the Grand Prairie section of the Central Lowlands Physiographic Province. This area is characterized by broad terrace surfaces sloping gently eastward, interrupted by

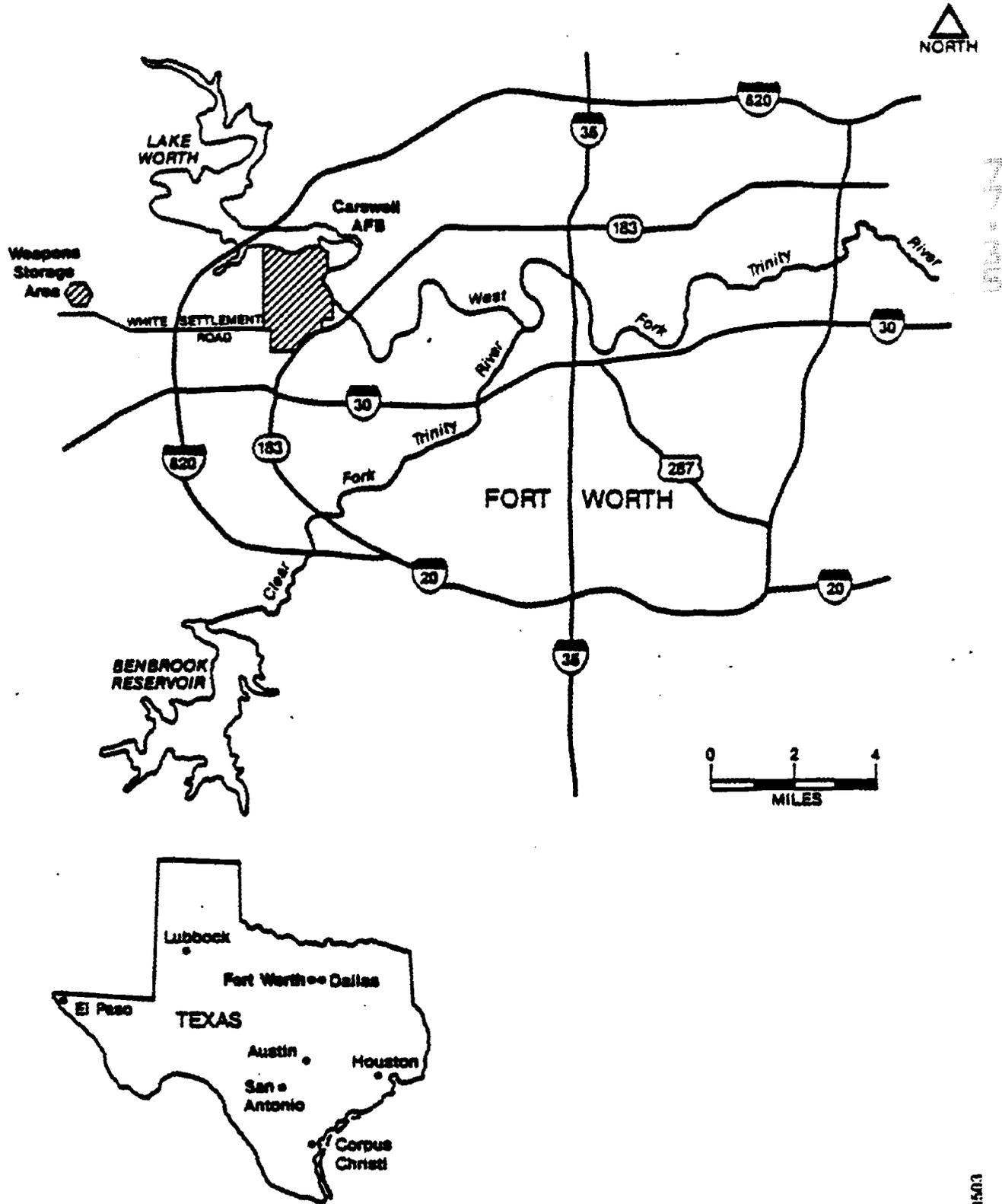


Figure 3-1. Regional Setting of Carswell AFB, Texas.

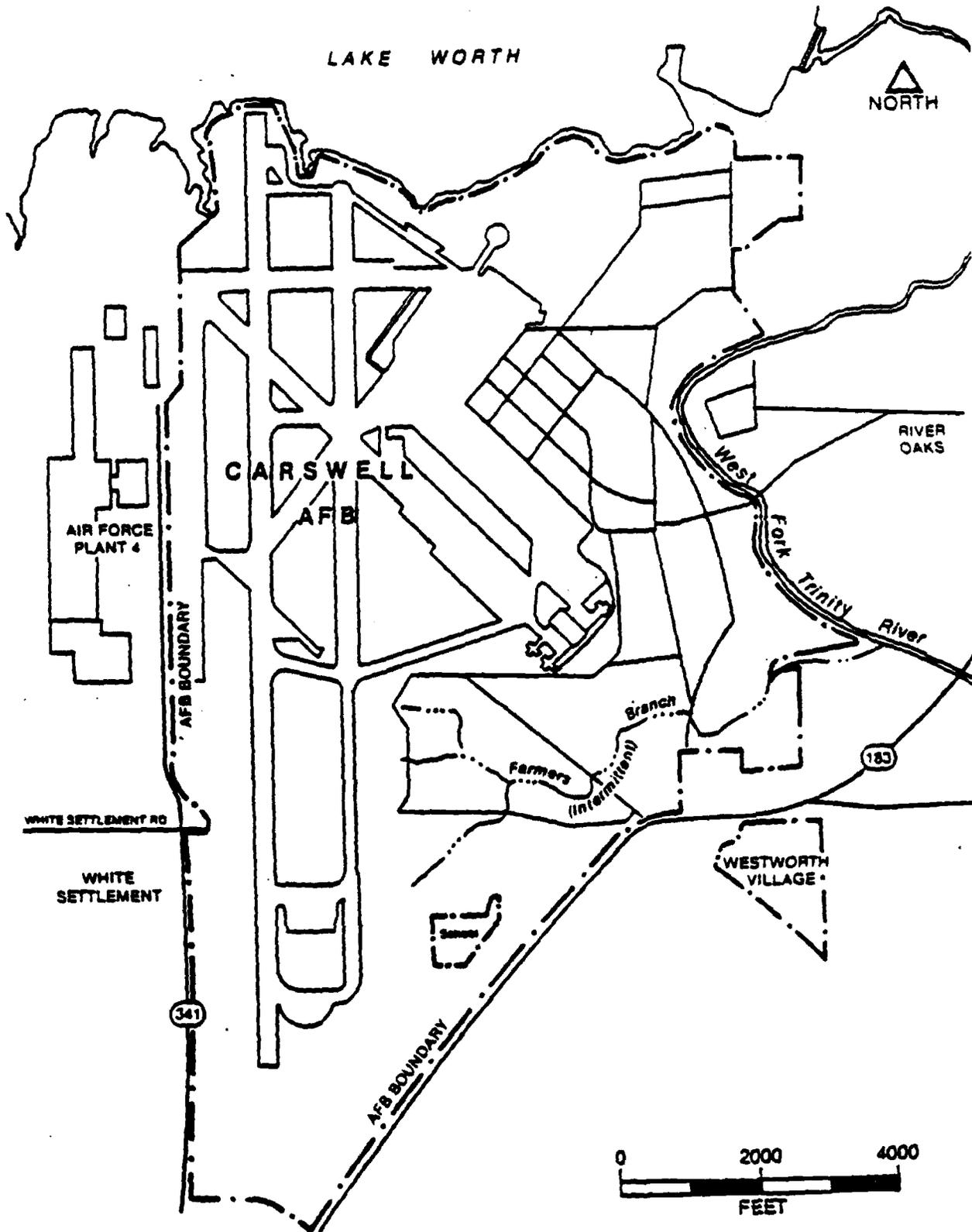


Figure 3-2. Area Location Map of Carswell AFB, Texas

21345

westward-facing escarpments. The land is typically grass covered and treeless, except for isolated stands of upland timber. The northwestern part of Carswell AFB is within the Western Cross Timbers Physiographic Province that is characterized by rolling topography and a heavy growth of post and black-jack oaks.

### 3.1.2 Topography

The topography of the base is fairly flat except for areas near Farmer's Branch and the Trinity River. Land surface slopes gently northeast toward Lake Worth and east toward the West Fork of the Trinity River. Elevations on base range from a high of approximately 690 feet above mean sea level (msl) at the southwest corner of the base to a low of approximately 550 feet msl at the east side of the base. The elevation of Lake Worth usually approximate the elevation of the dam spillway, 594 feet msl.

The principal drainage for Carswell AFB is the West Fork of the Trinity River. Farmers Branch drains the southern portion of the base, but in turn discharges into the Trinity. A small portion of the north end of the base drains into Lake Worth.

### 3.2 Geology

#### Surficial Soils

The U.S.D.A. Soil Conservation Service has identified four soil associations at Carswell AFB. The soils are described in Table 3-1, and their occurrences on base are shown on Figure 3-3. The surficial soils of the installation area are primarily nearly level to gently sloping clayey soils of the Sanger-Purves-Slidell and Aledo-Bolar-Sanger Associations. In addition to the above, the clayey soil of the Frio-Trinity Association and the loamy soil of the Bastsil-Silawa Association occur on the floodplain and stream terraces of the West Fork of the Trinity River.

TABLE 3-1. SOIL ASSOCIATIONS FOR CARSWELL AFB, TX

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

SOURCE: U. S. Department of Agriculture, 1981, Soil Survey of Tarrant County:  
Soil Conservation Service, 218 pp.

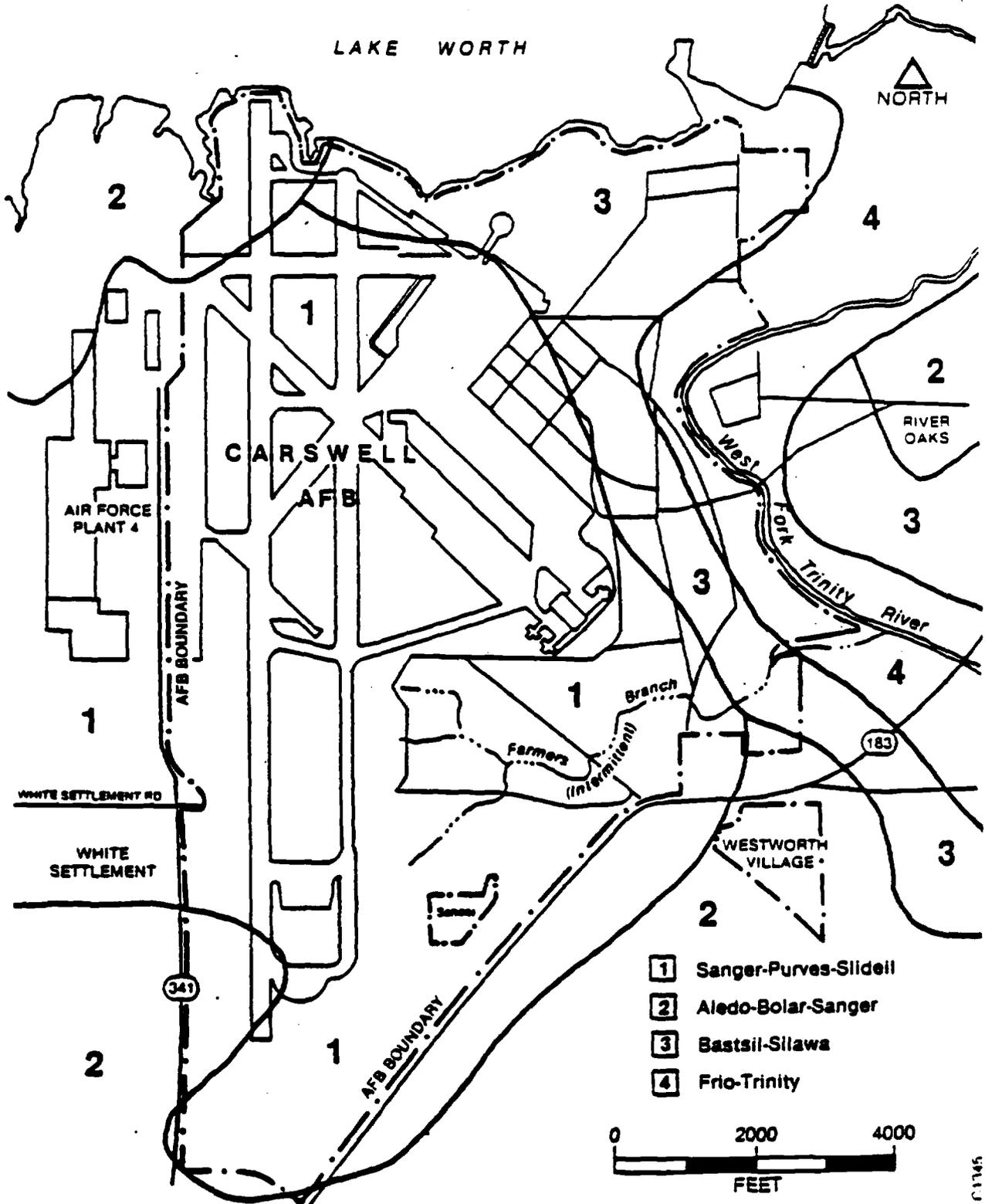


Figure 3-3: Soils Association Map, Carswell AFB, Texas

### Lithology

A geologic section showing the rock formations beneath Carswell AFB is presented in Figure 3-4. Descriptions and properties of units pertinent to this study are summarized in Table 3-2. From youngest to oldest, the geologic units of interest to Carswell AFB are as follows: 1) Quaternary Alluvium, 2) Cretaceous Goodland Limestone, 3) Cretaceous Walnut Formation, 4) Cretaceous Paluxy Formation, 5) Cretaceous Glen Rose Formation, and 6) Cretaceous Twin Mountains Formation. The occurrence of these units on base is shown on a geologic map, Figure 3-5.

The majority of the base is covered by alluvium deposited by the Trinity River. The alluvium is composed of gravel, sand, silt, and clay of varying thicknesses and lateral extents. 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. A small area exposing the Walnut and Paluxy Formations occurs in the northwestern corner of the base along the shores of Lake Worth. The Walnut Formation is a shell-agglomerate limestone with varying amounts of clay and shale. The Paluxy Formation is primarily a fine- to coarse-grained sand with minor amounts of clay, sandy clay, pyrite, lignite, and shale. Neither the Glen Rose Limestone, nor the Twin Mountains Formation are exposed at Carswell AFB.

### Structure

Carswell AFB 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 regional dip of the rocks beneath Carswell AFB is between 35 and 40 feet per mile in an easterly to southeasterly direction. The stratigraphic and structural relationships of the uppermost geologic units at Carswell AFB are illustrated in Figure 3-6 which shows a cross section from Site 12 eastward to the Trinity River at Site 1.

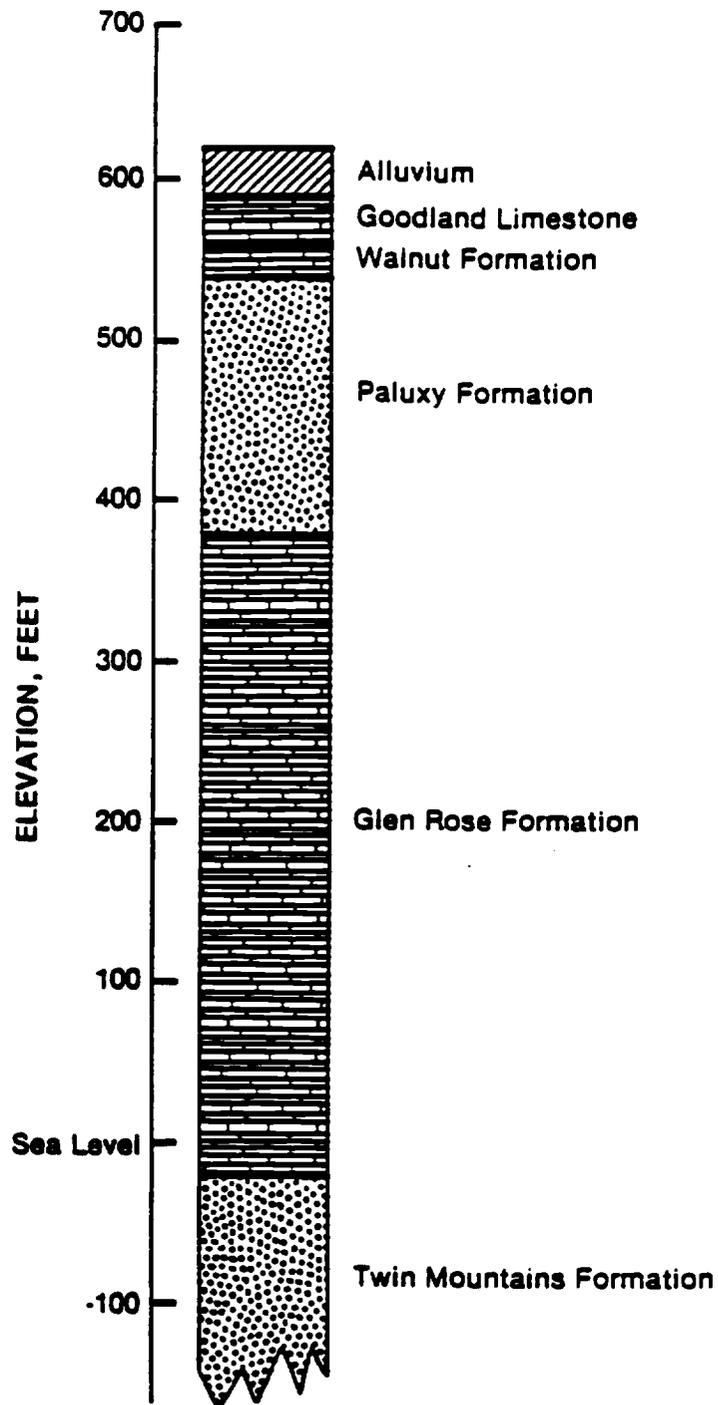


Figure 3-4. Stratigraphic Column at Carswell AFB, Texas

**TABLE 3-2. GEOLOGIC FORMATIONS BENEATH CARSWELL AFB, TEXAS**

| System        | Series and Group                       | Formation and Member                                      | Thickness (ft) | Character of Rocks  | Topographic Expression   | Water-Bearing Properties   |
|---------------|--|---|----------------|---|--|--|
| Bastropian    | Cansuda Series<br>Seabird Group        | Formation and Member                                      | 0-5            | Sand, gravel, clay, and silt.   | Terrace and flood-plain deposits.  | Shall to moderate yields.<br>Water unsatisfactory for use unless treated.  |
|               |  | Bush Creek Formation                                      | 0-20           | Impure limestone and marl, which is blue when fresh and straw-colored when weathered. Fossiliferous with distinctive ammonites. | Bush topography produced by lower limestone mt., upper soil forms slope separating the Bush Creek from Fort Worth limestone. | Shall to moderate yields.<br>Water unsatisfactory for use unless treated.  |
| Cretaceous    | Cansuda Series<br>Fredericksburg Group | Stenslie Formation  | 0-40           | Blue and brownish-pink marl, thin limestone and sandstone flags.  | Grassy slope separating corral of Scotland and Bush Creek formations.  | Shall to moderate yields.<br>Water unsatisfactory for use unless treated.  |
|               |  | Scotland Limestone  | 0-100          | Cherty-white fossiliferous limestone, and blue to yellowish brown marl.   | Precinct glistening-white escarpment along streams.  | Shall to moderate yields.<br>Water unsatisfactory for use unless treated.  |
|               |  | Blind Clay  | 0-50           | Shall argillaceous fossiliferous clay and limestone, sandy clay, and black shale.   | Forms conspicuous escarpment and waterfalls in western Cross Timbers belt.   | Not known to yield water to wells in Tarrant County.   |
|               |  | Palmy Sand  | 100-150        | Fine-grained sand, shale, sandy shale, lignite and pyrite.  | Sandy soil, hemicity topography, locally covered with mho.   | Source of supply for most households, smaller cities, and some industries.   |
| Cretaceous    | Cansuda Series<br>Trinity Group        | Stan Rose Limestone                                       | 200-400        | Fine-grained limestone, shale, coal, and sandstone.   | Not exposed in Tarrant County.   | Sands yield small supplies to wells in Fort Worth and western Tarrant County. Water too highly mineralized east of Fort Worth.                                       |
|               |  | Trin Mountain Formation (Formerly Trinity Peak Formation) | 200-400        | Coarse to fine-grained sandstone, red shale, red and yellow clay at base.   | Not exposed in Tarrant County.   | Principal aquifer in Tarrant County. Yields large supplies for municipal and industrial purposes. Water in upper sands east of Fort Worth may be highly mineralized. |
|               |  |   |                | MAJOR UNCONFORMITY  |  |  |
| Pennsylvanian | Undifferentiated                       |   | 0,000-7,000    | Gray, sandy shale, light quartzite sandstone, black limestone. Probably represents Strawn formation.                            | Not exposed in Tarrant County.   | Not tested. Probably would not yield fresh water.  |
|               |  |   |                |   |  |  |

Source: U.S. Geol. Surv.

Radian Corporation  
 10000 West Loop South  
 Houston, Texas 77042



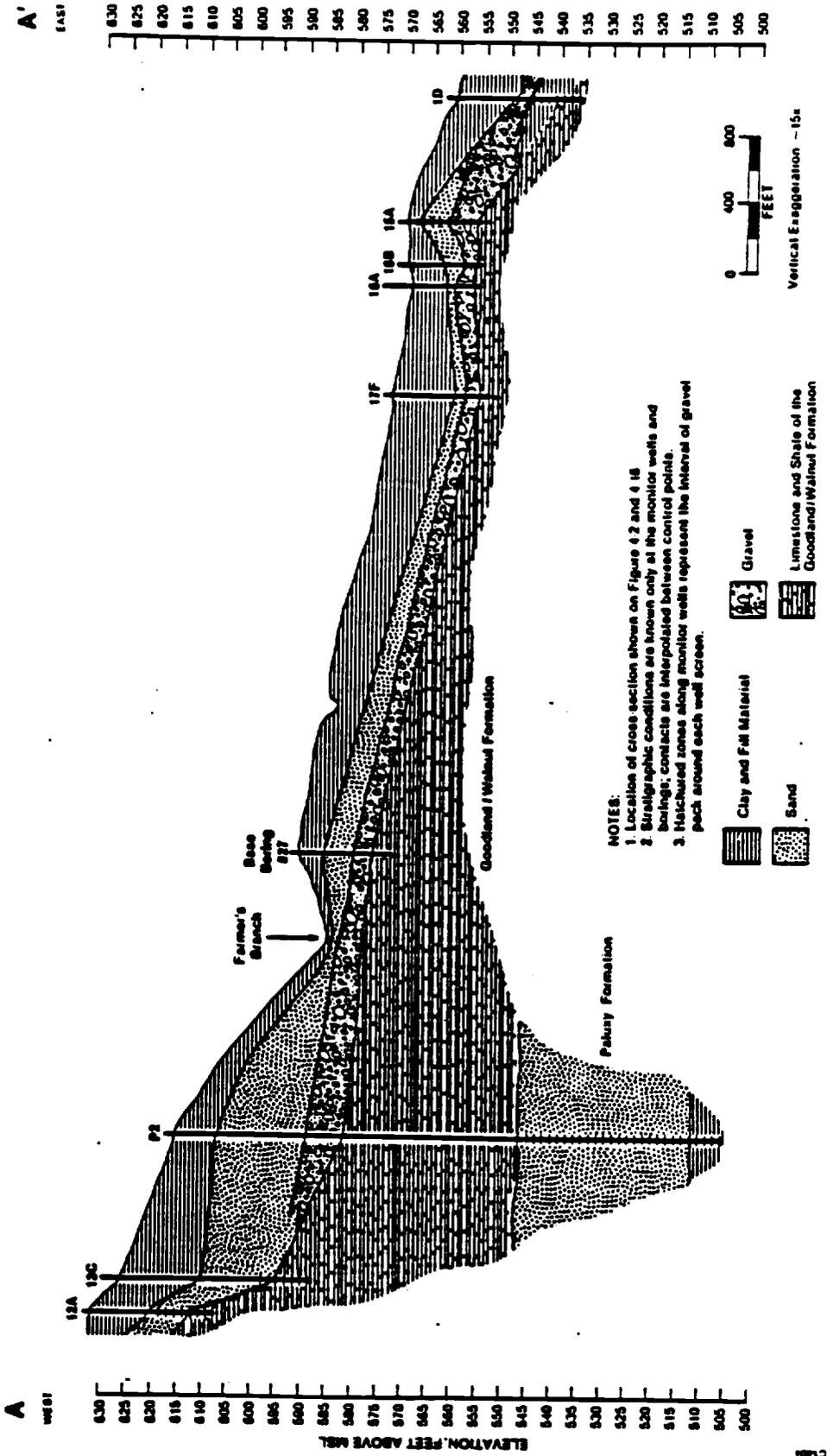


Figure 3-6. Geologic Cross Section A-A', Carswell AFB, Texas

3.3 Hydrogeology

3.3.1 Surface Water

Carswell AFB is located within the Trinity River basin just south of Lake Worth, a man-made reservoir on that river. Part of the base is drained by Farmers Branch which discharges into the West Fork Trinity River just south of the Contonment area. Farmers Branch begins within the community of White Settlement and flows eastward. Just south of AF Plant 4, Farmers Branch flows under the runway within two large culverts.

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

3.3.2 Groundwater

On the basis of their water-bearing properties, the geologic units at Carswell AFB may be divided into the following five hydrogeologic units, listed from most shallow to deepest: 1) an upper perched-water zone occurring in the alluvial terrace deposits left by 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 below.

Upper Zone - Groundwater occurs within the coarse sand and gravels deposited by the Trinity River, but these deposits are usually limited in areal extent and isolated by surrounding low-permeability clays and silts. Recharge to the water-bearing deposits is local, from rainfall and infiltration from stream channels and drainage ditches. Water flow in the alluvium is basically eastward, toward the West Fork of the Trinity River.

In parts of Tarrant County, generally close to the Trinity River, water in the alluvium is developed for irrigation and residential use. The community of River Oaks, immediately east of Carswell AFB, had supply wells that developed water from the alluvial deposits at a location near the USAF Hospital. The wells were abandoned when Carswell AFB purchased the property for hospital construction. For the most part, groundwater is not economical to develop from the alluvium due to the water's limited distribution and susceptibility to surface/stormwater pollution.

Goodland/Walnut Aquitard - The perched water present in the alluvium is separated from the aquifers below by the low permeability limestones and shales of the Goodland Limestone and Walnut Formation. The aquitard is composed of moist clay and shale layers interbedded with dry limestone beds. Though primarily dry, drillers in the area report that small amounts of water enter the borehole while drilling through the Walnut Formation, suggesting that groundwater may move through the Walnut along bedding planes (Hargis and Associates, Inc., 1984). The thickness of the Goodland/Walnut aquitard is approximately 25 feet or greater beneath most of Carswell AFB. However, the top of the aquitard is an erosional surface and weathering may have reduced the thickness of the limestone in isolated areas. A soil boring at AF Plant 4, across the runway to the west from Carswell AFB, revealed that the Goodland Limestone had been completely eroded and only three feet of the Walnut Formation remained (Hargis and Associates, Inc., 1984). It is also reported that the upper zone and Paluxy Formation are in contact at the eastern boundary of AF Plant 4, where both the Goodland and Walnut Formations have been removed by erosion (Hargis and Associates, 1985). In areas of similarly extensive erosion, water in the upper zone could come in contact with water in the Paluxy aquifer.

Paluxy Aquifer - The Paluxy aquifer is the most shallow aquifer occurring beneath Carswell AFB. The aquifer's area extent is shown in Figure 3-7. In the base area, water in the Paluxy would naturally occur under confined conditions beneath the Goodland/Walnut aquitard (except where the aquitard is missing due to erosion, as discussed above). However, extensive



pumping in the Fort Worth area has lowered the Paluxy potentiometric surface below the top of the formation, resulting in unconfined conditions beneath the base. The Paluxy Formation is divided into upper and lower sand members and the aquifer is likewise divided into upper and lower aquifers. The upper sand is fine-grained and shaley and the lower sand is coarser; therefore, most wells are completed in the lower section.

Recharge to the Paluxy aquifer occurs where the formation outcrops west of Carswell AFB. The Paluxy also outcrops north of the base in the bed of Lake Worth. The lake represents a significant recharge point for the aquifer and creates a potentiometric high in its vicinity. Regional groundwater flow within the Paluxy is eastward, in the direction of the regional dip. At Carswell AFB, groundwater flow is influenced by the Lake Worth potentiometric high and by a potentiometric low created by the groundwater withdrawals of the community of White Settlement, resulting in a more southeasterly flow direction.

Transmissivities in the Paluxy aquifer range from 1,263 to 13,808 gallons per day per foot (gpd/ft) and average 3,700 gpd/ft. The Paluxy Formation thickness ranges from 140 to 190 feet and averages 160 feet in Tarrant County. The actual water-bearing thickness in the Carswell AFB area probably approximates the formation thickness, but the aquifer is separated into two distinct water-bearing zones. In the vicinity of Carswell AFB, permeabilities range from 13 to 140 gpd/ft<sup>2</sup> (based on an approximate thickness for the aquifer of 100 ft.) Well yields within the Paluxy aquifer range from 10 to 480 gallons per minute (gpm) and average approximately 100 gpm.

The Paluxy aquifer is an important source of potable groundwater in the Fort Worth area. Communities surrounding Carswell AFB, especially White Settlement, develop municipal water supplies from the Paluxy, as well as from the deeper Twin Mountains aquifer. As a result of its extensive use as a water supply, water levels in the Paluxy aquifer have declined significantly over the years. Water levels in the immediate Carswell AFB vicinity have not

decreased as much as in the Fort Worth area in general because of the proximity of the Lake Worth recharge area and because the base does not develop water from the Paluxy.

Water quality in the Paluxy aquifer is generally good and is satisfactory for potable use. The range of chemical constituents occurring within Paluxy water is given in Table 3-3.

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 varies from 250 to 450 feet. Though the sands in the Glen Rose Formation yield small supplies to wells in Fort Worth and western Tarrant County, the relatively impermeable limestone is an aquitard restricting water movement between the Paluxy aquifer above and the Twin Mountains aquifer below.

Twin Mountains Aquifer - The Twin Mountains Formation is the oldest formation used for water supply in the Carswell AFB area. The formation consists of a basal conglomerate of chert and quartz, grading upward into coarse- to fine-grained sand interbedded with shale. The thickness of the formation varies between 250 and 430 feet.

Recharge to the Twin Mountains aquifer occurs west of Carswell AFB, where the formation crops out. Water movement is eastward in the downdip direction. Like water in the Paluxy aquifer, Twin Mountains water occurs under water-table conditions in the recharge area and becomes confined as it moves downdip.

The Twin Mountains aquifer is the principal aquifer in Tarrant County. The formation yields large water supplies for municipal and industrial purposes. Transmissivities in the Twin Mountains 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<sup>2</sup> and average 68 gpd/ft<sup>2</sup> in Tarrant County.

TABLE 3-3. RANGE OF CONSTITUENTS IN GROUND WATER FROM SELECTED WELLS  
IN THE PALUXY FORMATION, TARRANT COUNTY

| Constituent or Property              | Concentration |
|--------------------------------------|---------------|
| Bicarbonate ( $\text{HCO}_3$ )       | 177-689       |
| Boron (B)                            | 0.1-0.6       |
| Calcium (Ca)                         | 0-120         |
| Chloride (CL)                        | 5-117         |
| Fluoride (F)                         | 0-4.5         |
| Iron (Fe)                            | 0-9.9         |
| Magnesium(Mg)                        | 0-43          |
| Nitrate ( $\text{NO}_3$ )            | 0-10.0        |
| Silica ( $\text{SiO}_2$ )            | 1-30          |
| Sodium (Na)                          | 11-740        |
| Sulfate ( $\text{SO}_4$ )            | 6-1,080       |
| Dissolved Solids                     | 264-2,176     |
| Total Hardness ( $\text{CaCO}_3$ )   | 2-401         |
| Percent Sodium (X)                   | 7.1-99.5      |
| pH                                   | 7.1-9.2       |
| Sodium-Absorption Ratio (SAR)        | 0.2-68.8      |
| Residual Sodium Carbonate (RSC)      | 0-10.0        |
| Specific Conductance (umhos at 25°C) | 427-3,193     |

NOTE: Analyses given are in milligrams per liter except percent sodium, specific conductance, pH, SAR, and RSC.

SOURCE: Texas Department of Water Resources, 1982.

Groundwater withdrawals from the Twin Mountains aquifer, primarily for municipal water supply, have resulted in declining water levels. Between 1955 and 1976, the potentiometric surface of the aquifer dropped approximately 250 feet. Water quality in the Twin Mountains aquifer is suitable for potable use throughout the Fort Worth area. Water in the upper sands of Fort Worth may be too mineralized for human consumption.

3.4 Climatology/Air

Carswell AFB is located near 33' north latitude in north central Texas. The climate is humid subtropical with hot summers and dry winters. Tropical maritime air masses control the weather during much of the year; however, the passage of polar cold fronts and continental air masses create large variations in winter temperatures. Meteorological data summarizing the period 1946 through 1978 are presented in Table 3-4 and discussed briefly below.

The average annual temperature for Carswell AFB is 66°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 recorded at the base was 111°F in the month of June. On the average, freezing temperatures occur at Carswell AFB on 33 days per year.

Mean annual precipitation recorded at Carswell AFB is 32 inches. The wettest month is 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. On the average, measurable snowfall occurs on 2 days per year. Lake evaporation at Carswell AFB 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.

Thunderstorm activity occurs at Carswell AFB an average of 45 days per year. The greatest number of these storms occurs between April and June. Hail may fall on two to three days per year, and the maximum precipitation recorded in a 24-hour period is 5.9 inches.

Mean cloud cover averages 50 percent at Carswell AFB with clear weather occurring frequently during all months. 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. Wind direction is predominantly from the south during all months.

3.5 Human Environment

3.5.1 Population

The total work force at Carswell AFB is approximately 6,100, which includes about 1,000 civilian personnel.

3.5.2 Demographics

The City of Fort Worth had a population of 414,562 based on a 1984 estimate. This estimate also included a population density of 1,617 people per square mile. The smaller suburbs of Fort Worth adjacent to Carswell AFB had 1980 population data as follows:

|                  |   |        |
|------------------|---|--------|
| White Settlement | - | 13,508 |
| Westworth        | - | 3,651  |
| River Oaks       | - | 6,890  |

3.5.3 Land Use

The base is surrounded by residential, commercial, recreational, and industrial land. Residential land use is to the southwest, southeast, and east of the base. Commercial property is south and recreational (Lake Worth) is north of the base. AF Plant 4 is the industrial facility directly west of Carswell AFB.

#### 4.0 BASIS FOR PROGRAM APPROACH

The Stage 1 activities conducted at Carswell AFB documented the presence or absence of contamination at the study sites. The results of the Stage 1 investigation are the basis for the Stage 2 activities at Carswell AFB, to be described in Section 5. A major focus of the Stage 2 investigation is to fill data gaps remaining after the Stage 1 effort. This will result in further definition of the nature and extent of contamination at the Stage 2 sites and will allow evaluation of potential impacts to off-base areas and receptors. The Stage 2 effort will include borehole drilling and monitor well construction, surface water and sediment sampling, and geophysical and soil gas surveys.

#### 4.1 Physiochemical Properties of Contaminants

The hazards to potential receptors associated with any specific contaminant are related to its physical and chemical characteristics, its concentration, and the availability and nature of potential pathways for exposure. Contaminants that reach the groundwater will migrate in a generally downgradient direction and may eventually cross the base boundary. Due to differing physicochemical properties, some chemicals may tend to float on top of groundwater in a separate immiscible phase. Others may be dissolved in the groundwater. Some controls on the rate of contaminant migration in groundwater are the solubility of the contaminant in water, the persistence of the contaminant and/or its transformation products, and its potential adsorption onto subsurface materials. In general, most groundwater contaminants at the Carswell AFB IRP sites were introduced by downward migration of relatively dilute solutions rather than of concentrated streams. Therefore, density stratification of contaminants dissolved in the groundwater is not expected. Once a contaminant reaches a receptor, characteristics that define its hazardousness are of particular concern, e.g., toxicity, carcinogenicity, flammability, etc. Human health threats, if any, will be evaluated during this investigation as part of the risk assessment.

4.2 Pathways and Receptors

The potential pathways whereby contaminants could exit the base are infiltration through the shallow surface soils and migration within the unsaturated zone, shallow groundwater underflow, and surface water runoff. One group of sites (i.e., Sites 1, 15, 16, 17, and the Base Service Station) is located near the base property line; the remaining sites are located near the flightline in the interior of the base. Specific surface runoff pathways of concern for this investigation are the Flightline Drainage Ditch (Site 13) and Farmers Branch and its tributaries on the base. These pathways lead to the West Fork of the Trinity River located east of the base.

The potential receptors to contaminants found at and around the study site are limited because all sites are located inside the base property and access is controlled. The main potential receptors on-base are the field team members, especially during drilling activities. During drilling well installation and water sampling operations, the greatest potential exists for exposure to contaminants from the groundwater, surface water or soils.

Potential off-base receptors include people coming into contact with groundwater contaminants from either shallow wells in the alluvium or deeper wells in the Paluxy aquifer. If the groundwater exits the aquifer as seeps or springs into surface drainages, another potential route exists for receptor contact.

4.3 Environmental/Health Effects

The relationships between contaminants identified in Stage 1 and potential receptors have not been formally evaluated. Potential environmental and human health effects will be determined under the Risk Assessment task of this investigation. The objective is to identify and quantify potential environmental and health hazards within the base and in the off-base areas.

4.4 Preliminary Technologies

Preliminary technologies for alternative remedial actions are developed to identify general response actions, or classes of responses once a site or operable unit has been assessed. Site and operable unit assessments will be conducted during the Stage 2 IRP work. The data developed during the Stage 2 effort will be used to determine preliminary technologies per the statement of work. The preliminary technologies will be selected based on their applicability to site-specific conditions. No remedial alternatives will be implemented during this investigation.

4.5 Applicable or Relevant and Appropriate Requirements (ARARs)

All soil and water analyses will be compared to available regulatory criteria which include maximum contaminant levels (MCLs) and maximum contaminant level guidelines (MCLGs). Any applicable State water quality criteria will also be used. This information will be used to assess the applicability of preliminary technologies, and to determine whether an alternative remedial action can meet or exceed the ARARs. The ARARs are also useful in defining data sufficiency and developing an approach for the public health evaluation task. These activities will involve close interaction with regulatory agencies in order to agree on criteria and methods.

During the review of each alternative technology, a summary of its effectiveness for protecting public health will be prepared. Each alternative will be evaluated to determine the extent to which it meets, exceeds or falls short of the ARARs. The analysis for each alternative will involve discussion of the technical issues including contaminant control and minimization, estimated time required to achieve ARARs; and the degree to which the technology is proven for the proposed application. Potential routes of exposure to contaminants during the remedial actions will be addressed along with the ARARs. If an alternative technology cannot attain an ARAR, it will be examined to determine its potential to reduce the present or future threats to any identified receptors.

4.6 Data Requirements

The results of the Stage 1 activities are confirmed the presence of contamination at various sites at Carswell AFB. For the most part, the data represent only one or two sampling events and therefore do not adequately define the range of site-specific environmental conditions. Additional data are needed to characterize the site in sufficient detail to identify and screen preliminary technologies and develop alternative remedial actions. The general categories of data needed to fill gaps in the Stage 1 database relate to:

- Hydrogeologic setting;
- Groundwater flow directions and velocity estimates;
- Contamination distribution (vertical and horizontal);
- Contamination concentrations; and
- Off-base receptors and users of shallow groundwater.

These data will be obtained during the IRP Stage 2 activities described in Section 5.

5.0 SCOPE OF WORK

The IRP Phase II Stage 2 investigation at Carswell AFB will involve a series of field activities to collect environmental data at selected sites. The data collected will be used to determine the need for, and type of, remedial action for contaminated areas that pose a risk to public health or the environment. These activities will proceed in parallel at the different sites. The following subsections describe the work to be performed for this study. The activities are based upon the Statement of Work (SOW) in Appendix A.

5.1 Organization of Effort

5.1.1 Operable Units

Thirteen sites will be individually investigated as single operable units. These sites, as presented in the Statement of Work are:

- Site 1 - Landfill 1
- Site 3 - Landfill 3
- Site 4 - Landfill 4
- Site 5 - Landfill 5
- Site 10 - Waste Burial Area
- Site 11 - Fire Department Training Area 1
- Site 12 - Fire Department Training Area 2
- Site 13 - Flightline Drainage Ditch
- Site 15 - Entomology Dry Well
- Site 16 - Unnamed Stream
- Site 17 - POL Tank Farm
- Site WSA - Weapons Storage Area
- Site BSS - Base Service Station

These sites are shown on Figure 2-1. Site WSA (Weapons Storage Area) is located 4 miles west of Carswell AFB (Figure 3-1).

5.1.2 Combined Site Investigations

Combined site investigations will not be performed as part of the Stage 2 work. However, sites have been grouped into two main areas (Flight-line Area and East Area) shown on Figure 2-1.

5.2 General Discussion of Integrated IRP Tasks

This subsection provides a discussion of techniques and/or methodologies that will be used to accomplish this investigation. In general, these have been grouped into field evaluation and feasibility study tasks. These sections describe how the field activities will be conducted, and data evaluation will be conducted. All of the resulting information can be used for supporting the feasibility studies.

5.2.1 Field Related Tasks

The field investigation including all drilling and sampling operations will be supervised by a registered geologist or hydrogeologist certified by the American Institute of Professional Geologists (AIPG) or equivalent organization. A detailed log of the conditions and materials penetrated during the course of the work will be maintained by the geologist/hydrogeologist on site. Decisions on well locations, well depths, screened intervals, and other construction details will be made collectively by the USAFOEHL Technical Program Manager (TPM) and the Radian Project Director.

A summary of the field related tasks for the Stage 2 investigation is provided in Table 5-1. This table illustrates the type and amount of field work, consisting of soil gas surveys, geophysical surveys, drilling and well installation and soil and water sampling analysis.

TABLE 5-1. SUMMARY OF PHASE II STAGE 2 FIELD ACTIVITIES  
AT CARSWELL AFB, TEXAS

| SITES (b)                       | 1  | 3   | 4   | 5   | 10 | 11 | 12  | 13 | 15 | 16 | 17  | MEA | RES | UNMND | TOTAL |
|---------------------------------|----|-----|-----|-----|----|----|-----|----|----|----|-----|-----|-----|-------|-------|
| BORHOLES (c)                    | 2  | 6   | 3   | 5   | 3  | 0  | 7   | 0  | 0  | 0  | 5   | 0   | 4   | 0     | 35    |
| BORHOLE DEPTH                   | 60 | 403 | 105 | 173 | 69 | 0  | 184 | 0  | 0  | 0  | 173 | 0   | 138 | 0     | 1305  |
| UI WELLS (from boreholes above) | 2  | 5   | 3   | 5   | 0  | 0  | 2   | 0  | 0  | 0  | 5   | 0   | 4   | 0     | 26    |
| DEPTH UI WELLS                  | 60 | 173 | 105 | 173 | 0  | 0  | 69  | 0  | 0  | 0  | 173 | 0   | 138 | 0     | 891   |
| PALUDY WELLS                    | 0  | 1   | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0   | 0   | 0   | 0     | 1     |
| DEPTH PALUDY WELLS              | 0  | 200 | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0   | 0   | 0   | 0     | 200   |
| HAND AUGERS                     | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 1  | 0  | 0   | 8   | 0   | 0     | 11    |
| DEPTH AUGERS                    | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 30 | 0  | 0   | 40  | 0   | 0     | 70    |
| SOIL SAMPLES FROM AUGERS        | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 15 | 0  | 0   | 16  | 0   | 0     | 31    |
| SPLIT SPOON SAMPLES             | 6  | 15  | 9   | 15  | 18 | 0  | 28  | 0  | 0  | 0  | 15  | 0   | 12  | 0     | 118   |
| SLUR TESTS                      | 2  | 0   | 5   | 5   | 0  | 0  | 3   | 0  | 0  | 0  | 3   | 0   | 0   | 0     | 18    |
| SOIL GAS DAYS                   | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 2   | 0   | 2   | 0     | 4     |
| SOIL-SED SAMP BOUNDS            | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 2  | 0  | 0  | 0   | 0   | 0   | 0     | 2     |
| SOIL-SED SAMP POINTS            | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 5  | 0  | 0  | 0   | 0   | 0   | 0     | 5     |
| SOIL-SED SAMPLES                | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 10 | 0  | 0  | 0   | 0   | 0   | 0     | 10    |
| SURF WATER SAMP BOUNDS          | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 2  | 0   | 0   | 0   | 0     | 2     |
| SURF WATER SAMP POINTS          | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 4  | 0   | 0   | 0   | 0     | 4     |
| SURF WATER SAMPLES              | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 8  | 0   | 0   | 0   | 0     | 8     |
| GW SAMPLING BOUNDS              | 2  | 2   | 2   | 2   | 0  | 2  | 2   | 0  | 0  | 0  | 2   | 0   | 2   | 0     | 2     |
| GW SAMP POINTS                  | 6  | 6   | 9   | 9   | 0  | 2  | 5   | 0  | 0  | 0  | 5   | 0   | 4   | 0     | 50    |
| TOT GW SAMPLES                  | 12 | 12  | 18  | 18  | 0  | 4  | 10  | 0  | 0  | 0  | 10  | 0   | 8   | 0     | 100   |

NOTES

a. The numbers in this table represent the maximum effort to be performed. Actual work performed may be less due to technical considerations.

b. Sites are as follows:

|         |                                 |
|---------|---------------------------------|
| Site 1  | Landfill 1                      |
| Site 3  | Landfill 3                      |
| Site 4  | Landfill 4                      |
| Site 5  | Landfill 5                      |
| Site 10 | Waste Serial Area               |
| Site 11 | Fire Department Training Area 1 |
| Site 12 | Fire Department Training Area 2 |
| Site 13 | Flightline Drainage Ditch       |
| Site 15 | Entomology Dry Well             |
| Site 16 | Unnamed Stream                  |
| Site 17 | POL Tank Farm                   |
| MEA     | Weapons Storage Area (Off Base) |
| RES     | Base Service Station            |

c. Some boreholes are not to be completed as monitoring wells.

14677

5.2.1.1 Soil Gas Survey

Soil gas surveys will be conducted at two sites at Carswell AFB. The field crew will collect soil gas samples for on-site analyses over a four day period. The samples will be analyzed for hydrocarbons characteristic of JP-4 and MOGAS fuels at the POL Tank Farm (Site 17) and the Base Service Station (BSS). These sites represent fuel tank storage and pipeline areas.

The objectives of the soil gas investigation are to confirm the possible existence of subsurface contaminants, and to determine the areal extent and migration direction of hydrocarbon contamination from the sites. This information will also aid in selecting drilling locations.

The contractor will use a field vehicle equipped with a gas chromatograph. The sampling probes will be pushed to the desired depth (probably less than 10 feet). Soil gas will be flushed through the probe, then samples will be collected from the Teflon tubing attached to the probe. Soil gas samples will be analyzed immediately for real time evaluation of the data.

5.2.1.2 Geophysical Surveys

Magnetometer surveys will be performed at Sites 1 (Landfill 1) and 10 (Waste Burial Area) to investigate anomalies found in the Stage 1 investigation and assist in the location of boreholes in the Stage 2 investigation. Readings of the total magnetic field and magnetic gradient will be taken at appropriate locations using an EDA PPM 500 proton magnetometer (or equivalent).

5.2.1.3 Subsurface Soil Surveys

Up to thirty-five boreholes and 11 hand augers will be drilled among ten sites for this investigation. These sites are:

- Site 1 - Landfill 1;
- Site 3 - Landfill 3;
- Site 4 - Landfill 4;
- Site 5 - Landfill 5;
- Site 10 - Waste Burial Area;
- Site 12 - Fire Department Training Area 2;
- Site 15 - Entomology Dry Well;
- Site 17 - POL Tank Farm;
- Site WSA - Weapons Storage Area; and
- Site BSS - Base Service Station

The boreholes at these sites are to provide geologic and chemical data of the subsurface to detect and define lateral or vertical extent of contamination at a site. As many as 26 of the boreholes will be converted to monitoring wells.

Soil samples from boreholes will be obtained using ASTM Method D-1586. The samples will be collected at 2.5 foot intervals for the first 10 feet and at 5 foot intervals to the total depth drilled. The total depth of each borehole is expected to range between 20 and 40 feet.

Selected samples will be chosen for chemical analyses and soil tests as shown in Table 5-2. Also shown are sediment and drill cutting samples to be collected per the statement of work. Details of the quality control, handling and screening procedures are provided in the Quality Assurance Project Plan provided under separate cover.

Air monitoring during all well drilling and soil boring work will be accomplished with an organic vapor analyzer utilizing a photoionization detector (PID) or flame ionization detector (FID) to identify the presence of potentially hazardous and/or toxic vapors or gases. The air monitoring results will be noted in the boring logs. If soil encountered during borehole drilling is suspected to be hazardous because of abnormal discoloration, odor or air monitoring levels, the drill soil cuttings will be containerized in new, unused drums. A different drum will be used for each boring where soil

TABLE 5-2. SUMMARY OF PHASE II STAGE 2 SOIL ANALYSES AT CARSWELL AFB, TEXAS

| PARAMETER<br>(Soil Samples)         | ANALYTICAL METHOD |    |   |    |    |   |    |    |   |    |    |    |    |    |    |    |    | Total |
|-------------------------------------|-------------------|----|---|----|----|---|----|----|---|----|----|----|----|----|----|----|----|-------|
|                                     | 1                 | 2  | 3 | 4  | 5  | 6 | 7  | 8  | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |       |
| Oil and Grease                      | 6                 | 15 | 9 | 15 | 10 | - | -  | -  | - | -  | -  | -  | -  | -  | -  | -  | -  | 63    |
| Petroleum Hydrocarbons              | -                 | -  | - | -  | 10 | - | 20 | 10 | - | -  | 15 | 12 | -  | -  | -  | -  | -  | 83    |
| Metal Screen (23 metals)            | 6                 | 15 | 9 | 15 | 10 | - | 20 | 10 | - | -  | -  | -  | -  | -  | 16 | -  | -  | 117   |
| Arsenic                             | 6                 | 15 | 9 | 15 | 10 | - | -  | -  | - | -  | -  | -  | -  | -  | -  | -  | -  | 63    |
| Lead                                | -                 | -  | - | -  | -  | - | -  | -  | - | -  | -  | -  | 15 | 12 | -  | -  | -  | 27    |
| Mercury                             | 6                 | 15 | 9 | 15 | 10 | - | -  | 10 | - | -  | -  | -  | -  | -  | -  | -  | -  | 73    |
| Selenium                            | 6                 | 15 | 9 | 15 | 10 | - | -  | -  | - | -  | -  | -  | -  | -  | -  | -  | -  | 63    |
| Organochlorine Pesticides and PCB's | -                 | -  | - | -  | 10 | - | -  | -  | - | 15 | -  | -  | -  | -  | -  | -  | -  | 33    |
| Volatile Organic Compounds          | 6                 | 15 | 9 | 15 | 10 | - | 20 | 10 | - | -  | 15 | 12 | 16 | 50 | -  | -  | -  | 196   |
| Semivolatile Organic Compounds      | 6                 | 15 | 9 | 15 | 10 | - | 20 | 10 | - | -  | -  | -  | 16 | 50 | -  | -  | -  | 167   |
| Chlorinated Phenox Herbicides       | -                 | -  | - | -  | 10 | - | -  | -  | - | 15 | -  | -  | -  | -  | -  | -  | -  | 33    |
| Organophosphorous Pesticides        | -                 | -  | - | -  | -  | - | -  | -  | - | 15 | -  | -  | -  | -  | -  | -  | -  | 15    |
| Extraction Procedure Toxicity       | -                 | -  | - | -  | -  | - | -  | -  | - | -  | -  | -  | -  | -  | 50 | -  | -  | 50    |
| Soil Moisture Content               | 6                 | 15 | 9 | 15 | 10 | - | 20 | 10 | - | 15 | 12 | 16 | 16 | -  | -  | -  | -  | 149   |

REVISED 10/1/88

encountered is suspected to be hazardous. The field log will reflect the boring logs depth(s) from which the suspected contaminated soil cuttings were collected. Composite drill cutting samples will be obtained for chemical analysis as shown on Table 5-2 and described later in Section 5.2.1.9 Drum Sampling.

The discrete soil and formation samples will be screened using either the organic vapor analyzer described above and/or Draeger tubes in order to detect the presence of volatile organic contaminants. Selected samples will be placed into a clean glass jar for detailed contaminant screening. The volatile organic levels will be recorded on the field log. These field analyzers, although calibrated, will be useful only as indicators of the presence of significant contaminant levels. Because the instruments are sensitive to moisture and fluctuating environmental conditions at the site, small concentrations above background listed on the field logs would be considered insignificant. The organic vapor concentrations which may be detected in disturbed soil samples represent an indication of the presence of gross contamination only, and in no way are intended to represent the actual levels of contaminants present in the formations.

#### 5.2.1.4 Borehole Geophysical Surveys

No borehole geophysical surveys will be conducted during this IRP Phase II Stage 2 investigation.

#### 5.2.1.5 Monitoring Wells

An overall objective of the investigation at Carswell AFB is to define the presence, magnitude, direction, rate and extent of movement of any identified contaminants. To accomplish this task, a maximum of 27 monitoring wells will be installed. Well construction will be in accordance with the SOW for the purpose of examining the ground water for the presence of contamination and defining the local hydrogeology. For this investigation installation of monitor wells are planned at Sites 1, 3, 4, 5, 12, 17, and BSS. The exact

location, depth and number of test wells for each site will be determined in the field by the contractor in consultation with the Air Force Technical Program Manager. All wells will be completed in the upper zone (alluvium); the Paluxy well identified in the SOW will be considered optional (verbal communication between the USAFOEHL TPM and the Radian Project Director). Field drilling operations and logistics will be coordinated with Civil Engineering facility personnel to avoid interference with existing utilities and traffic patterns.

The field team will use a hollow-stem auger rig to drill the upper zone monitoring wells. This method performs well in unconsolidated sediments, allows the rig to operate without the use of drilling fluids, and permits ease of collection for formation samples. The hollow-stem auger can be used as a temporary casing to prevent the borehole from caving during drilling and completion of test wells. For the depths and geology involved, this drilling method will provide fast, efficient performance at a relatively low operating cost.

Following the completion of drilling operations, each well will be screened above and below the water table surface with a minimum of 10 feet and maximum of 35 feet of screen. The screen will consist of two-inch diameter, PVC casing with up to 0.020-inch slots. The material lengths selected will be based upon site-specific ground water conditions encountered. The screen will be capped at the bottom. All connections will be flush jointed and threaded.

The screened section will be joined to a two-inch diameter, Schedule 40 PVC, flush threaded casing. The casing will extend from the top of the screen to at least ground surface. To ensure the chemical integrity of the test wells, no glues, solvents, or thread compound will be employed during screen and casing installations. Prior to installation, the casing and screen sections will be thoroughly washed using a high-temperature, high-pressure sprayer, with Base potable water only.

After the casing and screen have been installed for each well, a sand or gravel pack will be emplaced between the screen and the boring wall. The pack will consist of washed and bagged rounded sand or gravel with a grain size distribution compatible with the screen and the formation. The pack will be emplaced from the bottom of the borehole to two feet above the top of the screen. The auger flights will be used as the tremie pipe.

Granulated or pelletized bentonite will be placed above the sand/-gravel pack to a minimum thickness of two feet to provide an adequate seal. The bentonite seal will be wetted in the hole using 1-2 gallons of Base potable water to ensure that the seal is developed before cementing operations begin.

Neat cement (Type I Portland cement) grout will be emplaced from above the top of the bentonite seal to land surface. No more than an eight percent gel mixture may be used. For water table conditions grout will be emplaced through the augers and then the auger string withdrawn. If artesian conditions exist a small diameter tremie pipe will be used to emplace the grout.

#### Surface Completions of Monitoring Wells

Two methods for the well surface completions will be employed at Carswell AFB depending on input from base officials. If well stick-up is of concern in an area, the well will be completed flush with the land surface. In the case of flush completion, the PVC casing will be cut two to three inches below land surface, and a protective locking lid will be cemented in place. The protective lid will consist of a cast-iron valve box assembly cemented in place with concrete. Care will be taken to maintain free drainage from the valve box such as with a subsurface drain tube. Also, a water tight PVC casing cap will be provided to prevent infiltration of surface water. A locking system will be provided to discourage any tampering.

When above-ground surface completion is used, the PVC well casing will be extended about two or three feet above land surface. An end plug or casing cap will be provided for each well. The extended PVC casing will be shielded with at least a four-inch diameter steel guard pipe. The guard pipe will be placed over the PVC casing and cap and will be seated in a 24-inch by 24-inch by 4-inch concrete surface pad. The protective casing will be installed with a lockable cap or lid to discourage vandalism.

In the case of an above-ground completion, three 3-inch diameter steel guard posts, five feet in total length each will be installed radially from each wellhead. The guard posts will be placed approximately two to three feet into the ground and may at some sites be removable to facilitate access for sampling activities. In these cases a locking mechanism will be provided to prevent unauthorized removal.

#### Monitoring Well Development

Each new monitoring well will be developed as soon as practical after completion. The monitoring wells will be developed by a submersible pump, and/or bailer. Monitoring well development will continue until the discharge water is clear and free of sediment to the fullest extent possible. All water during development will be collected and disposed of through an existing oil/water separator connected to a base sanitary sewer. The development water production (rates), pH, specific conductances and water temperature will be measured. These data will be included in the final report.

#### Surveying of Monitoring Wells and Boreholes

All monitoring wells and boreholes will be surveyed for elevations and locations. A registered professional land surveyor will be retained to survey the vertical elevations of the wells and the tops of the boreholes. This survey will have an accuracy for vertical elevations of  $\pm 0.01$  foot for all monitoring wells and  $\pm 0.1$  for bore holes. Horizontal locations will be

accurate to  $\pm 1$  foot. All surveying will use an established U.S.C. & G.S. or U.S.G.S. bench mark as point of origin. All surveyed points and bench marks used will be recorded on site maps.

#### 5.2.1.6 Aquifer Tests

Slug tests will be conducted on eighteen of selected monitoring wells (new and Stage 1 wells) after the completion of groundwater sampling. The slug test provides an indication of aquifer characteristics such as hydraulic conductivity. Also, this test is ideally suited for low-producing formations that cannot be pumped. Monitoring wells will be selected with the hydrogeologic characteristics that will optimize slug testing. The resulting data will be used in conjunction with the groundwater geologic data. The slug test equipment will be decontaminated between monitoring wells to prevent any cross contamination.

#### 5.2.1.7 Groundwater Samples

##### Groundwater Level Measurements

Following completion and development of the monitoring wells, but prior to sampling activities at each site, a round of water level measurements will be conducted on the monitoring wells. Water levels will be measured to the nearest 0.01 feet from the top of the marked casing using an electric line water level indicator. When the electrode of the water level meter comes in contact with the water, a meter reacts or a tone sounds. Additionally, the surface of the water will be examined for the presence of hydrocarbons. If hydrocarbons are present the thickness of the layer will be measured and recorded.

##### On-Site Field Analyses

Well Purging -- Each monitoring well will be purged immediately prior to sample collection to insure that fresh formation water is collected.

Purging will occur at least three days after completion of monitoring well development. When possible sampling will begin at upgradient monitoring wells and/or low contamination areas then move to downgradient and/or higher contamination areas.

Purging operations will be conducted using a submersible pump or a bailer. Purging operations will be considered complete when three wetted well casing volumes have been removed or when the pH ( $\pm 0.1$  unit), temperature ( $\pm 0.5^\circ\text{C}$ ), specific conductance ( $\pm 10$  micromhos), color and odor of the discharge are stabilized. After purging the wells, groundwater samples will be collected from the discharge line of the submersible pump or with a Teflon bailer or 2-inch stainless steel Kemmerer sampler. This latter sampler can provide non-aerated groundwater samples at discrete depths which aids in insuring the integrity of any volatiles in the groundwater.

The methods for obtaining the water data are as follows: All down-hole equipment used during the purging of the monitoring wells will be carefully washed to prevent cross-contamination. Details of the decontamination process are provided in the Quality Assurance Project Plan (QAPP). As an additional step to prevent cross-contamination of the wells, purging/sampling operations will progress from areas suspected to contain little or no contamination to areas assumed to have higher contamination levels. The purged groundwater will be disposed through an oil/water separator connected to a sanitary sewer.

Temperature -- Measurements of the sample temperature will be taken using a mercury thermometer. The field measurement represents the temperature of the groundwater at a particular location and time.

pH -- The pH of each sample will be measured with a Myron L pDS (Model EP11/pH) meter or equivalent. The pH of the sample will be measured as quickly as possible after collection.

Specific Conductivity -- The specific conductivity of each sample will be measured with a Myron L pDS meter (Model EP11/pH) or equivalent. Elevated specific conductivities indicate the presence of conductive ions in the groundwater.

#### Sampling for Laboratory Analysis

Water samples collected from the wells will be placed in laboratory prepared containers, preserved as appropriate, chilled to 4°C and shipped to Radian laboratories in Austin, Texas and/or Sacramento, California. The groundwater samples and type of analysis are summarized on Table 5-3. Also shown on the table are data for surface water sampling. Radian chain of custody documents will accompany all samples. Analytical methods, preservations and holding times are provided in detail in the QAPP.

#### Split Sample Procedures

When split samples are required, the sample will be divided such that all the containers have a representative portion. In the case of solid samples (soil and formation), samples will be split longitudinally when possible and any loose material will be divided as equally as possible among the containers. Samples for volatile contaminants will be placed directly into the sample container with minimal disturbance. Water samples will be split by pouring an equal volume of liquid among the containers for each collection. The containers will then be labeled on-site and the samples recorded in a log book.

#### 5.2.1.8 Trenching

No trenching activities are planned for this investigation.



#### 5.2.1.9 Drum Sampling

During the borehole and monitoring well drilling activities cuttings that are suspected of being hazardous because of abnormal discoloration, odor or air monitoring levels will be containerized as discussed previously in Subsection 5.2.1.3 Subsurface Soil Surveys. To determine the final disposition of the cuttings in the drums, a composite sample will be obtained from each drum identified using a stainless steel scoop. Up to 50 composite samples will be collected for chemical analysis. Each composite sample of the drill cuttings will be analyzed as shown on Table 5-2 for EP Toxicity 40 CFR 261.24, (metals, pesticides and herbicides) volatile organic compounds (Method SW5030/SW240), and for base/neutral and acid extractable organic compounds (Method SW3550/SW8270) to determine if the soil cuttings must be disposed of as a hazardous waste.

#### 5.2.2 Evaluation-Related Tasks

The objectives of the data evaluation process are to summarize the existing information on the hazardous waste sources, pathways, receptors, and to evaluate potential impacts on the base and public health, and the environment. Site-specific analytical data resulting from the field investigation at the Base as well as regional information are considered in the evaluation process.

##### 5.2.2.1 Data Management

The field investigation will generate large amounts of data on the hydrogeology and chemistry about the study sites. Therefore, the data will be managed through a computerized database system called Empress®. This system will be used to convert the raw field data and analytical data into usable form for reporting. In addition, this will support the USAFOEHL Installation Restoration Program Information Management System (IRPIMS) and data formats. Therefore, the data base will be designed to support the following activities:

- Archive, analyze and manipulate physical, chemical, biological and geological data collected during the IRP program;
- Analyze data with respect to trends or violations of environmental protection guidelines;
- Produce subsets of data to form summary reports and data files which can be analyzed by environmental models and statistical algorithms; and
- Interpret relationships between contaminant migration and biogeochemical relationships existing at a particular site.

Predefined Codes As part of the data management, the documentation and procedures used during collection of sampling data will follow appropriate protocols and guidelines to eliminate data gaps. Data will be classified according to guidelines that will use predefined codes from USAFOEHL. The coded values will minimize the size of the database and will reduce the time needed to perform the data entry effort.

Data Collection Forms -- Data collection forms will be provided by USAFOEHL and will be revised to record data gathered by field personnel or measured by laboratory technicians.

Automated Data Processing (ADP) Format -- In the USAFOEHL-specified ADP format all technical data, including site information, well characteristics, hydrogeologic, geologic, physical and chemical sampling results will be stored on magnetic media (floppy disk or magnetic tape). The technical data will be organized in ASCII flat files using data files specified in a USAFOEHL format.

#### 5.2.2.2 Hydrogeologic Assessment

The purpose of the hydrogeologic assessment is to develop a complete understanding of the ground water system on-and off-base by integrating the available data from earlier investigations and by conducting additional field studies to fill data gaps or provide additional detail where necessary. Specific purposes of this evaluation include: developing a better understanding of on-and off-base ground water flow; relationships between saturated zones; extent and migration of contamination plumes; seasonal changes in water levels and flow. Results of this study will form the framework of the evaluation of ground water impacts, qualitative risk assessment, and remedial action alternatives discussed in Section 5.2.3.

The focus of this task will be on developing a comprehensive knowledge of base-wide groundwater conditions at Carswell AFB. The information developed in the detailed site characterization of individual contamination areas will form an integral part of the data used in this task.

The hydrogeologic assessment will draw on the results of all previous groundwater investigations conducted as part of the IRP at Carswell AFB. In addition to those sources, previous IRP studies will now be updated with any regional and area studies by federal, state, and local agencies and other published and unpublished information will be used.

#### 5.2.2.3 Demographic Survey

The potential for contaminants to come in contact with various receptors is of prime concern during this investigation. This is particularly the case when waste sites exist close to the base boundary where a greater potential exists for off-base migration. Once a contaminant exits, a site, on or off-base human contact or other receptors can be impacted. Therefore, in order to evaluate the contaminant threat, it is necessary to identify the possible receptors. Data are readily available to determine on-base receptors,

while off-base demographic data will need to be generated during this investigation. Demographic and land use information will be developed during the program literature search, and specifically during a water well inventory within a mile around Carswell AFB. These activities will identify the demographics for potential human receptors, as well as determining the nature of the land use such as agricultural, industrial, commercial, or residential. Water wells, whether residential, municipal, or industrial, will also identified.

#### 5.2.2.4 Evaluation and Screening of Data

The basis for assessing the impact of a site on the environment is based on the value of the data collected about the site. These data are from field observations as well as physical and chemical data collected during the project. This information forms the foundation for making the interpretations about the site and its potential for adverse health determinations.

The data will be screened for quality control purposes as it is received. The content will be screened for appropriateness and completeness. All of the data collected in the field and subsequent chemical analysis will be reviewed prior to sending informal copies to USAFOEHL. The data will be screened in accordance with the Work Plan, Statement of Work, Data Base Management System and the QAPP.

#### 5.2.2.5 Endangerment Assessment

The confirmation of a hazardous substance at a site will be evaluated to determine the relative danger it can pose to public health, welfare or the environment. The data collected during this effort will be integrated with the results of the previous Stage 1 activities to provide a comprehensive picture of the threat potential. Pathways, receptors, and the nature of the contaminants will be used in conducting an endangerment or risk assessment. The result of this evaluation will be to identify what is or has been affected

by a site. These activities will be part of a risk assessment conducted during this investigation. During this endangerment or risk assessment the following will be identified:

- Receptors;
- Threat to human health and environmentally sensitive areas; and
- Carcinogenic risks.

#### 5.2.2.6 Map Preparation

To support the reporting effort, maps will be prepared utilizing an inhouse PC-based system Autocad. This system will permit relatively fast development of report maps and map changes. The system permits the integrating and development of geologic cross sections and plane maps. Additionally, the system permits various scales to provide the optimum map size for the report. The results will be maps, figures and legends that are clear for ease of interpretation and of publishable quality. Map and figure preparation will be developed from the applicable sections in the Statement of Work and the USAFOEHL handbook. In general, the following types of maps and figures will be developed:

- General Carswell AFB installation features and boundaries (e.g., major installation support and operational facilities);
- Site locations and plan views;
- Monitoring well/boring/sampling locations/cross sections; and
- Surface drainages and water bodies.

Some of the specific types of maps and figures that will be developed include hydrogeological cross-sections, water table elevation contour maps, water well inventory locations, and soil gas survey grids and related data.

5.2.2.7 Treatability Studies

No treatability studies are planned for this present effort. Requirements for treatability studies will be considered during the review of alternative remedial actions during this investigation.

5.2.2.8 IRP Reports

When evaluating a site, all site-specific data are important to understand the physical and chemical factors controlling the migration and distribution of contaminants at a site. Past site-specific data will be available from previous IRP activities which are summarized in the corresponding Phase I and Phase II Stage 1 reports. These reports, in general, and specifically the Phase II Stage 1 report, will be reviewed for the identification of data gaps. Therefore, any existing data gaps can be addressed in the present investigation to complete the data base and prevent duplications of effort within the present statement of work.

Preparation of Preliminary and Final Reports

Radian will prepare a draft report documenting all the findings from this study. A first draft report will be submitted to USAFOEHL and their comments incorporated prior to submittal of a second draft report. A final report will then be published after incorporating the second draft comments. Report distribution will be specified by USAFOEHL per the statement of work.

As part of the reporting task the following items will be provided as separate documents and/or included into the main report:

- Qualitative risk assessment;
- Finding of no significant impact;
- Preliminary alternative remedial actions;
- Data quality objectives;
- Informal technical informative report;

- Work plan and QAPP for next effort; and
- Cost estimate for next effort.

### 5.2.3 Feasibility Study Tasks

The purpose of this feasibility study is to select preliminary alternative remedial action for the various sites at Carswell AFB. This objective will be accomplished through the following general elements:

- Identify general response actions;
- Identify of remedial technologies and alternatives;
- Initial screening of technologies and alternatives; and
- Develop remedial alternatives for remaining technologies.

#### 5.2.3.1 Identification of General Response Actions

Radian will identify general alternatives that address all significant site problems and pathways of contamination identified for the study sites at the base during the remedial investigation. Based on site information from the remedial investigation, Radian will identify general response actions, or classes of response without necessarily identifying specific technologies. General response actions considered will include the "no action" alternative as a baseline against which other measures can be measured. Examples of general response actions include the following:

- No Action
- Containment
- Pumping
- Collection
- Complete Removal
- Partial Removal
- On-site Treatment
- In-situ Treatment
- Storage

- On-site Disposal
- Off-site Disposal
- Other Off-site Measures

#### 5.2.3.2 Identification and Screening of Remedial Technologies

A list of potential remediation technologies for both on-site and off-site remedies will be developed for the general response actions noted above. The list of technologies will then be narrowed through an initial screening process based on known site conditions, waste characteristics, and technical requirements. Those technologies which are difficult to implement; require unreasonable time periods, or rely on unproven methods will be eliminated. Special consideration will be given to technologies that permanently contain, immobilize, destroy, or recycle contaminants, and technologies that promote energy recovery.

Waste characteristics that limit the effectiveness or feasibility of the remedial technologies will also be identified in this process. Such characteristics include: 1) physical properties such as volatility, solubility, and density; 2) specific chemical constituents such as chlorinated organic chemicals or metals; and 3) properties that determine the waste's toxicity or degree of hazard, such as persistence, acute toxicity, and ignitability. Technologies clearly limited by waste characteristics should be eliminated from consideration.

Radian will refer to the EPA "Handbook for Remedial Action at Waste Disposal Sites" (June 1982) for a more comprehensive description of technologies. During technology screening, the use of this list will help ensure that all remedial technologies are considered.

#### 5.2.3.3 Development of Alternatives

During this task, the potential technologies for each of the general response actions will be developed and compiled into comprehensive, site-

7  
08  
0

specific remediation alternatives. Emphasis will be placed on long-term mitigation potential and protection of public health and the surrounding sensitive biological areas. The development of alternatives will be consistent with EPA guidance in Section 300.68 of the National Contingency Plan and the requirements of other federal and state regulations.

In developing remedial alternatives, Radian will rely on acceptable engineering practice to determine which of the screened technologies appear most suitable for the site. Consideration will be given to recycle, reuse, waste minimization, destruction, or other advanced, innovative, or alternative technologies, if appropriate. Radian will document the reasons for excluding technologies that passed the technology screening. But, as part of this study, at least one alternative for each of the following will be evaluated:

- Alternatives for treatment or disposal at an off-site facility approved by EPA (including Resource Conservation Recovery Act (RCRA), Toxic Substance Control Act (TSCA), Clean Water Act (CWA), Clean Air Act (CAA), Marine Protection, Research and Sanctuaries Act (MPRSA), and Safe Drinking Water Act (SDWA) approved facilities), as appropriate.
- Alternatives which attain applicable or relevant and appropriate Federal public health or environmental standards.
- As appropriate, alternatives which exceed applicable or relevant and appropriate public health or environmental standards;
- Alternatives which do not attain applicable or relevant and appropriate public health or environmental standards but will reduce the likelihood of present or future threat from the hazardous substances. This will include an alternative which closely approaches the level of protection provided by the applicable or relevant standards and meets CERCLA's objective

of adequately protecting public health, welfare, and environment.

- A no action alternative.

As part of the feasibility study, alternate contaminant levels (ACL's) of potential contaminants may be proposed. An ACL may be established for any contaminant upon a determination that the ACL will not be a substantial hazard to human health or the environment as long as the ACL is not exceeded. The ACL's will be based on a demonstration that there is a lack of exposure or that levels of exposure are adequate to protect human health. In establishing ACL's, Radian will consider isolation, attenuation, degradation, and dilution of the contaminants before they reach possible receptors.

#### 5.2.3.4 Screening of Alternatives

Screening of the alternatives identified above will be undertaken. The objective of this screening will be to eliminate any alternatives that are clearly not feasible, appropriate, or competitive with other alternatives because of environmental considerations, engineering considerations, or cost. The following paragraphs provide a brief discussion of three factors that will be considered during the screening of alternatives.

Environmental Effects and Environmental Protection -- The potential for adverse environmental or public health impacts during implementation or during the service life will be evaluated for each alternative. Factors considered under this subtask will be the following: 1) comparison of expected rates of release of contaminants and exposure levels; 2) minimizing the disruption of habitat; 3) aesthetic considerations; and 4) public acceptance and institutional and legal issues. Alternatives which have significantly greater risks or environmental impacts than other alternatives will be eliminated.

Implementation and Reliability -- Alternatives will be reviewed to determine the ease of implementation and the proven reliability of the technologies. Alternatives that rely on technologies which are unproven, are unduly complex, require unreasonable time periods, institutional and legal requirements, or are prone to construction or operational error will be considered for elimination.

#### 5.2.3.5 Technical Evaluation of Alternatives

For all past hazardous waste disposal and spill sites investigated at Carswell AFB, Texas, except those where a FONSI is applicable, the data and conclusions obtained from the hydrogeological survey, site characterization, and qualitative risk assessment will be used to technically evaluate the preferred alternative remedial actions.

Remedial alternatives will be developed based upon the technologies remaining after the initial screening. Alternatives developed will include the five following categories:

- 1) Alternatives for off-site treatment or disposal;
- 2) Alternatives that attain ARARs;
- 3) Alternatives that exceed ARARs
- 4) Alternatives that do not attain ARARs; and
- 5) No action.

Further, alternatives outside of these categories may also be developed, such as non-cleanup alternatives (e.g., alternative water supply, relocation, etc).

If applicable, the technologies will be grouped into operable units (OUs). An operable unit is a discrete part of the entire response action that decreases a release, threat of release, or pathway of exposure.

Documentation of the remedial alternative development process, including the decision rationale, along with the finalized list of preliminary remedial alternatives will be included in the final report.

5.2.3.6 Institutional Requirements Evaluation

The institutional factors associated with each alternative will be defined and the requirements of each identified. These include identifying applicable regulatory requirements, permits needed and participating agency cooperation. In addition, potential for public acceptance of each alternative will be estimated.

5.2.3.7 Exposure Assessment

Each alternative will be qualitatively assessed in terms of its ability to minimize public exposure to residual contamination both during and after completion of the remedial action. Estimates of residual contamination and further reduction over time will be made for each alternative and compared to the no action alternative. Short-term exposure mechanisms will also be identified. Where appropriate, reductions in impact will be determined by comparing residual levels to existing criteria, standards or guidelines.

5.2.3.8 Environmental Impact Evaluation

The environmental impacts of each of the alternative remedial actions will be assessed. This will provide information on impacts and measures to mitigate these impacts for each of the alternatives. Both short-term implementation impacts and long-term impacts will be considered. An evaluation of beneficial impacts will also be included.

5.2.3.9 Cost Analysis of Selected Alternatives

Cost as a screening factor will only be used to differentiate technologies which provide similar results. At this stage in the development of

the remedial alternatives, the engineering design of alternatives is quite general, so cost estimates will be approximations. Such approximations will be developed on a consistent basis, however, so that comparisons of these costs will be useful in comparing the cost-effectiveness of alternatives. A technology which will result in the destruction or reduction of a waste's mobility, toxicity and volume (MTU), although it may have a high capital cost, should not be eliminated. Alternatives which are more expensive than other alternatives without significant compensating advantages will be eliminated.

### 5.3 Site-Specific Discussion

The following will describe the specific work elements for each site or operable unit to be conducted during this investigation per the statement of work. Also a brief discussion of the rationale for the work activities will be provided.

#### 5.3.1 Field Investigation

##### Site 1. Landfill 1

Results of Stage 1 groundwater sampling and analysis at Landfill 1 are somewhat conflicting, but do suggest that groundwater contamination may be present. The physical setting of the landfill, including the occurrence of groundwater and the thickness and character of upper zone deposits, appears to be adequately characterized. It is also recognized that the landfill is adjacent to the Trinity River, which would be the immediate receptor for any contamination that migrated off-base. Accordingly, the following Stage 2 work will be performed:

- Install two upper zone monitoring wells.

- Conduct two rounds of sampling at the four existing and two new upper zone monitoring wells in order to determine if contamination exists in the groundwater. Samples will be analyzed for general water quality parameters, purgeable organics, heavy metals, and oil and grease.
- Perform two single well aquifer tests (slug tests) on selected upper zone wells in order to determine the physical characteristics (e.g., transmissivity) of the upper zone.

Site 3, Landfill 3

The geophysical surveys performed during Stage 1 at the landfill suggest that soil or groundwater contamination may be present in the upper zone. In addition, hydrogeologic investigations conducted at AF Plant 4 have revealed significant levels of contamination in the upper zone on the east side of that facility, bordering the active runway in the area north of Landfill 3. Results of drilling have also shown that the Goodland/Walnut aquitard may be thin or absent on the east side of AF Plant 4, suggesting an increased possibility of degradation of water quality in the Paluxy aquifer. However, analyses of Paluxy aquifer groundwater from wells at the southeast corner of AP Plant 4 have not revealed contamination. Based on these observations, the following work will be performed:

- Install three upper zone monitor wells at the site. The wells will be located southeast, northwest and northeast of the inferred site boundaries, flanking the active runway.
- Install two upper zone monitor wells west of the landfill, adjacent to the drainageway (Farmers Branch) leading from AF Plant 4.

- Install one well (optional) into the upper Paluxy aquifer at a location west of the landfill site (between the landfill and the drainage coming from AF Plant 4).
- Conduct two rounds of sampling at these six wells and analyze for general water quality parameters, metals, oil and grease, phenols, organochlorine pesticides, and purgeable organic compounds.

Site 4. Landfill 4 ✓

Results of Stage 1 water quality analyses indicated that the upper zone groundwater is contaminated with halogenated organic compounds east of the landfill. The degree of TCE (trichloroethylene) contamination far exceeds the federal guidelines for TCE in drinking water. A variety of other halogenated compounds are present in lower concentrations, but still in excess of federal guidelines. The downgradient limits of the contaminated groundwater are not presently defined. The following additional activities will be conducted:

- Install three upper zone monitor wells east and north of the landfill. These wells will be located on the golf course so that at least one well monitors conditions directly north of the landfill at White Settlement Road, and other wells monitor conditions at greater distances east of the landfill.
- Perform five single well aquifer tests (slug tests) on selected upper zone wells in order to determine the physical characteristics (e.g., transmissivity) of the upper zone.
- Sample groundwater in two rounds from the existing Paluxy well (P2) and both new and existing upper zone wells. The samples will be analyzed for general water quality parameters, metals, and purgeable organic compounds.

Site 5. Landfill 5 /

Results of water quality analyses indicate that the upper zone groundwater is contaminated with halogenated organic compounds both upgradient and downgradient of the landfill. The degree of TCE contamination far exceeds the federal guidelines for TCE in drinking water. A variety of other halogenated compounds are present in lesser concentrations. The upgradient and downgradient limits of the contaminated groundwater are not presently defined. The stream north of the landfill, as well as monitor well 5B, also shows evidence of contamination with vinyl chloride. The following work will be performed:

- Install five upper zone monitor wells east, west, and south of the landfill. Three wells will be located on the golf course east of the landfill in order to define water quality conditions downgradient of the site. Two wells will be installed west of the landfill in order to define hydraulic and water quality conditions closer to the taxiway.
- Perform five single well aquifer tests (slug tests) on selected upper zone wells in order to determine the physical characteristics (e.g., transmissivity) of the upper zone in order to support eventual design of remedial actions.
- Sample groundwater in two rounds from the existing Paluxy well (P1) and from both new and existing upper zone wells. The samples will be analyzed for general water quality parameters, metals, and organic compounds.

Site 10. Waste Burial Area /

Considering that the Waste Burial Area (Site 10) is very close to both Landfills 5 and 4 (Sites 5 and 4) and recognizing that there are few hydrogeologic distinctions between Sites 10 and 5, the follow-on activities at

Landfill 5 incorporate work that would be appropriate for Site 10. However, since Site 10 is identified as a waste burial area, rather than a landfill, it is also appropriate to perform direct waste/soil sampling within Site 10. Three borings will be taken within the site, with analyses for:

- Oil and grease;
- Petroleum hydrocarbons;
- Metals;
- Organochlorine pesticides and PCBs;
- Volatile and semivolatile organic; and
- Chlorinated Phenoxy Herbicides.

These borings will be preceded by a magnetometer survey, in order to preclude drilling directly into a buried drum. Exact location of these borings will be selected on the basis of the geophysics.

Site 11. Fire Training Area 1 ✓

Results of the Stage 1 investigation have shown that very low levels of organic compounds are present in the upper zone groundwater. Therefore, no additional wells are recommended for this site. However, the discovery of TCE in soils suggests that continued groundwater monitoring is warranted. Follow-on investigations will include two rounds of sampling and analysis of the two existing wells for general water quality parameters, metals, petroleum hydrocarbons, pesticides and volatile organic compounds.

Site 12. Fire Training Area 2

Results of soil and water quality analyses indicate that the upper zone is contaminated with halogenated and aromatic organic compounds. The degree of contamination, particularly in soil downgradient and at the center of the site, is significant enough to warrant additional monitoring and analysis. In addition, levels of TCE in groundwater downgradient of the site exceed the federal guidelines established for TCE in drinking water. A

variety of other halogenated compounds are present in lower, but excessive concentrations. The downgradient limits of the contaminated groundwater are not presently defined. The intermittent drainage that flows to the north from the site also shows evidence of contamination. The following additional characterization will be performed

- Install two upper zone groundwater monitor wells north and east of the site in order to determine the downgradient water quality conditions. These wells will be located in the vicinity of the intersection of White Settlement Road and Coody Drive and near the western boundary of Landfill 4.
- Conduct a series of five soil borings within the fire training area in order to assess near-surface soil conditions. Analyze samples recovered for:
  - Petroleum hydrocarbons;
  - Metals;
  - Volatile and semivolatile organic compounds; and
  - Soil moisture content.
- Conduct two rounds of sampling and analysis of groundwater from new and existing monitor wells. The parameters for analysis will include general water quality parameters, metals, volatile organics, petroleum hydrocarbons, and oil and grease.
- Perform three single well aquifer tests (slug tests) on selected upper zone wells in order to determine the physical characteristics (e.g., transmissivity) of the upper zone.

Site 13. Flightline Drainage Ditch /

Phase II (Stage 1) data gathered at the Flightline Drainage Ditch confirmed that soils were affected by runoff from the flightline. Groundwater

conditions directly under the site are not known, although monitor wells proposed at Site 17 would detect downgradient movement of any contamination. Otherwise the soils data were considered sufficient for development of corrective actions. Since that time, the ditch has been cleaned and the waste treatment facilities redesigned and upgraded. The only remaining issue at the Flightline Drainage Ditch is the degree of residual contamination, if any. Therefore, a very limited program will be conducted. Soil or sediment samples will be collected at five locations in the bottom of the ditch to verify that cleanup has occurred. Samples recovered will be analyzed for petroleum hydrocarbons, metals, and volatile and semivolatile organic compounds.

Site 15. Entomology Dry Well

Results of drilling and analysis of samples collected from three upper zone monitor wells do not reveal contamination at the site. However, because the dry well was not located, the degree of soil contamination, if any, in the former location of the Entomology Building is not known. The following activities will be performed:

- Three hand augers will be drilled at the location of the former Entomology Building. Samples of soil will be analyzed for pesticides and herbicides.
- Water levels at the existing upper zone monitor wells will continue to be measured in order to define the direction of groundwater flow and provide groundwater flow information for the investigation at Site 16.

Site 16. Unnamed Stream

Field activities at Site 16 have documented the presence of organic contamination in upper zone groundwater west of the inferred location of the french drain. In addition, elevated levels of metals and some organic compounds have also been discovered at the Unnamed Stream. These conclusions are

based on a one-time sampling event; monitor wells were not installed as part of the Stage 1 actions. Therefore, the areal limits of contamination, as well as groundwater flow patterns, are not known in enough detail to proceed with design of corrective measures. Further, the results of the one-time sampling event are not sufficient to warrant immediate consideration of remedial actions.

The following activities will be performed at the Unnamed Stream:

- Resample the stream at four locations in two separate events.
- The samples will be analyzed for general water quality parameters, petroleum hydrocarbons, and purgeable organic compounds.

Site 17. POL Tank Farm

The POL Tank Farm currently consists of four large, above-ground fuel storage tanks. Recently, the tank farm area has been enclosed with concrete-lined spill retention basins. It is likely that any future activities at the site will not affect the subsurface environment, since permanent drainage and surface sealing have been installed. However, the issue of past occurrences of subsurface hydrocarbons must be addressed.

As reported in the Phase I document, fuels were discovered in the ground in this area during the 1960s. Samples of groundwater collected from Phase II (Stage 1) borings placed in the vicinity of the POL Tank Farm showed that the upper zone was contaminated with organic compounds. Because the borings were grouted upon completion, no additional data are available.

In order to determine the current conditions at the site and assess the likely environmental impacts of past releases, it will be necessary to perform additional site exploration. This exploration can be done in

conjunction with the previously recommended site definition activities. The actions to be performed at Site 17 are:

- Conduct a soil gas survey of the complete area surrounding the tank farm as it is presently configured to identify current extent of subsurface hydrocarbon vapors. This survey will not only show extent, but also aid in proper placement of the monitoring wells discussed below.
- Install five upper zone groundwater monitoring wells near the POL Tank Farm in order to assess the degree of groundwater contamination. The first three wells will be installed and water level measurements taken in order to identify current groundwater flow directions. The five wells will be installed with long screens extending above the water table to intercept floating hydrocarbon product (if any).
- Conduct two rounds of groundwater sampling, and analyze for general water quality parameters, petroleum hydrocarbons, metals, and purgeable organic compounds.
- Perform three single well aquifer tests (slug tests) on selected upper zone wells in order to determine the transmissivity of the upper zone.

Weapons Storage Area

Field activities in the Stage 1 investigation consisted of shallow soil sampling which revealed low levels of TCE in soil. The Stage 2 investigation will consist of the following activities:

- Eight hand augers will be drilled in and around the drainage ditch west of the Inspection Shop.

- Soil samples will be analyzed for metals, volatile and semivolatile organic compounds, and moisture content.

#### Base Service Station

The Phase II (Stage 1) investigation did not include any field activities at the Base Service Station. Therefore, the Base Service Station area will have the following Stage 2 activities:

- A soil gas survey will be performed of the BSS site as well as the property east (toward Trinity River) of the site to identify the current extent of subsurface hydrocarbon vapors (if any). This survey will not only show extent, but will also aid improper placement of the monitoring wells discussed below.
- Install four upper zone groundwater monitoring wells to assess the degree of groundwater contamination.
- Conduct two rounds of ground sampling and analyze for metals, petroleum hydrocarbons, and purgeable organic compounds.

#### 5.3.2 Evaluation of Alternatives

No site-specific alternatives have been identified for evaluation during this investigation. Alternatives will be identified as discussed in Section 5.2.3 Feasibility Studies.

6.0 REPORTING REQUIREMENTS

6.1 Monthly Research and Development (R&D) Status Report

Each month a project status report will be provided to USAFOEHL. The report will include all appropriate data required as delineated in the Statement of Work and USAFOEHL Handbook. Field and laboratory results along with QA/QC data will be incorporated into the next monthly R&D status report as they become available and after internal QA/QC checks have been accomplished.

6.2 Informal Technical Information Report (ITIR)

Upon completing all chemical analyses, the results will be tabulated, and compiled into an informal report. The ITIR will contain the laboratory test results, QA/QC data, a discussion of analytical methods and holding times, and chain-of-custody documents. This report will be provided to USAFOEHL.

6.3 RI/FS Reports

A final report will be prepared delineating all findings from the Stage 2 investigation. The reports to be submitted will reflect an integrated IRP approach with elements of the RI/FS. All reports will be submitted per the Statement of Work. The final report will also include a detailed discussion of the recommended alternative remedial and a description of the work proposed, including the Data Quality Objectives, for any follow-on RI/FS work.

7.0 SCHEDULE

The schedule for the IRP Phase II Stage 2 activities at Carswell AFB is provided on Table 7-1. This schedule is based on the proposed revision of the current Statement of Work. A final field schedule and milestone will be completed upon receipt of final approval of the work plan from USAFOEHL.

7-1

TABLE 7-1. SCHEDULE FOR CARSWELL AFB IRP PHASE II STAGE 2 ACTIVITIES

| Activity                                       | Estimated Completion<br>or Start Date |
|--|---------------------------------------|
| Notice to proceed                              | 25 Sep 87                             |
| Final Health & Safety Plan                     | 29 Oct 87                             |
| Draft Work Plan                                | 13 Nov 87                             |
| Final Quality Assurance Project Plan           | 20 Nov 87                             |
| Literature Search                              | 14 Dec 87                             |
| Final (Plans) Submission                       | 20 Jan 88                             |
| Field Effort Begins                            | 14 Dec 87                             |
| Soil Gas Surveying                             | 14 Dec 87                             |
| Borehole and Monitor Well Drilling Begins      | 25 Jan 88                             |
| Borehole and Monitor Well Drilling Ends        | 26 Feb 88                             |
| Surveying                                      | 23 Mar 88                             |
| Aquifer Testing                                | 29 Feb 88                             |
| Sampling Begins                                | 1 Feb 88                              |
| Sampling Ends                                  | 15 Apr 88                             |
| Sampling Analytical Data completed             | 1 Jun 88                              |
| Field Effort Ends                              | 15 Apr 88                             |
| Reporting Activities                           | 15 Apr 88                             |
| Informal Technical Information<br>Report       | 18 Jul 88                             |
| Technical Report (Draft)                       | 15 Aug 88                             |
| Qualitative Risk Assessment                    | 15 Aug 88                             |
| Finding of No Significant Impact<br>(FONSI)    | 15 Aug 88                             |
| Preliminary Remedial Actions                   | 15 Aug 88                             |
| Work Plan IRP Stage 3                          | 15 Dec 88                             |
| QAPP Stage 3                                   | 15 Dec 88                             |
| Technical Report (Final)                       | 15 Dec 88                             |
| Cost Letter for Proposed Stage 3<br>Activities | 15 Dec 88                             |

## A.0 INTRODUCTION

This Work Plan Addendum provides guidance for accomplishing those tasks required by the Carswell AFB IRP Phase II Stage 2 Modification 0004 Statement of Work that were either 1) not addressed in the Stage 2 Work Plan dated January 1988; or 2) were revised by the Schedule of Changes for the current effort. Unless otherwise indicated, all procedures/protocols documented in the approved Stage 2 Work Plan (January 1988) for tasks common to the previous Stage 2 effort and those tasks required in Modification 0004 (Mod 4) remain in effect.

### A.1 COMBINED SITE INVESTIGATION

A combined site investigation of the Flightline Area (Sites 4, 5, 10 and 12) will be performed. The results of this investigation will be presented in a site characterization report (see Section A.7) that describes the Flightline Area in terms of contaminant source(s), extent of Upper Zone contamination, and impacts of the contaminant plume(s) on Carswell AFB. Figure A-1 shows the approximate locations of soil borings, monitor wells, a pump test well, and surface water sampling points in the Flightline Area.

### A.2 SUBSURFACE SOIL SURVEYS

Up to 38 boreholes will be drilled using the hollow-stem auger (HSA) technique at the sites indicated in Table A-1. As many as 17 of the boreholes will be converted to monitoring wells (Table A-1). One large-diameter borehole will be drilled by HSA for construction of a six-inch diameter pump test well.

Soil samples from boreholes will be obtained as continuous cores in five-foot sections. Cores will be screened for evidence of organic contamination with an HNu or equivalent organic vapor detector, and will be logged lithologically using the IRPIMS Data Collection Forms (provided separately). A major objective of the soil boring program is to delineate the paleochannel

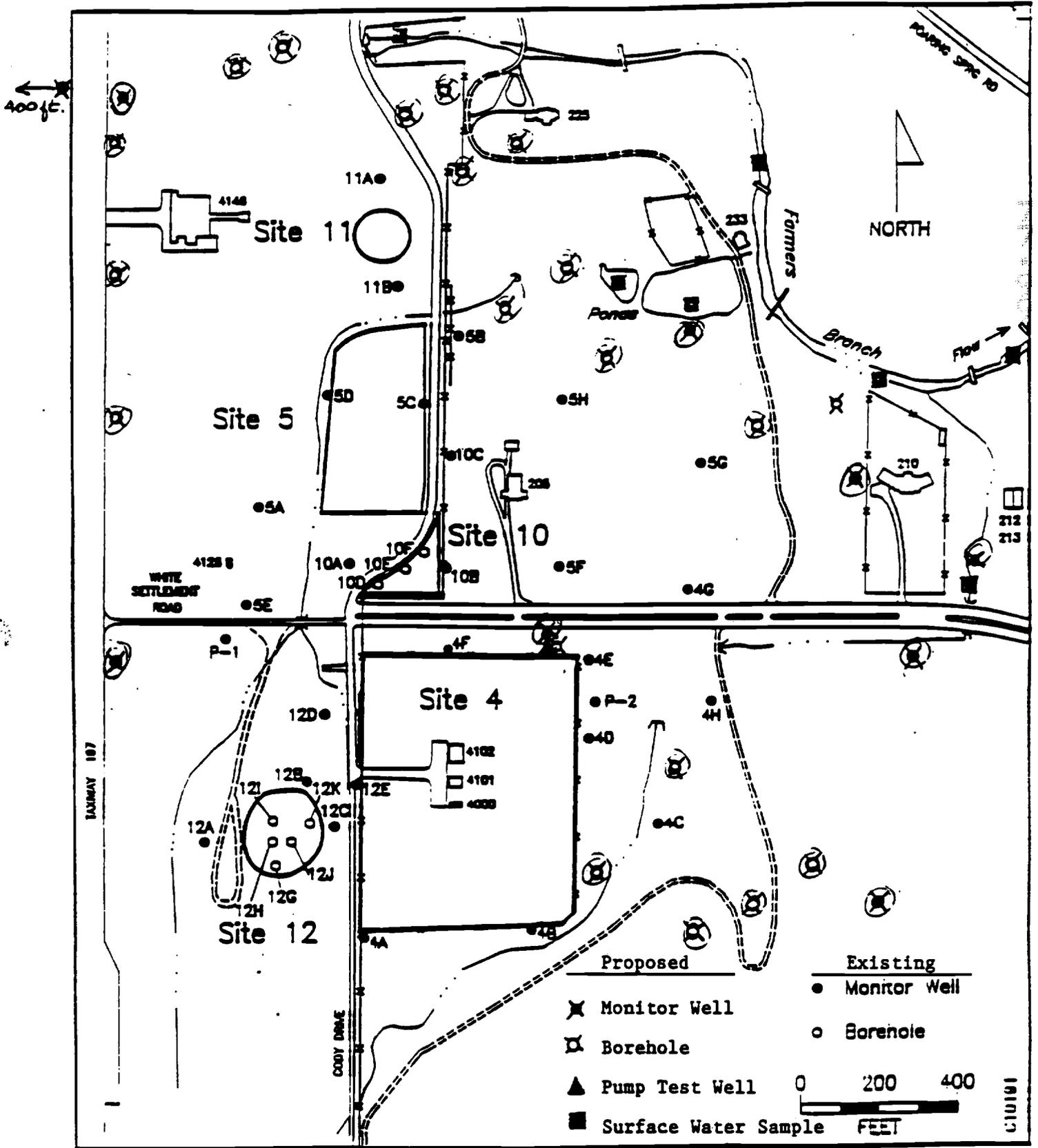


Figure A-1. Locations of Proposed (and Existing) RI/FS Stage 2 Activities and Sampling Points, Carswell AFB, Flightline Area

TABLE A-1. FIELD WORK SUMMARY, CARSWELL AFB, IRP PHASE II STAGE 2, MOD 4

| Site                                | 1  | 4               | 5               | 10 | 12 | 16             | 17             | BSS | Total |
|-------------------------------------|----|-----------------|-----------------|----|----|----------------|----------------|-----|-------|
| Boreholes (#)                       | -- | 15 <sup>c</sup> | 15 <sup>c</sup> | -- | -- | 4 <sup>b</sup> | 4 <sup>b</sup> | --  | 38    |
| Borehole Depth (max. ft)            | -- | 600             | 600             | -- | -- | 80             | 80             | --  | 1360  |
| UZ Wells (#)                        | -- | 5               | 5               | -- | -- | 4              | 4              | --  | 18    |
| Well Depth (max. ft)                | -- | 200             | 200             | -- | -- | 80             | 80             | --  | 560   |
| Surf. Water Smpl. Rds.              | -- | --              | 1               | -- | -- | 1              | --             | --  | 11    |
| Surf. Water Smpl. Pts.              | -- | --              | 7               | -- | -- | 4              | --             | --  | 11    |
| Surf. Water Smpls. (#) <sup>a</sup> | -- | --              | 7               | -- | -- | 4              | --             | --  | 11    |
| GW Smpl. Rds.                       | 1  | 1               | 1               | 1  | 1  | 1              | 1              | 1   | 1     |
| GW Smpl. Pts.                       | 6  | 13              | 14              | 3  | 5  | 4              | 9              | 3   | 57    |
| GW Smpls (#) <sup>a</sup>           | 6  | 13              | 14              | 3  | 5  | 4              | 9              | 3   | 57    |
| Aquifer Pump Test (Days)            | -- | 3               | --              | -- | -- | --             | --             | --  | 3     |

<sup>a</sup>Does not include QC samples; see Table A-2.  
<sup>b</sup>All boreholes at Sites 16 and 17 will be converted to monitor wells.  
<sup>c</sup>Five of the boreholes at Sites 4 and 5 will be converted to wells.

004444

features suggested in previous efforts. These highly permeable channel deposits may act as preferential pathways for migration of contaminants in ground water.

Up to 100 photographs of the cores may be taken. No core samples will be retained after logging (and photographing, if appropriate). Cores that exhibit evidence of contamination will be drummed for subsequent proper disposal by the base. No soil toxicity analysis requirements were retained in the Statement of Work for Mod 4. The locations and surface elevations of all soil borings will be professionally surveyed to the specification required in the Stage 2 Work Plan (January 1988).

### A.3 WELL CONSTRUCTION

Monitor well construction materials for the current effort are the same as those specified in the Stage 2 Work Plan (January 1988). New monitor wells installed in the Flightline Area (nine total) however will be screened across the basal section of the Upper Zone Aquifer (normally the lower 10 feet). Depending on the saturated thickness of the Upper Zone, some wells may not intercept the water table. This monitor well design modification was made because trichloroethylene (TCE), a compound that tends to sink in water, is the primary organic contaminant of concern in the Flightline Area. Also, by comparing organic and inorganic contaminant concentrations in samples from existing water table wells with those from the new wells, contaminant concentration profiles and vertical hydraulic gradients in the Upper Zone can be evaluated. Individual well locations may be refined in the field by the Radian Supervising Geologist, upon concurrence of the HSD/YAQI Consulting Hydrogeologist, to target the channel deposits determined from the soil borings.

Four monitor wells each will be installed at Sites 16 and 17 (see Figures A-2 and A-3). These wells will be drilled and sampled continuously, as previously described, to an average depth of 20 feet (total drilled depth

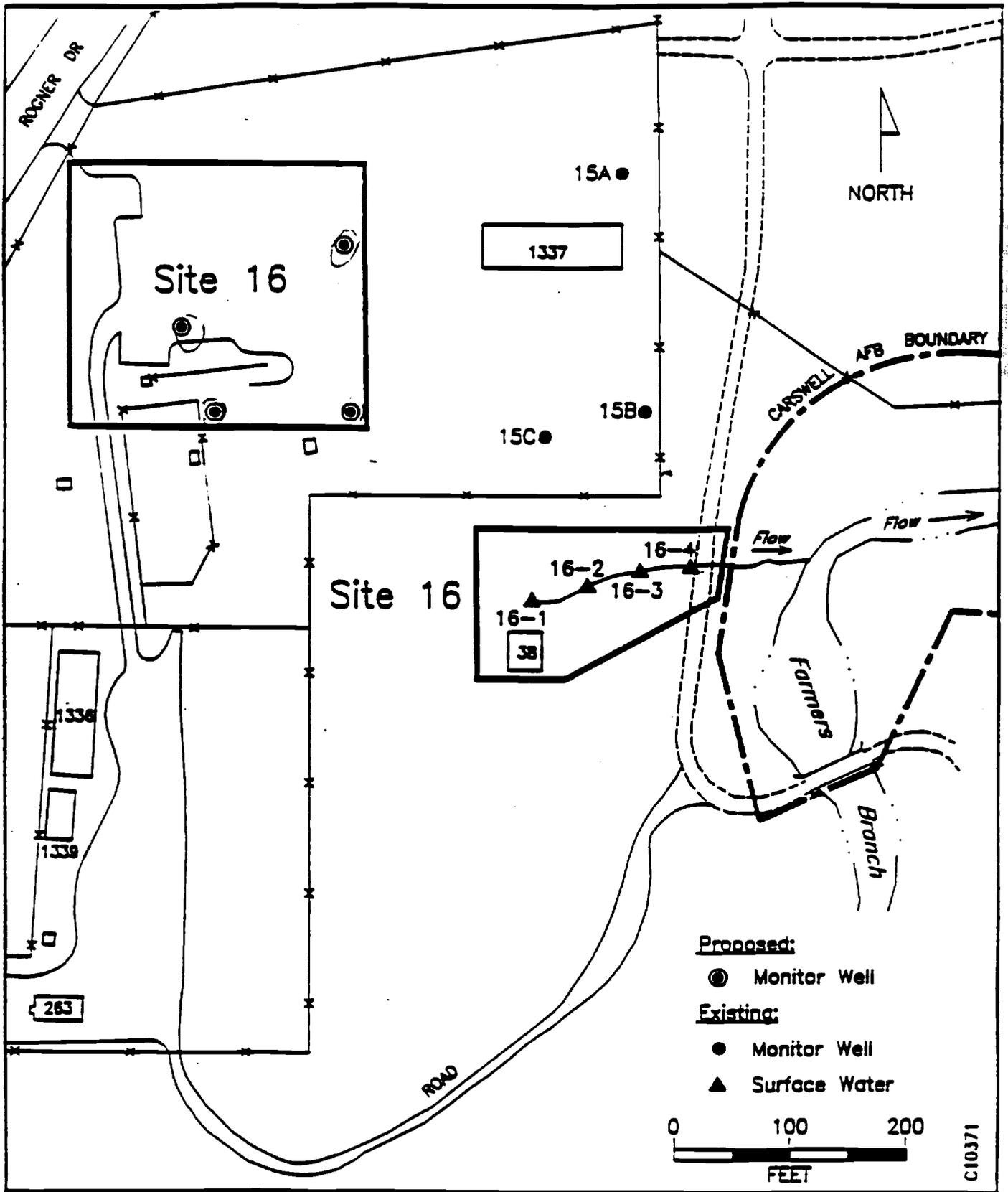


Figure A-2. Locations of Proposed (and Existing) RI/FS Stage 2 Activities and Sampling Points, Carswell AFB, Site 16, Unnamed Stream

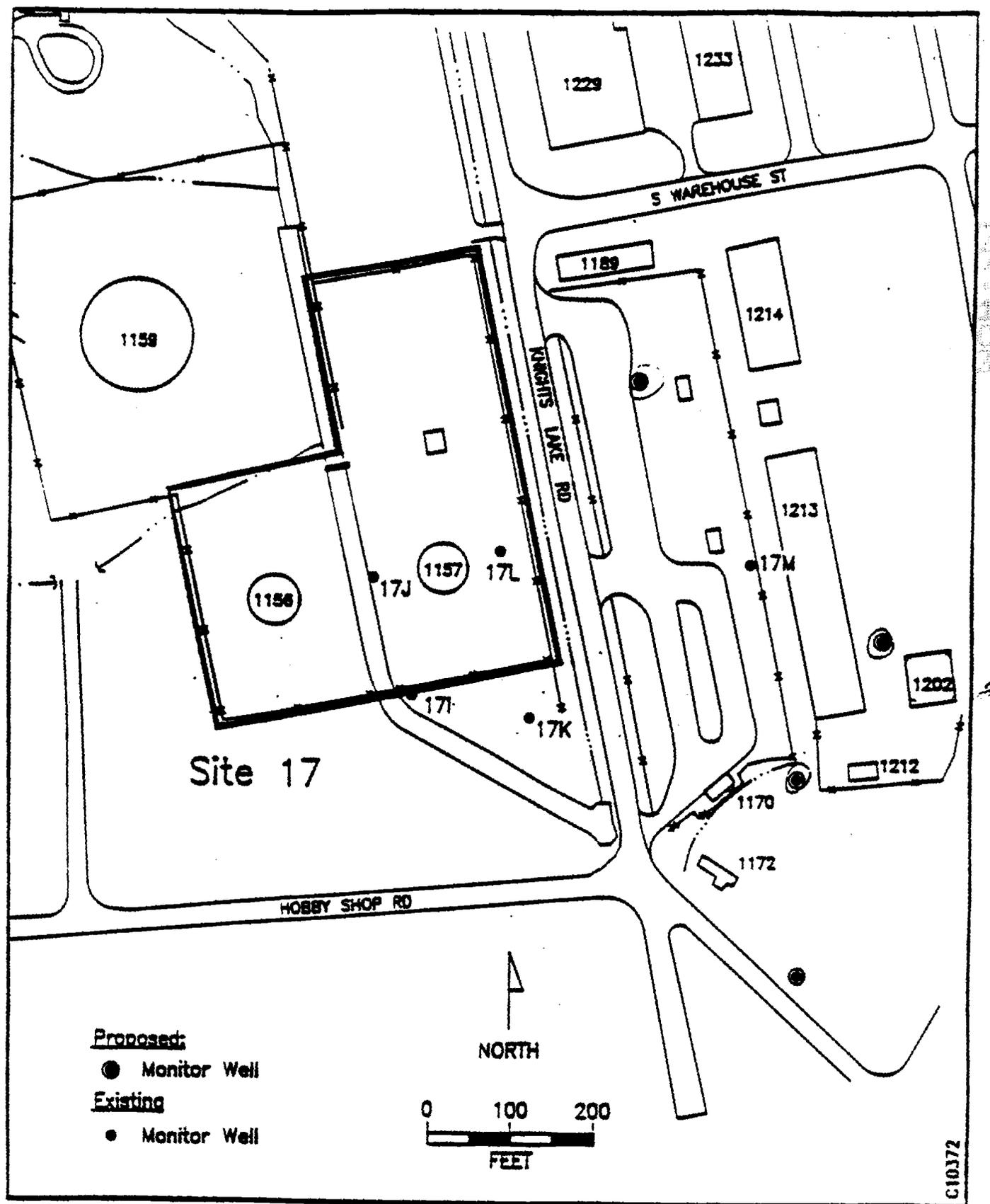


Figure A-3. Locations of Proposed (and Existing) RI/FS Stage 2 Activities and Sampling Points, Carswell AFB, Site 17, POL Tank Farm

not to exceed 160 linear feet). The wells will be screened to intercept the water table (Stage 2 Work Plan, January 1988).

One six-inch diameter well will be installed at the approximate location shown on Figure A-1 to perform a 24-hour pump test. A pilot boring will be drilled and continuously cored, then re-entered and reamed with large-diameter augers to allow installation of the pump test well. The well will be constructed of Schedule 80 PVC and will be screened over the entire saturated thickness of the Upper Zone (slot size 0.020 inches). A description of the pump test procedure is provided in Section A.6.

The type of well completion required (i.e., flush or stick-up with protective casing and guard posts) will be specified by the base POC, Mr. Frank Grey. Mr. Grey will also specify the identification numbers for the new wells and will obtain base clearances/permits for all drilling locations (previously staked).

The locations and elevations of the wells will be professionally surveyed as required in the Stage 2 Work Plan (January 1988).

#### A.4 WATER LEVEL SURVEY

One staff gauge will be installed at a location on Farmers Branch (to be determined jointly by the HSD/YAQI Consulting Hydrogeologist, Mr. Karl Ratzlaff and the Radian supervising geologist). The horizontal location and elevation of the staff gauge will be professionally surveyed to an accuracy of  $\pm 0.01$  foot vertical and  $\pm 1$  foot horizontal. The synoptic water level survey of Upper Zone ground water in monitor wells at Sites 4, 5, 10, and 12; and surface water in Farmers Branch at the staff gauge will be performed.

#### A.5 WATER SAMPLING AND ANALYSIS

One round of ground-water and surface water samples will be collected as indicated in Table A-1. Monitor wells and surface water sampling

points are shown on Figures A-1, A-2, and A-3. Sampling procedures will be as described in the Stage 2 Work Plan (January 1988). Table A-2 indicates the number and types of required analyses by site, as well as the number and type of field QC samples. Note that two aliquots will be collected from each well for analysis of metals. One of the samples will be unfiltered and the other will be filtered at the well head using a 0.45  $\mu\text{m}$  filter with millipore pump and portable generator prior to pH adjustment.

#### A.6 UPPER ZONE PUMP TEST

An aquifer pump test will be performed to evaluate the hydraulic characteristics of the Upper Zone deposits in the Flightline Area. The pump test will involve several wells, with one six-inch diameter well being pumped, and several others being monitored. Figure A-4 shows a generalized cross sectional view of a typical pump test battery of wells.

Pump tests usually provide the means to stress an aquifer to such a degree that reliable estimates of transmissivity, storativity and hydraulic conductivity can be made. These values can be calculated by observing the drawdown and recovery of the pumping well and observation wells. Each of these parameters will help to define the nature of ground-water contaminant plume migration.

The proposed site for the aquifer test pumping well is immediately outside the northern perimeter of Site 4 approximately 100 feet west of existing monitor well 4E. A six-inch diameter well screened in the Upper Zone will be installed as the pumping well. A two-inch diameter observation (monitor) well will be installed within 50 feet of the pump test well. It is anticipated that several existing wells in the vicinity of the pumping well (4#, 4F, 5F, and potentially others) will be monitored either electronically or by hand. The number of wells monitored during the test will depend upon the lateral extent of the pumping effect on the Upper Zone. A duration of 24 hours is proposed for the test.

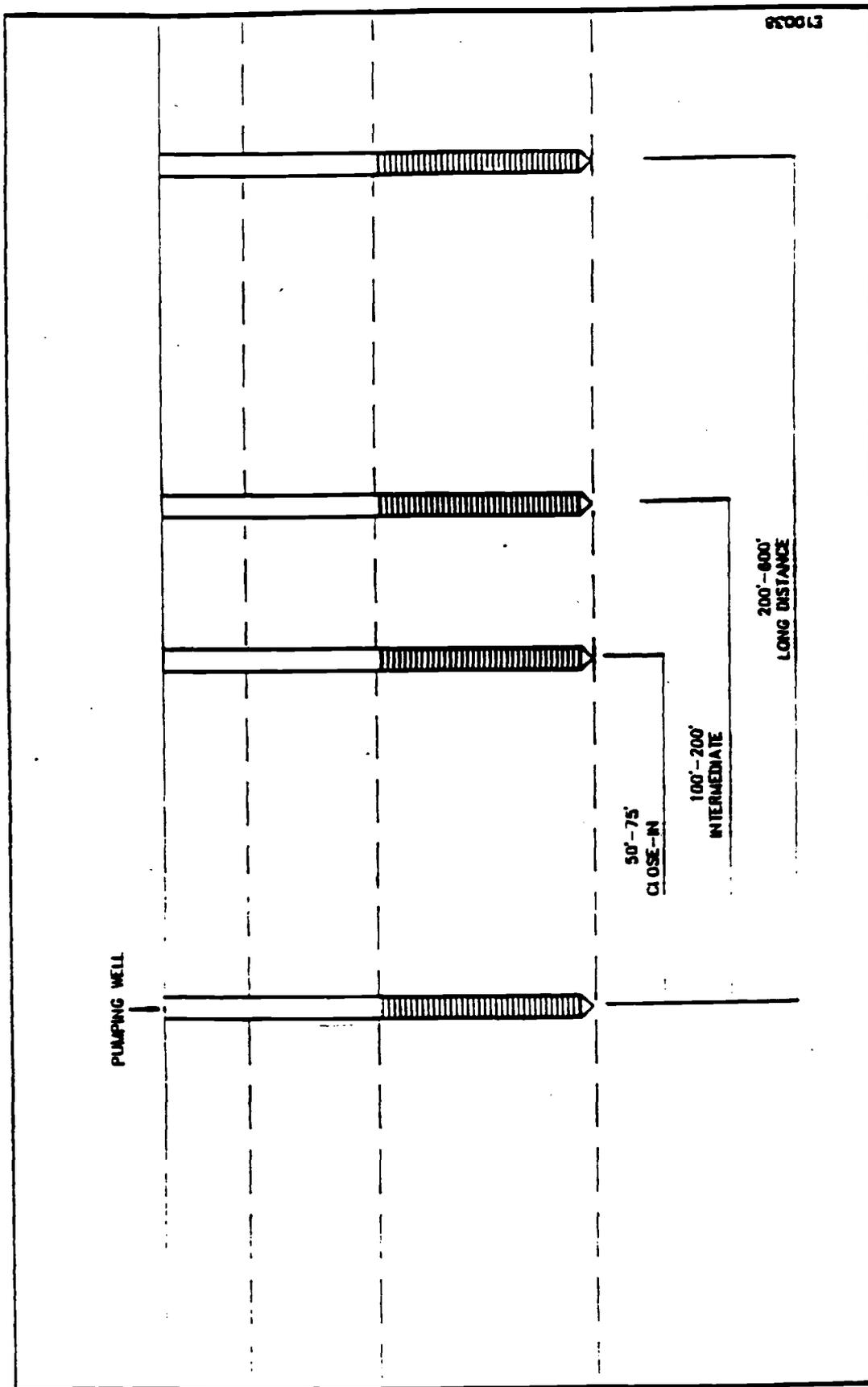


Figure A-4. Generalized Cross Section View of Typical Pumping Test Well Battery

61244-4/4



Prior to the start of the pumping test, an 8 to 12 hour step test will be performed. This test will be used to establish the optimum pumping rate for achieving the desired drawdown in the pumping well. Data from the step test will allow preliminary determination of the number and locations of wells which can be productively monitored during the formal pump test. In addition to the step test, it is anticipated that background data will be collected electronically prior to the test for a period of up to seven days. Collection of background data will document how changes in atmospheric conditions (primarily barometric pressure) might affect the water table.

A four-inch submersible pump will be used in both the step test and the pump test. The pump will be powered by a portable gasoline generator. Step test pumping will begin when all well monitoring equipment is in place. The pumping rate, in gallons per minute, will be determined by timing discharge. Using a gate valve on the discharge hose, the pumping rate will be increased in steps during the test and the drawdown will be measured. The steps will be of sufficient duration to allow drawdown to stabilize.

Continuous monitoring of the drawdown in the pumping well and the rate of discharge will allow the determination of the rate at which the maximum sustained drawdown of the pumping well can be achieved. It will also provide information regarding the suitability of the pump and water disposal capacity to the desired rate. In addition, surrounding wells will be periodically monitored during the step test to determine the preliminary effects of ground-water pumping. These data will be used to determine the number of wells to be formally monitored during the 24-hour test.

The 24-hour pump test will be initiated after a sufficient period of time has elapsed to allow the full recovery of the aquifer. All required data from the pump test will be recorded on IRPIMS Pump/Recovery Test Data Collection forms. At the start of pumping, discharge will be monitored continuously until the desired pumping rate stabilizes. Because drawdown is more rapid at the beginning of the test, electronic recording of water levels in

the pumping well and surrounding wells will be in a logarithmic progression. Hand monitoring, as necessary, will also be at more frequent intervals during the early stages of the test. During the test, pH, conductivity, temperature and the visual characteristics of the discharge water will be recorded at regular intervals. In addition, the pumping rate and drawdown of the pumping well will be periodically checked to ensure consistency throughout the test, as wells will typically show a slow decline in discharge with time as drawdown increases.

Electronic data logging equipment will be periodically downloaded by hand during the test. This will allow the construction of time-drawdown plots, or hydrographs, in the field for all wells being monitored during the test. These plots will be used for preliminary determination of aquifer characteristics. Discharge water from both tests will be pumped temporarily into a holding tank to allow observation of water characteristics and recording of water quality data. Pending approval of the base POC, it is proposed to discharge water from the holding tanks, directly to the storm water sewer system.

At the conclusion of the 24-hour ground-water pumping, well monitoring and observation will continue so that the effects of ground-water recovery can be recorded. Recovery data will be included on the hydrographs for each well. Data from the aquifer pumping test will be used to calculate hydraulic parameters for the Upper Zone.

#### A.7 REPORTING

In addition to the required monthly R & D Status Reports, the following deliverables will be produced in accordance with the schedule indicated in VI DELIVERABLES of the Statement of Work, as amended for Mod 4:

- Decision Documents - for each site/area for which a finding of NFA or a preferred remedial alternative can be identified.

Format is specified in USAFOEHL/TS Handbook, Section 3, Version 3.0.

- Informal Technical Information Report (ITIR) - to include results of all new Stage 2 analyses. Format is specified in USAFOEHL/TS Handbook, Section 8, Version 3.0.
- Site Characterization Report - for Flightline Sites 4, 5, 10, and 12 in terms of delineating the extent, identification of potential sources, and impact of the TCE and chromium plumes on base.
- Letter Report - critique of Hargis and Associates, 1989 report, with special emphasis on their contaminant plume findings as they impact Carswell AFB.
- RI/FS Report - incorporate new results into IRP RI/FS Stage 2 Final Draft (April, 1988) to produce third and fourth Drafts, and Final IRP RI/FS Stage 2 reports.

# APPENDIX B

## Quality Assurance Project Plan



INSTALLATION RESTORATION PROGRAM  
PHASE II - CONFIRMATION/QUANTIFICATION  
STAGE 2

CARSWELL AIR FORCE BASE  
QUALITY ASSURANCE PROJECT PLAN

HEADQUARTERS STRATEGIC AIR COMMAND  
COMMAND SURGEON'S OFFICE (HQSAC/SGPB)

JANUARY 1988

PREPARED BY  
RADIANT CORPORATION  
8501 MO-PAC BOULEVARD  
POST OFFICE BOX 201088  
AUSTIN, TEXAS 78720-1088

USAF CONTRACT NO. F33615-87-D-4023, DELIVERY ORDER NO. 04  
RADIANT CONTRACT NUMBER 227-005-04

USAFOEHL TECHNICAL PROGRAM MANAGER  
MR. KARL RATZLAFF  
TECHNICAL SERVICES DIVISION (TS)

UNITED STATES AIR FORCE  
OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY (USAFOEHL)  
TECHNICAL SERVICES DIVISION (TS)  
BROOKS AIR FORCE BASE, TEXAS 78235-5001

## TABLE OF CONTENTS

| <u>Section</u>                                      | <u>Page</u> |
|---|-------------|
| 1.0 QUALITY ASSURANCE/QUALITY CONTROL .....         | 1-1         |
| 1.1 Introduction .....                              | 1-1         |
| 1.2 Project Description .....                       | 1-2         |
| 1.3 Project Organization and Responsibility .....   | 1-8         |
| 1.4 Quality Assurance Objectives .....              | 1-9         |
| 1.5 Sampling Procedures .....                       | 1-16        |
| 1.5.1 Geophysical Techniques .....                  | 1-16        |
| 1.5.2 Drilling .....                                | 1-16        |
| 1.5.2 Well Installation .....                       | 1-16        |
| 1.5.4 Water Sampling .....                          | 1-16        |
| 1.5.5 Soil and Sediment Sampling .....              | 1-17        |
| 1.5.6 Air Monitoring and Soil Gas Sampling .....    | 1-17        |
| 1.6 Sample Custody .....                            | 1-18        |
| 1.6.1 Chain of Custody .....                        | 1-18        |
| 1.6.2 Documentation .....                           | 1-23        |
| 1.6.3 Sample Packaging and Shipping .....           | 1-24        |
| 1.7 Calibration Procedures .....                    | 1-26        |
| 1.8 Analytical Procedures .....                     | 1-28        |
| 1.8.1 Metals Analyses .....                         | 1-28        |
| 1.8.2 Organic Analyses .....                        | 1-34        |
| 1.8.3 Extraction Procedures .....                   | 1-35        |
| 1.8.4 Organic Analyses by GC/MS .....               | 1-37        |
| 1.8.5 Organic Analyses by GC .....                  | 1-40        |
| 1.8.6 Other Water Parameters .....                  | 1-42        |
| 1.9 Data Reduction, Validation, and Reporting ..... | 1-44        |
| 1.9.1 Data Reduction .....                          | 1-44        |
| 1.9.2 Data Validation .....                         | 1-44        |
| 1.9.3 Data Quality Review .....                     | 1-46        |
| 1.9.4 Reporting .....                               | 1-50        |
| 1.10 Internal Quality Control .....                 | 1-51        |
| 1.10.1 Laboratory QC .....                          | 1-66        |

|          |   |       |
|----------|---|-------|
| 1.11     | Performance and Systems Audits .....                                  | 1-77  |
| 1.11.1   | Audit Approach .....  | 1-77  |
| 1.11.2   | Systems Audit .....   | 1-79  |
| 1.11.3   | Performance Audit .....   | 1-81  |
| 1.12     | Preventative Maintenance .....  | 1-83  |
| 1.12.1   | Maintenance Responsibilities .....                                    | 1-83  |
| 1.12.2   | Maintenance Schedules .....   | 1-87  |
| 1.12.3   | Spare Parts .....   | 1-87  |
| 1.13     | Assessment of Precision, Accuracy, and<br>Completeness .....          | 1-89  |
| 1.13.1   | Precision .....   | 1-89  |
| 1.13.2   | Accuracy .....  | 1-91  |
| 1.13.3   | Completeness .....  | 1-94  |
| 1.14     | Corrective Action .....   | 1-95  |
| 1.15     | Quality Assurance Reporting .....                                     | 1-100 |
| 1.15.1   | Quality Assurance Reporting .....                                     | 1-101 |
| 1.15.2   | Quality Control Data Reporting .....                                  | 1-101 |
| 1.15.2.1 | Sampling Quality Control Review and<br>Reporting Requirements .....   | 1-102 |
| 1.15.2.2 | Analytical Quality Control Review and<br>Reporting Requirements ..... | 1-102 |
| 1.15.2.3 | Monthly QC Progress Reports .....                                     | 1-104 |
| 2.0      | METHODS, PROTOCOLS .....  | 2-1   |
| 2.1      | Magnetometer Surveys .....  | 2-1   |
| 2.2      | Drilling Techniques .....   | 2-1   |
| 2.2.1    | Hollow-Stem Augering .....  | 2-2   |
| 2.2.2    | Mud/Air Rotary Drilling (Optional) .....                              | 2-2   |
| 2.3      | Monitor Well Installation .....                                       | 2-3   |
| 2.3.1    | Hollow-Stem Auger Method .....  | 2-3   |
| 2.3.2    | Mud/Air Rotary Method (Optional) .....                                | 2-5   |
| 2.3.3    | Aquifer Testing .....   | 2-6   |
| 2.4      | Sample Collection .....   | 2-6   |
| 2.4.1    | Water Samples .....   | 2-7   |
| 2.4.2    | Soil and Sediment Samples .....                                       | 2-22  |
| 2.4.3    | Gas Sampling .....  | 2-27  |
| 2.4.4    | Sample Requirements .....   | 2-30  |
| 2.5      | Site Management .....   | 2-30  |

## LIST OF FIGURES

| <u>Figure</u> |  | <u>Page</u> |
|---------------|--|-------------|
| 1.6-1         | Radian Sample Label .....  | 1-19        |
| 1.6-2         | Radian Chain of Custody Form .....   | 1-21        |
| 1.6-3         | Radian Custody Seal .....  | 1-22        |
| 1.9-1         | Data Reporting Scheme .....  | 1-45        |
| 1.11-1        | Example Systems Audit Checklist .....  | 1-80        |
| 1.12-1        | Equipment Status Tag .....   | 1-85        |
| 1.12-2        | Equipment Inventory Control Form .....   | 1-86        |
| 1.12-3        | Example of Maintenance Log .....   | 1-88        |
| 1.14.1        | Malfunction Reporting Form .....   | 1-96        |
| 1.14-2        | Corrective Action Flow Scheme .....  | 1-97        |
| 1.14-3        | Recommendation for Corrective Action Form .....                                | 1-98        |
| 1.15-1        | Example of Duplicate and Blank Sample Summary .....                            | 1-103       |
| 2-1           | Bottom Entry Teflon <sup>®</sup> Bailer .....                                  | 2-17        |
| 2-2           | Bladder Pump .....   | 2-18        |
| 2-3           | Piston Pump .....  | 2-19        |
| 2-4           | Hand Augering Equipment .....  | 2-23        |
| 2-5           | Typical Hollow-Stem Augering Rig .....   | 2-25        |
| 2-6           | Foxboro Century Systems Portable Organic Vapor<br>Analyzer Model OVA-108 ..... | 2-29        |

LIST OF TABLES

| <u>Table</u> |  | <u>Page</u> |
|--------------|--|-------------|
| 1.2-1        | Field Work Summary .....   | 1-4         |
| 1.4-1        | Summary of Estimated Precision, Accuracy and Detection Limit Objectives .....  | 1-10        |
| 1.4-2        | QC Acceptance Criteria for Method 8240 .....                                   | 1-12        |
| 1.4-3        | QC Acceptance Criteria for Methods 625 and 8270 .....                          | 1-13        |
| 1.8-1        | Number of Water Analyses by Site .....   | 1-29        |
| 1.8-2        | Analytical Methods, Detection Limits, and Total Number of Water Analyses ..... | 1-30        |
| 1.8-3        | Number of Soil Analyses by Site .....  | 1-31        |
| 1.8-4        | Analytical Methods, Detection Limits, and Total Number of Soil Analyses .....  | 1-32        |
| 1.10-1       | Summary of Internal Quality Control Procedures .....                           | 1-52        |
| 1.13-1       | Measures of Precision .....  | 1-90        |
| 2-1          | Solid/Analytical Summary .....   | 2-8         |
| 2-2          | Water Sample/Analytical Summary .....  | 2-12        |

04/14/2014

1.0 QUALITY ASSURANCE/QUALITY CONTROL

The Quality Assurance (QA) and Quality Control (QC) protocols to be used to accomplish the IRP Phase II (Stage 2) study at Carswell Air Force Base (AFB) Texas are described in Section 1.

1.1 Introduction

This document presents the Quality Assurance Project Plan (QAPP) for work to be performed during IRP Phase II (Stage 2) at Carswell (AFB) under Contract F33615-87-D-4023, Delivery Order No. 04. The purpose of the Stage 2 IRP field activities at Carswell AFB is to complete field investigations begun in the IRP Phase II (Stage 1) project, as directed by the Statement of Work dated 25 September 1987. Field activities at Carswell AFB will include shallow and deep monitor well installation, sampling newly constructed and existing wells, soil borings and sampling, sediment sampling and surface water sampling.

This QAPP provides instructions, specifications, and procedures for the performance of these activities by Radian employees and their subcontractors. Changes or modifications to this plan will require the approval of the Radian Project Director.

## 1.2 Project Description

The Carswell AFB IRP Phase II Stage 2 Project involves the concise delineation of contamination at the known sites by a variety of hydrogeologic, geophysical, and geochemical means. The project will involve the installation of new upper zone and Paluxy Aquifer (optional) groundwater monitoring wells, sampling of these wells and of the previously installed monitoring wells, and a variety of soil and soil vapor sampling programs designed to establish the extent of contamination at the eleven known sites at Carswell AFB.

Upper zone groundwater contamination was originally discovered in the Phase II Stage 1 study, and the purpose now will be to define the extent of contamination at the various sites. This effort will consist of investigation of both groundwater levels and groundwater quality at the existing wells and new wells which will be installed during this stage of the project. Hydraulic conductivity of the materials comprising the upper zone aquifer will be measured as a means of estimating the probable migration of contaminated fluids within the upper zone.

In addition to the contamination of the upper zone aquifer, contamination of the underlying Paluxy Aquifer is also a concern. If necessary, one additional well will be installed near the western margin of Carswell AFB to evaluate possible contamination found in the Paluxy Aquifer west of Carswell AFB. Continued sampling of the two existing Paluxy Aquifer wells at Carswell AFB will be a part of this effort.

Soil sampling will be undertaken at sites known to have sustained leaks or spills of hazardous substances. These programs will assess the extent and nature of contamination in soils at the sites, and provide information critical to later remediation efforts. A soil vapor study will also be conducted at the Base Service Station and a Fire Training Area. In addition to the soil sampling, stream sampling will be conducted on identified

surface drainages to determine the nature and extent of contamination along their length.

The following listing of sites contains a description of the planned major activities on a site by site basis; a detailed breakdown of activities by site is provided in Table 1.2-1.

- Site 1: Landfill 1

- Perform magnetometer survey to define/investigate anomalies noted during Stage 1.
- Install two new upper zone wells at locations to be determined in the field.
- Sample groundwater from the two newly installed upper zone monitor wells and the four existing upper zone monitor wells.
- Perform slug tests to determine hydraulic conductivity of upper zone materials.

- Site 3: Landfill 3

- Install three upper zone monitor wells southeast, northwest, and northeast of site boundaries.
- Install two upper zone monitor wells west of landfill near flight line drainageway.
- Install one Paluxy Aquifer monitor well, west of the landfill (optional).

TABLE 1.2-1. FIELD WORK SUMMARY (a)

| SITES (b)                      | 1  | 3   | 4   | 5   | 10 | 11 | 12  | 13 | 15 | 16 | 17  | NSA | BSS BOUND | TOTAL |
|--------------------------------|----|-----|-----|-----|----|----|-----|----|----|----|-----|-----|-----------|-------|
| BORHOLES                       | 2  | 6   | 3   | 5   | 3  | 0  | 7   | 0  | 0  | 0  | 5   | 0   | 4         | 35    |
| BORHOLES DEPTH                 | 60 | 483 | 105 | 173 | 69 | 0  | 104 | 0  | 0  | 0  | 173 | 0   | 130       | 1385  |
| US WELLS (from borholes above) | 2  | 5   | 3   | 5   | 0  | 0  | 2   | 0  | 0  | 0  | 5   | 0   | 4         | 26    |
| DEPTH US WELLS                 | 60 | 173 | 105 | 173 | 0  | 0  | 69  | 0  | 0  | 0  | 173 | 0   | 130       | 891   |
| PALURY WELLS                   | 0  | 1   | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0   | 0   | 0         | 1     |
| DEPTH PALURY WELLS             | 0  | 200 | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0   | 0   | 0         | 200   |
| BAND AUGERS                    | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 3  | 0  | 0   | 0   | 0         | 11    |
| DEPTH AUGERS                   | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 30 | 0  | 0   | 0   | 0         | 70    |
| SOIL SAMPS FROM AUGERS         | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 15 | 0  | 0   | 16  | 0         | 31    |
| SPLIT SPOON SAMPLES            | 6  | 15  | 9   | 15  | 10 | 0  | 20  | 0  | 0  | 0  | 15  | 0   | 12        | 110   |
| PLUM TESTS                     | 2  | 0   | 5   | 5   | 0  | 0  | 3   | 0  | 0  | 0  | 3   | 0   | 0         | 10    |
| SOIL GAS DATA                  | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 2   | 0   | 2         | 4     |
| SOIL-SED SAMP BOUNDS           | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 2  | 0  | 0  | 0   | 0   | 0         | 2     |
| SOIL-SED SAMPLE POINTS         | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 5  | 0  | 0  | 0   | 0   | 0         | 5     |
| SOIL-SED SAMPLES               | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 10 | 0  | 0  | 0   | 0   | 0         | 10    |
| PUMP WATER SAMP BOUNDS         | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 2  | 0   | 0   | 0         | 2     |
| PUMP WATER SAMP POINTS         | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 4  | 0   | 0   | 0         | 4     |
| PUMP WATER SAMPLES             | 0  | 0   | 0   | 0   | 0  | 0  | 0   | 0  | 0  | 0  | 0   | 0   | 0         | 0     |
| ON SAMPLING BOUNDS             | 2  | 2   | 2   | 2   | 0  | 2  | 2   | 0  | 0  | 0  | 2   | 0   | 2         | 2     |
| ON SAMP POINTS                 | 6  | 6   | 9   | 9   | 0  | 3  | 5   | 0  | 0  | 0  | 5   | 0   | 0         | 50    |
| TOT ON SAMPLES                 | 12 | 12  | 10  | 10  | 0  | 4  | 10  | 0  | 0  | 0  | 10  | 0   | 0         | 100   |

NOTES

a. The numbers in this table represent the maximum effort to be performed. Actual work performed may be less due to technical considerations.

b. Sites are as follows:

- Site 1 Landfill 1
- Site 3 Landfill 3
- Site 4 Landfill 4
- Site 5 Landfill 5
- Site 10 Waste Burial Area
- Site 11 Fire Department Training Area 1
- Site 12 Fire Department Training Area 2
- Site 13 Flightline Drainage Ditch
- Site 15 Detonology Dry Well
- Site 16 Unnamed Stream
- Site 17 POL Tank Farm
- NSA Weapons Storage Area (off Base)
- BSS Base Service Station

c. Some borholes are not to be completed as monitoring wells.

-- Collect groundwater (two rounds) from the six newly installed monitor wells.

● Site 4: Landfill 4

-- Install three upper zone monitor wells east and north of the landfill.

-- Perform slug tests to determine hydraulic conductivity of upper zone.

-- Sample groundwater (two rounds) from all upper zone and Paluxy Aquifer wells at the site.

● Site 5: Landfill 5

-- Install three upper zone monitor wells east of landfill and two upper zone monitor wells west of the landfill.

-- Perform slug tests on newly installed upper zone wells to determine hydraulic conductivity.

-- Sample groundwater (two rounds) from existing and newly installed wells.

● Site 10: Waste Burial Area

-- Conduct magnetic survey to prevent drilling into buried container drums.

-- Perform three soil borings and analyze soil samples.

- Site 11: Fire Department Training Area 1
  - Continued sampling (two rounds) and analysis of two existing wells.
  
- Site 12: Fire Department Training Area 2
  - Install two upper zone monitor wells, sample groundwater (two rounds) from the newly installed wells and three existing wells.
  
  - Drill and sample five soil borings in Fire Training Area to test subsurface conditions.
  
  - Perform slug tests on three upper zone monitor wells to determine hydraulic conductivity.
  
- Site 13: Flightline Drainage Ditch
  - Collect surface soil and/or sediment samples (two rounds) at five locations along the bottom of the ditch to verify cleanup.
  
- Site 15: Entomology Dry Well
  - Determine location of Entomology Dry well. Hand auger and sample three soil borings in probable vicinity of the dry well.
  
  - Measure water levels in existing upper zone monitor wells.
  
- Site 16: Unnamed Stream
  - Collect surface water samples (two rounds) at four locations near oil/water separator.

- Site 17: POL Tank Farm

- Conduct a soil vapor survey of the entire area near the tank farm.
- Install five upper zone groundwater monitor wells.
- Sample groundwater (two rounds) from the newly installed upper zone wells.
- Perform slug tests on three selected upper zone monitor wells to determine hydraulic conductivity.

- Site WSA: Weapons Storage Area (Off Base)

- Hand auger and sample eight shallow soil borings.

- Site BSS: Base Service Station

- Conduct a soil vapor survey.
- Install four upper zone monitor wells.
- Sample groundwater (two rounds) from the newly installed upper zone wells.

1.3 Project Organization and Responsibility

Phase II (Stage 2) activities of the Carswell AFB IRP field program will be organized as follows: Program Manager (F.J. Smith), Project Director (L.N. French), Supervising Geologist (G.J. Childs), and Drilling Subcontractor Supervisor (not determined). The Program Manager and Project Director have overall responsibility to ensure that all activities are performed in accordance with EPA, U.S. Air Force, all state, federal, and local requirements, and according to Radian Corporation policy. The Program Manager and Project Director are further charged with assuring that all applicable field personnel receive adequate Health and Safety training and that all health and safety procedures are followed. The Supervising Geologist will be responsible for the conduct of field activities including the supervision of drilling and surveying, collection of soil and water samples, and the proper handling and shipping of samples from the field to the laboratory.

#### 1.4 Quality Assurance Objectives

The objectives of the quality assurance efforts for this program are twofold. First, they will provide the mechanism for ongoing control and evaluation of measurement data quality throughout the course of the project. Second, audit results and quality control data will ultimately be used to define data quality for the various measurement parameters, in terms of precision and accuracy.

Data quality objectives for the various measurement parameters associated with site characterization efforts are presented in Tables 1.4-1 through 1.4-3. Precision values presented in the tables represent a measure of variability for replicate measurements of the same parameter, expressed in terms of the coefficient of variation (relative standard deviation). Accuracy values include components of both random error (i.e., variability due to imprecision) and systematic error (i.e., bias), and thus reflect the total error for a given measurement, expressed as a percentage of the true value. The basis for these estimates are, in most cases, described in the methods. Some of the accuracy estimates are, for instance, based on recovery studies using reagent water. Actual results for samples in a solid matrix (which is much more difficult from an analytical standpoint) would not be expected to be as accurate or precise.

Precision and accuracy objectives presented in Tables 1.4-1 through 1.4-3 are not intended to represent data validation criteria. Measurement data validation is discussed in Section 1.9. Rather, these values simply represent estimates of the magnitude of uncertainty which might be associated with the measurement data due to measurement error. The QA/QC efforts will focus upon controlling measurement error within these limits and will ultimately provide a database for estimating the actual uncertainty in the measurement data. It is anticipated that this uncertainty will generally fall within the limits shown in Tables 1.4-1 through 1.4-3. In terms of impact upon the program objectives, data quality objectives are not equally important

TABLE 1.4-1. SUMMARY OF ESTIMATED PRECISION, ACCURACY,  
AND DETECTION LIMIT OBJECTIVES

| Parameter                              | Precision <sup>a</sup><br>(RPD) | Accuracy <sup>b</sup><br>(Recovery)     | Detection Limit <sup>c</sup> |
|--|---------------------------------|---|------------------------------|
| Pesticides & PCBs<br>(Method 8080)     | 50%                             | 8% to 202% (See<br>Method) <sup>d</sup> | See Method 8080<br>Table 1   |
| Herbicides<br>(Method 8150)            | 50%                             | 2% to 26% <sup>d</sup>                  | See Method 8150<br>Table 1   |
| Phenols<br>(Method 8040)               | 50%                             | -88% to 145% <sup>d</sup>               | See Method 8040<br>Table 1   |
| Volatile Halocarbons<br>(Method 8010)  | 50%                             | -30% to 110% <sup>d</sup>               | See Method 8010<br>Table 1   |
| Volatile Aromatics<br>(Method 8020)    | 50%                             | -4% to 65% <sup>d</sup>                 | See Method 8020<br>Table 1   |
| Pesticides<br>(Method 8140)            | 50%                             | See Method 8140<br>Table 3              | See Method 8140<br>Table 1   |
| Volatile Halocarbons<br>(Method 8240)  | 50%                             | Refer to Table<br>1.4-2                 | See Method 8240<br>Table 2   |
| Semivolatile Organics<br>(Method 8270) | 50%                             | Refer to Table<br>1.4-3                 | See Method 8270<br>Table 2   |
| Metals (Method 6010)                   |                                 |   |                              |
| Antimony                               | 20%                             | 90-110%                                 | 0.060 mg/L                   |
| Barium                                 | 20%                             | 90-110%                                 | 0.009 mg/L                   |
| Beryllium                              | 20%                             | 90-110%                                 | 0.001 mg/L                   |
| Cadmium                                | 20%                             | 90-110%                                 | 0.003 mg/L                   |
| Chromium                               | 20%                             | 90-110%                                 | 0.009 mg/L                   |
| Cobalt                                 | 20%                             | 90-110%                                 | 0.010 mg/L                   |
| Copper                                 | 20%                             | 90-110%                                 | 0.010 mg/L                   |
| Molybdenum                             | 20%                             | 90-110%                                 | 0.050 mg/L                   |
| Nickel                                 | 20%                             | 90-110%                                 | 0.020 mg/L                   |
| Silver                                 | 20%                             | 90-110%                                 | 0.009 mg/L                   |
| Vanadium                               | 20%                             | 90-110%                                 | 0.020 mg/L                   |
| Zinc                                   | 20%                             | 90-110%                                 | 0.006 mg/L                   |
| Arsenic<br>(Method 7060)               | 20%                             | 85-115%                                 | 0.004 mg/L                   |
| Selenium<br>(Method 7740)              | 20%                             | 85-115%                                 | 0.002 mg/L                   |

(Continued)

TABLE 1.4-1. (Continued)

| Parameter                                | Precision <sup>a</sup><br>(RPD) | Accuracy <sup>b</sup><br>(Recovery) | Detection Limit <sup>c</sup> |
|--|---------------------------------|-------------------------------------|------------------------------|
| Mercury<br>(Method 7470)                 | 20%                             | 85-115%                             | 0.0002 mg/L                  |
| Lead<br>(Method 7421)                    | 20%                             | 85-115%                             | 0.003 mg/L                   |
| pH<br>(Method 9040)                      | ±0.1 pH<br>units                | ±0.05 pH<br>units                   | -----                        |
| Chloride<br>(Method 325.3)               | 15%                             | 85-115%                             | 1 mg/L                       |
| Sulfate<br>(Method 375.4)                | 15%                             | 90-110%                             | 1 mg/L                       |
| Fluoride<br>(Method 340.2)               | 10%                             | 90-110%                             | 0.1 mg/L                     |
| Oil & Grease (soil)<br>(Method 413.2)    | 10%                             | ±20%                                | See Method 413.2             |
| Petroleum Hydrocarbons<br>(Method 418.1) | Not Specified                   | Not Specified                       | See Method 418.1             |
| Alkalinity<br>(Method SM403)             | 10%                             | ±20%                                | See Method SM 403            |
| Total Dissolved Solids<br>(Method 160.1) | 20%                             | ±15%                                | See Method 160.1             |

<sup>a</sup>Precision - Relative Percent Difference (RPD) between duplicate matrix spike recoveries, or duplicate analyses.

<sup>b</sup>Accuracy - Expected range of recovery for QC check samples and, as specified by the method, for matrix spike recoveries.

<sup>c</sup>Detection Limit - Minimum detection limit in clean aqueous matrix. Practical quantitation limits are given in methods, or may be estimated based on sample size and final extract/digestate volume.

<sup>d</sup>Range of relative error for species of interest, based on EPA method validation testing. See method for further explanation.

TABLE 1.4-2. QC ACCEPTANCE CRITERIA FOR METHOD 8240

| Parameter                 | Accuracy<br>(Percent Recovery) | Precision<br>(RPD) (%) |
|---------------------------|--------------------------------|------------------------|
| Chloromethane             | D-273                          | 50                     |
| Bromomethane              | D-242                          | 50                     |
| Vinyl chloride            | D-251                          | 50                     |
| Chloroethane              | 14-230                         | 50                     |
| Methylene chloride        | D-221                          | 50                     |
| Trichlorofluoromethane    | 17-181                         | 50                     |
| 1,1-Dichloroethene        | D-234                          | 50                     |
| 1,1-Dichloroethane        | 59-155                         | 50                     |
| trans-1,2-Dichloroethene  | 54-156                         | 50                     |
| Chloroform                | 51-138                         | 50                     |
| 1,2-Dichloroethane        | 49-155                         | 50                     |
| 1,1,1-Trichloroethane     | 52-162                         | 50                     |
| Carbon Tetrachloride      | 70-140                         | 50                     |
| Bromodichloromethane      | 35-155                         | 50                     |
| 1,2-Dichloropropane       | D-210                          | 50                     |
| cis-1,3-Dichloropropene   | D-227                          | 50                     |
| Trichloroethene           | 71-157                         | 50                     |
| Dibromochloromethane      | 53-149                         | 50                     |
| 1,1,2-Trichloroethane     | 52-150                         | 50                     |
| Benzene                   | 37-151                         | 50                     |
| trans-1,3-Dichloropropene | 17-183                         | 50                     |
| 2-Chloroethylvinyl ether  | D-305                          | 50                     |
| Bromoform                 | 45-169                         | 50                     |
| Tetrachloroethene         | 64-148                         | 50                     |
| 1,1,2,2-Tetrachloroethane | 46-157                         | 50                     |
| Toluene                   | 47-163                         | 50                     |
| Chlorobenzene             | 37-160                         | 50                     |
| Ethyl benzene             | 37-162                         | 50                     |
| <b>Surrogates</b>         |                                |                        |
| <b>Water</b>              |                                |                        |
| 4-Bromofluorobenzene      | 86-115                         | NA                     |
| Toluene-d <sub>8</sub>    | 88-110                         | NA                     |
| 1,2-Dichloroethane        | 76-114                         | NA                     |
| <b>Soil</b>               |                                |                        |
| 4-Bromofluorobenzene      | 74-121                         | NA                     |
| Toluene-d <sub>8</sub>    | 81-117                         | NA                     |
| 1,2-Dichloroethane        | 70-121                         | NA                     |

D - Detected.

NA - Not Applicable.

TABLE 1.4-3. QC ACCEPTANCE CRITERIA FOR METHODS 625 AND 8270

| Parameter                   | Accuracy<br>(Percent Recovery) | Precision<br>(RPD) (%) |
|-----------------------------|--------------------------------|------------------------|
| N-Nitrosodimethylamine      | NA                             | 50                     |
| Phenol                      | 5-112                          | 50                     |
| Bis(2-Chloroethyl)ether     | 12-158                         | 50                     |
| 2-Chlorophenol              | 23-134                         | 50                     |
| 1,3-Dichlorobenzene         | D-172                          | 50                     |
| 1,4-Dichlorobenzene         | 20-124                         | 50                     |
| 1,2-Dichlorobenzene         | 32-129                         | 50                     |
| Bis(2-Chloroisopropyl)ether | 36-166                         | 50                     |
| N-Nitroso-di-n-propylamine  | D-230                          | 50                     |
| Hexachloroethane            | 40-113                         | 50                     |
| Nitrobenzene                | 35-180                         | 50                     |
| Isophorene II               | 21-196                         | 50                     |
| 2-Nitrophenol               | 29-182                         | 50                     |
| 2,4-Dimethylphenol          | 42-109                         | 50                     |
| Bis(2-Chloroethoxy)methane  | 33-184                         | 50                     |
| 2,4-Dichlorophenol          | 39-135                         | 50                     |
| 1,2,4-Trichlorobenzene      | 44-142                         | 50                     |
| Naphthalene                 | 21-133                         | 50                     |
| Hexachlorobutadiene         | 24-116                         | 50                     |
| 4-Chloro-3-methylphenol     | 22-147                         | 50                     |
| Hexachlorocyclopentadiene   | NA                             | 50                     |
| 2,4,6-Trichlorophenol       | 37-144                         | 50                     |
| 2-Chloronaphthalene         | 60-118                         | 50                     |
| Dimethyl Phthalate          | D-112                          | 50                     |
| Acenaphthylene              | 33-145                         | 50                     |
| Acenaphthene                | 47-145                         | 50                     |
| 2,4-Dinitrotoluene          | D-191                          | 50                     |
| 4-Nitrophenol               | D-132                          | 50                     |
| 2,6-Dinitrotoluene          | 50-158                         | 50                     |
| 2,4-Dinitrotoluene          | 39-139                         | 50                     |
| Diethylphthalate            | D-114                          | 50                     |
| 4-Chlorophenyl-phenylether  | 25-158                         | 50                     |
| Fluorene                    | 59-121                         | 50                     |
| 4,6-Dinitro-2-methylphenol  | D-181                          | 50                     |
| N-Nitrosodiphenylamine      | NA                             | 50                     |
| 4-Bromophenyl-phenylether   | 65-114                         | 50                     |
| Hexachlorobenzene           | NA                             | 50                     |
| Pentachlorophenol           | 14-176                         | 50                     |
| Phenanthrene                | 54-120                         | 50                     |
| Anthracene                  | 27-133                         | 50                     |
| Di-n-butylphthalate         | 1-118                          | 50                     |
| Fluoranthene                | 26-137                         | 50                     |
| Benzidine                   | NA                             | 50                     |

(Continued)

TABLE 1.4-3. QC ACCEPTANCE CRITERIA FOR METHODS 625 AND 8270 (cont.)

| Parameter                   | Accuracy<br>(Percent Recovery) | Precision<br>(RPD) (%) |
|-----------------------------|--------------------------------|------------------------|
| Pyrene                      | 52-115                         | 50                     |
| Butylbenzylphthalate        | D-152                          | 50                     |
| 3,3-Dichlorobenzidine       | 8-213                          | 50                     |
| Benzo(a)anthracene          | 33-143                         | 50                     |
| Bis(2-ethyl hexyl)phthalate | 29-137                         | 50                     |
| Chrysene                    | 17-168                         | 50                     |
| Di-n-octyl phthalate        | 4-146                          | 50                     |
| Benzo(b)fluoranthene        | 24-159                         | 50                     |
| Benzo(k)fluoranthene        | 11-162                         | 50                     |
| Benzo(a)pyrene              | 17-163                         | 50                     |
| Indeno(1,2,3-CD)pyrene      | D-171                          | 50                     |
| Dibenz(a,h)anthracene       | D-227                          | 50                     |
| Benzo(g,h,i)perylene        | D-219                          | 50                     |
| <b>Surrogates</b>           |                                |                        |
| <b>Water</b>                |                                |                        |
| Nitrobenzene-d <sub>6</sub> | 35-114                         | NA                     |
| 2-Fluorobiphenyl            | 43-116                         | NA                     |
| p-Terphenyl-d <sub>14</sub> | 33-141                         | NA                     |
| Phenol-d <sub>5</sub>       | 10-94                          | NA                     |
| 2-Fluorophenol              | 21-100                         | NA                     |
| 2,4,5-Tribromophenol        | 10-123                         | NA                     |
| <b>Soil</b>                 |                                |                        |
| Nitrobenzene-d <sub>5</sub> | 23-120                         | NA                     |
| 2-Fluorobiphenyl            | 30-115                         | NA                     |
| p-Terphenyl-d <sub>14</sub> | 18-137                         | NA                     |
| Phenol-d <sub>5</sub>       | 24-113                         | NA                     |
| 2-Fluorophenol              | 25-121                         | NA                     |
| 2,4,5-Tribromophenol        | 19-122                         | NA                     |

D - Detected.

NA - Not Applicable.

for all measurement parameters, or even for the same measurement parameter used for different purposes.

Measurement data representativeness is a function of sampling strategy and will be achieved using the procedures discussed in Section 2. Data comparability will be achieved using standard units of measure as specified in the methods described in Section 1.8. The objective for data capture for all measurement parameters will be 90%, where completeness is defined as the valid data percentage of the total number of tests conducted.

## 1.5 Sampling Procedures

The following section briefly describes the sampling procedures outlined in Section 2. Refer to Section 2 for detailed description.

### 1.5.1 Geophysical Techniques

Surface geophysics will be used to help define disposal activities and locate buried objects. The method is magnetic gradient surveying.

### 1.5.2 Drilling

Drilling will be accomplished by using a hollow-stem auger for shallow soil borings and the installation of upper zone monitors. Air rotary drilling will be used to install the Paluxy well if necessary.

### 1.5.3 Well Installation

Groundwater monitoring wells will be installed in the lower aquifer using either a hollow-stem auger rig or a rotary rig. The type of drilling will be dependent on the type of formation and the depth of the boring. Monitor wells will be installed according to specifications in Section 3 of the RCRA Groundwater Technical Enforcement Guidance Document.

### 1.5.4 Water Sampling

Water samples will include groundwater and surface water. Groundwater samples will be collected from monitor wells by using a submersible electric pump or a Teflon bailer. Groundwater sampling will follow the techniques in Section 3 of the RCRA Groundwater Technical Enforcement Guidance Document.

#### 1.5.5 Soil and Sediment Sampling

- Hand auger sampling will be used to collect soil samples to a maximum depth of 10 feet below land surface (BLS). Samples will be collected in one-foot intervals at selected depths until total depth is reached.
- Split-spoon samples will be collected using a split-barrel sampler and a hollow-stem auger drill rig. Samples will be collected at 5-foot intervals for lithologic characterization. Samples collected for chemical analysis will be selected based on visual observation. Split-spoon sampling will follow the American Society for Testing Materials (ASTM) standard method for penetration test and split-barrel sampling of soil.
- Soils will be classified using the Unified Soil Classification System prepared by the U.S. Army Engineer Waterways Experiment Station Corps of Engineers.

#### 1.5.6 Air Monitoring and Soil Gas Sampling

Gas phase sampling will include air monitoring during drilling and soil gas surveys.

- Air sampling during drilling will be conducted using an organic vapor analyzer to detect the generation of potentially hazardous and/or toxic vapors or gases.
- Soil gas samples will be collected by pumping a small amount of soil gas from the ground through a hollow probe driven a few feet into the ground and analyzing the gas for volatile contaminants.

## 1.6 Sample Custody

Sample custody procedures for this program are based on EPA-recommended procedures which emphasize careful documentation of sample collection and transfer data. The Supervising Geologist will be responsible for field team adherence to proper custody and documentation procedures for all sampling operations. To ensure that all of the important information pertaining to each sample is recorded, the following documentation procedures will be executed. Preformatted field data and sample custody forms will be used to document the relevant information for each sample taken. A master sample logbook will be maintained on site for all samples collected. Field data and sample custody information will supplementally be backed up on a computerized data base system, to facilitate retrieval and sample tracking. Specific procedures which will be used are discussed below.

### 1.6.1 Chain of Custody

Sample chain of custody involves documenting the handling of a sample from the time of acquisition to the time of disposition. This section describes the procedures which will be used to accomplish chain of custody control.

#### Sample Tags

Each sample taken will immediately receive a sample label (Figure 1.6-1). Sample labels serve to identify the sample by documenting the sample type, who took it, where it was taken, when it was taken, and the preservation method used. These labels are completed with a ballpoint ink pen and affixed to the sample container.

OFFICIAL USE ONLY

**RADIAN** Radioactive Analytical Division Field Number \_\_\_\_\_

8801 Mc-Pee Blvd., P. O. Box 680840, Houston, Texas 77268-0477

Sample Type: \_\_\_\_\_

Client: \_\_\_\_\_

Location: \_\_\_\_\_

Preservative: \_\_\_\_\_

Sampler: \_\_\_\_\_

Date: \_\_\_\_\_

Comment: \_\_\_\_\_

Figure 1.6-1. Radian Sample Label

### Chain of Custody Record

Sample custody will be documented using the form shown in Figure 1.6-2. After the water, soil, or vapor sample information is entered in the master logbook (Section 1.6.2), a chain of custody form will be completed and will accompany the samples throughout all analytical work to final disposition. On each container of samples sent off site for analysis, a tampering indication seal (Figure 1.6-3) will be affixed. This seal should remain intact until the container is opened at the appropriate laboratory.

### Transfer of Custody and Shipment

The chain of custody forms are printed on four-part NCR (no carbon required) paper and distributed in the following manner:

- Original (white) - Sent to the laboratory with samples and completed and signed off when the sample is disposed of. The original copy is then returned to the Project file.
- Second Copy (yellow) - Sent to the laboratory with samples. This copy is retained by the laboratory when analyses are completed and the sample is disposed of.
- Third Copy (pink) - Retained by the Supervising Geologist when the sample is shipped to the laboratory for analysis.
- Fourth Copy (amber) - Retained by the Supervising Geologist to be placed in the Project file to document the existence of the sample.



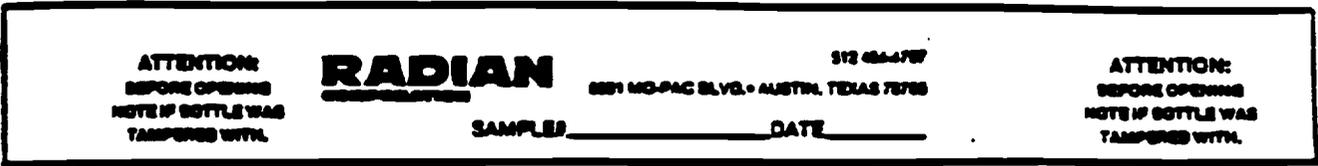


Figure 1.6-3. Radian Custody Seal

## Laboratory Custody Procedures

Each laboratory conducting analyses for this program will be required to use the described chain of custody forms to document the handling of each sample. Exception will be made only if the laboratory has an internal sample tracking system that satisfactorily documents continuous chain of custody.

When analytical results are returned by the analytical laboratories, the Supervising Geologist or designee will date stamp the analytical results and annotate the sample master log to indicate receipt of sample results. The information recorded in the master log will be checked to ensure that complete analytical results have been reported. The laboratory will be notified if errors such as incorrect sample control numbers, incomplete lab analysis, or other incorrect or incomplete information are found. An amended report will then be requested.

### 1.6.2 Documentation

#### Sample Identification

All samples brought in from the field immediately receive a "sample control number." This number will be unique to each individual sample and a label bearing the sample control number will be affixed to each container. The number will remain with the sample throughout the analysis and data entry procedures. Boring logs and other "real time" data sheets should also receive a sample control number. Typically, the number sequence used for sample control numbers will include the month and year the sample was collected.

#### Logs

Sample Control Logs--A Master Sample Log will be maintained for all samples taken. Each sample will be assigned a unique identification number

(sample control number); and a full description of the sample, its origin, and its disposition will be included in the master log entry.

Laboratory Logs—Analytical data will be recorded in bound, paginated laboratory notebooks. All notebook entries will be dated and initialed by the author. In addition to the analytical results, any reagent and standard preparation will be documented in a separate section of the appropriate analytical notebook. Typical information will include documentation of dates for preparation of stock solutions, manufacturers' lot numbers, preparation procedures, etc. Other media for recording analytical data will be acceptable if they can be considered to be legally defensible.

Copies of raw data, laboratory notes, chromatograms, stripchart recordings, and standard curves will be maintained in a central file for future inspection. Copies of instrument logs and maintenance records will also be available for review.

#### Corrections to Documentation

Corrections made to chain of custody and related documents (labels, logs, records, etc.) should be made by drawing a single line through the incorrect section and initialing the action. Any affected persons should be immediately notified.

#### 1.6.3 Sample Packaging and Shipping

The Supervising Geologist is responsible for properly packaging and shipping the samples to the laboratory. All pertinent Department of Transportation (DOT) shipping regulations will be followed. Packaging and shipping requirements will be discussed in this section for each type of sample. The entering of shipping data into the sample master log and procedures for contacting laboratories about incoming shipments will also be discussed.

## Water Samples

Packaging--Water sample containers are taped and sealed around the cap with electrical tape. If the container is glass, a protective poly-net is placed over the container to protect it from breakage. The samples are placed in an ice chest and enough blue ice is placed in the ice chest to maintain the proper storage temperature. The ice chest is then packed with vermiculite to prevent breakage. The original and yellow copies of the chain of custody form are enclosed in a waterproof envelope and placed in the shipping container. The shipping container is closed and a tampering indicator seal is affixed on the container to prevent the container from opening during shipment.

Shipping--A Federal Express airbill form is completed and addressed to the proper laboratory. Airbill charge numbers will vary according to the location where the sample was taken and the type of sample. The pink copy will be retained and filed. The completed airbill is enclosed in a waterproof envelope and affixed on the shipping container. The sealed shipping container is taken to Federal Express for delivery, generally overnight.

The shipping data will be entered into the sample master log, and the contracting laboratory will be informed of the incoming shipment (number of samples and airbill number).

Packaging--Soil samples are packaged in the same manner as described for water samples.

Shipping--Soil samples are shipped in the same manner as described for water samples.

## 1.7 Calibration Procedures

Documented calibration procedures are required to provide consistency in preparing equipment for performing specific analytical measurements. Established calibration procedures then provide a mechanism for making measurements taken with a specific type of equipment comparable. Information is presented in this section which pertains to the calibration of the analytical systems. See Tables 1.10-1 and 1.10-2 for quality control checks for individual analytical methods.

### Inductively-Coupled Plasma Emission Spectrophotometer Calibration

For metals analyses by inductively-coupled plasma emission spectrophotometer, the method requires generating a single-point calibration curve. A quality control check sample and a system blank should be run after calibration and after every 10 samples to verify instrument calibration.

### Atomic Absorption Spectrophotometer Calibration

For atomic absorption analyses, a multi-point calibration curve with a correlation coefficient of greater than 0.995 must be generated. In addition to this, a quality control check sample and a system blank must be analyzed after calibration and every 10 samples.

### Gas Chromatograph Calibration

For GC analyses, calibration curves are generated based on multi-point instrument responses for each target analyte. The correlation coefficient must be greater than 0.995. Daily, prior to analysis, a standard solution containing the target analytes is injected. The response for each analyte must agree within  $\pm 15\%$  of the multi-point response.

### Gas Chromatography/Mass Spectrophotometer Calibration

For method 8270/625, a multi-point concentration curve is generated with a correlation coefficient greater than 0.95. Decafluorotriphenylphosphine (DFTPP) is added to the internal standard to permit mass spectrophotometer tuning daily. A daily single-point check must agree within 30% of the value predicted from the multi-point curve.

Before analysis by method 8240, the GC/MS is tuned with bromofluorbenzene (BFB) to give an acceptable mass spectrum, as defined by EPA. After meeting the tuning criteria, a five-point calibration curve will be generated according to method protocol. Response factors for the volatile compounds obtained from the five-point average will be used for quantitation. Response factors will be calculated by tabulating the area response of the primary characteristic ions against the concentration for each compound, including the internal standards.

## 1.8 Analytical Procedures

Several types of samples will be collected during the Carswell AFB site investigation including soil, sediments, groundwater, surface water and soil gas samples. The majority of the sample analyses will be performed according to EPA methods detailed in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," henceforth referred to as SW-846. These methods and numbers of analyses (specified in the Scope of Work) to be performed are listed in Tables 1.8-1 through 1.8-4. By utilizing various extraction and or digestion procedures, most test methods are applicable to both solid and liquid sample types. Copies of the standard methods are available at Radian. Brief descriptions of the methods are presented in this section.

If methods other than those specified in this QAPP are to be used, the following procedure must be completed before making the change. A copy of the proposed method, including a table detailing the differences in the methods, the expected precision and accuracy, and an explanation for the change, must be submitted to the Radian QA Coordinator. The QA Coordinator will review the request for change and will respond in writing as to whether the method may be substituted or not.

### 1.8.1 Metals Analyses

Two techniques, inductively coupled plasma atomic emission spectroscopy (ICP) and atomic absorption (AA), will be employed to measure levels of specified metals in samples. Both methods are applicable to all sample matrices including groundwater, aqueous samples, EP extracts, industrial wastes, soils, sludges, and sediments. Sample digestion is required prior to all ICP analysis, and most AA analysis.

A description of the digestion and analytical methods to be used in the Carswell AFB Phase II Stage 2 work follows.



TABLE 1.8-2. ANALYTICAL METHODS, DETECTION LIMITS, AND TOTAL NUMBER OF WATER ANALYSIS

| PARAMETER  | ANALYTICAL METHOD (a) | DETECTION LIMIT (b) | REPORTING UNITS (c) | NUMBER OF ANALYSES | TRIP BLANKS | AVG COND BLANKS | EQUIP BLANKS | DUP/REP | SECOND COLUMN | TOTAL ANALYSES |
|--|-----------------------|---------------------|---------------------|--------------------|-------------|-----------------|--------------|---------|---------------|----------------|
| Alkalinity - Carbonate, Bicarbonate, & Hydroxide (Field Test)        | A403                  | 10                  | mg/L                | 100                | -           | -               | 10           | 10      | -             | 120            |
| Common Anions (Chloride, Fluoride, Nitrate, Sulfate, Orthophosphate) | A429                  | 0.5                 | mg/L                | 92                 | -           | -               | 10           | 10      | -             | 112            |
| Chlorinated Phenony Acid Herbicides                                  | A5090                 | 0.01                | ug/L                | 12                 | -           | -               | 2            | 2       | 0             | 24             |
| Specific Conductance (Field Test)                                    | E120.1                | -                   | uohms/cm            | 100                | -           | -               | -            | -       | -             | 100            |
| pH (Field Test)  | E150.1                | -                   | pH Units            | 100                | -           | -               | -            | -       | -             | 100            |
| Total Dissolved Solids   | E160.1                | 10                  | mg/L                | 100                | -           | -               | -            | 10      | -             | 110            |
| Temperature (Field Test)   | E170.1                | -                   | deg C               | 100                | -           | -               | -            | -       | -             | 100            |
| Metal Screen (25 metals)   | E200.7                | 0.2-90              | mg/L                | 100                | -           | -               | 10           | 10      | -             | 120            |
| Arsenic  | E206.2                | 0.005               | mg/L                | 100                | -           | -               | 10           | 10      | -             | 120            |
| Lead   | E239.2                | 0.005               | mg/L                | 50                 | -           | -               | 5            | 5       | -             | 60             |
| Mercury  | E245.1                | 0.001               | mg/L                | 100                | -           | -               | 10           | 10      | -             | 120            |
| Selenium   | E270.2                | 0.005               | mg/L                | 90                 | -           | -               | 9            | 9       | -             | 100            |
| Oil and Grease   | E413.2                | 0.2                 | mg/L                | 32                 | -           | -               | 4            | 4       | -             | 40             |
| Petroleum Hydrocarbons   | E418.1                | 1                   | mg/L                | 32                 | -           | -               | 4            | 4       | -             | 40             |
| Purgeable Halocarbons  | E601                  | 0.02-5.10           | ug/L                | 100                | 10          | 10              | 10           | 10      | 70            | 210            |
| Phenols  | E606                  | 0.5-80              | ug/L                | 12                 | -           | -               | 2            | 2       | 0             | 24             |
| Organochlorine Pesticides  | E608                  | 0.05-1.0            | ug/L                | 12                 | -           | -               | 2            | 2       | 0             | 24             |
| Extractable Priority Pollutants                                      | E625                  | 1.0-50              | ug/L                | 60                 | -           | -               | 2            | 2       | -             | 10             |
| Purgeable Aromatics  | SM5030/<br>SM8020     | 0.2-0.4             | ug/L                | 100                | 10          | 10              | 10           | 10      | 70            | 210            |

0-314-1-1-1

TABLE 1.8-3. NUMBER OF SOIL ANALYSES BY SITE

| PARAMETER<br>(Soil Samples)         | ANALYTICAL METHOD |    |   |    |    |    |   |   |   |    |    |    |    |    |    |    |    | Total |                       |             |
|-------------------------------------|-------------------|----|---|----|----|----|---|---|---|----|----|----|----|----|----|----|----|-------|-----------------------|-------------|
|                                     | 1                 | 2  | 3 | 4  | 5  | 6  | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |       | BSS MSA Cuttingground | Drill Back- |
| Oil and Grease                      | 6                 | 15 | 9 | 15 | 10 | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 63          |
| Petroleum Hydrocarbons              | -                 | -  | - | -  | -  | 10 | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 83          |
| Metal Screen (23 metals)            | 6                 | 15 | 9 | 15 | 10 | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 117         |
| Arsenic                             | 6                 | 15 | 9 | 15 | 10 | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 63          |
| Lead                                | -                 | -  | - | -  | -  | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 27          |
| Mercury                             | 6                 | 15 | 9 | 15 | 10 | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 73          |
| Selenium                            | 6                 | 15 | 9 | 15 | 10 | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 63          |
| Organochlorine Pesticides and PCB's | -                 | -  | - | -  | -  | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 33          |
| Volatile Organic Compounds          | 6                 | 15 | 9 | 15 | 10 | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 194         |
| Semi-volatile Organic Compounds     | 6                 | 15 | 9 | 15 | 10 | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 167         |
| Chlorinated Phenol Herbicides       | -                 | -  | - | -  | -  | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 33          |
| Organophosphorous Pesticides        | -                 | -  | - | -  | -  | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 11          |
| Extraction Procedure Toxicity       | -                 | -  | - | -  | -  | -  | - | - | - | -  | -  | -  | -  | -  | -  | -  | -  | -     | -                     | 11          |

TABLE 1.8-4. ANALYTICAL METHODS, DETECTION LIMITS, AND TOTAL NUMBER OF SOIL ANALYSES

| PARAMETER                              | ANALYTICAL METHOD | DETECTION LIMIT | REPORTING UNITS | NUMBER OF ANALYSES | TRIP BLANKS | AMB COND BLANKS | EQUIP BLANKS | DUP/REP | SECOND COLUMN | TOTAL ANALYSES |
|--|-------------------|-----------------|-----------------|--------------------|-------------|-----------------|--------------|---------|---------------|----------------|
| Oil and Grease                         | SW3550/<br>E413.2 | 10              | mg/kg           | 63                 | -           | -               | -            | 7       | -             | 70             |
| Petroleum Hydrocarbons                 | SW3550/<br>E410.1 | 50              | mg/kg           | 63                 | -           | -               | -            | 9       | -             | 92             |
| Metal Screen (23 metals)               | SW3050/<br>SM6010 | 0.2-90          | mg/kg           | 117                | -           | -               | -            | 12      | -             | 129            |
| Arsenic                                | SW3050/<br>SW7060 | 0.5             | mg/kg           | 63                 | -           | -               | -            | 7       | -             | 70             |
| Lead                                   | SW3050/<br>SW7020 | 0.5             | mg/kg           | 27                 | -           | -               | -            | 3       | -             | 30             |
| Mercury                                | SW7071            | 0.5             | mg/kg           | 73                 | -           | -               | -            | 7       | -             | 80             |
| Selenium                               | SW3050/<br>SW7060 | 1               | mg/kg           | 63                 | -           | -               | -            | 7       | -             | 70             |
| Organochlorine Pesticides<br>and PCB's | SW3550/<br>SW8000 | 0.01-0.2        | mg/kg           | 33                 | -           | -               | -            | 4       | 19            | 56             |
| Volatile Organic Compounds             | SW5030/<br>SW2400 | 0.1             | mg/kg           | 204                | 21          | -               | -            | 21      | -             | 246            |
| Semivolatile Organic<br>Compounds      | SW3550/<br>SW2700 | 1.0             | mg/kg           | 177                | -           | -               | -            | 18      | -             | 195            |
| Chlorinated Phenoxly Herbicides        | SW8150            | 0.1-160         | mg/kg           | 33                 | -           | -               | -            | 4       | 19            | 56             |
| Organophosphorus Pesticides            | SW8100            |                 | mg/kg           | 15                 | -           | -               | -            | 2       | 9             | 26             |
| Extraction Procedure Toxicity          | 40 CFR<br>261.24  | 0.002-0.5       | mg/L            | 50                 | -           | -               | -            | 5       | -             | 55             |
| Soil Moisture Content                  | ASTM D2216        | -               | per cent (%)    | 169                | -           | -               | -            | 15      | -             | 164            |

### EPA Method 3050 Acid Digestion

This digestion method is used to prepare sediments, sludges, and soil samples for analysis by AA or ICP. A portion (1 to 2g) of the sample is digested in nitric acid and hydrogen peroxide. A final reflux procedure is performed using either dilute hydrochloric or dilute nitric acid depending upon the metals to be analyzed for and the procedure used for the analysis.

### EPA Method 6010/200.7 - ICP Procedures

Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP) determines elements in solution. All matrices, including groundwater, surface water, aqueous samples, EP extracts, industrial wastes, soils, sludges, and sediments require digestion prior to analysis.

Elements for which Method 6010 is applicable are listed in Table 1.4-1. The method describes a simultaneous or sequential multi-elemental determination by ICP. Element-emitted light is measured by optical spectrometry. Samples are nebulized and the resulting aerosol is transported to the plasma torch. Element-specific atomic line emission spectra are produced by radio-frequency inductively coupled plasma. The spectra are dispersed and the lines monitored by photomultiplier tubes. Background must be measured and corrected for. Additional interferences are also possible and must be accounted for.

### EPA Method 7000 - Atomic Absorption

Metals in solution may be rapidly determined by Atomic Absorption Spectroscopy (AA). Most samples, with the exception of particulate free

drinking water, require digestion prior to analysis. Two methods of AA spectroscopy are commonly used: direct aspiration and a furnace procedure. Table 1.8-2 and 1.8-4 lists method detection limits for each procedure. A graphite furnace (GFAA) technique will be used to analyze samples from Carswell AFB. AA techniques for specific elements to be analyzed in this study are arsenic (EPA 7060), lead (EPA 7420), mercury (EPA 7471) and selenium (EPA 7740).

When using GFAA, a sample aliquot is placed in a graphite tube in the furnace, evaporated, charred, and atomized. Radiation from a given excited element is passed through the vapor containing ground-state atoms of that element. The intensity of the radiation decreases in proportion to the amount of ground-state atoms present. A monochromator isolates the characteristic radiation from the hollow cathode tube or electrodeless discharge lamp, and a photosensitive device measures the attenuated transmitted radiation.

AA methods are susceptible to some chemical interference and matrix effects. These interferences and effects must be accounted for. Several treatments are described in the EPA Methods.

### 1.8.2 Organic Analyses

In this section, several "general organic" analyses will be presented, followed by a series of extraction procedures typically used prior to more specific GC and GC/MS analyses. The extraction procedures are then followed by brief summaries of the analyses for the specific classes of organics.

#### EPA Method 413.2 - Oil and Grease (Infrared)

This method includes the measurement of fluorocarbon-113 extractable matter from surface water and industrial and domestic wastes. It is applicable to the determination of hydrocarbons, vegetable oils, animal fats, waxes, soaps, greases and related matter. It will measure light petroleum fuels.

and is generally a more accurate estimation of the oil and grease parameter than the gravimetric method. The sample is acidified to a low pH and extracted with fluorocarbon-113. The oil and grease is determined by comparison of the infrared absorbance of the sample extract with standards.

#### EPA Method 418.1 - Petroleum Hydrocarbons (Infrared)

Oil and grease is a measure of biodegradable animal greases and vegetable oils whereas petroleum hydrocarbons are considered mineral oils. A sample of 1 liter volume is collected in a wide mouth glass bottle. The sample is acidified to <2 pH with  $H_2SO_4$  as a means of preventing microbial activity. Serial extraction with fluorocarbon-113 is accomplished in a separatory funnel, with interferences removed in silica gel adsorbant. Analysis is performed by infrared spectrophotometry.

#### 1.8.3 Extraction Procedures

##### EPA Method 1310 - Extraction Procedure (EP) Toxicity Test

This extraction procedure is employed to determine whether a waste exhibits characteristics of Extraction Procedure Toxicity (EP Toxicity) as specified in 40 CFR Part 261.24. It may also be used to simulate leaching in a sanitary landfill. If the sample contains >0.5% solids, the solid phase must be ground to pass a 9.5 mm sieve. This solid phase is extracted with deionized water in a specially designed mixer for 24 hours. The pH is maintained at 5 with acetic acid. The sample is then filtered and the filtrate analyzed for the specified metals and organics. Samples containing less than 0.5% solids are directly analyzed.

##### EPA Method 3550 - Sonication Extraction

EPA Method 3550 is a procedure for extracting nonvolatile and semivolatile organic compounds from solids such as soils and sludges. The

sonication process ensures intimate contact of the sample matrix with the extraction solvent.

A weighed sample of the solid material is ground, mixed with the extraction medium, then dispersed into the solvent using sonication. The extract may be dried with anhydrous sodium sulfate. The resulting solution may then be cleaned up further or analyzed directly using the appropriate technique. Freon is typically used as the solvent, although other solvents may be used for specific analytical applications.

#### EPA Method 5030 - Purge and Trap

EPA Method 5030 is used to determine the concentration of volatile organic compounds in a variety of liquid and solid matrices. It is based upon a purge-and-trap, gas chromatographic procedure.

The method is applicable to nearly all types of samples, regardless of water content, including aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, water, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments. The success of this method depends on the level of interferences in the sample; results may vary due to the large variability and complexity of matrices of solid waste samples.

A portion of the solid sample is dispersed in polyethylene glycol (PEG), tetraglyme, or distilled-in-glass methanol to dissolve the volatile organic constituents. A portion of the PEG, tetraglyme, or methanol solution is combined with water in a specially designed purging chamber. An inert gas is then bubbled through the solution at ambient temperature and the volatile components are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatile

components are trapped. After purging is completed, the sorbent column is heated and backflushed with inert gas to desorb the components onto a gas chromatographic column. (For EPA Method 8020, drying of the trap for 4 minutes under helium flow is required.) The gas chromatographic column is heated to elute the components which are detected by the appropriate detector.

#### 1.8.4 Organic Analyses by GC/MS

Several analytical techniques will be used for analysis of the sample extracts. Halogenated volatiles will be analyzed by GC with a halide-specific detector (GC/HSD). Ethylene dichloride, ethylene dibromide, and benzene will be analyzed by GC/MS. Semi-volatile extractables will also be analyzed by GC/MS. Analytical techniques for chlorinated hydrocarbons and volatile aromatics are GC methods, with an electron capture detector (ECD) used for chlorinated hydrocarbons, and a photoionization detector (PID) used for aromatic hydrocarbons. These methods are described below.

#### EPA Method 8240 - GC/MS for Volatile Organics

This method is based upon a purge-and-trap, gas chromatographic/mass spectrometric (GC/MS) procedure and may be used to determine volatile organic compounds in a variety of solid matrices. It is applicable to nearly all types of samples, regardless of water content, including water, aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousses, tars, fibrous waste, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments. The detection limit of EPA Method 8240 for an individual compound is approximately 1 ug/L (wet weight) in solid samples. For samples containing more than 1 mg/g of total volatile material, the detection limit is proportionately higher.

The volatile compounds are introduced to the gas chromatograph by the purge-and-trap method, using water as the solvent and dispersion medium. The components are separated via the gas chromatograph and detected using a

mass spectrometer which provides both qualitative and quantitative information. For some programs, a mass spectral library search will be used to tentatively identify a specified number (see current work plan) of major compounds which were not identified by direct comparison to a calibration standard. A compound will be considered major if its peak area is at least 25% of the peak area of the closest eluting internal standard.

Qualitative identification of sample components will be based upon the Extracted Ion Current Profile (EICP) for the primary characteristic ion and at least two other characteristic ions for each compound. A qualitative identification will require that the following criteria be met:

- The characteristic ions of each compound of interest must maximize in the same scan or within one scan of each other.
- The retention time must fall within +/-30 seconds of the retention time of the authentic compound.
- The relative peak heights of the characteristic ions in the internal standard EICPs must fall within -50% to 100% of the relative intensities of these ions in a reference mass spectrum.

When a compound has been identified, quantitation of that compound will be based on the integrated abundance from the EICP of the primary characteristic ion. In general, the primary characteristic ion selected should be a relatively intense ion, as interference-free as possible, and as close as possible in mass to the characteristic ion of the internal standard used. Generally, the base peak of the mass spectrum is used.

Internal standards will be employed during analysis of all samples and during all calibration procedures. The analyst will select one or more internal standards that are similar in analytical behavior to the compounds of

interest. The analyst will further demonstrate that the measurement of the internal standard is not affected by method or matrix interferences. Because of these limitations, no internal standard can be suggested that is applicable to all samples. However, for general use, bromochloromethane, 1,4-difluorobenzene, and  $d_5$ -chlorobenzene are used as internal standards covering a wide boiling point range.

4-Bromofluorobenzene (BFB) will be added to the surrogate standard solution to permit the mass spectrometer tuning for each GC/MS run to be checked. Surrogate standards will be added to samples and calibration solutions to assess the effect of the sample matrix on recovery efficiency. The compounds employed for this purpose will be  $d_8$ -toluene, p-bromofluorobenzene, and  $d_4$ -1,2-dichloroethane.

#### EPA Method 8270/625 - GC/MS for Semi-Volatile Organics

Semi-volatile extractable organics in solid samples will be determined using EPA Method 8270 as modified for CLP use (EPA Method 625 in water samples). This is a capillary column gas chromatographic/mass spectrometric (GC/MS) procedure. The method is applicable to nearly all types of samples, regardless of water content, as long as the samples can be volatilized without decomposition. EPA Method 8270 can be used to quantitate most neutral, acidic, and basic organic compounds that are soluble in methylene chloride and capable of being eluted without derivatization as sharp peaks from a gas chromatographic-fused silica capillary column coated with a slightly polar silicone. Such compounds include polynuclear aromatic hydrocarbons, chlorinated hydrocarbons and pesticides, phthalate esters, organophosphate esters, nitrosamines, haloethers, aldehydes, ethers, ketones, anilines, pyridines, quinolines, aromatic nitro compounds, and phenols, including nitrophenols. The detection limit of EPA Method 8270 for determining an individual compound is approximately 1 ug/g (wet weight). For samples that contain more than 1 mg/g of total solvent extractable material, the detection

limit is proportionately higher. Prior to using this method, solid samples must be prepared for chromatography using the appropriate sample preparation method -- i.e., sonication (EPA Method 3550), or Soxhlet extraction (EPA Method 3540). Qualitative identification and quantitative determination of the species of interest are performed in the manner described for EPA Method 8240.

#### 1.8.5 Organic Analyses by GC

##### EPA Method 601 - Halogenated Volatile Organics

Halogenated volatile organics in solid samples will be determined using EPA Method 601. This is a packed-column gas chromatographic method for detection of the species listed in the footnotes for Table 2-2. Samples are typically extracted using the purge-and-trap method (EPA Method 5030). Separation for the species of interest is accomplished by operating the GC in temperature-programmed mode. Detection is achieved using a halide-specific detector (i.e., an electrolytic conductivity detector).

##### EPA Method 8020 - Purgeable Aromatics

Aromatic volatile organics in samples will be determined using EPA Method 8020. This is a packed-column chromatographic technique utilizing a photoionization detector (PID). Samples may be analyzed using direct injection or purge-and-trap (Method 5030). Water samples must be analyzed using Method 5030. Separation for the species listed in footnotes for Table 2-2 is accomplished by operating the GC in temperature-programmed mode.

##### EPA Method 8080/608 - Organochlorine Pesticides and PCBs

Method 8080/608 is used to determine the concentration of various organochlorine pesticides and polychlorinated biphenyls (PCB's). The

footnotes for Table 2-2 indicate the compounds which may be determined. The method provides gas chromatographic conditions using either Electron Capture (ECD) or Halogen Specific (HSD) detectors. Appropriate extraction and/or dilution procedures must be used prior to sample injection. The sensitivity of Method 8080 usually depends on the level of interferences. Cleanup of samples may be necessary using Methods 3620 (Florisil Cleanup) or Method 3660 (Sulfur Cleanup).

#### EPA Method 604 - Phenols

Method 604 is a flame ionization detector gas chromatographic (FIDGC) method for determination of phenol and certain substituted phenols. A measured volume of sample, approximately one liter, is acidified and extracted with methylene chloride. The methylene chloride extract is dried and exchanged to a 2-propanol during concentration to a volume of 10 mL or less. The extract is separated by gas chromatography and the phenols are then measured with an FID.

#### EPA Method 8150/SM 509B - Chlorinated Phenoxy Herbicides

Method 8150/SM509B provides extraction, esterification, and gas chromatographic conditions for the analysis of chlorinated acid herbicides. Spiked samples are used to verify the applicability of the chosen extraction technique to each new sample type. The esters are hydrolyzed with potassium hydroxide, and extraneous organic material is removed by a solvent wash. After acidification, the acids are extracted with solvent and converted to their methyl esters using diazomethane as the derivatizing agent. After excess reagent is removed, the esters are determined by gas chromatography employing an electron capture detector, microcoulometric detector, or electrolytic conductivity detector. The results are reported as the acid equivalents. The footnotes for Table 2-2 present the compounds which may be determined.

1.8.6 Other Water Parameters

EPA Method 150.1 - pH

The pH of water samples will be measured in the field potentiometrically using a standard pH meter. The pH meter will be routinely calibrated at three points using buffered standards.

EPA Method 120.1 - Specific Conductance

The specific conductance of water samples will be determined in the field using a conductivity meter. The conductivity meter will be routinely calibrated against a standard solution.

EPA Method 170.1 - Temperature

Temperature will be measured for selected water samples according to EPA Method 170.1 using of a factory calibrated, mercury filled thermometer.

Standard Method 403 - Alkalinity

Alkalinity of a substance is expressed as its ability to neutralize acid. It is commonly referred as the sum of its titratable bases and is expressed in units of pH equivalence at the reaction end point. Determinations will be made in the field according to indicator color change (phenolphthalein, metacresol purple, or bromcresol green), or potentiometric titration. Methods assume incompatibility of hydroxide and bicarbonate alkalinities and therefore no definitive results can be obtained for specific contaminants with this method.

### Standard Method 429 - Common Anions

Determination of common anions is performed to characterize a specific water type, and is accomplished by several techniques. Samples are collected and stored in polyethylene bottles and filtered prior to analysis. A selective ion electrode is used to determine fluoride; colorimetry is used for determining nitrate, phosphate, and chloride; and the turbidimetric method is used for sulfate.

### EPA Method 160.1 - Total Dissolved Solids

Total dissolved solids are determined by thoroughly mixing the solution sample, passing the solution through a standard glass fiber filter, and then evaporating the filtrate to isolate the residue. The residue is dried at a constant temperature of 180°C until mass stabilization indicates that the residue is dry. Residue mass is then comparable to volume of solvent.

## 1.9 Data Reduction, Validation, and Reporting

Figure 1.9-1 presents the overall data reduction, validation, review, and reporting flow scheme for this project. In most cases, calculations from raw data are included in discussions of analytical procedures presented in the EPA methods. These data reduction and validation procedures will not be repeated here. Details of data reduction, validation, and reporting not addressed elsewhere are discussed in this section.

### 1.9.1 Data Reduction

Data reduction calculations used for this program are typically included on the standard reporting forms associated with each type of sample. Calculations not covered on the standard reporting forms include computer-based data reduction programs. Each laboratory is responsible for maintaining a listing of these data reduction programs and for being able to demonstrate their validity. The complete calculation procedures used in computer-based data reduction programs (i.e., GC/MS and ICP analyses) are based on the calculation procedures specified in each method and will not be covered here.

### 1.9.2 Data Validation

All laboratory generated analytical data will be transmitted from the laboratories via 9-track magnetic tape. Phone line data dumps will be used for minor corrections requested from the laboratories, and these changes will either be stored on files appended to the original tape, or on a separate tape, with attending documentation and validation checks so entered into the master log. Validation procedures will be performed on the downloaded data prior to entry into the database. The database will reside on a Sun computer running the EMPRESS database management system. Original tapes will receive write-protect rings at the laboratory, or prior to downloading. After downloading and validation, the original tapes will be labelled, logged into the master log, and filed in a security area with restricted access. Entry into

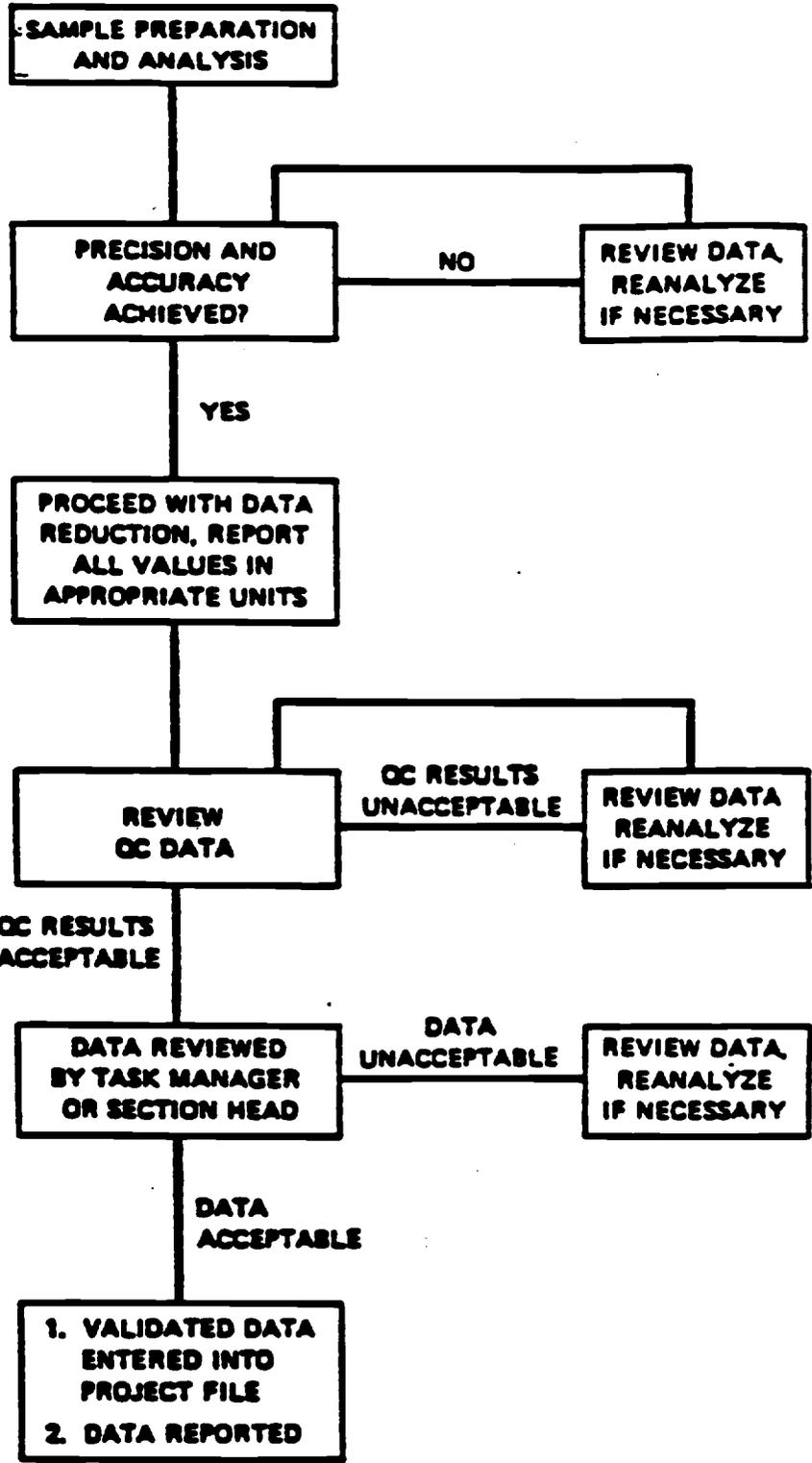


Figure 1.9-1. Data Reporting Scheme

the database will be accomplished programmatically. Reports will then be issued to the appropriate project staff. Daily backups of the database will be maintained by the data management group. Data will be maintained in this fashion and will be available for downloading into flat files for transmission to Air Force database systems when Radian Corporation receives official notification of proper specifications from designated data management entities within the Air Force.

All real-time measurement data will be reported on preformatted data collection forms. The reported data will be verified by the Supervising Geologist for completeness, logged into the master log, and turned over to Quality Control. After review by Quality Control (see Section 1.9.3), the data are turned back to data management where they will be copied and filed in secure files with restricted access. Copies will be distributed to appropriate project staff and data entry personnel. After data are entered in the EMPRESS database, validation will be performed by data management personnel. Database review will always be conducted by a person other than whom entered the data originally. Changes to the original data will be made on copies indicating the nature of the change, reason for the change, and person requesting the change. This information will be filed with the original documents. Data management personnel will receive copies of the changes and make the appropriate changes to the database.

Additional validation will be performed by the Supervising Geologist reviewing copies of the original documents and through various applications (reports, maps, etc.) of the database. Errors will be documented and reported to data management personnel for correction.

### 1.9.3 Data Quality Review

Quality Control will review all measurement data for representative conditions during sampling or testing, acceptable sample collection testing procedures, consistency with expected and/or other results, adherence to

prescribed QC procedures, and the specific acceptance criteria outlined in Section 1.7 for calibration procedures and Section 1.10 for internal quality control procedures. Any suspect data will be flagged in the database and identified with respect to the nature of the validity problem.

Several of the data validation acceptance criteria presented in Sections 1.7 and 1.10 involve specific calculations. Representative examples of these are presented below.

#### Instrument Response Linearity

Acceptance criteria for instrument response linearity checks are based upon the correlation coefficient,  $r$ , of the best fit line for the calibration data points. The correlation coefficient reflects the linearity of response to the calibration gas mixtures and is calculated as:

$$r = \frac{n \sum (xy) - (\sum x)(\sum y)}{\sqrt{[n(\sum x^2) - (\sum x)^2] [n(\sum y^2) - (\sum y)^2]}}$$

where,  $x$  = calibration concentrations

$y$  = instrument response (peak area)

$n$  = number of calibration points ( $x, y$  data pairs)

#### Precision

Control limits for control sample analyses, acceptability limits for replicate analyses, and response factor agreement criteria specified in Sections 1.7 and 1.10 are based upon precision, in terms of the coefficient of

variation (CV), i.e., the relative standard deviation or relative percent difference (RPD). The standard deviation of a sample set is calculated as:

$$S = \text{standard deviation} = \sqrt{\frac{\sum (x - \bar{x})^2}{(n-1)}}$$

where,  $x$  = individual measurement

$\bar{x}$  = mean value for the individual measurements

$n$  = number of measurements

The CV is then calculated as:

$$CV = (S/\bar{x}) \times 100\%$$

Pooled or "average" measurements of CV are calculated as:

$$\text{Pooled CV} = \sqrt{\frac{\sum (CV)^2 df}{\sum df}}$$

where,  $df$  = degrees of freedom.

The relative percent difference (RPD) calculation allows for the comparison of two analysis values in terms of precision with no estimate of accuracy. Relative percent difference is calculated as:

$$RPD = \frac{|M-m|}{(M+m)/2} \times 100\%$$

where, M = first measurement value  
m = second measurement value

### Accuracy

The accuracy of data is typically summarized in terms of relative error (RE). This calculation reflects the degree to which the measured value agrees with the actual value, in terms of percent of the actual value. Relative error is calculated as:

$$\% \text{ Relative Error} = \frac{\text{Measured Value} - \text{Actual Value}}{\text{Actual Value}} \times 100\%$$

This way of expressing accuracy allows for a comparison of accuracy at different levels (e.g., different concentrations), and for different parameters of the same type (e.g., different compounds analyzed by the same method). Control sample analyses are typically evaluated using this calculation. Relative error (RE) and relative percent difference (RPD) appear very similar at a glance, but they are not the same and should not be confused. The information that each calculation conveys is very specific about the data being compared.

In this program, another calculation is frequently used to assess the accuracy of a procedure. Percent recovery is a calculation used to determine the performance of many of the quality control checks. Percent recovery is calculated as:

$$\% \text{ Recovery} = \frac{\text{Measured Value}}{\text{Actual Value}} \times 100\%$$

Another similar calculation used to determine the performance of a method for recovery of a spike concentration added to a sample is the % spike recovery calculation. The % spike recovery is determined as:

$$\% \text{ Spike Recovery} = \frac{\text{Value of Sample Plus Spike} - \text{Value of Unspiked Sample}}{\text{(Value of Spike Added)}} \times 100$$

#### 1.9.4 Reporting

The Project Director will coordinate the preparation of all formal reports for this program with input from the Supervising Geologist, QA Coordinator, and other project team members. The report will include a summary and discussion of the results of QC procedures and QA activities performed as part of the investigation.

In addition, the QC Coordinator will prepare reports to the QA Coordinator which will summarize QC results for all project activities. These reports will also document any quality control problems and the actions taken to correct them.

1.10 Internal Quality Control

An internal quality control system is a set of routine internal procedures for assuring that the data output of a measurement system meets prescribed criteria for data quality. Inherent and implied in this control function is a parallel function of measuring and defining the quality of the data output. A well-designed internal QC program must be capable of controlling and measuring the quality of the data, in terms of precision and accuracy. Precision reflects the influence of the inherent variability in any measurement system. Accuracy reflects the degree to which the measured value represents the actual or "true" value for a given parameter, and includes elements of both bias and precision. Accuracy of measurement data is related to the precision and bias of the component parts of the measurement system.

Generally, internal quality control procedures may be divided into two overlapping categories. One category includes those procedures which are used to control data quality within prescribed limits of acceptability. These acceptability limits are usually related to data precision, accuracy, and completeness. The other category includes those procedures designed to provide a quantitative assessment of data quality, again in terms of precision, accuracy, and completeness. Some internal QC procedures, by their nature, serve both control and assessment functions.

This section addresses QC procedures associated with analytical efforts. Included are general quality control considerations as well as specific quality control checks which provide ongoing control and assessment of data quality, in terms of precision and accuracy. Quality control checks which provide the basis for quantitative control and assessment of data quality, along with required frequency, acceptance criteria, and corrective action are summarized in Table 1.10-1. A brief discussion of sampling QC to be used for the Carswell AFB Stage 2 work is presented below.

TABLE 1.10-1. SUMMARY OF INTERNAL QUALITY CONTROL PROCEDURES

| Parameter         | Analytical Method      | Quality Control Check                 | Frequency                                      | Acceptance Criteria  | Purpose/Corrective Action  |
|-------------------|------------------------|---------------------------------------|--|--|--|
| <u>Laboratory</u> |                        |                                       |  |  |  |
| Metals            | 6010 or 200.7<br>ICPES | Laboratory mixed standard calibration | Daily  | Measured value for high calibration standard $\pm 5\%$ of expected value | Repeat calibration   |
|                   |                        | Calibration check                     | 10%  | Measured value within 10% of true value for element of interest          | Repeat calibration   |
|                   |                        | Preparation blank                     | 10%  | $\leq 5 \times$ Method detection limit                                   | 1) Reextract<br>2) Reanalyze   |
|                   |                        | Calibration blank                     | 10%  | $\leq 5 \times$ Method detection limit                                   | 1) Rerun<br>2) Clean system<br>3) Rerun samples back to last clean blank |
|                   |                        | Matrix spike analysis                 | 10%, minimum one per set                       | $\pm 25\%$ Recovery  | Flag data  |
|                   |                        | Matrix spike duplicate                | 10%, minimum one per set                       | Relative percent difference $< 20\%$                                     | Flag data  |
|                   |                        | ICP interference check                | Run at beginning, middle, and end of daily run | 80-120% of true value for EPA check sample elements                      | 1) Repeat calibration<br>2) See lab manager                              |
|                   |                        | ICP linear range check                | Quarterly                                      | Measured value within $\pm 5\%$ of expected value                        | Teste upper limit of ICP linear range                                    |
|                   |                        | Limit of Detection check              | Quarterly                                      | $< MDL$  | Used to verify current LOD   |
|                   |                        | <u>Field</u>                          |  |  |  |
|                   |                        | Duplicate field sample                | 10%, minimum one per program                   | None   | Used to determine sampling/analytical variability                        |
|                   |                        | Equipment blanks                      | 10%, minimum one per program                   | None   | Used to determine sources of contamination                               |

(Continued)

BIOLOGICAL

TABLE 1.10-1. (Continued)

| Parameter       | Analytical Method | Quality Control Check    | Frequency                    | Acceptance Criteria               | Purpose/Corrective Action  |
|-----------------|-------------------|--------------------------|------------------------------|-----------------------------------|--|
| <b>Metals -</b> |                   |                          |                              |                                   |  |
| As              | 7060 or 206.2     | Multipoint calibration   | Daily prior to analyses      | $r > 0.995$                       | Repeat calibration   |
| Se              | 7740 or 270.2     |                          |                              |                                   |  |
| Hg              | 7471 or 245.1     | Calibration check        | 10%                          | ±15% Recovery                     | Recalibrate  |
| Pb              | 7421 or 239.1     |                          |                              |                                   |  |
|                 | AA                |                          |                              |                                   |  |
|                 |                   | Preparation blank        | 10%                          | < 5 x Method detection limit      | 1) Reextract<br>2) Reanalyze   |
|                 |                   | Calibration blank        | 10%                          | < 5 x Method detection limit      | 1) Rerun<br>2) Clean system<br>3) Rerun samples back to last clean blank |
|                 |                   | Matrix spike analysis    | 10%; minimum one per set     | ±25% Recovery                     | Flag data  |
|                 |                   | Matrix spike duplicate   | 10%; minimum one per set     | Relative Percent Difference < 20% | Flag data  |
|                 |                   | Limit of Detection check | Quarterly                    | < MDL                             | Used to verify current LOD   |
| <b>Field</b>    |                   |                          |                              |                                   |  |
|                 |                   | Duplicate field samples  | 10%; minimum one per program | None                              | Used to determine sampling/analytical variability                        |
|                 |                   | Equipment blanks         | 10%; minimum one per program | None                              | Used to determine sources of contamination                               |

(Continued)

Environmental Protection Agency  
 Office of Research and Development  
 Environmental Systems Laboratory  
 Research Triangle Park, NC 27711

TABLE 1.10.1 (Continued)

| Parameter                   | Analytical Method            | Quality Control Check            | Frequency   | Acceptance Criteria                          | Purpose/Corrective Action  |  |
|-----------------------------|------------------------------|----------------------------------|---|--|--|--|
| Organophosphorus Pesticides | 8140 GC/ECD                  | <u>Laboratory</u>                |   |  |  |  |
|                             |                              | Multipoint calibration, 4 points | Weekly  | r $\geq$ 0.995                               | Repeat calibration   |  |
|                             |                              | Single point calibration         | Daily prior to sample analyses                    | Relative Percent Difference (RPD) $<$ 15%    | Repeat calibration   |  |
|                             |                              | Reagent blank                    | Daily   | Less than minimum detection limit            | 1) Clean instrument<br>2) Rerun blank<br>3) See lab manager                |  |
|                             |                              | Surrogate standards              | Every sample                                      | $\pm$ 30%                                    | 1) Check calculations<br>2) Reanalyze extract<br>3) Reextract or flag data |  |
|                             |                              | Matrix spike                     | 10%; minimum one per set                          | Refer to method                              | 1) Check calculations<br>2) Reanalyze extract<br>3) Reextract or flag data |  |
|                             |                              | Matrix spike duplicate           | 10%; minimum one per set                          | RPD $<$ 30% for 90% of the quantitated peaks | Flag data  |  |
|                             |                              | Extraction blank                 | 5%  | $\leq$ 5 xIDL                                | 1) Run cleanup procedure<br>2) Rerun test<br>3) Reextract or flag data     |  |
|                             |                              | QC check standard                | Once a year                                       | Refer to method                              | 1) Evaluate system<br>2) Repeat test for criteria that failed              |  |
|                             |                              | <u>Field</u>                     |   |  |  |  |
| Duplicate field samples     | 10%; minimum one per program | N/A                              | Used to determine sampling/analytical variability |  |  |  |

(Continued)

TABLE 1.10-1. (Continued)

| Parameter              | Analytical Method   | Quality Control Check            | Frequency                      | Acceptance Criteria  | Purpose/Corrective Action  |  |
|------------------------|---------------------|----------------------------------|--------------------------------|----------------------|--|--|
| Chlorinated Herbicides | 8150 or 509B GC/MSD | <u>Laboratory</u>                |                                |                      |  |  |
|                        |                     | Multipoint calibration. 5 points | Weekly                         | r > 0.995            | Repeat calibration   |  |
|                        |                     | Single point calibration         | Daily prior to sample analyses | RPD < 15%            | Repeat calibration   |  |
|                        |                     | Reagent blank                    | Daily                          | ≤ MDL                | 1) Clean instrument<br>2) Run blank<br>3) See lab manager                  |  |
|                        |                     | Surrogate standards              | Every sample                   | ± 30%                | 1) Check calculations<br>2) Reanalyze extract<br>3) Reextract or flag data |  |
|                        |                     | Matrix spike                     | 5%                             | Refer to Method 8000 | 1) Check calculations<br>2) Reanalyze extract<br>3) Reextract or flag data |  |
|                        |                     | Matrix spike duplicate           | 5%                             | ± 50                 | Flag data  |  |
|                        |                     | Extraction blank                 | 5%                             | ≤ 5 xIDL             | 1) Cleanup procedure<br>2) Run<br>3) Reextract                             |  |
|                        |                     | QC check standard                | Once a year                    | Refer to Method 8000 | 1) Evaluate system<br>2) Repeat test for criteria that failed              |  |
|                        |                     | <u>Field</u>                     |                                |                      |  |  |
|                        |                     | Duplicate field sample           | 10%; minimum one per program   | None                 | Used to assess sampling/analytical variability                             |  |
|                        |                     | Equipment blanks                 | 10%; minimum one per program   | None                 | Used to assess sources of contamination                                    |  |

(Continued)

10/10/10

TABLE 1.10-1. (Continued)

| Parameter                 | Analytical Method            | Quality Control Check                            | Frequency   | Acceptance Criteria  | Purpose/Corrective Action  |
|---------------------------|------------------------------|--|---|--|--|
| Volatiles<br>CLP Modified | 8240<br>(GC/MS)              | <u>Laboratory</u>                                |   |  |  |
|                           |                              | Check of mass spectral ion intensities using NFB | Daily prior to sample analyses                    | Refer to method (Table 3)  | Retune instrument<br>Repeat NFB analysis   |
|                           |                              | System performance check compounds               | Every 12 hours                                    | RP 10.100 (0.250 for bromoform)  | 1) Evaluate system<br>2) Repeat calibration  |
|                           |                              | Calibration check compounds                      | Every 12 hours                                    | % Difference <30%  | 1) Evaluate system<br>2) Repeat calibration  |
|                           |                              | Surrogate spikes                                 | Every sample                                      | Based on CLP (See Table IV)  | 1) Evaluate system<br>2) Recalculate data and/or reanalyze extract<br>3) Reextract and reanalyze sample or flag data |
|                           |                              | Internal standard                                | Every sample                                      | Refer to method (Table 5)  | Flag data  |
|                           |                              | Extraction blank                                 | Daily prior to analyses                           | <CLP CRDL except for common laboratory contaminants which may be 5% CRDL | 1) Reanalyze blank<br>2) Reextract blanks/samples for analytes that are > than CRDL<br>3) Reanalyze samples/blank    |
|                           |                              | Matrix spike                                     | 5%  | Refer to method (Table 6)  | 1) Run check standard<br>2) Correct problem<br>3) Flag data  |
|                           |                              | Matrix spike duplicate                           | 5%  | Refer to method (Table 6)  | Flag data  |
|                           |                              | <u>Field</u>                                     |   |  |  |
| Trip blanks               | 10%; minimum one per program | None   | Used to determine sources of contamination        |  |  |
| Duplicate field samples   | 10%; minimum one per program | None   | Used to determine sampling/analytical variability |  |  |

(Continued)

TABLE 1.10-1. (Continued)

| Parameter                      | Analytical Method           | Quality Control Check              | Frequency  | Acceptance Criteria   | Purpose/Corrective Action  |
|--------------------------------|-----------------------------|------------------------------------|--|---|--|
| Semi-volatiles<br>CLP Modified | 8270 or 625<br>(GC/MS)      | <u>Laboratory</u>                  |  |   |  |
|                                |                             | Mass scale calibration using DFTPP | Daily prior to sample analyses                   | Refer to method (Table 3)                                   | Repeat calibration   |
|                                |                             | System performance check compounds | Every 12 hours                                   | RF >0.050   | 1) Evaluate system<br>2) Repeat calibration  |
|                                |                             | Calibration check compounds        | Every 12 hours                                   | % Difference <30%   | 1) Evaluate system<br>2) Take corrective action<br>3) Repeat test<br>4) See lab manager                              |
|                                |                             | Surrogate spikes                   | Every sample                                     | Refer to method (Table 8)                                   | 1) Evaluate system<br>2) Recalculate data and/or reanalyze extract<br>3) Reextract and reanalyze sample or flag data |
|                                |                             | Internal standards                 | Every sample                                     | Refer to method (Table 5)                                   | Flag data  |
|                                |                             | Extraction blank                   | Daily prior to sample analyses                   | <CLP CRDL except for phthalate esters which may be 5 X CRDL | 1) Reanalyze blank<br>2) Reextract blank/samples for analytes that are > than CRDL                                   |
|                                |                             | Matrix spike analysis              | 5% minimum one per set                           | Refer to method (Table 6)                                   | 1) Run check standard<br>2) Correct problem<br>3) Flag data  |
|                                |                             | Matrix spike duplicate samples     | 5% minimum one per set                           | Refer to method (Table 6)                                   | Flag data  |
|                                |                             | <u>Field</u>                       |  |   |  |
| Duplicate field samples        | 10% minimum one per program | None                               | Will be used to determine analytical variability |   |  |
| Equipment blanks               | 10% minimum one per program | None                               | Used to assess sources of contamination          |   |  |

(Continued)

Continued on next page

TABLE 1.10-1. (Continued)

| Parameter  | Analytical Method | Quality Control Check               | Frequency                                      | Acceptance Criteria                                       | Purpose/Corrective Action   |  |
|--|-------------------|-------------------------------------|--|---|---|--|
| Organochlorine<br>Pesticides and<br>PCBs<br>CLP Modified | 6080 or 608<br>GC | <u>Laboratory</u>                   |  |   |   |  |
|  |                   | Multipoint calibration,<br>4 points | Initial calibration<br>if response factor <20% | Repeat calibration  | Repeat calibration  |  |
|  |                   | Single point calibration            | Daily prior to<br>sample analyses              | Repeat test   | Repeat calibration  |  |
|  |                   | Reagent blank                       | Daily  | 1) Clean instrument<br>2) Run blank<br>3) See Lab manager | 1) Clean instrument<br>2) Run blank<br>3) See Lab manager                                       |  |
|  |                   | Surrogate standards                 | Every sample                                   | Dibutylchloroethane<br>24-1542 water<br>20-1502 soil      | 1) Check calculations<br>2) Reanalyze extract<br>3) Reextract or flag data                      |  |
|  |                   | Matrix spike                        | 10%; minimum<br>one per set                    | Refer to method   | 1) Check calculations<br>2) Reanalyze extract<br>3) Reextract or flag data                      |  |
|  |                   | Matrix spike duplicate              | 10%; minimum<br>one per set                    | Refer to method   | Flag data   |  |
|  |                   | Extraction blank                    | Daily prior to<br>sample analysis              | Refer to method   | 1) Clean system<br>2) Repeat test   |  |
|  |                   | Breakdown check<br>(Endrin & DDT)   | Daily  | <20%  | 1) Clean injection port<br>2) Replace front 2 inches<br>of column packing<br>3) Refer to method |  |
|  |                   | <u>Field</u>                        |  |   |   |  |
|  |                   | Duplicate field sample              | 10%; minimum<br>one per program                | None  | Used to assess sampling/<br>analytical variability  |  |
|  |                   | Equipment blanks                    | 10%; minimum<br>one per program                | None  | Used to assess sources<br>of contamination  |  |

(Continued)

TABLE 1.10-1. (Continued)

| Parameter                     | Analytical Method            | Quality Control Check                        | Frequency   | Acceptance Criteria                                     | Purpose/Corrective Action   |  |
|-------------------------------|------------------------------|--|---|---|---|--|
| Halogenated Volatile Organics | 601/8010 (GC/MSD)            | <u>Laboratory</u>                            |   |   |   |  |
|                               |                              | Multipoint calibration (minimum five points) | Initially and as required                         | RSD <20% for RPs  | Recalibrate   |  |
|                               |                              | Daily calibration (single-point)             | Daily, before sample analysis                     | Refer to Method 8010                                    | 1) Rerun<br>2) Recalibrate  |  |
|                               |                              | QC/S (analytes of interest)                  | Daily, before sample analysis                     | Measured value within 95% CI                            | 1) Repeat QC/S analysis for analytes that failed; if problem persists;<br>2) Evaluate system; correct problem.  |  |
|                               |                              | Reagent blank                                | Daily   | ≤ 5 XIDL  | Used to assess sources of contamination   |  |
|                               |                              | System blank                                 | Daily   | < IDL   | Run until system is clean   |  |
|                               |                              | Matrix spike                                 | 10%; minimum one per set                          | Established criteria in Method 8010 Table 3             | 1) Analyze QC/S for analytes that failed spike test; if passes;<br>2) Flag data for matrix effects; if QC/S fails; effects;<br>3) Evaluate system; recalibrate; and reanalyze any samples affected by out-of-control condition. |  |
|                               |                              | Matrix spike duplicate                       | 10%; minimum one per set                          | RPD <50%  | Flag data   |  |
|                               |                              | Surrogate spikes                             | Every sample, reagent blank, and standard.        | ±50%; lab must set own criteria (p.3a) after 30 samples | 1) Check for errors in calculations or standards;<br>2) Recalculate data and/or reanalyze extract;<br>3) Reextract and reanalyze or flag data.  |  |
|                               |                              | <u>Field</u>                                 |   |   |   |  |
| Equipment blanks              | 10%; minimum one per program | None   | Used to assess sources of contamination           |   |   |  |
| Trip blanks                   | 10%; minimum one per program | None   | Used to assess sources of contamination           |   |   |  |
| Duplicate field samples       | 10%; minimum one per program | None   | Used to determine sampling/analytical variability |   |   |  |
| Ambient Condition blanks      | 10%; minimum one per program | None   | Used to assess sources of contamination           |   |   |  |

(Continued)

TABLE 1.10-1. (Continued)

| Parameter               | Analytical Method            | Quality Control Check                        | Frequency                                  | Acceptance Criteria                                     | Purpose/Corrective Action  |  |
|-------------------------|------------------------------|--|--|---|--|--|
| Volatile Aromatics      | 602/8020 (GC/PID)            | <u>Laboratory</u>                            |  |   |  |  |
|                         |                              | Multipoint calibration (minimum five points) | Initially and as required                  | RSD <20% for MPs  | Recalibrate  |  |
|                         |                              | Daily calibration (single-point)             | Daily, before sample analysis              | Refer to Method 8020                                    | 1) Rerun<br>2) Recalibrate   |  |
|                         |                              | QCCS (analytes of interest)                  | Daily, before sample analysis              | Measured value within 95% CI                            | 1) Repeat QCCS analysis for analytes that failed; if problem persists;<br>2) Evaluate system; correct problem.   |  |
|                         |                              | Reagent blank                                | Daily                                      | ≤ 5 XIDL  | Used to assess sources of contamination  |  |
|                         |                              | System blank                                 | Daily                                      | < IDL   | Run until system is clean  |  |
|                         |                              | Matrix spike                                 | 10%; minimum one per set                   | Established criteria in Method 8020 Table 3             | 1) Analyze QCCS for analytes that failed spike test; if passes;<br>2) Flag data for matrix effects; if QCCS fails;<br>3) Evaluate system; recalibrate; and reanalyze any samples affected by out-of-control condition. |  |
|                         |                              | Matrix spike duplicate                       | 10%; minimum one per set                   | RPD <50%  | Flag data  |  |
|                         |                              | Surrogate spikes                             | Every sample, reagent blank, and standard. | ≤50%; lab must set own criteria (p.3a) after 30 samples | 1) Check for errors in calculations or standards;<br>2) Recalculate data and/or reanalyze extract;<br>3) Reextract and reanalyze or flag data.   |  |
|                         |                              | <u>Field</u>                                 |  |   |  |  |
|                         |                              | Equipment blanks                             | 10%; minimum one per program               | None  | Used to assess sources of contamination  |  |
|                         |                              | Trip blank                                   | 10%; minimum one per program               | None  | Used to assess sources of contamination  |  |
|                         |                              | Duplicate Field Sample                       | 10%; minimum one per program               | None  | Used to assess sampling/analytical variability   |  |
| Ambient Condition Blank | 10%; minimum one per program | None   | Used to assess sources of contamination    |   |  |  |

(Continued)

TABLE 1.10-1. (Continued)

| Parameter         | Analytical Method | Quality Control Check                        | Frequency  | Acceptance Criteria  | Purpose/Corrective Action  |
|-------------------|-------------------|--|--|--|--|
| <u>Laboratory</u> |                   |  |  |  |  |
| Phenols           | 604 GC            | Multipoint calibration (minimum five points) | Initially and as required  | RSD $\pm 20\%$ for RPs   | Recalibrate  |
|                   |                   | Daily calibration (single-point)             | Daily, before & after sample analysis, and once every 10 samples | Single-point RP within $\pm 15\%$ of multipoint RP or initial daily RP   | Recalibrate  |
|                   |                   | Reagent blank                                | 1/sample set or with new reagents                                | $\leq 3 \times MDL$  | 1) Clean system<br>2) Repeat blank   |
|                   |                   | Matrix spike                                 | 1/sample set (minimum 10%)                                       | $\pm 50\%$   | 1) Analyze QCCS for analytes that failed spike test; if passes:<br>2) Flag data for matrix effects; if QCCS fails:<br>3) Evaluate system; recalibrate; and reanalyze any samples affected by out-of-control condition. |
|                   |                   | Matrix spike duplicate                       | 1/sample set (minimum 10%)                                       | $\pm 50\%$   | See corrective action for matrix spikes.   |
|                   |                   | Surrogate spikes                             | Every sample, reagent blank, and standard.                       | Refer to Method 8000   | 1) Check for errors in calculations or standards;<br>2) Recalculate data and/or reanalyze extracts;<br>3) Reextract and reanalyze sample.  |
|                   |                   | Daily retention time window check            | Daily, before sample analysis                                    | Daily calibration standard must fall within established window; established daily window based on single-point cal. std. | 1) Evaluate system<br>2) Correct problem   |
|                   |                   | Retention window establishment               | Whenever new GC column is installed                              | Established window as mean absolute retention time $\pm 3$ standard deviations based on four analyses of standard        |  |
| <u>Field</u>      |                   |  |  |  |  |
|                   |                   | Equipment blanks                             | 10%; minimum one per program                                     | None   | Used to assess sources of contamination  |
|                   |                   | Duplicate field samples                      | 10%; minimum one per program                                     | None   | Used to assess sampling/analytical variability   |

(Continued)

TABLE 1.10-1. (Continued)

| Parameter              | Analytical Method | Quality Control Check        | Frequency  | Acceptance Criteria                                    | Purpose/Corrective Action                          |
|------------------------|-------------------|------------------------------|--|--|--|
| TDS                    | 160.1             | QC Check Sample              | One per batch  | ±10% Recovery  | Reanalyze samples                                  |
|                        |                   | Duplicate analysis           | 10%  | RPD 20%  | 1) Obtain third value<br>2) Flag data              |
|                        |                   | Blank                        | One per batch  | ≤ 5 x MDL  | Flag data  |
|                        |                   | Duplicate field sample       | 10%; minimum one per program                                       | None   | Used to assess sampling/analytical variability     |
| Conductance (aqueous)  | 120.1             | Single-point calibration     | Prior to sample analyses   | Measured value within ±2% of true value                | 1) Repeat calibration<br>2) See instrument manual  |
|                        |                   | QC sample                    | After calibration and after every 20 samples (minimum two per set) | Measured value within ±10% of true value               | 1) Repeat check<br>2) Repeat calibration and check |
|                        |                   | Duplicate analysis           | 5%   | Coefficient of variation (CV) < 2%                     | Obtain third value                                 |
|                        |                   | Two-point calibration        | Daily, prior to sample analyses                                    | Reading within 0.05 pH units of buffer solution values | 1) Repeat calibration<br>2) See instrument manual  |
| pH (aqueous)           | 150.1             | QC sample                    | After calibration and after every 20 samples (minimum two per set) | Analysis within 0.1 pH units of true value             | 1) Repeat check<br>2) Repeat calibration and check |
|                        |                   | Duplicate analysis           | 5%   | Coefficient of variation (CV) < 1%                     | Obtain third value                                 |
|                        |                   | Laboratory Calibration curve | Daily  | r > 0.995  | Re-run calibration                                 |
|                        |                   | QC sample                    | 10%  | Measured value within ±20% of expected value           | 1) Reanalyze<br>2) Re-run calibration              |
| Petroleum Hydrocarbons | 418.1             | Reagent blank                | Daily  | < 2 ug/ml  | 1) Clean system<br>2) Repeat blank analysis        |
|                        |                   | Field Equipment blank        | 10%; minimum one per program                                       | None   | Used to assess sources of contamination            |
|                        |                   | Field duplicate sample       | 10%; minimum, one per program                                      | None   | Used to assess sampling and analytical variability |

(Continued)

TABLE 1.10-1. (Continued)

| Parameter              | Analytical Method            | Quality Control Check  | Frequency                    | Acceptance Criteria                 | Purpose/Corrective Action                         |
|------------------------|------------------------------|------------------------|------------------------------|-------------------------------------|---|
| Fluoride               | 340.2                        | <u>Laboratory</u>      |                              |                                     |   |
|                        |                              | Multipoint calibration | Daily prior to analyses      | $r > 0.995$                         | Repeat calibration                                |
|                        |                              | QC Check Sample        | 10%                          | $\pm 10\%$ error                    | Repeat calibration                                |
|                        |                              | Blank                  | 10%                          | None                                | Used to assess memory                             |
|                        |                              | Duplicate analyses     | 10%                          | RPD $< 10\%$                        | 1) Obtain third value<br>2) Flag data             |
|                        |                              | Matrix spike           | 10%                          | $\pm 10\%$ error                    | Flag data   |
|                        |                              | <u>Field</u>           |                              |                                     |   |
|                        |                              | Equipment blanks       | 10%; minimum one per program | None                                | Used to determine sources of contamination        |
|                        |                              | Duplicate field sample | 10%; minimum one per program | None                                | Used to determine sampling/analytical variability |
|                        |                              | Chloride               | 325.3                        | <u>Laboratory</u>                   |   |
| Standardise titrant    | Daily                        |                        |                              | RPD $< 5\%$ for standard duplicates | Repeat calibration                                |
| QC check sample        | Every 15 samples             |                        |                              | $\pm 10\%$ error                    | Repeat standardization                            |
| Blank                  | One per batch                |                        |                              | None                                | Used to assess memory effects                     |
| Duplicate analyses     | 5%                           |                        |                              | RPD $< 15\%$                        | 1) Obtain third value<br>2) Flag data             |
| Matrix spike           | 5%                           |                        |                              | $\pm 20\%$ error                    | Flag data   |
| <u>Field</u>           |                              |                        |                              |                                     |   |
| Equipment blank        | 10%; minimum one per program |                        |                              | None                                | Used to assess sources of contamination           |
| Duplicate field sample | 10%; minimum one per program |                        |                              | None                                | Used to assess sampling/analytical variability    |

(Continued)

TABLE 1.10-1. (Continued)

| Parameter | Analytical Method | Quality Control Check  | Frequency                    | Acceptance Criteria | Purpose/Corrective Action                      |
|-----------|-------------------|------------------------|------------------------------|---------------------|--|
| Sulfate   | 375.4             | <u>Laboratory</u>      |                              |                     |  |
|           |                   | Multipoint calibration | Daily                        | r > 0.995           | Repeat calibration                             |
|           |                   | QC check sample        | 10%                          | ±10% error          | Repeat calibration                             |
|           |                   | Method blank           | One per batch                | None                | Used to assess memory effects                  |
|           |                   | Duplicate analyses     | 5%                           | RPD < 15%           | 1) Obtain third value<br>2) Flag data          |
|           |                   | Matrix spike           | 5%                           | ±20% error          | Flag data                                      |
|           |                   | <u>Field</u>           |                              |                     |  |
|           |                   | Equipment blank        | 10%; minimum one per program | None                | Used to assess sources of contamination        |
|           |                   | Duplicate field sample | 10%; minimum one per program | None                | Used to assess sampling/analytical variability |

- One (1) ambient conditions blank per VOC sampling round (water) will be collected at a particular site or zone. Ambient conditions blanks consist of Type II Reagent Water poured into a sample container at the site, handled like a sample, and transported to the laboratory for analysis.
- One (1) set of equipment blanks will be collected for every day of groundwater sampling (all parameters analyzed). Type II Reagent water is poured into the sampling device (or pumped through it in the case of sampling pumps), transferred to the sample bottle, and then transported to the laboratory for analysis.
- Ten (10) percent field duplicates will be collected (all parameters analyzed) for water samples. Two samples will be collected independently at a sampling location during a single act of sampling. Field duplicates shall be indistinguishable from other analytical samples so that personnel performing the analyses are not able to determine which samples are duplicates.
- Ten (10) percent field replicates will be collected (all parameters analyzed) for soil/sediment samples. A single sample (e.g., one bailer volume, one grab sample) is collected, then divided into two equal parts for the purpose of analysis. Field replicates shall be indistinguishable from other analytical samples so that personnel performing the analyses are not able to determine which samples are duplicates.

In addition to these sampling QC requirements, additional QC procedures will be performed as part of the analytical methods. These are discussed below.

1.10.1 Laboratory QC

Methods 509B/8150, 601, 604, 608/8080, 8020, 8140 (GC)

Analytical quality control procedures for GC analyses are described generally in Method 8000 of SW-846, 3rd ed. (and equivalent methods in the 600 and 500 series EPA Methods) and include the following:

- Initial demonstration of capability;
- Calibration verification;
- Analysis of surrogate spiked samples;
- Method blank analyses;
- Analysis of matrix spike/matrix spike duplicates;
- Retention time window checks; and
- Analysis of QC check samples.

These procedures are described below.

Initial Demonstration of Capability—Before analyzing samples by a method, the laboratory must demonstrate the ability to generate acceptable accuracy and precision. This is done by analyzing four aliquots of a QC check sample (QCCS) by the same procedure used to analyze samples. The laboratory should calculate the average recovery and the standard deviation of the recovery for each analyte of interest using the four results. The mean recovery and standard deviation for each analyte should be compared with the corresponding acceptance criteria published in the SW-846 method. If the experimental accuracy and precision data are acceptable, analyses may proceed; if not, remedial action must be taken to improve system performance.

QC Check Sample Analyses—QC check samples may be obtained from EPA or prepared from suitable reference materials, but must be prepared independently of calibration standards. The QCCS should contain the analyte(s) of interest at a concentration in the mid-calibration range.

Measured values should be plotted on a QC control chart. A QCCS must be analyzed if matrix spike recoveries are unacceptable to verify that the analytical system is in a state of control.

Method Blank Analyses--Before processing any samples, the analyst should demonstrate through the analysis of a reagent water method blank that all glassware and reagents are interference-free. Each time a set of samples is extracted or there is a change in reagents, a method blank should be processed as a safeguard against chronic laboratory contamination. The blank samples should be carried through all stages of the sample preparation and measurement steps.

Matrix Spike/Matrix Spike Duplicate--For each analytical batch or matrix type (5 percent minimum frequency), matrix spike and matrix spike duplicate samples should be analyzed. The laboratory should maintain control charts (using two standard deviation control limits) of MS/MSD results, in terms of percent recovery of the spike and relative percent difference between duplicates. When matrix spike results fall outside the laboratory established limits, or outside limits published in the respective methods, a QCCS must be analyzed to demonstrate analytical control. If spike recoveries are outside normal limits due to matrix problems, the data should be flagged.

Surrogate Spikes--A surrogate standard is a chemically inert compound not expected to occur in an environmental sample. The use of surrogate compounds may be project dependent, and limited by the ability to select a suitable surrogate for a particular parameter class. The laboratory must establish control limits (as the mean recovery  $\pm$ three standard deviations) for each surrogate compound after thirty samples of the same matrix have been analyzed. These control limits should be revised at least annually. If the surrogate spike recovery in any sample is not within limits:

- Check for errors in calculations, surrogate solutions and standards. Check instrument performance.
- Recalculate the data and/or reanalyze the extract if any of the above checks reveal a problem.
- Reextract and reanalyze the sample if none of the above are a problem, or flag the data as "estimated concentration".

Retention Time Windows--The laboratory will calculate retention time windows for each standard on each GC column and whenever a new GC column is installed. To establish windows, make three injections of all single component standard mixtures and multiresponse products (e.g., PCBs) throughout the course of a 72-hr period. Calculate the standard deviation of the three absolute retention times for each single component standard. For multiresponse products, choose one major peak from the envelope. If the standard deviation for a particular standard is zero, substitute the standard deviation of a close eluting, similar compound to develop a valid retention time window.

The laboratory will establish daily retention time windows for each analyte. Use the absolute retention time for each daily calibration standard as the midpoint of the window for that day. The daily retention time window equals the midpoint  $\pm$  three times the standard deviation determined above. All succeeding standard in an analysis sequence must fall within the daily retention time window established by the first standard of the sequence.

Methods 625, 8240, and 8270 (GC/MS)

Analytical quality control procedures for GC/MS analyses (Methods 8240 and 8270) are described in SW-846, 3rd ed. and include:

- Initial demonstration of capability;
- Calibration verification;
- Surrogate standard spike samples;
- Method blank analyses;
- Analysis of field blanks;
- Matrix spike duplicate analyses;
- Analysis of duplicate samples;
- Mass spectrometer sensitivity check; and
- Daily GC/MS performance tests.

Each of these is described below.

Initial Demonstration of Capability—Before analyzing samples by a method, the laboratory must demonstrate the ability to generate acceptable accuracy and precision. This is done by analyzing four aliquots of a QC check sample (QCCS) by the same procedure used to analyze samples. The laboratory should calculate the average recovery and the standard deviation of the recovery for each analyte of interest using the four results. The mean recovery and standard deviation for each analyte should be compared with the corresponding acceptance criteria published in the SW-846 method. If the experimental accuracy and precision data are acceptable, analyses may proceed; if not, remedial action must be taken to improve system performance.

QC Check Sample Analyses—QC check samples may be obtained from EPA or prepared from suitable reference materials, but must be prepared independently of calibration standards. The QCCS should contain the analyte(s) of interest at a concentration in the mid-calibration range.

Measured values should be plotted on a QC control chart. A QCCS must be analyzed if matrix spike recoveries are unacceptable to verify that the analytical system is in a state of control.

Calibration Verification--Instrument tuning and calibration procedures are described in Section 1.7.

Surrogate Standard Spike Samples--All samples will be spiked with a surrogate standards as described in SW-846. The spiking level used should be that which will give an amount in the purge apparatus that is equal to 50 ug/kg of the sample. If the recovery for any surrogate standard does not fall within the control limits for method performance, the sample will be reanalyzed. If the surrogate recovery fails twice, the results reported for that sample must be qualified as being outside of control limits. The laboratory must monitor the frequency of data so qualified to ensure that it remains at or below 5%. Three surrogate standards, 4-bromofluorobenzene, 1,2-dichloroethane  $d_4$ , and toluene  $d_8$ , are used to monitor recovery of volatile compounds varying in volatility and polarity. Three base/neutral--nitrobenzene- $d_5$ , 2-fluorobiphenyl, and p-terphenyl- $d_{14}$ --and three acid--phenol- $d_5$ , 2-fluorophenol, and 2,4,6-tribromophenol--extractable surrogate compounds are used to monitor recovery of semivolatile organics.

Method Blank Analyses--A method (reagent) blank should be analyzed every 12 hours to demonstrate that analytical system interferences are below acceptable limits. Surrogate recoveries for the blank must meet the requirements established in SW-846 before analyses can continue.

Matrix Spike/Matrix Spike Duplicate Analyses (MS/MSD)--A minimum of 5% of the samples will be split and spiked with target analytes. Whenever possible, samples which were collected in duplicate should be chosen for MS/MSD analyses. This sample will be split in the laboratory and each fraction will be carried through all of the stages of sample preparation and analysis. If spike recoveries do not meet the acceptance criteria published in SW-846 for Methods 8240 and 8270, a QC check sample must be analyzed to

verify that the analytical system is in control. If the QCCS recovery is acceptable, qualify the sample results as suspect due to matrix problems. If the matrix spike duplicates do not meet the precision limits published in the methods, evaluate the system for the source of the imprecision.

Mass Spectrometer Sensitivity Check--If the extracted ion current profile (EICP) area for any internal standard changes by more than a factor of two (-50% - +100%), the mass spectrometer must be inspected for malfunctions and correction action taken. Samples analyzed while the system was malfunctioning must be reanalyzed.

Daily GC/MS Performance Tests--Each day that analyses are performed, the GC/MS system will be checked using bromofluorobenzene (BFB) or decafluorotriphenylphosphine (DFTPP). The acceptance criteria presented in Table 2 of Methods 8240 and 8270 must be met prior to performing any analyses. If all criteria are not met, the instrument will be returned and the test repeated until all criteria are achieved.

#### Metals Analyses by ICPEs and Atomic Absorption

The quality control procedures associated with metals analyses are described in SW-846 Method 6010 (EPA Method 200.7) for ICPEs and Method 7000 (EPA Methods 206.2, 270.2, 245.1, 239.1) series for atomic absorption, and include:

- Calibration verification;
- Analysis of QC check samples;
- Calibration blank analyses;
- Reagent blank analyses;
- Analysis of matrix spike/matrix spike duplicates;
- Instrument check standard analyses; and
- Interference blank analyses.

These procedures are described below.

Calibration--Calibration procedures are described in Section 1.7.

QC Check Sample Analyses--Immediately after calibration, a quality control check sample (QCCS) containing all elements of interest will be analyzed. The results will be calculated prior to analyzing any other samples. If the measured value differs from the theoretical value for any parameter by more than  $\pm 10\%$ , these parameters will be restandardized. The QC standard will be prepared from a stock standard solution which is different than that from which the calibration standards were prepared. Alternatively, it may be purchased from a commercial source. The QCCS should be prepared in the same acid matrix as the calibration standards at 10 times the instrumental detection limit or in the mid-calibration range. Measured values should be plotted on a QC control chart. To ensure the continuity of QC control charts, the same QC standard should be used throughout the project.

After every 10 samples, the QC standard will be reanalyzed. If the measured value differs from the theoretical value by more than  $\pm 10$  for ICPES, or  $\pm 20$  percent for AAS, recalibrate the instrument.

Calibration Blank (ICPES)--At a frequency of 10 percent, a calibration blank will be analyzed during sample analyses. As specified in Method 6010, this standard is prepared by diluting 2 mL of (1+1)HNO<sub>3</sub> and 10 mL of (1+1)HCl to 100 mL DI H<sub>2</sub>O. If response to this standard is verified to be outside three standard deviations of the mean calibration blank value, then correct the problem, recalibrate, and reanalyze the previous ten samples.

Reagent Blank--A reagent blank, containing all the reagents and in the same volumes as used in the processing of the samples, and carried through the complete preparation/analysis procedure, should be analyzed at a minimum frequency of 5 percent, or one per sample batch. Reagent blank results should be used to correct for possible contamination resulting from varying amounts of the acids used in processing samples.

Matrix Spike/Matrix Spike Duplicate--For each analytical batch or matrix type (5 percent minimum frequency), matrix spike and matrix spike duplicate samples should be analyzed. Matrix spike results should fall within 75-125 percent recovery of the spike. If the spike is not recovered within the specified limits, the data should be flagged as suspect due to matrix effects. Depending on the project, provisions should be established to use standard-addition analysis procedures to compensate for matrix effects.

Duplicate spiked sample results should agree within 20 percent RPD. If they do not, evaluate the system for the source of the imprecision, and correct the problem.

Instrument Check Standard (ICPES)--The instrument check standard is composed of compatible elements at a concentration equivalent to the midpoint of their respective calibration curves. This standard will be analyzed at a frequency of 10% of the samples. If response to any parameter is verified to be outside +5% of the true value, the instrument must be recalibrated before sample analysis continues.

Interference Check Standard (ICPES)--The interference check standard will be analyzed at the beginning, end, and at intervals during analysis of a batch of samples. This standard contains the analytes of interest at minimal concentrations by known concentration of interfering elements. If results exceed 1.5 times the standard deviation of the mean analysis value for this standard, instrument recalibration must be performed before sample analysis may proceed.

## Fluoride Analyses

Fluoride analyses will be performed according to EPA Method 340.2.

Quality control procedures include:

- Multipoint calibration;
- Method blank analyses;
- Analyses of QC check samples;
- Duplicate analyses; and
- Analyses of matrix spiked samples.

Calibration--Calibration procedures are described in Section 1.7. The method specifies a daily multipoint calibration, followed by periodic verification.

Method Blank Analyses--A minimum of one reagent blank per sample batch (minimum 10 percent) will be analyzed to determine if contamination or memory effects have occurred.

QC Check Sample Analyses--A QC check sample, prepared independently of calibration standards, should be analyzed every 10 samples. Recovery should be within  $\pm 10$  percent of the expected value.

Duplicate Analyses--A duplicate analysis or matrix spike duplicate analysis should be run every 10 samples. The duplicate run should include the whole sample-preparation and analytical process. Precision should be within 10 percent RPD.

Matrix Spike Analyses--For each batch or matrix type (minimum 10 percent), an aliquot of sample should be spiked and analyzed. Recovery of the spike should be within 10 percent of the amount added.

## Titrimetric Determination of Chloride

Titrimetric determination of chloride will be performed according to EPA Method 325.3 or SW-846 Method 9252. Quality control procedures include the following:

- Titrant standardization;
- QC check sample analyses;
- Method blank analyses;
- Duplicate analyses; and
- Matrix spike analyses.

Titrant Standardization—The mercuric chloride titrant is standardized daily against primary standard sodium chloride.

QC Check Sample Analyses—A chloride QC check standard is analyzed every 15 samples. Recovery within 90-110 percent of the expected value is required for analyses to proceed.

Method Blank Analyses—A blank sample is analyzed with every batch of routine samples (maximum 20) to assess memory effects.

Duplicate Analyses—A duplicate analysis (or matrix spike duplicate) is analyzed every 20 samples. The duplicate analysis should include all sample preparation steps. Precision should be within 15 percent RPD, or a third value should be obtained and the data flagged.

Matrix Spike Analyses—For each batch of samples of a matrix type (20 maximum), an aliquot of sample will be spiked and analyzed. Recovery of the spike should be within 20 percent of the expected value; if not, the data will be flagged.

## Turbidimetric Determination of Sulfate

Turbidimetric determination of sulfate will be performed according to EPA Method 375.4 or SW-846 Method 9038. Quality control procedures include the following:

- Multipoint calibration;
- QC check sample analyses;
- Method blank analyses;
- Duplicate analyses; and
- Matrix spike analyses.

Multipoint Calibration—A multipoint calibration curve will be prepared daily, as described in Section 1.7.

QC Check Sample Analyses—A sulfate QC check standard is analyzed every 10 samples. Recovery within 90-110 percent of the expected value is required for analyses to proceed.

Method Blank Analyses—A blank sample is analyzed with every batch of routine samples (maximum 20) to assess memory effects.

Duplicate Analyses—A duplicate analysis (or matrix spike duplicate) is analyzed every 20 samples. The duplicate analysis should include all sample preparation steps. Precision should be within 15 percent RPD, or a third value should be obtained and the data flagged.

Matrix Spike Analyses—For each batch of samples of a matrix type (20 maximum), an aliquot of sample will be spiked and analyzed. Recovery of the spike should be within 20 percent of the expected value; if not, the data will be flagged.

## 1.11 Performance and Systems Audits

A quality assurance (QA) audit is an independent assessment of a measurement system. It typically includes performance evaluation using apparatus and/or standards that are different from those used in the measurement system. It also may include an evaluation of the potential of the system to produce data of adequate quality to satisfy the objectives of the measurement efforts. The independent, objective nature of the audit requires that the auditor be functionally independent of the sampling/analytical team.

Quality assurance audits play an important role in Radian's overall QA/QC program. This section describes the role of the QA auditor and the nature of both performance and systems audits.

The QA auditor is the person who designs and/or performs QA performance and systems audits. Since QA audits represent, by definition, independent assessments of a measurement system and associated data quality, the auditor must be functionally independent of the measurement effort to ensure objectivity. However, the auditor must be familiar enough with the objectives, principles, and procedures of the measurement efforts to be able to perform a thorough and effective evaluation of the measurement system. Especially important is the ability to identify components of the system which are critical to overall data quality, so that the audit focuses heavily upon these elements. The auditor's technical background and experience should also provide a basis for appropriate audit standard selection, audit design, and data interpretation.

### 1.11.1 Audit Approach

At least once per quarter during this project, a QA auditor will be on site for two or three days to perform independent performance and systems audits. If possible, the QA audits will be conducted during the first weeks of each sampling program. The function of the field QA auditor will be to:

- Observe procedures and techniques in use in the various measurement efforts, including field sampling and analysis,
- Check and verify instrument calibration records,
- Assess the effectiveness of and adherence to the prescribed QC procedures,
- Review document control and chain-of-custody procedures,
- Submit audit samples of comparable composition as those being tested for analysis,
- Review the malfunction reporting procedures,
- Identify and correct any weaknesses in the sampling/analytical approach and techniques,
- Assess the overall data quality of the various sampling/ analytical systems, and
- Challenge the various measurement systems with certified audit standards.

Generally, the role of the auditor is to observe and document the overall performance of each of the various sampling and analytical efforts (systems audits). Audit standards and test equipment which are traceable to acceptable reference standards are used to assess the performance of each analytical method and/or measurement device (performance audit). Based on the audit results, the auditor may, as necessary, initiate corrective action at the project level through the Program Manager or Project Director.

Upon completion of performance and systems audits, the auditor will discuss any specific weaknesses with the field team leader and make recommendations for corrective action. An audit report will subsequently be prepared and distributed to the task leaders and the Project Director. This report will outline the audit approach and present a summary of results and recommendations.

On a monthly basis, one or more of the laboratories conducting analytical work for this program will be given representative performance audit samples. Results for these audit samples will be tabulated and reported as they become available. The audit samples will be used to evaluate the analytical performance and data reporting protocols for each laboratory.

#### 1.11.2 Systems Audit

A systems audit is an on-site qualitative review of the various aspects of a total sampling and/or analytical system to assess its overall effectiveness. It represents an objective evaluation of a set of interactive systems with respect to strengths, weaknesses, and potential problem areas. The audit provides an evaluation of the adequacy of the overall measurement system(s) to provide data of known quality which are sufficient, in terms of quantity and quality, to meet the program objectives.

The systems audit will consist of observations and documentation of all aspects of the on-site sampling and analytical activities. Checklists which delineate the critical aspects of each methodology will be used by the Radian auditor during the audit and will serve to document all observations. An example systems audit checklist is illustrated in Figure 1.11-1. In addition to evaluating sampling and analytical procedures and techniques, the systems audit will emphasize review of all record keeping and data handling systems including:

**AUDIT OF DATA QUALITY AND SYSTEMS FOR A GC/MS LABORATORY  
QUALITY ASSURANCE AUDIT CHECKLIST**

Site: \_\_\_\_\_ Date: \_\_\_\_\_

Contract: \_\_\_\_\_ Auditor: \_\_\_\_\_

| Yes   | No    | Comments | Item   |
|-------|-------|----------|--|
|       |       |          | <b>ORGANIZATION AND PERSONNEL</b>  |
| _____ | _____ | _____    | 1. Laboratory or Project Manager<br>(individual responsible for overall technical effort)<br>Name: _____   |
| _____ | _____ | _____    | 2. GC/MS Operator: 9 months experience suggested<br>Name: _____  |
| _____ | _____ | _____    | 3. GC/MS Spectral Interpretation Expert: 2 years experience suggested<br>Name: _____   |
| _____ | _____ | _____    | 4. Purge and Trap Expert: 6 months experience suggested<br>Name: _____   |
| _____ | _____ | _____    | 5. Extraction Concentration Expert: 1 year experience suggested<br>Name: _____   |
| _____ | _____ | _____    | 6. Pesticide Residue Analysis Expert: 2 years experience suggested<br>Name: _____  |
| _____ | _____ | _____    | 7. Do personnel assigned to this project have the appropriate level and type of experience to successfully accomplish the objectives of the program? |
| _____ | _____ | _____    | 8. Is the organization adequately staffed to meet project commitments in a timely manner?  |
| _____ | _____ | _____    | 9. Was the Quality Assurance Officer available during the evaluation?<br>Name: _____   |

Figure 1.11-1. Example Systems Audit Checklist

- Calibration documentation for analytical instrumentation and sampling apparatus,
- Documentation of quality control data (control charts, etc.),
- Completeness of data forms and notebooks,
- Data review and validation procedures,
- Data storage and filing procedures,
- Sample logging procedures,
- Chain of custody procedures,
- Documentation of field maintenance activities, and
- Review of malfunction reporting procedures.

### 1.11.3 Performance Audit

Radian will conduct monthly performance audits. The performance audits will be designed to provide a quantitative, point-in-time evaluation of the data quality of the sampling and analytical systems being tested. This will be accomplished by addressing specific component parts of the overall system. Each performance audit will address the two general measurement categories of this project:

- Chemical analysis of samples, and
- Physical measurements supporting the sampling effort.

Audit activities will consist of challenging the various measurement systems with standards and test equipment traceable to accepted reference standards.

CONFIDENTIAL

## 1.12. Preventative Maintenance

The primary objective of a preventative maintenance program is to help ensure the timely and effective completion of a measurement effort. Radian's preventative maintenance program is designed to minimize the down time of crucial sampling and/or analytical equipment due to expected or unexpected component failure. In implementing this program, efforts are focused in three primary areas:

- Establishment of maintenance responsibilities;
- Establishment of maintenance schedules for major and/or critical instrumentation and apparatus; and
- Establishment of an adequate inventory of critical spare parts and equipment.

Each of these efforts are discussed in the following sections.

### 1.12.1 Maintenance Responsibilities

Equipment and apparatus used in Radian's environmental measurement programs fall into two general categories:

- Equipment which is permanently assigned to a specific laboratory (e.g., GC Laboratory, Industrial Hygiene Laboratory, GC/MS Laboratory, etc.); and
- Equipment which is available for field or laboratory use on an as-needed basis (e.g., field sampling equipment, mobile laboratories, etc.).

Maintenance responsibilities for permanently assigned equipment are assigned to the respective laboratory managers. The laboratory managers then establish maintenance procedures and schedules for each major equipment item. Specific responsibilities for specific items may be delegated to laboratory personnel, although the laboratory managers retain responsibility for ensuring adherence to prescribed protocol.

Maintenance responsibilities for non-assigned equipment are coordinated through the Physical Chemistry Division. Equipment in this category includes source sampling equipment, real-time emissions monitoring instrumentation, and mobile laboratories and associated instrumentation. All equipment in this category is available for project-specific measurement efforts on an as-needed basis. This use schedule requires three related maintenance efforts:

- Ensuring that available equipment is functional and ready for use;
- Maintenance during use; and
- Check-out and servicing after use.

Two instrument technicians in the Physical Chemistry Division have, as their primary duty, responsibility for ensuring that available equipment and instrumentation are ready for use and that returned equipment is checked out, serviced, and returned to available inventory in a timely manner. Maintenance during use is the responsibility of the project team using the equipment. A status tag used for non-assigned equipment is shown in Figure 1.12-1. Figure 1.12-2 is an example of an equipment inventory control form.

**RADIAN  
PHYSICAL CHEMISTRY**

---

**INSTRUMENT**

---

|              |                   |
|--------------|-------------------|
| <b>MODEL</b> | <b>S/N</b>        |
| <b>DATE</b>  | <b>TECHNICIAN</b> |

---

**CONDITION**

|   |                      |
|---|----------------------|
| <input type="checkbox"/> <b>OPERATIONAL</b> | <b>LAST CAL DATE</b> |
| <input type="checkbox"/> <b>UNKNOWN</b>     | _____                |
| <input type="checkbox"/> <b>BROKEN</b>      | <b>BY</b> _____      |

---

**COMMENTS**

Figure 1.12-1. Equipment Status Tag

FORM 4-64

Designation Source

Instrument SO<sub>2</sub> Analyzer

Model Thermo-Electron Series 40

S/N SDM-10269-115

|                      |  |
|----------------------|--|
| Condition            | Operational  |
| Value (est.)         |  |
| % Use (year)         | 33-1/3%  |
| Maintenance Labor    | 100 hrs  |
| Maintenance Supplies | \$100.00<br>Spare Parts: 5A fuse<br>pump diaphragm<br>UV lamp<br>optical filters |

Figure 1.12-2. Equipment Inventory Control Form

### 1.12.2 Maintenance Schedules

The effectiveness of any maintenance program depends to a large extent on adherence to specific maintenance schedules for each major equipment item. A specific schedule is established for all routine maintenance activities. Other maintenance activities may also be identified as requiring attention on an as-needed basis. Manufacturers' recommendations provide the primary basis for the established maintenance schedules, and manufacturers' service contracts provide primary maintenance for many major instruments (e.g., GC/MS instruments, atomic absorption spectrometers, analytical balances, etc.). Maintenance activities are documented in a maintenance log which indicates the required frequency for each procedure and provides for dated entries. An example of the format used is shown in Figure 1.12-3.

### 1.12.3 Spare Parts

Along with a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment down time. This inventory should emphasize those parts (and supplies) which:

- Are subject to frequent failure;
- Have limited useful lifetimes; or
- Cannot be obtained in a timely manner should failure occur.

Field sampling task leaders and the respective laboratory managers will be responsible for maintaining an adequate inventory of necessary spare parts. In addition to spare parts and supplies inventories, Radian's non-assigned equipment represents an extensive in-house source of back-up equipment and instrumentation.

INSTRUMENT: Model 944C NOx Analyzer S/N 102

FREQUENCY: Monthly

| MAINTENANCE  | DATE | COMMENTS |
|--|------|----------|
| Fan filter: clean  |      |          |
| Ozone scrubber: Replace in 3 months or when charcoal level has dropped to 1/2" above connection. |      |          |
| Chopper Drive Belt: Check for cracks or shredding. Replace if required.                          |      |          |
| Gas Sample Particulate Filter: Replace element if required.                                      |      |          |
|  |      |          |
|  |      |          |
|  |      |          |
|  |      |          |
|  |      |          |
|  |      |          |
|  |      |          |
|  |      |          |
|  |      |          |
|  |      |          |
|  |      |          |

Figure 1.12-3. Example of Maintenance Log

### 1.13 Assessment Of Precision, Accuracy, and Completeness

The performance audits and QC analyses conducted during this project are designed to provide a quantitative assessment of the measurement data. These assessments will provide the basis for comparisons of measured emissions to results for the predictive models. The two aspects of data quality which are of primary concern are precision and accuracy. Accuracy reflects the degree to which the measured value represents the actual or "true" value for a given parameter, and includes elements of both bias and precision. Precision is a measure of the variability associated with the measurement system. The completeness of the data will be evaluated based upon the valid data percentage of the total tests conducted.

#### 1.13.1 Precision

Precision, by the definition presented in the EPA Quality Assurance Handbook for Air Pollution Measurement Systems, Volume I, Principles (EPA-600/9-76-005) is "a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions." Different measures of precision exist, depending upon these "prescribed similar conditions." Radian typically uses the EPA definitions for replicability, repeatability, and reproducibility, as summarized in Table 1.13-1, taken from the EPA Quality Assurance Handbook referred to above.

Quality control procedures, such as control sample analyses and replicate analyses, represent the primary mechanism for evaluating measurement data variability or precision. Replicate analyses will be used to define analytical replicability, while results for replicate samples may be used to define the total variability (replicability) of the sampling/analytical system as a whole.

Precision of the measurement data for this program will be based upon replicate analyses (replicability), control sample analyses (repeatability), and results for duplicate samples (sampling replicability). Variability

TABLE 1.13-1. MEASURES OF PRECISION

| Source<br>Variability   | Replicability     | Repeatability     | Reproducibility       |
|-------------------------|-------------------|-------------------|-----------------------|
| Specimen<br>(subsample) | Same or different | Same or different | Most likely different |
| Sample                  | Same              | Same              | Same                  |
| Analyst                 | Same              | <At least one of  | Different             |
| Apparatus               | Same              | these must be     |                       |
| Day                     | Same              | different>        | Same or different     |
| Laboratory              |                   | Same              | Different             |

will be expressed in terms of the coefficient of variation (CV) for the replicate and repeat analyses where:

$$CV = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

This term is independent of the error (accuracy) of the analyses and reflects only the degree to which the measurements agree with one another, not the degree to which they agree with the "true" value for the parameter measured. The CV is in units of percent since it is the standard deviation of the mean expressed as percent of the mean (relative standard deviation).

For the portable analyzer data, the daily drift checks will provide another means of controlling and assessing monitoring data precision. These data will be summarized in terms of average percent drift for each instrument.

#### 1.13.2 Accuracy

Accuracy, according to EPA's definition is "the degree of agreement of a measurement (or an average of measurements of the same thing), X, with an accepted reference or true value T." This definition actually encompasses two concepts, which creates a strong potential for confusion if the difference between the concepts is not clearly understood. The confusion arises from the discrepancy between the concept of accuracy of individual measurements and the concept of accuracy of average values obtained from replicate or repeat measurements of a given parameter. In the case of accuracy of individual measurements, accuracy includes components of bias and precision, i.e., both systematic and random error. On the other hand, accuracy of the average of individual measurements equates accuracy with bias and represents an attempt to quantitate systematic error (bias) independently of random error (precision). Under this approach, a set of measurements could be said to be accurate without being precise. Under the other approach, where individual measurements are considered, precision is a requisite of accuracy since random variability is a component of the total measurement error and does not get "averaged out."

The validity or significance of the estimate of bias is directly related to the number of individual measurements used to compute the average. It is based on the principle that as the number of individual measurements is increased indefinitely, the sample mean, X, approaches a definite value, u. The difference between u and the true value, T, represents the magnitude of the measurement bias, or systematic error. The error in each individual measurement represents this systematic bias plus random error due to imprecision.

Performance audits represent one mechanism for defining measurement system error. Typically, repeated measurements are made of the parameter of interest for the same audit sample or using additional samples at different levels, and the average error is then calculated. As discussed above, this error value represents an estimate of measurement bias or systematic error, although it is often simply referred to as "accuracy." The significance of the bias estimate may be evaluated using confidence intervals. An approximate 95% confidence interval for the mean error (bias) can be calculated using:

$$\text{Mean (X)} \pm t_{0.025(n-1)} \frac{\text{Standard Deviation}}{\sqrt{n}}$$

where n is the number of measurements used to compute the average and standard deviation and t is a tabulated statistical value (0.025 confidence level, n-1 degrees of freedom; when n is greater than 10, t approaches 2.0).

As an example, for a particular set of nine measurements, assume an overall mean of 20 ppm is reported, and that the standard deviation of these data is 10 ppm. Also, assume that the true concentration is 30 ppm. For these measurements, the 95% confidence interval is:

$$20 \pm 2.3 (10/\sqrt{9}) \quad \text{or} \quad 20 \pm 7.7$$

which is the interval (12,28). Since this interval does not include the true value, 30 ppm, a conclusion of bias is justified. The magnitude of this bias is between 2 and 18 ppm. The uncertainty in the estimate is due to variability arising from random error.

The choice of definitions of accuracy should be made based on the specific applications and the meaningfulness of the choice in the context of the application. For some measurements, for instance, it may not be possible to perform multipoint audits. In these cases, measured error will include both bias and variability due to imprecision. Regardless of the definition chosen, performance audit results provide only a point-in-time measure of accuracy, and actually reflect only the capability of the system. In most cases, the results provide some insight into the precision, as well as the bias of measurements. These data supplement data generated by the internal QC procedures. Extrapolation of the audit and QC data to actual samples and measurements provides the primary mechanism whereby error limits for various measurements may be estimated and the confidence in the measurement data defined.

Radian audit data are typically summarized in terms of "relative error." This reflects the degree to which the measured value agrees with the actual value, in terms of percent of the actual value:

$$\text{Relative Error} = \frac{\text{Measured Value} - \text{Actual Value}}{\text{Actual Value}} \times 100\%$$

This way of expressing accuracy allows for a comparison of accuracy at different levels (e.g., different concentrations) and for different parameters of the same type (e.g., different compounds analyzed by the same method). In summarizing audit results, mean relative errors (or percent recoveries) are usually presented. In most cases, the variability in these error measurements reflects one aspect of the overall precision associated with the measurement system. This variability is frequently quantitated in terms of the standard deviation of the relative error (or percent recovery), which is also presented.

Daily control samples analyses may also be used to assess measurement bias. While performance audit results represent a point-in-time assessment of measurement error, the average degree of agreement between measured

values and actual values for control samples provides a long-term or average estimate of measurement bias, as well as precision (repeatability).

1.13.3 Completeness

Measurement data completeness is a measure of the extent to which the database resulting from a measurement effort fulfills objectives for the amount of data required. For this program, completeness will be defined as the valid data percentage of the total tests conducted.

7  
7  
2  
0

#### 1.14 Corrective Action

During the course of the Carswell AFB site characterization program, it will be the responsibility of the Project Director, Supervising Geologist, and sampling team members to see that all measurement procedures are followed as specified and that measurement data meet the prescribed acceptance criteria. In the event a problem arises, it is imperative that prompt action be taken to correct the problem. Problems requiring major corrective action will be documented by the use of "Malfunction Reporting Forms" as presented in Figure 1.14-1. The QC Coordinator will be included in the distribution for each malfunction report issued for this program. The Project Director or Supervising Geologist will initiate corrective action in the event of QC results which exceed acceptability limits or upon identification of some other problem or potential problem. Corrective action may also be initiated by the QA Coordinator based upon QC data or audit results. The corrective action scheme is shown in the form of a flow chart in Figure 1.14-2. Acceptability limits and prescribed corrective action related to the various internal QC checks are discussed in Section 1.10.

In addition to the malfunction reporting system for addressing problems identified from within the program through the internal quality control system, a system for issuing formal Recommendations for Corrective Action (RCAs) exists for addressing problems identified through independent quality assurance review. RCAs may be issued only by a member of the Research and Engineering Quality Assurance (QA) Group, or by their designee in a specific QA role. Each RCA addresses a specific problem or deficiency, usually identified during QA audits of laboratory or project operations. Although the RCA system (and form) provides for distinguishing among problems of different urgency, RCAs are typically issued only to address significant, systematic deficiencies. An example RCA form is presented as Fig 1.14-3. Each of these formal written recommendations requires a written response from the responsible party (i.e., to whom the RCA was issued). A system has been established to track these RCAs and the corresponding responses. On a monthly basis a

**MALFUNCTION REPORT**

Malfunction Type \_\_\_\_\_ Urgency Level \_\_\_\_\_  
1 - QC Limits Exceeded 1 - Requires immediate attention  
2 - Documentation 2 - Should be addressed within 7 days  
3 - Other (explain) 3 - Requires written explanation  
within 14 days.

Laboratory: \_\_\_\_\_ Reported to: \_\_\_\_\_

Location: \_\_\_\_\_ Position: \_\_\_\_\_

Contract: \_\_\_\_\_

Date/Time of Malfunction: \_\_\_\_\_ Date Reported: \_\_\_\_\_

Malfunction Reported by: \_\_\_\_\_

Matrix:  Solid  Liquid Hydrocarbon  Groundwater  Air

Description of Problem: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Action: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Date/Time Resolved: \_\_\_\_\_ By Whom: \_\_\_\_\_

(Upon completion, send copies to distribution listed and return original to person who reported the malfunction.)

White - Original  
Yellow - Laboratory Supervisor's Copy  
Pink - Originator's Copy

Distribution: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Figure 1.14.1. Malfunction Reporting Form

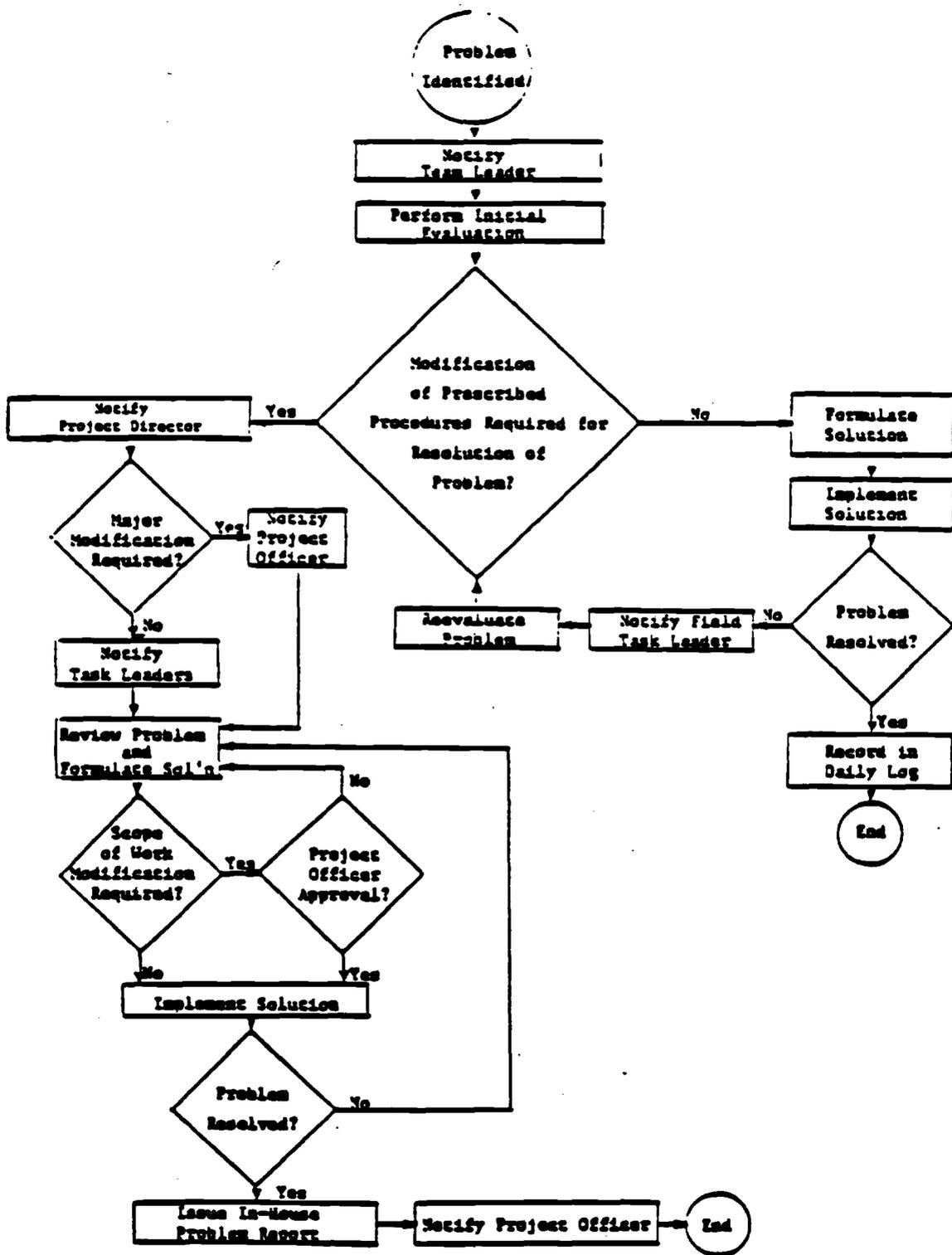


Figure 1.14-2. Corrective Action Flow Scheme



RESEARCH & ENGINEERING

# RECOMMENDATION FOR CORRECTIVE ACTION

|   |       |   |
|---|-------|---|
| RCA NO.:  | DATE: | <b>URGENCY LEVEL</b> <input type="checkbox"/><br>1. Problem of first and last use of problem.<br>2. Problem of first to second use only concern.<br>3. Suggested improvement. |
| CREATOR:  |       |   |
| ORGANIZATION/INDIVIDUAL RESPONSIBLE FOR ACTION: |       |   |

### A. Problem Identification

|                         |         |                          |
|-------------------------|---------|--------------------------|
| SITE/LAB:               | SYSTEM: | DATE PROBLEM IDENTIFIED: |
| DESCRIPTION OF PROBLEM: |         |                          |

### B. Recommended Corrective Action

|              |               |
|--------------|---------------|
| DESCRIPTION: | IMPLEMENT BY: |
|--------------|---------------|

### C. Problem Resolution

|                            |              |                |                           |
|----------------------------|--------------|----------------|---------------------------|
| PLANNED CORRECTIVE ACTION: | PROPOSED BY: | DATE PROPOSED: | SCHEDULED IMPLEMENTATION: |
|----------------------------|--------------|----------------|---------------------------|

|                                |                   |
|--------------------------------|-------------------|
| IMPLEMENTED CORRECTIVE ACTION: | DATE IMPLEMENTED: |
|--------------------------------|-------------------|

### D. QA Verification

|              |       |
|--------------|-------|
| VERIFIED BY: | DATE: |
|--------------|-------|

When Copied

When Laboratory Subscribed/Graded/Checked/Ready

When Copied's Copy

3.87 70-10

Figure 1.14-3. Recommendation for Corrective Action Form

summary report of the "unresolved" RCAs is prepared by the QA group and issued to the work areas that each manager is responsible for and the current status of each. Each RCA requires the response and verification by the QA group that the corrective action has been implemented before the status is changed on the monthly report. In the event that there is no response to an RCA within 30 days, or the proposed corrective action is disputed, the recommendation and/or conflict is pursued to successively higher management levels until the issue is resolved.

1.15 Quality Assurance Reporting

Effective management of a field sampling and analytical effort requires timely assessment and review of field activities. This will require effective interaction and feedback between the field team members, Supervising Geologist, Project Director, and the QA Coordinator.

The Supervising Geologist and appropriate project team members will be responsible for keeping the QA Coordinator and Project Director up to date regarding status of their respective tasks so that quick and effective solutions can be implemented should any data quality problems arise. At a minimum, this should include frequent (weekly or biweekly) QC data summaries and test data summaries. The use of frequent status reports also provides an effective mechanism for ensuring ongoing evaluation of measurement efforts. These status reports may address some or all of the following:

- Summary of activities and general program status,
- Summary of calibration data and QC data,
- Summary of unscheduled maintenance activities,
- Summary of corrective action activities,
- Status of any unresolved problems,
- Assessment and summary of data completeness, and
- Summary of any significant QA/QC problems and recommended and/or implemented solutions not included above.

#### 1.15.1 Quality Assurance Reporting

The QA Coordinator will prepare audit reports following each performance and systems audit which address the audit results and provide a qualitative assessment of overall system performance. These reports are submitted to the Program Manager, Project Director, and Task Leaders.

Major project (campaign) reports will include separate QA/QC sections which summarize audit results and QC data collected during the program.

Problems requiring swift resolution will be brought to the immediate attention of the Project Director via the malfunction reporting/corrective action scheme discussed in Section 1.14.

#### 1.15.2 Quality Control Data Reporting

The QC Coordinator has the responsibility of reviewing all on-site sampling and analytical activities to ensure compliance with the QC requirements outlined in this QAPP. This review serves as a control function in that it should be conducted on a daily basis so that deviations from project requirements will be immediately identified and corrected. These reviews will be summarized in standardized, weekly reports to the program QA/QC Coordinator, and Project Director.

On a monthly basis, these weekly reports will be compiled along with summaries of the analytical quality control results received from each laboratory. The compilation of these results will serve an assessment function and reflect the current quality status for analytical work being conducted. Details of the required review and reporting tasks are presented in this section.

#### 1.15.2.1 Sampling Quality Control Review and Reporting Requirements

Sampling activities will be reviewed on a daily basis to determine if the sampling quality control requirements are being fulfilled. In other words, were the proper numbers of blanks and duplicate samples taken for each parameter sampled?

A weekly summary of this information will be prepared using Figure 1.15-1 and submitted to the QA Coordinator and Project Director. Each week will run from Sunday through Saturday. This report will be due on Tuesday of the week following the period reported.

#### 1.15.2.2 Analytical Quality Control Review and Reporting Requirements

On a weekly basis, a summary report will be prepared by the Supervising Geologist that tabulates what analytical results were received by Sample Control during the week. Each week will run from Sunday through Saturday. The sample control numbers and other pertinent information will be taken from each data package received. This report will be due to the QA Coordinator, Analytical Task Leaders, and Project Director by Tuesday of the week following the period reported.

Also, on a weekly basis, each data package received will be reviewed for completeness and adherence to the quality control protocol established for each type of analysis. A summary report will be made for each data package detailing what QC data were reported to support the analytical results. These summary reports will accompany the "data received" summaries each week. Malfunction reports will be issued by the on-site QC Coordinator addressing any abnormalities or deviations from the established quality control protocols.

**DUPLICATE AND BLANK SAMPLE SUMMARY**

PERIOD \_\_\_\_\_ PREPARED BY \_\_\_\_\_ DATE \_\_\_\_\_

| PARAMETER | SOURCE TYPE | SAMPLING METHOD | NUMBER OF SAMPLES | DUPLICATES      |                  | BLANKS |                  |
|-----------|-------------|-----------------|-------------------|-----------------|------------------|--------|------------------|
|           |             |                 |                   | NUMBER OF PAIRS | PERCENT OF TOTAL | NUMBER | PERCENT OF TOTAL |
|           |             |                 |                   |                 |                  |        |                  |
|           |             |                 |                   |                 |                  |        |                  |
|           |             |                 |                   |                 |                  |        |                  |
|           |             |                 |                   |                 |                  |        |                  |

Total number of samples collected during the indicated period, not counting the second sample of each duplicate pair.

Figure 1.15-1. Example of Duplicate and Blank Sample Summary

### 1.15.2.3 Monthly QC Progress Reports

The quality control activities will be summarized on a monthly basis in a progress report to the Project QA Coordinator. The monthly QC report will cover a calendar month and will be due by the 10th of the month following the period covered in the report. The following format will be used in preparing these reports.

- Section 1.0 - Introduction and Summary

This section will briefly outline what programs are currently underway and what type of samples are being collected for each.

The section should start with, "Programs currently underway as part of the Carswell AFB IRP Phase II Stage 2 study are Program X, Program Y, and Program Z. Program X involves the characterization of groundwater quality at Site 1. Sampling for this program consists of collecting groundwater samples from three monitor wells. Program Y ..." Programs, past or present, for which analytical data were received during the month should also be described.

A brief summary of the major QC problems noted during the month will be presented. These will be discussed in detail in Section 5 and should be presented here as a statement of the nature of the problem and the area affected.

- Section 2.0 - Sampling QC Activities

This section will discuss in detail what sampling activities were conducted during the month and what sampling QC was performed. Included will be copies of the weekly "duplicate and blank samples summaries" (Figure 1.15-1). Any deviations from

the required sampling QC will be discussed in this section with a description of what steps were taken to correct the problems.

- Section 3.0 - Analytical QC Activities

This section will discuss what analytical data were received during the month and what analytical QC was performed. Any deviations from the required analytical QC will be discussed in this section with a description of what steps were taken to correct the problems.

- Section 4.0 - Summary of QC Data

This section will contain printed tables of the QC data received during the month. Each table will be specific for type of matrix, method of analysis, and control check. A discussion of any problems noted will be made with consideration given to impact and corrective action required.

- Section 5.0 - Malfunctions Reported and Completed

This section will contain a discussion of malfunctions that were addressed during the month. Copies of the corresponding "malfunction reports" will be included. Additionally, any previously reported malfunctions that were corrected during the month will be discussed. Included will be copies of the completed malfunction reporting forms.

## 2.0 METHODS PROTOCOLS

The methods and protocols to be used to accomplish the field program are described in this section.

### 2.1. Magnetometer Surveys

Magnetometer surveys will be accomplished at Sites 1 and 10 using an EDA PPM500 proton magnetometer or equivalent. The magnetometer will detect any buried metal objects. Readings of the total field and the magnetic gradient will be taken to determine the positions and size of the buried objects. The units for these readings are gammas/1/2 meter. Magnetic surveys will be accomplished by first delineating an area of low magnetic gradient to be used as a magnetic base station. The magnetic base station will be used to measure the natural flux of the earth's magnetic field over time, and to detect the effects of magnetic storms which could affect the validity of the survey. Once a base station is defined, profiles will be run across the site with readings taken at regular intervals spaced to delineate the presence and character of buried magnetically susceptible objects. Readings will be taken at the base station before the site survey begins, and roughly every hour thereafter to estimate the flux of the total field. Values recorded along the profiles will include the time of reading, and the magnetic values will be adjusted for the flux measured in the total field. Final adjusted readings will be plotted on stacked profiles for comparison and identification of anomalies by standard interpretation techniques for source and depth.

### 2.2 Drilling Techniques

Drilling will be accomplished using a hollow-stem auger rig for the upper zone monitor wells and soil borings and a rotary drilling rig (using both mud and air) for installation of the Paluxy monitor well. Borehole locations will be located on a project map for each specific site or zone. The field investigation including all drilling and sampling operations will be

supervised by a qualified professional geologist or hydrogeologist. A detailed log of the conditions and materials penetrated during the course of the work will be maintained by the geologist or hydrogeologist on site. Decisions on well locations, well depths, screened intervals and other well construction details will be made by the USAFOEHL Technical Program Manager and Radian's Supervising Geologist and Project Director.

#### 2.2.1 Hollow-Stem Augering

A hollow-stem auger drill rig using five-foot sections of eight-inch O.D. hollow-stem auger, will be used to perform all shallow soil borings and the installation of upper zone monitor wells. The hollow stem auger method will allow for accurate examination of soil conditions, identification of the position of the water table, and recovery of soil samples. Soil samples will be collected with a standard split-spoon sampler at 5-foot intervals. The recovered samples will be described in terms of lithology and moisture, and retained. Selected samples will be frozen and shipped to the laboratory for chemical analysis. After the completion of the boring, the groundwater level will be measured before the screen and casing of the monitoring well are installed. Boreholes that are not completed as permanent wells will be entirely plugged to the surface with a bentonite/cement slurry.

All augers and drilling equipment that has been in contact with the soil will be thoroughly cleaned prior to drilling at the next well location. The method of decontamination will be high pressure steam cleaning.

#### 2.2.2 Mud/Air Rotary Drilling (Optional)

Mud/Air rotary drilling for the Paluxy monitor well will be performed, if necessary, with a Gardner-Denver 1500 CD (or equivalent) truck mounted rig. A six-inch bit will be used to advance a pilot borehole through the upper zone alluvial material to a depth at least 5 feet into the underlying Goodland Limestone. The borehole will then be reamed to a diameter of

14-inches. A 10-inch diameter steel casing will then be installed to the full depth of the borehole and the annular space grouted. Upon achieving a positive seal, the borehole will be advanced using a 6-inch diameter bit to the final depth of the shale unit dividing the upper and lower Paluxy Formation. Bentonite drilling fluid will be used while drilling in the Paluxy Formation. This material will be used to help prevent hole collapse. As the borehole is advanced, the cuttings that discharge at the surface will be examined and described. Drilling conditions, such as relative rate and ease of penetration will be noted by the driller. Water encountered during drilling will be noted with respect to depth and rate of production. If necessary, drilling will be temporarily suspended to allow for recovery of water in the borehole.

### 2.3 Monitor Well Installation

Groundwater monitoring wells will be installed using the hollow-stem auger method in the upper aquifer, while mud/air rotary will be used to install the optional monitor well in the Paluxy Aquifer. Monitor wells will be installed upon completion of the drilling operations. The decisions relating to the setting of the screen and casing, length of screen, and amount of gravel pack for each well will be made on the basis of the observed static water level. If appropriate, the borehole will be allowed to remain open overnight to determine the static level.

#### 2.3.1 Hollow-Stem Auger Method

The steps used in constructing a monitoring well through the hollow-stem auger are as follows:

- Screen and casing sections will be cleaned and assembled on the ground, then carefully lowered into the borehole. Two-inch I.D., flush joint Schedule 40 PVC casing with a slotted screen is placed inside the augers and positioned as directed by the supervising geologist/hydrogeologist. The length of the screen

will be a minimum of 10 feet in length and a maximum of thirty-five feet in length and the slot size will not exceed 0.020-inch. A cap will be placed at the bottom of the screen.

- Following casing and screen placement, a gravel pack (washed and bagged silica sand or gravel) having a grain size distribution compatible with the screen slot size is slowly placed between the well screen and the auger before the augers are pulled. As the augers are pulled, the gravel pack settles around the screen. The top of the gravel pack is placed approximately three feet above the top of the screen. After the gravel pack height is measured, a three foot bentonite seal (granulated or pellets) is emplaced through the augers directly on top of the gravel pack. After the bentonite has formed a complete seal, the remainder of the annulus is grouted to land surface with a Type I Portland cement and bentonite slurry.
  
- If well stick-up is of concern in an area, the well will be completed flush with the land surface. The specifications for a below surface well completion are as follows. Cut the casing two to three inches below land surface, and install a protective locking lid with a cast iron valve box assembly. Center the lid assembly in a three foot diameter concrete pad sloped away from the valve box. Ensure that free drainage is available within the valve box. Also, provide a screw-type casing cap to prevent infiltration of surface water. Maintain a minimum of one foot clearance between the casing top and the bottom of the valve box. Clearly mark the well number on the valve box lid and well casing. Securely lock the valve box lid.
  
- For above ground well completions, the well casing will extend two to three feet above land surface. The specifications for an above land surface well completion are as follows. Provide

an end plug or casing cap for each well. Shield the extended casing with a steel guard pipe which is placed over the casing and cap, and seated in a two-foot by two-foot by four-inch concrete surface pad. Slope the pad away from the well sleeve. Install a lockable cap or lid on the guard pipe. If added protection is needed, three, three-inch diameter cement filled posts will be installed. Securely lock the guard pipe lid.

- The wells will be developed by using a submersible pump, bailer and/or air lift method. The flow rate of the water, pH, specific conductance, and water temperature will be recorded prior to terminating development. Well development will continue until the discharge water is clear and free of sediment and field parameters have stabilized.

### 2.3.2 Mud/Air Rotary Method (Optional)

After mud/air rotary drilling operations are completed, the monitor well in the Paluxy Aquifer will be installed as follows. Screen and casing (previously washed), consisting of 5-inch diameter Schedule 80 PVC and a 10 to 35-foot section of screen with a maximum slot size of 0.020 inch will be installed into a 10-inch borehole. Gravel pack material will be placed into the annular space to a level three feet above the top of the screen. Bentonite pellets will be added to form a three foot thick seal, and then the annular space will be grouted to the surface by the tremie pipe method. A 1/3 horsepower stainless steel submersible pump will be installed in the well. A protective casing, surface electrical connections, and a concrete well pad will be placed after the pump is installed. Finally the well will be securely locked. The well will be developed using the same techniques presented in Section 2.3.1.

### 2.3.3 Aquifer Testing

Slug tests will be performed at selected locations by removing a slug of water by pumping or bailing the well and measuring the recovered water level with time. The water is removed to a point not to exceed the top of the screened interval. This is done to avoid partial dewatering of the formation. The method used to calculate the hydraulic conductivities was developed by Bouwer and Rice (1976). The formula for calculating hydraulic conductivity using field data is as follows:

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L} \frac{1}{t} \ln \frac{y_o}{y_t}$$

$r_c$  - radius of well (feet)

$R_e$  - effective radius over which  $y$  is dissipated

$r_w$  - radius of borehole

$\ln$  - natural log

$L$  - length of screen (feet)

$t$  - time (seconds) between change in water levels from  $y_o$  to  $y_t$

$y_o$  - difference between water level at start of test and static water level

$y_t$  - difference between water level at time  $t$  in seconds after test started and static water level

### 2.4 Sample Collection

Sampling and analytical efforts associated with the Carswell AFB Phase II Stage 2 study are aimed at characterization of the soil, surface water and groundwater in areas of past and present waste disposal activities. Sampling activities will include:

- Collection of water samples (groundwater and surface water);
- Collection of solid samples (soil, sediment); and
- Subsurface gas sampling (soil gas probe).

Approaches that will be used for the collection of these samples are summarized in Tables 2-1 and 2-2, along with sample storage procedures, holding times, and corresponding analytical methods. Brief descriptions of each of the sampling approaches are presented in the remainder of this section.

#### 2.4.1 Water Samples

##### Groundwater Samples

Groundwater samples will be collected from new and selected existing monitoring wells.

Monitor Well Sampling--Water samples will be collected from monitoring wells using a permanently installed submersible electric pump, or a Teflon bailer (Figure 2-1). Sample quantities and preservation are specified in the individual work plan for each phase of the investigation or may be taken from Table 2-2.

Prior to collecting a sample, the water level will be checked using a water sensing probe. Water levels will be measured to the nearest 0.01 foot. Following each well measurement, the probe and associated cord will be thoroughly cleaned with deionized water to prevent cross contamination. Each well will also be purged prior to collecting a sample. Purging will be performed using a dedicated pump or bailer, or a portable bladder pump or submersible piston pump (Figures 2-2 and 2-3). At least three well volumes will be purged, and the water appropriately contained and removed.

The bladder pump consists of a stainless steel body, Teflon sampling lines, and a replaceable silicon bladder. The bladder pump is actuated by compressed air. The compressed air used to drive the pump does not contact the sample. The bladder pump is placed near the bottom of the well for

TABLE 2-1. SOLID/ANALYTICAL SUMMARY

| Reference Method | Parameter                               | Method          | Detection Limit | Method Type     | Container Type, No. and Volume                               | Preservation and Storage Requirements | Sample Extraction Procedures            | Maximum Holding Time (Preparation) | Maximum Holding Time (Analysis) |
|------------------|---|-----------------|-----------------|-----------------|--|---------------------------------------|---|------------------------------------|---------------------------------|
| EPA 8270         | Semi-Volatile Organic Compounds         | GC/MS           | 1 ug/g          | GC/MS           | (1) 250 mL stainless steel sleeve or (1) 250 mL glass bottle | Refrigerated at 4°C                   | Sonication (3550)                       | 14 days                            | 40 days                         |
| EPA 6010         | Metals: (1)                             | ICP Emission    | 0.2 - 90 ug/g   | ICP Emission    | 250 mL glass bottle  | Refrigerated at 4°C                   | Acid digestion (3050R)                  | N/S                                | 6 months                        |
| EPA 7060         | Metals: As                              | Fluorescence AA | 0.5 ug/g        | Fluorescence AA | 250 mL Glass Bottle  | Refrigerated at 4°C                   | Acid digestion (3050R)                  | N/S                                | 6 months                        |
| EPA 7740         | Metals: Se                              | Fluorescence AA | 0.5 ug/g        | Fluorescence AA | 250 mL Glass Bottle  | Refrigerated at 4°C                   | Acid digestion (3050R)                  | N/S                                | 6 months                        |
| EPA 7471         | Metals: Hg                              | Cold Vapor AA   | 0.5 ug/g        | Cold Vapor AA   | 250 mL Glass Bottle  | Refrigerated at 4°C                   | Acid digestion (3050R)                  | N/A                                | 28 days                         |
| EPA 413.2        | Oil and Grease                          | Infrared        | 10 ug/g         | Infrared        | 250 mL glass bottle  | Refrigerated at 4°C                   | Freon Extraction by Sonication (3550)   | N/S                                | 28 days                         |
| EPA 8040         | Volatile Organic Compounds              | GC/MS           | 0.1 ug/g        | GC/MS           | 250 mL Glass Bottle  | Refrigerated at 4°C                   | Purge and Trap (5090)                   | 14 days                            | 14 days                         |
| EPA 418.1        | Petroleum Hydrocarbons                  | IR              | 50 ug/g         | IR              | 250 mL Glass Bottle  | Refrigerated at 4°C                   | Sonication extraction (3550) with Freon | N/S                                | 28 days                         |
| EPA 8150         | Chlorinated Phenacy Herbicides (3)      | GC/ED           | 0.1 - 160 ug/g  | GC/ED           | 250 mL Glass Bottle  | Refrigerated at 4°C                   | Extraction, hydrolysis, GC              | 7 days                             | 40 days                         |
| EPA 8080         | Organochloride (4) Pesticides and PCB's | GC/ED           | 0.01 - 0.2 ug/g | GC/ED           | 250 mL Glass Bottle  | Refrigerated at 4°C                   | Sonication Extraction (3550)            | 7 days                             | 40 days                         |

2025 RELEASE UNDER E.O. 14176

TABLE 2-1. (CONTINUED)

| Reference Method         | Parameter                   | Method Detection Limit | Method Type        | Container Type, No. and Volume | Preservation and Storage Requirements | Sample Preparation Procedures            | Minimum Holding Time (Preparation) | Maximum Holding Time (Analysis) |
|--------------------------|-----------------------------|------------------------|--------------------|--------------------------------|---------------------------------------|--|------------------------------------|---------------------------------|
| 40 CFR 261.21 (EPA 1310) | EP Toxicity                 | 0.002-0.5 mg/L         | Extraction AA, ICP | 250 mL Glass                   | Refrigerated at 4°C                   | Extraction                               | N/S                                | 28 days                         |
| EPA 7420                 | Lead                        | 0.5 mg/g               | AA (flameless)     | 250 mL Glass Bottle            | Refrigerated at 4°C                   | Acid digestion (3050R)                   | N/S                                | 6 months                        |
| EPA 8140                 | Organophosphorus Pesticides | 0.5 - 5 ug/g           | GC                 | 250 mL Glass Bottle            | Refrigerated at 4°C                   | Sonication, Extraction (3550) with Freon | 7 days                             | 40 days                         |
| ASTM D2216               | Soil Moisture               |                        |                    |                                |                                       |  |                                    |                                 |

(1) Metals in water and soil/sediment samples. Limits of Detection must be at or below the values specified. (E206.7, SM5018)

| Metal      | Detection Limits                |                       |
|------------|---------------------------------|-----------------------|
|            | Water (ug/L)                    | Soil/Sediment (mg/kg) |
| Aluminum   | 0.2                             | 20                    |
| Antimony   | 0.2                             | 20                    |
| Arsenic    | 0.3                             | -                     |
| Ba         | 0.01                            | 1                     |
| Beryllium  | 0.002                           | 0.2                   |
| Boron      | 0.03                            | 3                     |
| Cadmium    | 0.005                           | 2                     |
| Calcium    | 0.05                            | 5                     |
| Chromium   | 0.03                            | 4                     |
| Cobalt     | 0.04                            | 4                     |
| Copper     | 0.03                            | 3                     |
| Iron       | 0.04                            | 4                     |
| Lead       | 0.2                             | 20                    |
| Magnesium  | 0.2                             | 20                    |
| Manganese  | 0.01                            | 1                     |
| Molybdenum | 0.04                            | 4                     |
| Nickel     | 0.015                           | 5                     |
| Potassium  | (determine at time of analysis) |                       |
| Selenium   | 0.4                             | -                     |
| Silica     | 0.3                             | 30                    |
| Silver     | 0.03                            | 4                     |
| Sodium     | 0.9                             | 90                    |
| Thallium   | 0.2                             | 20                    |
| Vanadium   | 0.04                            | 4                     |
| Zinc       | 0.01                            | 1                     |

01/14/14

TABLE 2-1. (CONTINUED)

(2) Volatile organic compounds (VOCs) in water and soil/sediment samples. Limits of detection must be at or below the values specified. (E624, SW6240)

| Analyte                      | Detection Limits |                       |
|------------------------------|------------------|-----------------------|
|                              | Water (ug/L)     | Soil/Sediment (mg/kg) |
| Acetone                      | 10               | 0.1                   |
| Benzene                      | 3                | 0.1                   |
| Bromodichloromethane         | 5                | 0.1                   |
| Bromoform                    | 5                | 0.1                   |
| Bromomethane                 | 10               | 0.1                   |
| 2-Butanone (MEK)             | 10               | 0.1                   |
| Carbon disulfide             | 5                | 0.1                   |
| Carbon tetrachloride         | 3                | 0.1                   |
| Chlorobenzene                | 5                | 0.1                   |
| Chloroethane                 | 10               | 0.1                   |
| 2-Chloroethyl vinyl ether    | 10               | 0.1                   |
| Chloroform                   | 5                | 0.1                   |
| Chloromethane                | 10               | 0.1                   |
| Dibromochloromethane         | 5                | 0.1                   |
| 1,2-Dichlorobenzene          | 5                | 0.1                   |
| 1,3-Dichlorobenzene          | 5                | 0.1                   |
| 1,4-Dichlorobenzene          | 5                | 0.1                   |
| 1,1-Dichloroethane           | 5                | 0.1                   |
| 1,2-Dichloroethane           | 3                | 0.1                   |
| 1,1-Dichloroethene           | 3                | 0.1                   |
| trans-1,2-Dichloroethene     | 5                | 0.1                   |
| 1,2-Dichloropropane          | 5                | 0.1                   |
| cis-1,3-Dichloropropene      | 5                | 0.1                   |
| trans-1,3-Dichloropropene    | 5                | 0.1                   |
| Diethyl ether                | 10               | 0.1                   |
| Ethylbenzene                 | 5                | 0.1                   |
| Methylene chloride           | 5                | 0.1                   |
| 2-Methyl-2-pentanone (MIBK)  | 10               | 0.1                   |
| 1,1,2,2-Tetrachloroethane    | 5                | 0.1                   |
| Tetrachloroethene            | 3                | 0.1                   |
| Toluene                      | 5                | 0.1                   |
| 1,1,1-Trichloroethane        | 5                | 0.1                   |
| 1,1,2-Trichloroethane        | 5                | 0.1                   |
| Trichloroethene              | 3                | 0.1                   |
| Trichlorofluoromethane       | 10               | 0.1                   |
| Vinyl chloride               | 0.5              | 0.1                   |
| Xylenes (total, all isomers) | 5                | 0.1                   |

TABLE 2-1. (CONTINUED)

(3) Chlorinated phenoxy acid herbicides in water and soil/sediment samples. Limits of Detection must be at or below the values specified. (AS098, SW8150)

| Analyte           | Detection Limits |                       |
|-------------------|------------------|-----------------------|
|                   | Water (ug/L)     | Soil/Sediment (mg/kg) |
| 2,4-D             | 6.0              | 0.8                   |
| 2,4,5-T           | 1.0              | 0.1                   |
| 2,4,5-TP (Silvex) | 0.8              | 0.1                   |
| 2,4-DB            | -                | 0.6                   |
| Desapon           | -                | 3.9                   |
| Dicamba           | -                | 0.18                  |
| Dichloroprop      | -                | 0.44                  |
| Dinoseb           | -                | 0.05                  |
| MCPA              | -                | 166.                  |
| MCPP              | -                | 128.                  |

W/S - Not specified in method  
 W/A - See specific method for specific analyte  
 S1 - Standard Method  
 W/A - not applicable  
 W/S - not specified

(4) Organochlorine pesticides in water and soil/sediment samples. Limits of detection must be at or below the values specified. (E608, SW8080)

| Parameter          | Detection Limits |                       |
|--------------------|------------------|-----------------------|
|                    | Water (ug/L)     | Soil/Sediment (mg/kg) |
| Aldrin             | 0.05             | 0.01                  |
| alpha-BHC          | 0.05             | 0.01                  |
| beta-BHC           | 0.05             | 0.01                  |
| delta-BHC          | 0.05             | 0.01                  |
| gamma-BHC          | 0.05             | 0.01                  |
| Chlordane          | 0.05             | 0.1                   |
| 4,4'-DDD           | 0.1              | 0.02                  |
| 4,4'-DDE           | 0.1              | 0.02                  |
| 4,4'-DDT           | 0.1              | 0.02                  |
| Dieldrin           | 0.02             | 0.02                  |
| Endrin             | 0.06             | 0.02                  |
| Endrin aldehyde    | 0.1              | 0.02                  |
| Endosulfan I       | 0.05             | 0.01                  |
| Endosulfan II      | 0.1              | 0.02                  |
| Endosulfan sulfate | 0.1              | 0.02                  |
| Heptachlor         | 0.02             | 0.01                  |
| Heptachlor epoxide | 0.05             | 0.01                  |
| Toxaphene          | 1                | 0.2                   |
| PCB-1016           | 0.5              | 0.1                   |
| PCB-1221           | 0.5              | 0.1                   |
| PCB-1232           | 0.5              | 0.1                   |
| PCB-1242           | 0.5              | 0.1                   |
| PCB-1248           | 0.5              | 0.1                   |
| PCB-1254           | 1                | 0.2                   |
| PCB-1260           | 1                | 0.2                   |

TABLE 2-2. WATER SAMPLE/ANALYTICAL SUMMARY

| Reference Method | Parameter  | Method Detection Limit | Method Type                               | Container Type, No. and Volume                    | Preservation and Storage Requirements | Sample Preparation Procedures                                     | Maximum Holding Time (Preparation) | Maximum Holding Time (Analysis) |
|------------------|--|------------------------|---|---|---------------------------------------|---|------------------------------------|---------------------------------|
| 8403             | Alkalinity-Carbonates Bicarb. & Hydroxide (Field Test) | 10 mg/L                | Titration                                 | Polyethylene or borosilicate glass bottle 1-liter | Refrigerated at 4°C                   | none  | N/S                                | 14 days                         |
| 8505b            | Chlorinated Phenyl Acid Herbicides                     | 0.01 ug/L              | GC  | 1-L glass bottles 4°C w/TPE lined caps            | None                                  | Hydrolysis, Esterify, GC  | 7 days                             | 40 days                         |
| EPA 120.1        | Specific Conductance (Field Test)                      | N/S                    | Wheatstone Bridge-type conductivity meter | None  | None                                  | Determine temperature measure conductivity                        | -                                  | 2.8 days                        |
| EPA 150.1        | pH (Field Test)  | N/S                    | Electrometric pH meter                    | None  | None                                  | Measure directly in field medium                                  | -                                  | Analyze Immediately             |
| EPA 625          | Priority Pollutants (2)                                | 1-20 ug/L              | GC/MS                                     | (2) 1000 mL glass; TPE-lined cap                  | Refrigerated at 4°C                   | Continuous extraction with methylene chloride                     | 7 days                             | 40 days                         |
| EPA 200.7        | Metals (3)   | 0.002-0.9 mg/L         | ICP                                       | (1) 500 mL polyethylene bottle                    | pH < 2 w/HNO <sub>3</sub>             | HNO <sub>3</sub> HCl digestion                                    | N/S                                | 6 months                        |
| EPA 206.3        | As   | 4 ug/L                 | AA (flame)                                | (1) 500 mL polyethylene                           | pH 2 w/HNO <sub>3</sub>               | HNO <sub>3</sub> digestion  | N/S                                | 6 months                        |
| EPA 270.3        | Sr   | 2 ug/L                 | AA (flame)                                | (1) 500 mL polyethylene                           | pH 2 w/HNO <sub>3</sub>               | HNO <sub>3</sub> digestion  | N/S                                | 6 months                        |
| EPA 245.1        | Hg   | 0.2 ug/L               | AA (vapour)                               | (1) 500 mL polyethylene bottle                    | pH 2 w/HNO <sub>3</sub>               | EtOH, HNO <sub>3</sub> , H <sub>2</sub> SO <sub>4</sub> digestion | N/S                                | 6 months                        |
| EPA 413.2        | Oil & Grease   | 0.2 mg/L               | IR  | (1) 1000 mL glass bottle                          | pH 2, w/HCl, refrigerated at 4°C      | Free Extraction   | N/S                                | 28 days                         |

(Cont. In next)

TABLE 2-2. (Continued)

| Reference Method | Parameter              | Method Detection Limit | Method Type             | Container Type, No. and Volume | Preservation and Storage Requirements        | Sample Preparation Procedures       | Maximum Holding Time (Preparation) | Maximum Holding Time (Analysis) |
|------------------|------------------------|------------------------|-------------------------|--------------------------------|--|-------------------------------------|------------------------------------|---------------------------------|
| EPA 245.1        | Hg                     | 0.2 ug/L               | AA (vapoc)              | bottle                         | pH2, w/HNO <sub>3</sub>                      | HNO <sub>3</sub> , HNO <sub>3</sub> | N/S                                | 28 days                         |
| EPA 413.2        | Oil & Grease           | 0.2 mg/L               | IR                      | (1) 1000 mL glass bottle       | pH2, w/HCl, refrigerated at 4°C              | Freeze Extraction                   | N/S                                | 28 days                         |
| EPA 160.1        | Total Dissolved Solids | 10 ug/L                | Gravimetric             | (1) 1000 mL plastic bottle     | Refrigerated at 4°C                          | N/A                                 | N/S                                | 14 days                         |
| EPA 170.1        | Temperature            | N/A                    | Thermometric            | (1) 500 mL plastic bottle      | None   | N/A                                 | N/A                                | Analyze Immediately             |
| EPA 8020         | Purgeable Aromatics    | 0.2-0.4 ug/L           | GC/PID                  | (3) 40 mL WDA vial             | pH2, w/111 HCl, refrigerated at 4°C          | Nitrogen purge                      | N/S                                | 14 days                         |
| EPA 601          | Purgeable Halocarbons  | 0.02-5.0 ug/L          | GC/MSD                  | (3) 40 mL WDA vial             | Refrigerated at 4°C                          | Nitrogen purge                      | N/S                                | 14 days                         |
| EPA 325.3        | Chloride               | 1 mg/L                 | Titration               | (1) 1-L Polyethylene           | Refrigerated at 4°C                          | None                                | N/S                                | 28 days                         |
| EPA 240.2        | Fluoride               | 0.1 mg/L               | Ion Selective Electrode | (1) 1-L Polyethylene           | Refrigerated at 4°C                          | None                                | N/S                                | 28 days                         |
| EPA 353.1        | Nitrate                | 0.02 mg/L              | Colorimetry             | (1) 500 mL Polyethylene        | 4°C, pH < 2 w/H <sub>2</sub> SO <sub>4</sub> | None                                | N/S                                | 14 days                         |
| EPA 375.4        | Sulfate                | 1 mg/L                 | Turbidimetry            | (1) 1-L Polyethylene           | Refrigerated at 4°C                          | None                                | N/S                                | 28 days                         |
| EPA 365.1        | O-Phosphate            | 0.02 mg/L              | Colorimetry             | (1) 500 mL Polyethylene        | 4°C, pH < 2 w/H <sub>2</sub> SO <sub>4</sub> | None                                | N/S                                | 28 days                         |

(Cont. In next)

TABLE 2-2. (Continued)

| Reference Method | Parameter                     | Method Detection Limit | Method Type | Container Type, No. and Volume | Preservation and Storage Requirements | Sample Preparation Procedures | Maximum Holding Time (Extraction) | Maximum Holding Time (Analysis) |
|------------------|-------------------------------|------------------------|-------------|--------------------------------|---------------------------------------|-------------------------------|-----------------------------------|---------------------------------|
| EPA 604          | Fluoride (4)                  | 0.5 - 80 ug/L          | GC          | (2) 1-L Glass Bottle           | Refrigerated at 4°C                   | Methylene Chloride Extraction | 7 days                            | 40 days                         |
| EPA 608          | Organochloride Pesticides (5) | 0.05 - 1 ug/L          | GC          | (2) 1-L Glass Bottle           | 4°C pH 5 to 9                         | Methylene Chloride Extraction | 7 days                            | 40 days                         |
| EPA 239.2        | Lead                          | 0.005 ug/L             | AA(furnace) | (1) 500 mL Polyethylene        | 4°C, pH < 2 w/NO <sub>3</sub>         | HNO <sub>3</sub> Digestion    | N/S                               | 6 months                        |
| EPA 418.1        | Petroleum Hydrocarbons        | 1 ug/L                 | IR          | (1) 1-L Glass Bottle           | 4°C, pH < 2 w/HCl                     | Freon Extraction              | N/S                               | 28 days                         |

(1) Chlorinated phenoxy acid herbicides in water and soil/sediment samples. Limits of Detection must be at or below the values specified. (AS098, SW8150)

| Analyte           | Detection Limits |                       |
|-------------------|------------------|-----------------------|
|                   | Water (ug/L)     | Soil/Sediment (mg/kg) |
| 2,4-D             | 6.0              | 0.8                   |
| 2,4,5-T           | 1.0              | 0.1                   |
| 2,4,5-TP (Silvex) | 0.8              | 0.1                   |
| 2,4-DB            | -                | 0.6                   |
| Dalepon           | -                | 3.9                   |
| Dicamba           | -                | 0.18                  |
| Dichloroprop      | -                | 0.44                  |
| Dinoseb           | -                | 0.05                  |
| MCPA              | -                | 166.                  |
| MCPP              | -                | 128.                  |

TABLE 2-2. (continued)

(2) Semivolatile organic compounds in water and soil/sediment samples.  
 Limits of detection must be at or below the values specified.  
 (E625, SW8270)

| Analyte (Base/neutral & acid extractables) | Detection Limits |                       |
|--|------------------|-----------------------|
|  | Water (ug/L)     | Soil/Sediment (mg/kg) |
| Acenaphthene                               | 10               | 0.5                   |
| Acenaphthylene                             | 10               | 0.5                   |
| Anthracene                                 | 10               | 0.5                   |
| Benzo(a)anthracene                         | 10               | 0.5                   |
| Benzo(b)fluoranthene                       | 10               | 0.5                   |
| Benzo(k)fluoranthene                       | 10               | 0.5                   |
| Benzo(a)pyrene                             | 10               | 0.5                   |
| Benzo(ghi)perylene                         | 10               | 0.5                   |
| Benzyl butyl phthalate                     | 10               | 0.5                   |
| 4-Bromophenyl phenyl ether                 | 10               | 0.5                   |
| bis(2-Chloroethoxy)methane                 | 10               | 0.5                   |
| bis(2-Chloroethyl) ether                   | 10               | 0.5                   |
| bis(2-Chloroisopropyl) ether               | 10               | 0.5                   |
| 2-Chloronaphthalene                        | 10               | 0.5                   |
| 4-Chlorophenyl phenyl ether                | 10               | 0.5                   |
| Chrysene                                   | 10               | 0.5                   |
| Dibenzofluoranthene                        | 10               | 0.5                   |
| Di-n-butylphthalate                        | 10               | 0.5                   |
| 1,2-Dichlorobenzene                        | 5                | 0.5                   |
| 1,3-Dichlorobenzene                        | 5                | 0.5                   |
| 1,4-Dichlorobenzene                        | 5                | 0.5                   |
| 3,3'-Dichlorobenzidine                     | 20               | 0.5                   |
| Diethyl phthalate                          | 20               | 0.5                   |
| Dimethyl phthalate                         | 10               | 0.5                   |
| 2,4-Dinitrotoluene                         | 10               | 0.5                   |
| 2,6-Dinitrotoluene                         | 10               | 0.5                   |
| Di-n-octyl phthalate                       | 10               | 0.5                   |
| bis(2-ethylhexyl)phthalate                 | 10               | 0.5                   |
| Fluoranthene                               | 10               | 0.5                   |
| Fluorene                                   | 10               | 0.5                   |
| Hexachlorobenzene                          | 10               | 0.5                   |
| Hexachlorobutadiene                        | 10               | 0.5                   |
| Hexachloroethane                           | 10               | 0.5                   |
| Indeno(1,2,3-cd)pyrene                     | 20               | 0.5                   |
| Isophorone                                 | 10               | 0.5                   |
| Naphthalene                                | 10               | 0.5                   |
| Nitrobenzene                               | 10               | 0.5                   |
| n-Nitrosodi-n-propylamine                  | 10               | 0.5                   |
| Phenanthrene                               | 10               | 0.5                   |
| Pyrene                                     | 10               | 0.5                   |
| 1,2,4-Trichlorobenzene                     | 10               | 0.5                   |
| 4-Chloro-3-methylphenol                    | 10               | 0.5                   |
| 2-Chlorophenol                             | 10               | 0.5                   |
| 2,4-Dichlorophenol                         | 10               | 0.5                   |
| 2,4-Dimethylphenol                         | 10               | 0.5                   |
| 2,4-Dinitrophenol                          | 50               | 1.5                   |
| 2-Methyl-4,6-dinitrophenol                 | 50               | 1.5                   |
| 2-Nitrophenol                              | 10               | 0.5                   |
| 4-Nitrophenol                              | 10               | 0.5                   |
| Pentachlorophenol                          | 10               | 0.5                   |
| Phenol                                     | 10               | 0.5                   |
| 2,4,5-Trichlorophenol                      | 50               | 1.5                   |
| 2,4,6-Trichlorophenol                      | 10               | 0.5                   |

G-1111-1-1

TABLE 2-2. (Continued)

- (3) Report must include calibration standards and precision data.
- (4) Phenols in water and soil/sediment samples. Limits of Detection must be at or below the values specified. (E604, SW8000)

N/A - Not applicable  
 N/S - Not specified  
 HSD - Halogen specific detector  
 SH - Standard method

| Analyte                    | Detection Limits |                       |
|----------------------------|------------------|-----------------------|
|                            | Water (ug/L)     | Soil/Sediment (mg/kg) |
| 4-Chloro-3-methylphenol    | 1.8              | 0.2                   |
| 2-Chlorophenol             | 1.6              | 0.2                   |
| 2,4-Dichlorophenol         | 2.0              | 0.3                   |
| 2,4-Dimethylphenol         | 1.6              | 0.2                   |
| 2,4-Dinitrophenol          | 65.              | 8.7                   |
| 2-Methyl-4,6-dinitrophenol | 80.              | 11.                   |
| 2-Nitrophenol              | 2.3              | 0.3                   |
| 4-Nitrophenol              | 14.              | 1.9                   |
| Pentachlorophenol          | 37.              | 5.0                   |
| Phenol                     | 0.5              | 0.09                  |
| 2,4,6-Trichlorophenol      | 3.2              | 0.4                   |

- (5) Organochlorine pesticides in water and soil/sediment samples. Limits of detection must be at or below the values specified. (E608, SW8000)

| Parameter          | Detection Limits |                       |
|--------------------|------------------|-----------------------|
|                    | Water (ug/L)     | Soil/Sediment (mg/kg) |
| Aldrin             | 0.05             | 0.01                  |
| alpha-BHC          | 0.05             | 0.01                  |
| beta-BHC           | 0.05             | 0.01                  |
| delta-BHC          | 0.05             | 0.01                  |
| gamma-BHC          | 0.05             | 0.01                  |
| Chlordane          | 0.05             | 0.1                   |
| 4,4'-DDD           | 0.1              | 0.02                  |
| 4,4'-DDE           | 0.1              | 0.02                  |
| 4,4'-DDT           | 0.1              | 0.02                  |
| Dieldrin           | 0.02             | 0.02                  |
| Endrin             | 0.06             | 0.02                  |
| Endrin aldehyde    | 0.1              | 0.02                  |
| Endosulfan I       | 0.05             | 0.01                  |
| Endosulfan II      | 0.1              | 0.02                  |
| Endosulfan sulfate | 0.1              | 0.02                  |
| Heptachlor         | 0.02             | 0.01                  |
| Heptachlor epoxide | 0.05             | 0.01                  |
| Toxaphene          | 1                | 0.2                   |
| PCB-1016           | 0.5              | 0.1                   |
| PCB-1221           | 0.5              | 0.1                   |
| PCB-1232           | 0.5              | 0.1                   |
| PCB-1242           | 0.5              | 0.1                   |
| PCB-1246           | 0.5              | 0.1                   |
| PCB-1254           | 1                | 0.1                   |
| PCB-1260           | 1                | 0.2                   |

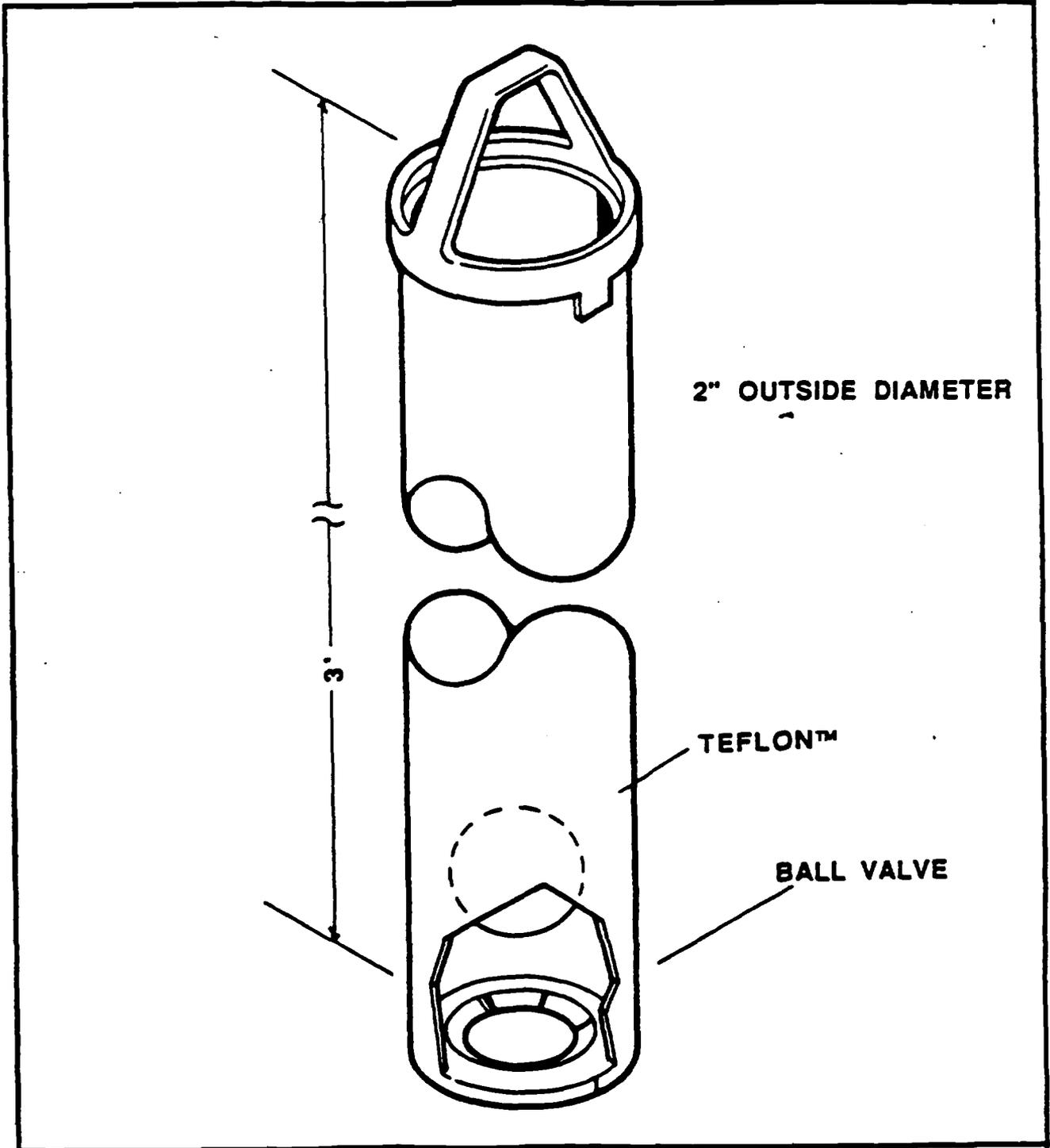


Figure 2-1. Bottom Entry Teflon™ Bailer

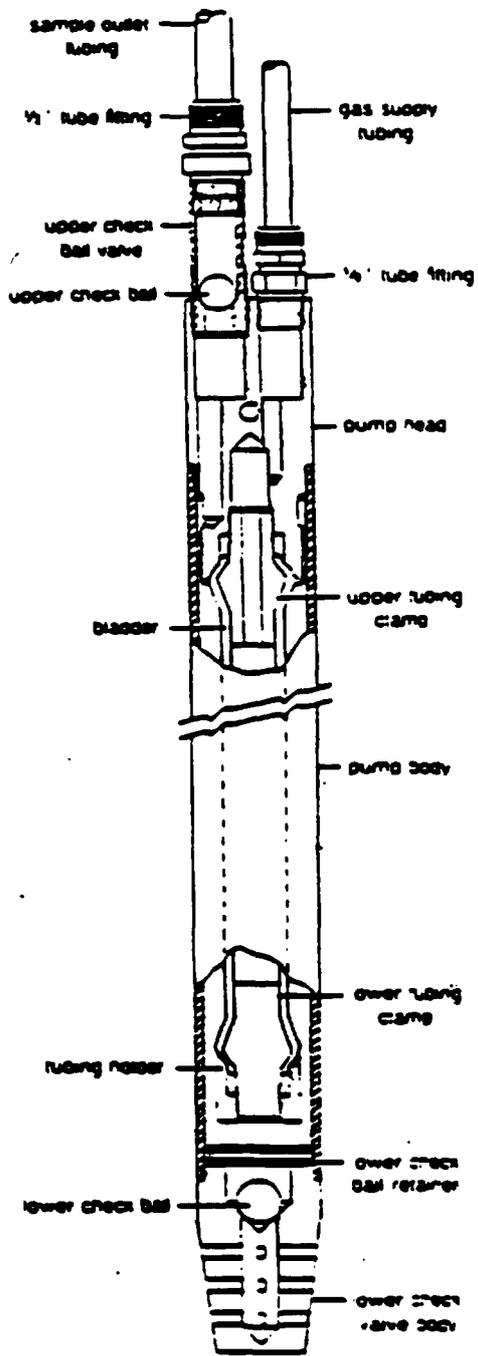


Figure 2-2. Bladder Pump

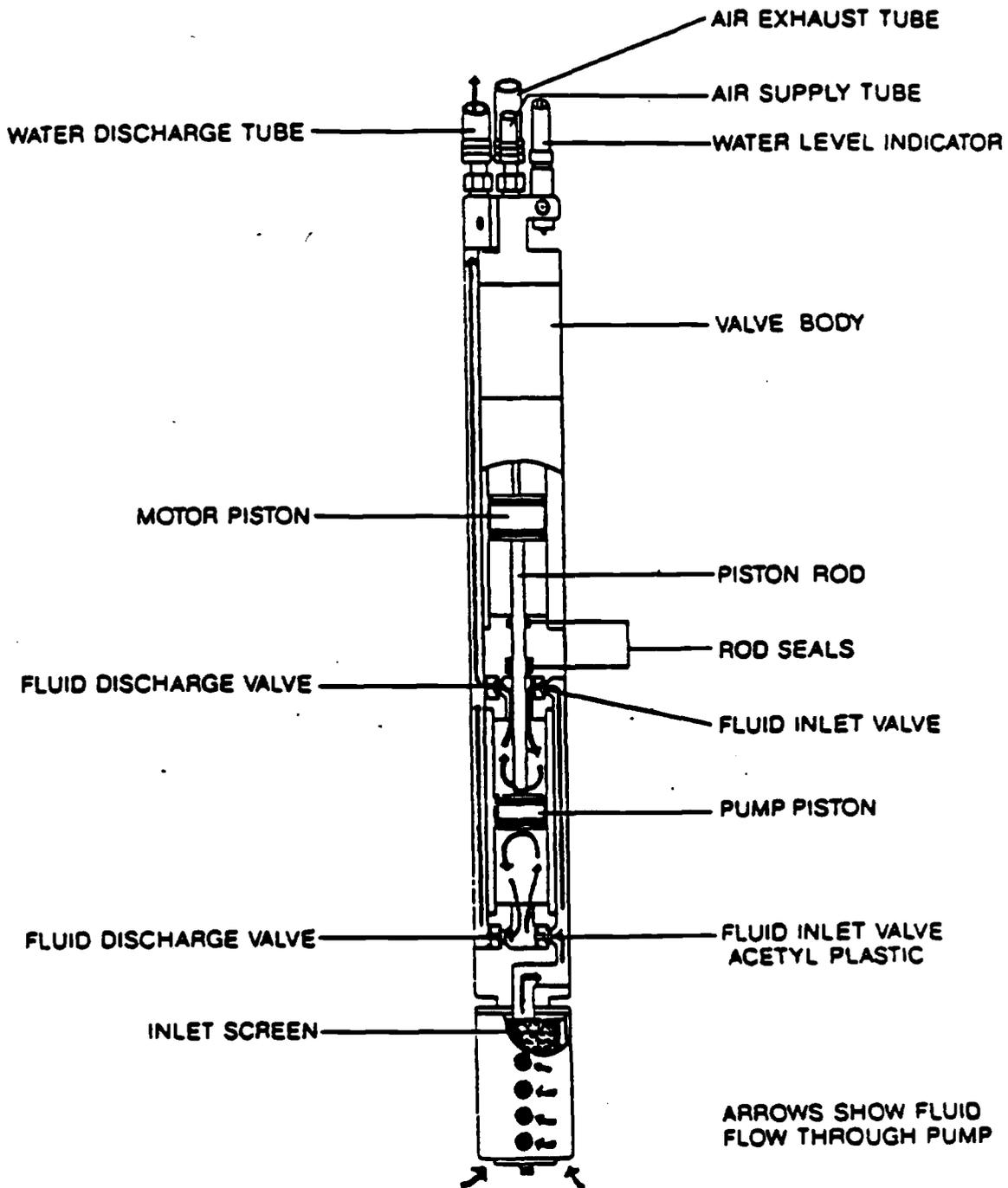


Figure 2-3. Piston Pump

purging. The piston pump is shown in Figure 2-3. This pump consists of a stainless steel body, Teflon lines, and an electric water sensing line. Compressed air from a portable air compressor is used to power the pump. The pump is driven by a double acting air piston. The pump is lowered to a point 3 feet from the top of the groundwater table. The amount of compressed air required to operate the pump is dependent on the depth to the groundwater and the volume of the well.

Samples recovered from dedicated pumps will be collected from discharge lines or taps directly into the appropriate sample containers (Table 2-2). To collect replicate samples, water from the discharge line will be directed to a clean container, from which equal volumes of water will be placed into the sample containers. Samples retrieved with a bailer will be carefully poured into sample containers in a manner which minimizes loss of volatile compounds. Prior to receiving the samples, each container will have been cleaned by the supplier according to EPA protocol. Samples will be immediately placed on ice and maintained at 4°C until received by the laboratory. Samples must be packaged, shipped and stored in a manner which avoids contamination and ensures sample integrity. Field measurements of temperature, pH, and conductivity will be made at the time of sample collection.

After each well is sampled by bailer, the bailer will be decontaminated according to the following procedures: 1) washing with laboratory grade detergent and potable water, 2) rinsing in potable water, 3) rinsing in ASTM Type II Reagent Water, 4) rinsing with pesticide grade methanol, and 5) rinsing with pesticide grade hexane.

If used for purging, the outside of the pump and sampling tube will be decontaminated using the following three-step process: 1) wash pump and sampling tube in detergent and potable water solution using a brush, 2) rinse equipment with potable water, and 3) rinse equipment with deionized water.

### Surface Water Samples

Water samples will be collected from Site 16 (Unnamed Creek and the oil/water separator) by submerging and filling the sample containers approximately six inches below the water surface. Sample parameters, sample quantities, and required preservation are given in Table 2-2. Samples will be collected directly into the sample container to prevent cross-contamination. After collection, samples will be placed on ice and maintained at 4°C until received by the laboratory. Samples will be stored at the laboratory at 4°C until the analyses are performed.

### Water Blanks and Duplicates

Equipment blanks are collected by filling the Teflon bailer (previously cleaned in accordance with requirements of the SOW) with Type II Reagent water; the bailer is then used to fill the sample bottles as usual. In the case of sampling with the downhole pump system, the decontaminated pump is inserted into a five gallon container of Type II Reagent water. The container will be filled with fresh DI water each time this procedure is performed. The water is pumped through the pump system and sample containers are filled. Surface water blanks and ambient conditions blanks are collected by pouring Type II Reagent Water directly into the sample container. Trip blanks (sealed vial of ASTM Type II Reagent Water) will accompany volatile organics samples sent to the laboratory (one per shipment up to the total number allotted in the SOW).

Groundwater duplicates are collected by filling duplicate sets of sample bottles with the same pass of the bailer. When the downhole pump system is used, duplicate samples are collected from the same pump cycle. Surface water duplicates and other types of water samples not collected with a sampling apparatus are collected by submerging duplicate sample containers beneath the surface of the water.

## 2.4.2 Soil And Sediment Samples

Solid samples will be collected using two approaches: 1) hand augering using barrel augers for shallow subsurface samples; and 2) drilling using the hollow-stem auger and air-rotary method along with split-spoon samples for shallow and deep subsurface samples. Selected solid samples collected during the investigation of a given site will be frozen and stored as specified in Table 2-1. A review of the real-time data and field observations from the site will be performed to determine which samples are to be selected for chemical analysis. Solid samples are selected for chemical analysis as soon as possible after sample collection. The samples should not exceed their holding times as specified in Table 2-1. All samples collected during a particular phase of the investigation will be retained until one month after release of the final report for that phase of the investigation.

### Hand Auger Sampling

Hand augers will be used to collect soil samples to depths as great as 10 feet below land surface (BLS). Hand auger kits include: sand barrel auger bits and clay auger bits, extensions of various lengths, and handles (see Figure 2-4). The auger bits are approximately three inches in diameter and are constructed of stainless steel. Soil samples will be collected in one-foot intervals at selected depths over the length of the borehole as follows:

- Soil samples retained in the auger bit will be composited from a selected depth interval below the land surface;
- Soils from the selected interval will be placed in an inert stainless steel bowl and homogenized with an inert stainless steel spoon;

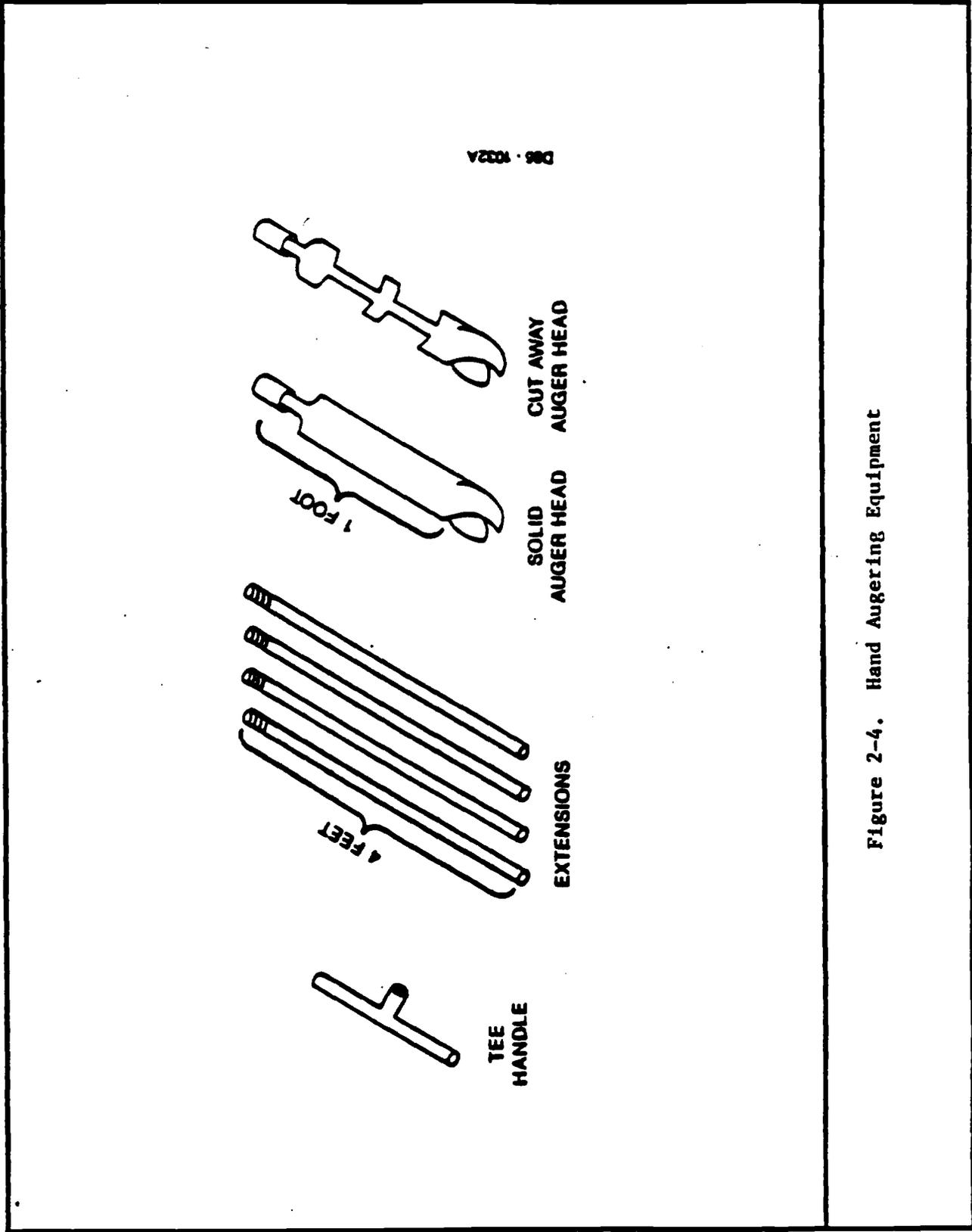


Figure 2-4. Hand Augering Equipment

Approved for Release by NSA on 05-08-2014 pursuant to E.O. 13526

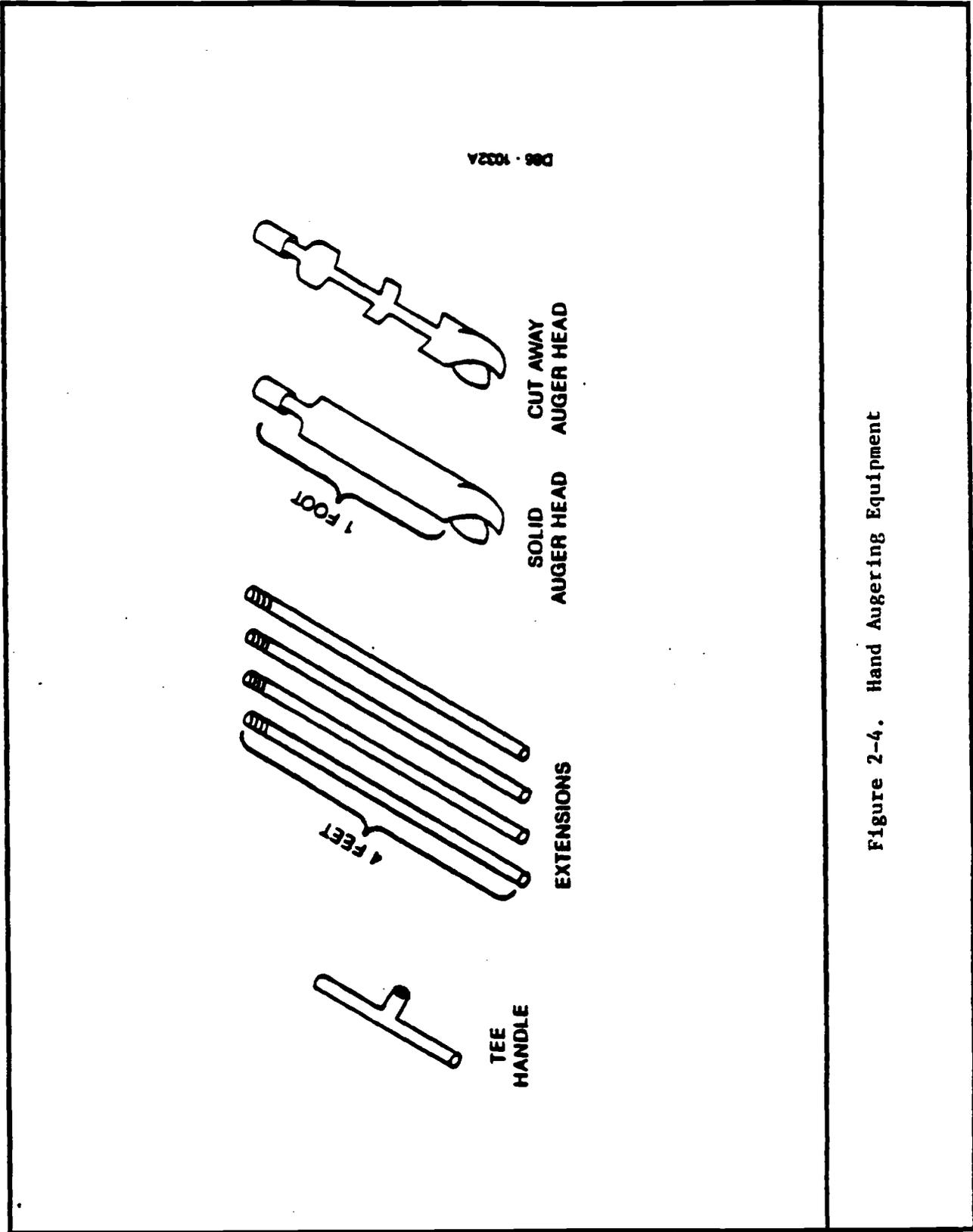


Figure 2-4. Hand Augering Equipment

UNCLASSIFIED

- Samples for chemical analysis will be retained as needed in glass bottles and refrigerated as specified in Table 2-1;
- The hand auger barrel, spoon, and bowl will be cleaned between samples; and
- After completion of each sample and each hole, the sampling equipment will be decontaminated using: 1) laboratory grade detergent and potable water wash; 2) potable water rinse; 3) ASTM Type II Reagent Water rinse; 4) pesticide-grade methanol rinse; and 5) pesticide grade hexane rinse.

Data for each hand auger borehole will be placed on a geologic log.

#### Split-Spoon Samples

Lithologic samples will be collected using a hollow-stem auger drill rig and a split-spoon sampler as follows:

- A drill rig using 5 foot sections of eight-inch hollow-stem auger (Figure 2-5) will be used to bore to the depth of interest. At depth, the drive tip of the auger (and drive shaft) will be removed. An internal hollow-stem hammer (or a drill stem with external hammer) and a split-spoon sampler will be lowered inside the auger stem to the sampling depth. The sampler will be driven into the soil approximately 18 inches and then removed with the solid sample retained in the split-spoon.
- A standard penetration split-spoon will be used to obtain samples at 5-foot intervals for visual observation. The standard split-spoon measures 18 inches long and two inches in diameter. The sampler will be split lengthwise to remove the sample. A portion of the sample will be retained for visual inspection.

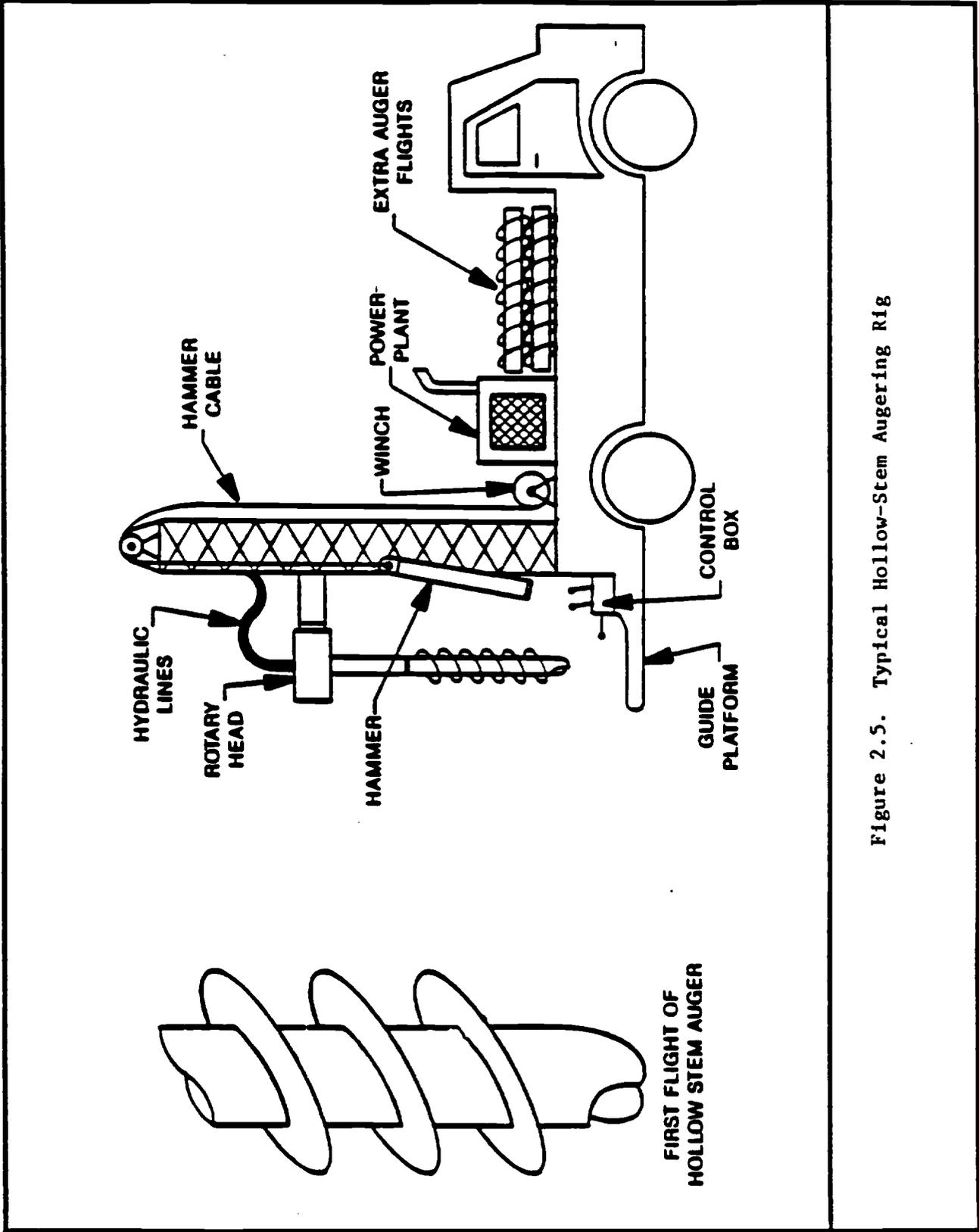


Figure 2.5. Typical Hollow-Stem Augering Rig

2025 RELEASE UNDER E.O. 14176

Immediately following the splitting of the spoon, a vapor measurement will be taken using an organic vapor analyzer (OVA).

- Split spoon samplers will be decontaminated as described for hand auger sampling before re-use.
- Chain of custody forms will be prepared for all the samples collected for chemical analysis to document the progression of the sample throughout the collection and analytical process.
- Data for each borehole will be documented on a geologic log.

At the completion of each boring, the borehole will be abandoned. Abandonment will consist of backfilling with native material to a depth of 10 feet BLS (below land surface) or 10 feet below the lower extent of visible contamination, whichever is deeper. The remainder of the borehole will be grouted with cement. This method of abandonment should prevent migration of soil contaminants, if present.

#### Soil Toxicity Sampling

Soil samples that are suspected to be hazardous because of abnormal discoloration, odor or high air monitoring levels will be collected from drums containing soil cuttings generated during drilling.

#### Solid Sample Duplicates

Solid sample duplicates are collected by two different methods. In the case of duplicate hand auger soil samples, two passes with the hand auger are made at the desired depth. Soil is collected from each pass and mixed together in an inert stainless steel bowl with an inert stainless steel spoon; two sets of sample bottles are then filled with the soil mixture. In the case of split-spoon soil duplicates, duplicate samples are collected by making

consecutive passes with the split-spoon sampler. The duplicate samples come from slightly different depths. This is unavoidable because removal of the soil from the sample sleeve in order to mix a composite from two depths would ruin sample integrity. (Duplicate split spoon samples are taken assuming that the soil formation and constituents are continuous over the interval sampled).

#### 2.4.3 Gas Sampling

Gas phase sampling associated with the Carswell AFB investigation will involve a variety of different sampling approaches to address specific types of gas phase samples which will be collected and analyzed. Each of the sampling approaches used will be tailored to the specific parameters of interest. Many of the sampling approaches allow for the use of different sample collection methods, while others, inherently less versatile, apply only under specific circumstances. The methods which will be used for gas phase sampling are described below.

##### Gas Sampling Approaches

Gas phase sampling will include collection of subsurface vapor samples. The types of sampling will include:

- Real-time air monitoring during drilling; and
- Mobile GC laboratory soil gas sampling.

##### Air Monitoring - Drilling and Hand Augering Activities

Air monitoring will be performed during all subsurface drilling and hand augering with an organic vapor analyzer (OVA) or a photoionization detector (HNU or equivalent) to characterize the generation of potentially hazardous and/or toxic vapors or gases.

Portable organic vapor analyzers will be used to perform real-time screening of total hydrocarbon vapors. This method will be used to some extent with all of the sampling approaches described above. Screening results will be used to help determine where and when samples will be collected using time-integrated sample collection methods. Certain chain of custody documents also have provisions for recording this information.

A Foxboro Century Systems Corporation Model 108 or equivalent organic vapor analyzer (OVA) with a dynamic range of 1 to 10,000 ppm and 100,000 ppm will be used to detect total hydrocarbons (see Figure 2-6). The OVA will provide real-time, non-specific data as total hydrocarbons (THC) present using the flame ionization principle of detection (FID). The OVA will be calibrated daily using certified methane-in-air gas standards. All measured concentrations will be corrected for the OVA's response to hydrocarbon-free air.

In addition to the OVA, an Analytical Instrument Development, Inc. (AID) Model 580 or equivalent photoionizer, with a range from 0 to 2,000 ppmv will be available for use. The AID has low sensitivity to methane, but high sensitivity to other hydrocarbons such as benzene. These portable instruments are particularly useful in finding the probable sources of gas in an area containing hydrocarbon vapors.

#### Mobile GC Laboratory Soil Gas Sampling

Shallow soil gas will be collected by pumping a small amount of the soil gas out of the ground through a hollow probe driven a few feet into the ground and analyzing the gas for the presence of volatile contaminants. The soil gas analysis is performed in the field so that samples do not have to be packed or shipped. The analytical results are available immediately and can be used to help direct an investigation.

Soil gas samples are collected by driving a probe into the ground by a hydraulic pusher/puller mechanism, then the probes are purged. After

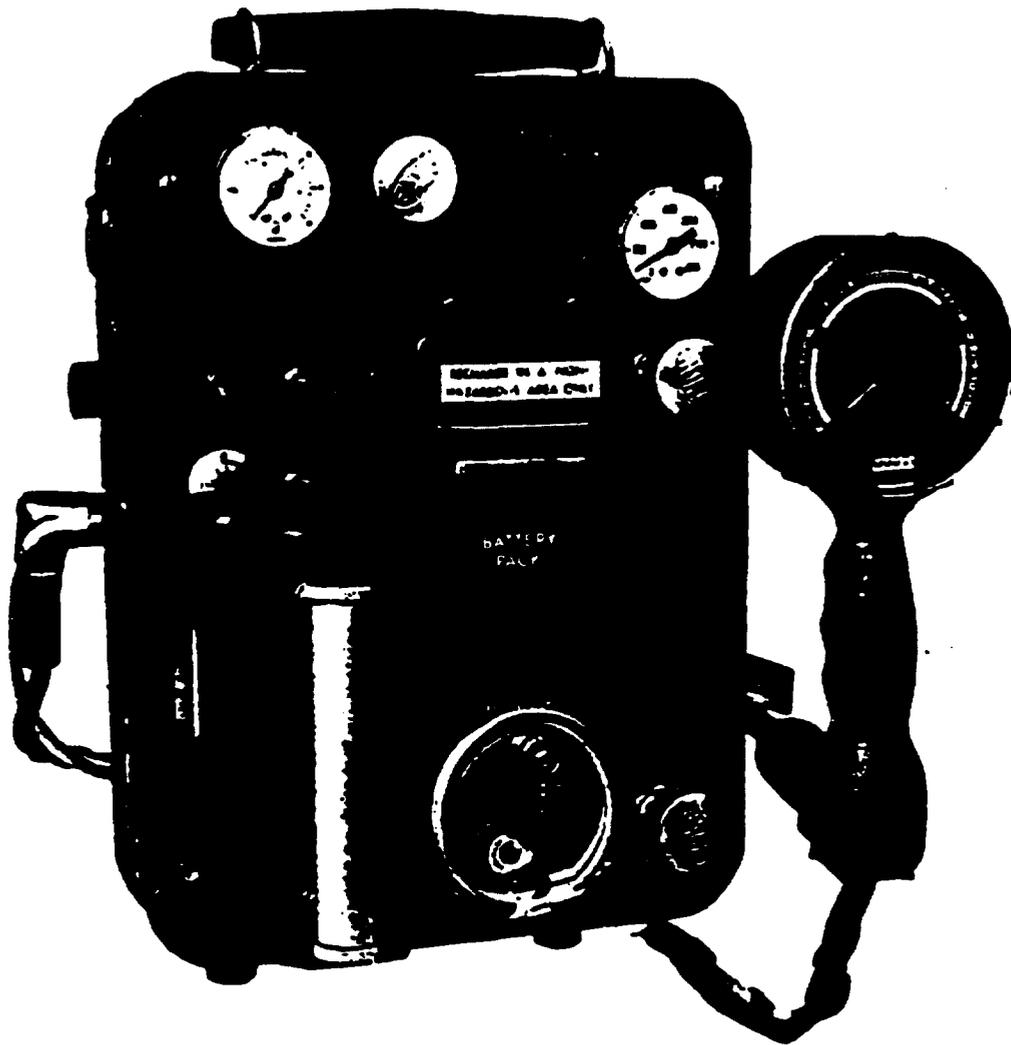


Figure-2-6. Foxboro Century Systems Portable Organic Vapor Analyzer Model OVA-108

purging and while the soil gas is being drawn through the probe, a gas sample is taken by a glass syringe which is inserted through a section of silicone tubing (leading to the pump) and into the stainless steel tubing into the adaptor. Gas samples only contact steel surfaces and are never in contact with potentially sorbing materials (i.e., tubing, hose, pump diaphragm). A vacuum gauge monitors the negative pressure in the evacuation line to assure that there is no impedance to gas flow through clay or water-saturated soils.

One or two 10 ml air samples are collected from each sampling probe after one to four minutes of pumping. These 10 ml samples are subsampled according to analytical requirements and replicates are injected into the gas chromatograph for documentation of reproducibility. More than two injections may be necessary where there are multiple contaminants which require different sample sizes for chromatographic analysis. The reproducibility of soil gas samples from the same probe is typically within 20 percent and is always within a factor of two.

After the analysis is completed the probe is removed and the probe hole is backfilled with native materials.

#### 2.4.4 Sample Requirements

Samples will be collected in the containers specified for the particular analysis. The container types, preservation techniques, holding times and sample volumes for each analysis are presented in detail in Tables 2-1 and 2-2.

#### 2.5 Site Management

After completion of each borehole or well the soil cuttings will be placed in drums and removed per direction of the base civil engineer. The

site will then be cleaned of any remaining cuttings. The drums will be transported to a location within the installation boundary. The base is responsible for ultimate disposal of the contaminated soils using base resources.

10/10/00

# APPENDIX C

## Health and Safety Plan

227-005-04-01

INSTALLATION RESTORATION PROGRAM  
PHASE II - CONFIRMATION/QUANTIFICATION  
STAGE 2

CARSWELL AIR FORCE BASE, TEXAS  
HEALTH AND SAFETY PLAN

HEADQUARTERS STRATEGIC AIR COMMAND  
COMMAND SURGEON'S OFFICE (HQSAC/SGPB)

October 1987

PREPARED BY:  
RADIAN CORPORATION  
8501 MO-PAC BOULEVARD  
POST OFFICE BOX 201088  
AUSTIN, TEXAS 78720-1088

USAF CONTRACT NO. F33615-87-D-4023, DELIVERY ORDER NO. 04  
RADIAN CONTRACT NUMBER 227-005-04

USAF OEHL TECHNICAL PROGRAM MANAGER  
MR. KARL RATZLAFF  
TECHNICAL SERVICES DIVISION (TS)

UNITED STATES AIR FORCE  
OCCUPATIONAL AND ENVIRONMENTAL HEALTH LABORATORY (USAF OEHL)  
TECHNICAL SERVICES DIVISION (TS)  
BROOKS AIR FORCE BASE, TEXAS 78235-5001

TABLE OF CONTENTS

|   | <u>Page</u> |
|---|-------------|
| 1.0 INTRODUCTION .....  | 1-1         |
| 2.0 FIELD ACTIVITIES AND KEY PERSONNEL .....                            | 2-1         |
| 2.1 Key Personnel .....   | 2-1         |
| 2.2 Program Manager/Project Director Responsibilities .....             | 2-2         |
| 2.3 Radian Supervising Geologist Responsibilities .....                 | 2-2         |
| 2.4 Drilling Subcontractor Supervisor Responsibilities .....            | 2-3         |
| 2.5 Field Team Responsibilities .....                                   | 2-3         |
| 3.0 FIELD ACITIVITIES/HAZARD ANALYSIS .....                             | 3-1         |
| 3.1 Hazard Analysis: Hollow-Stem Auger Drilling .....                   | 3-4         |
| 3.2 Hazard Analysis: Air/Mud Rotary Drilling .....                      | 3-5         |
| 3.3 Hazard Analysis: Development and Sampling of Monitor<br>Wells ..... | 3-5         |
| 3.4 Hazard Analysis: Aquifer Testing .....                              | 3-6         |
| 3.5 Hazard Analysis: Magnetometer Survey .....                          | 3-6         |
| 3.6 Hazard Analysis: Soil Vapor Analysis.....                           | 3-6         |
| 3.7 Hazard Analysis: Soil Boring and Sampling .....                     | 3-6         |
| 3.8 Other Hazards: Stream Sampling .....                                | 3-7         |
| 3.9 Hazard Analysis: Sample Preparation and Shipment .....              | 3-7         |
| 3.10 Other Hazards: Heat Stress, Hypothermia, and Frostbite ..          | 3-7         |
| 4.0 SAFE WORK PRACTICES AND PERSONNEL PROTECTION .....                  | 4-1         |
| 4.1 Dermal Protection .....   | 4-4         |
| 4.2 Respiratory Protection .....  | 4-4         |
| 4.3 Hearing Protection .....  | 4-5         |
| 4.4 Head Protection .....   | 4-5         |

7-1-1990

TABLE OF CONTENTS (Continued)

|   | <u>Page</u> |
|---|-------------|
| 5.0 PERSONNEL TRAINING .....                        | 5-1         |
| 5.1 Respiratory Protection Training .....           | 5-1         |
| 5.2 Personal Hygiene Practices .....                | 5-2         |
| 6.0 EXPOSURE MONITORING PLAN .....                  | 6-1         |
| 6.1 Chemical Exposure Monitoring Plan .....         | 6-1         |
| 6.2 Heat Stress Control and Monitoring Plan .....   | 6-2         |
| 6.2.1 Heat Stress Control .....                     | 6-2         |
| 6.2.2 Heat Stress Monitoring .....                  | 6-4         |
| 6.3 Frostbite Control and Monitoring Program .....  | 6-5         |
| 7.0 WORK ZONES AND DECONTAMINATION PROCEDURES ..... | 7-1         |
| 7.1 Work Zones .....                                | 7-1         |
| 7.1.1 Exclusion Zone .....                          | 7-1         |
| 7.1.2 Decontamination Zone .....                    | 7-1         |
| 7.1.3 Support Zone .....                            | 7-2         |
| 7.2 Decontamination Procedures .....                | 7-2         |
| 8.0 EMERGENCY RESPONSE AND COMMUNICATION PLAN ..... | 8-1         |
| 8.1 Emergency Medical Response .....                | 8-1         |
| 8.2 Fire Emergency Procedures .....                 | 8-1         |
| 9.0 RECORD KEEPING PROCEDURES .....                 | 9-1         |
| ATTACHMENT A - Equipment Supplies List .....        | A-1         |

2.0 FIELD ACTIVITIES AND KEY PERSONNEL

Phase II (Stage 2) activities of the Carswell AFB IRP field program will include:

- Monitor well installation using hollow stem auger and air/mud rotary drilling techniques;
- Development and sampling of monitor wells;
- Aquifer testing;
- Magnetometer survey;
- Soil vapor analysis;
- Soil boring and sampling using hollow stem auger with split spoon or Shelby tube samplers;
- Collection of stream (bottom) sediment and surface water samples; and
- Sample preparation and shipment to analytical facilities.

2.1 Key Personnel

Radian and subcontractor personnel who are responsible for the safe conduct of this project are:

- Radian Contract Program Manager--F.J. Smith;
- Radian Program Manager--W.L. Boettner;
- Radian Project Director--L.N. French;
- Radian Supervising Geologist--G.J. Childs; and
- Drilling Subcontractor Supervisor--Not Determined.

7  
4  
2  
1

2.2 Program Manager/Project Director Responsibilities

The Program Manager and Project Director have overall responsibility to ensure that the site Health and Safety program is implemented in accordance with all applicable federal, state, and local requirements and Radian Corporation policy.

2.4 Radian Supervising Geologist Responsibilities

The Radian Supervising Geologist will ensure that the health and safety procedures described in this plan are followed. These procedures cover all on-site activities of Radian and direct subcontractor personnel. All participants in the field work will comply with Federal and State occupational safety and health regulations, 29 CFR 1910, and are responsible for complying with this plan.

Specific safety responsibilities of the supervising geologist include:

- Locating the support facilities in an uncontaminated area.
- Initiating contact with the base emergency response agencies (police, fire, medical), testing the emergency phone numbers to ensure their accuracy, and posting the numbers.
- Implementing the safety training as described in Section 5 of this plan.
- Observing site activities to ensure the proper use of personal protective equipment.
- Conducting daily safety review sessions with the drilling crew.

- Setting safe work schedules, considering required work levels and outside temperature.
- Ensuring that the field team observes the work zone and decontamination procedures as described in this plan.
- Ensuring that Radian safety equipment is maintained properly (respirators are cleaned after each day).
- Initiating corrective action for observed safety violations and report unsuccessful attempts to correct a violation to the Radian Project Director or Program Manager.

2.4 Drilling Subcontractor Supervisor Responsibilities

The Drilling Subcontractor Supervisor will be responsible for enforcing drilling crew compliance with the health and safety procedures presented in this plan. The Drilling Subcontractor Supervisor will initiate corrective action and, as appropriate, disciplinary and/or dismissal measures with any drilling crew member who does not comply with the plan, as directed by the Radian Supervising Geologist.

2.5 Field Team Responsibilities

The responsibilities of the field team members are:

- Read and understand this plan;
- Perform work safely;
- Report any unsafe conditions to their immediate supervisor; and

- Be aware and alert for signs and symptoms of exposure to site contaminants and adverse weather conditions (i.e., temperature extremes and wind chill).

14043-412

3.0 FIELD ACTIVITIES/HAZARD ANALYSIS

The field activities to be conducted during this program will involve potential health and safety risks to field team members. An analysis of these potential hazards (associated with the activities presented in Section 2) are discussed individually in the following subsections.

The general types of hazards associated with this program are described below. A listing of specific suspected hazards by site is provided in Table 3-1. A summary of field activities, by site, is provided in Table 3-2.

- Mechanical Hazards: Cuts, contusions (bruises), being struck by or striking objects, or being caught between objects.
- Electrical Hazards: Possible excavation of buried cables and contact with overhead power lines during drilling. Electrical storms.
- Chemical Hazards: Field exposure to chemicals listed in Section 3.1 of this plan.
- Fire Hazards: Possible excavation of buried gas lines. Grass fires. Equipment fires.
- Thermal Hazards: Exposure to outside temperature extremes, especially heat stress when wearing protective clothing.
- Acoustical Hazards: Exposure to excessive noise during drilling operations involving hollow-stem augering and air rotary drilling.

10040-77

TABLE 3-1. POTENTIAL HEALTH AND SAFETY HAZARDS, BY SITE

| Hazard                   | Site |   |   |    |    |    |   |    |    |    |    | BSS* | WSA* |   |
|--------------------------|------|---|---|----|----|----|---|----|----|----|----|------|------|---|
|                          | 3    | 4 | 5 | 10 | 11 | 12 | 1 | 13 | 15 | 16 | 17 |      |      |   |
| Aromatic Hydrocarbons    | X    |   |   |    | X  | X  |   |    |    |    |    | X    | X    |   |
| Chlorinated Hydrocarbons | X    | X | X | X  | X  | X  | X |    |    |    |    | X    |      | X |
| Petroleum Products       | X    |   |   |    | X  | X  |   |    |    |    |    | X    | X    |   |
| Metals                   | X    |   |   |    |    |    |   |    | X  | X  |    |      |      |   |
| Pesticides               |      |   |   |    |    |    |   |    |    | X  |    |      |      |   |
| Ordnance                 |      |   |   | X  |    |    |   |    |    |    |    |      |      |   |
| Drilling Hazards         | X    | X | X |    |    |    |   |    |    |    |    |      |      |   |

\* BSS = Base Service Station  
WSA = Weapons Storage Area

10/27/77

TABLE 3-2. FIELD ACTIVITIES, BY SITE

| Activity               | Site |   |   |    |    |    |   |    |    |    |    | BSS* | WSA* |   |  |
|------------------------|------|---|---|----|----|----|---|----|----|----|----|------|------|---|--|
|                        | 3    | 4 | 5 | 10 | 11 | 12 | 1 | 13 | 15 | 16 | 17 |      |      |   |  |
| Shallow Drilling       | X    | X | X |    |    |    |   |    |    |    |    | X    | X    |   |  |
| Deep Drilling          | X    |   |   |    |    |    |   |    |    |    |    |      |      |   |  |
| Aquifer Test           |      | X | X |    |    | X  | X |    |    |    |    | X    |      |   |  |
| Groundwater Sampling   | X    |   | X |    | X  | X  | X |    |    |    |    | X    | X    |   |  |
| Magnetometer Survey    |      |   |   | X  |    |    |   |    |    |    |    |      |      |   |  |
| Soil Vapor Analysis    |      |   |   |    |    | X  |   |    |    |    |    | X    | X    |   |  |
| Soil/Sediment Sampling |      |   |   |    |    |    |   | X  |    |    |    |      |      |   |  |
| Stream Sampling        |      |   |   |    |    |    |   |    |    |    | X  |      |      |   |  |
| Separator Sampling     |      |   |   |    |    |    |   |    |    |    | X  |      |      |   |  |
| Soil Boring            |      |   |   | X  |    | X  |   |    | X  |    |    | X    |      | X |  |

\*BSS = Base Service Station  
WSA = Weapons Storage Area

Unexploded Ordinance:

Unexploded ordinance is a very real concern during activities at any military installation. Site activities should be coordinated with the Explosive Ordinance Disposal detachment before beginning site work in area where buried ordinance is suspected such as Site 10.

3.1 Hazard Analysis: Hollow-Stem Auger Drilling

Hollow-stem auger drilling activities will potentially expose field personnel to the hazards listed below:

Chemical Hazards:

- Exposure to chemical contamination present in groundwater and soils. Suspected and confirmed chemical contamination presently includes:
  - aromatic hydrocarbon compounds,
  - chlorinated hydrocarbon compounds,
  - petroleum products,
  - metals, and
  - pesticides.
  
- Previous analysis indicates the presence of many of the above categories of chemicals. Specific chemical compounds found include:
  - trichloroethylene,
  - vinyl chloride,
  - tetrachloroethylene,

- trans-1,2-dichloroethylene,
- benzene, and
- toluene.

Drilling personnel will also be exposed to exhaust fumes from the equipment operation.

Physical Hazards--Exposure to physical hazards associated with hollow-stem augering include the following:

- snapping cables,
- brush, equipment, or gas-main fires,
- being hit by equipment,
- becoming entwined in rotating tools,
- falling objects,
- drilling into buried utilities or waste ordnance,
- exposure to excessive noise, and
- exposure to extreme outside temperatures.

### 3.2 Hazard Analysis: Air/Mud Rotary Drilling

During the installation of monitor wells using the air/mud rotary technique, the field team will generally be exposed to the same chemical and physical hazards as listed for the hollow-stem auger work (Section 3.1).

### 3.3 Hazard Analysis: Development and Sampling of Monitor Wells

During development and sampling of the monitor wells there is a high potential for exposure to contaminated groundwater. The various types of chemical contaminants listed in Section 3.1 (Chemical Hazards) should be

considered present during well development and sampling. Use of electrical pumping equipment during development and sampling of the wells also presents some electrical shock hazards.

3.4 Hazard Analysis: Aquifer Testing

The greatest potential hazard associated with aquifer testing is possible exposure to contaminated groundwater. However, due to the nature of the test, this potential is limited. As described in Section 3.3 electrical shocks, associated with the use of electrical pumps and automatic gaging equipment, are also possible.

3.5 Hazard Analysis: Magnetometer Survey

Potential hazards associated with this activity are limited to physical hazards such as slips, trips, and falls. The magnetometer survey itself poses no hazards to field personnel.

3.6 Hazard Analysis: Soil Vapor Analysis

During soil vapor analysis, the field team could be exposed to hazardous vapors emanating from contaminated soil. The most probable types of airborne contaminants are volatile organic compounds (see Section 3.1). Physical hazards, similar to those listed in Section 3.1 are also possible.

3.7 Hazard Analysis: Soil Boring and Sampling

This activity will be accomplished using the hollow-stem auger drilling technique and split spoon or Shelby tube core samplers. The potential hazards are the same as those listed in Section 3.1.

3.8 Hazard Analysis: Stream Sampling

Elevated concentrations of metals and some hazardous organic compounds were identified in stream samples from Unnamed Stream collected during a single sampling event. However, at the low levels detected, there is little hazard associated with casual contact with the surface water or bottom sediment.

3.9 Hazard Analysis: Sample Preparation and Shipment

After the samples have been collected in sampling jars, the samples must be preserved, as appropriate, and properly packaged to protect shipping personnel from potential exposure to contaminants. There is no great hazard in performing the packaging operation, yet if this operation is not done properly, unsuspecting individuals may be exposed if the containers leak or break. Shipping procedures are described in detail in the Work Plan. Preservation of water samples may involve the use of acids or bases to adjust sample pH. Proper precautions must be taken to avoid contact with these reagents.

3.10 Other Hazards: Heat Stress, Hypothermia, and Frostbite

During field work conducted in warm conditions, the Radian Supervising Geologist must be alert for the signs and symptoms of heat stress. A hazard exists when individuals are required to work in warm temperatures while wearing impervious protective clothing. When the ambient air temperature at the site exceeds about 65 degrees Fahrenheit, heat stress may become a problem. When field activities are conducted during cold weather conditions (below freezing ambient air temperature or high wind chill factor) the Radian Supervising Geologist must be alert for signs of hypothermia or frostbite.

4.0 SAFE WORK PRACTICES AND PERSONNEL PROTECTION

The following subsections describe procedures for safely performing the different tasks required at the sites included in this program. Based on the results of the hazards analysis of field activities summarized in the preceding section, activities at all sites can be safely conducted using either modified EPA level C or D personal protection. As defined for this project, EPA level C protection includes:

- Tyvek® coveralls,
- Hard hat,
- Safety glasses or splash goggles,
- Air purifying full- or half-face respirator (worn),
- Rubber boots, and
- Gloves.

EPA Level D protection includes:

- Long sleeve shirt and trousers,
- Hard hat,
- Safety glasses or splash goggles,
- Air purifying, full- or half-face respirator (carried),
- Rubber boots, and
- Gloves.

In addition, hearing protection is required during drilling operations and in any areas where aircraft engines pose a potential noise hazard.

Table 4-1 identifies the appropriate level of personal protection for activities at each project site, based on evaluation of the available information. Depending on actual site conditions encountered at the time of field activities, the Radian Supervising Geologist may increase or decrease

TABLE 4-1. PERSONAL PROTECTION LEVELS

| Protection/Site Level    | 3 | 4 | 5 | 10 | 11 | 12 | 1 | 13 | 15 | 16 | 17 | BSS <sup>3</sup> | WSA <sup>4</sup> |
|--------------------------|---|---|---|----|----|----|---|----|----|----|----|------------------|------------------|
| EPA Level C <sup>1</sup> | X | X | X | X  |    | X  |   |    |    |    | X  |                  |                  |
| EPA Level D <sup>2</sup> |   |   |   |    | X  |    | X | X  | X  | X  |    | X                | X                |

1. Level C Equipment: Tyvek coverall, hard hat, safety glasses, respirator (worn), rubber boots, gloves.
2. Level D Equipment: Long sleeve shirt, trousers, hard hat, safety glasses, respirator (carried), rubber boots, gloves.
3. BSS = Base Service Station.
4. WSA = Weapons Storage Area.

04/11/02

the required level of protection. Some general guidelines that will be used are as follows:

- Disposable Tyvek® coveralls should be worn by drilling personnel who handle potentially contaminated auger flights and other parts of the downhole drilling equipment. Tyvek® coveralls should only be worn when there is a high probability of skin contact with contaminants. They should not be worn in the absence of splash or dust hazards. They contribute little in the way of skin protection against volatile organic chemicals and greatly increase the danger of heat injury. Heat stress monitoring will be increased when workers are wearing Tyvek® clothing.
- Chemical splash goggles or safety glasses with side shields should be worn at all times during field activities.
- PVC disposable gloves worn over butyl rubber or nitrile gloves will provide an extra measure of hand protection when handling contaminated soils and water samples.
- Respiratory protection will be worn during drilling and sampling activities that may expose the field team to hazardous airborne materials. In cases where monitoring confirms that contamination is not present, the Radian Supervising Geologist may discontinue the use of respiratory protection. Air monitoring activities will increase when respirators are not being used (see Section 6, Exposure Monitoring Plan).
- Hearing protection will be worn during operation of heavy equipment.

Personal protective equipment, for the prevention of personnel exposure to chemical hazards via inhalation and skin contact, and to reduce

potential physical hazards, are described in the following subsections. An equipment supplies list, including personal protective equipment and vendors is appended (Attachment A).

#### 4.1 Dermal Protection

Drilling operations may expose field team members to certain dermal hazards, should contaminated soil or groundwater come in contact with their skin or eyes. To reduce the risk of physical contact with hazardous materials:

- Disposable Tyvek® coveralls will be worn by the field team when handling wet drill cuttings or physically handling any of the drilling equipment (auger flights, etc.) that potentially have contacted the contaminated materials.
- Eye protection (safety glasses with side shields meeting ANCI. std. 287.1 ) will be worn by all field team members during all drilling and sampling activities. Splash goggles will be worn during steam cleaning activity.
- Neoprene or PVC boots with steel toes will be worn by all field team members when contact with contaminated soils or standing water may occur. (Steel toed boots must be worn at all times by personnel working near drill rigs or other heavy equipment).

#### 4.2 Respiratory Protection

The following guidelines will be in force regarding respiratory protection:

- Air purifying respirators fitted with combination organic vapor/High Efficiency Particulate (HEP) filter/cartridges will be worn when the field activities disturb the soils.

Approved Respirator

- MSA Comfo II Half Mask with GMA-H Cartridges or equivalent
- MSA Ultratwin Full Mask with GMA-H Cartridges or equivalent.

4.3 Hearing Protection

Since operations will be conducted near aircraft engines and jet taxi and maintenance areas, the noise level of these activities combined with that from the drilling rigs may result in a noise hazard. The field team must protect their hearing during drilling operations by wearing either or both of the devices listed below:

- E.A.R. brand foam ear plugs.
- Ear muffs.

4.4 Head Protection

Head protection will be worn by all employees at all times they are on site. The type of head protection selected for this project is a nonmetallic, impact resistant hard hat (Class B helmet).

5.0 PERSONNEL TRAINING

During drilling and sampling of the sites, Radian team members will be provided with and required to wear the recommended equipment. Personnel protective equipment required by the drilling subcontractor personnel will be the responsibility of the subcontractors' supervisor. The following paragraphs discuss training information for respiratory protection.

5.1 Respiratory Protection Training

Respirators will be provided to the field team by their respective firms. All personnel have or will be qualitatively fit tested with their personally assigned respirator as part of the OSHA Health and Safety Training. The team members will be expected to use these respirators properly.

The half-face air purifying respirator, equipped with the proper cartridge, is capable of filtering certain gases, vapors, dusts, mists, fumes, and particulates out of inhaled air. This respirator does not provide oxygen and should not be used in oxygen deficient atmospheres or IDLH\* conditions. The respirator will not provide adequate protection if the face seal is poor, and all male members of the field team will be required shave daily before wearing this respirator. It is a violation of OSHA regulations to wear a respirator with any facial hair that interferes with the face seal. Contact lenses are also prohibited when respirator protection is required.

Respirators must fit properly to afford adequate protection. To ensure that a proper fit is obtained, fit testing is performed. The Radian Supervising Geologist will perform three types of fit tests at the start of field activities and will ensure that each Radian person is periodically checked for proper respirator fit. These tests are:

---

\*IDLH = Immediately Dangerous to Life and Health.

- Negative pressure testing,
- Positive pressure testing, and
- Odor testing.

5.2 Personal Hygiene Practices

The field team must pay strict attention to the hygiene requirements listed below to avoid ingesting or sustained dermal contact with any of the possible site contaminants:

- Never put anything in your mouth, including your fingers, while conducting field activities.
- All employees must wash their hands, forearms, face and neck before eating, drinking, smoking, or using the rest room. There will be no exceptions to this rule.
- At the end of the day, each employee will shower thoroughly.

6.0 EXPOSURE MONITORING PLAN

Employee exposure to site contaminants and physical hazards will be monitored during the site activities by using a combination of techniques:

- Organic vapor measurements using photoionization detector (PID) (HNU or comparable device);
- Air quality screening for total organic vapors and selected organic compounds using indicator colorimetric tubes (Draeger tubes); and
- Heat and cold stress monitoring will be conducted by the Radian Supervising Geologist through field observations and body temperature measurements.

6.1 Chemical Exposure Monitoring Plan

The Radian Supervising Geologist will monitor airborne levels of organic contaminants during all drilling activities (monitor well drilling and soil coring). Measurements will be taken in the borehole, over cuttings, and in the breathing zone for comparison with background levels. Monitoring for chemical exposure will include the following activities:

- Obtain a background organic vapor reading near the upwind boundary of the site, using a photoionization detector (PID);
- Monitor the ambient air in the vicinity of the drill rig with the PID during drilling activities;
  - check borehole concentrations whenever the drill stem is broken to add new sections; and

- if borehole concentrations or concentrations over cuttings increase from background, immediately check breathing zone concentrations.
- Drilling operations will be suspended and respiratory protection requirements will be reevaluated if the PID total organics measurement in the breathing zone increases by more than 5 ppm above background;
- Use Draeger "Polytest" tubes for backup of the PID in the event of malfunction and to verify PID total organic concentrations; and
- Use compound-specific Draeger tubes (benzene, trichloroethylene, tetrachloroethylene, vinyl chloride, and toluene) for on-site identification of organic contaminants.

## 6.2 Heat Stress Control and Monitoring Plan

Workers who wear protective clothing will be at increased risk of heat stress. The Radian Supervising Geologist should observe the field team at all times and be alert for the signs of heat illness.

- Make sure that the workers adhere to a work/rest schedule; and
- Everyone on site should replace lost fluids frequently.

### 6.2.1 Heat Stress Control

The Radian Supervising Geologist will set work and break schedules depending on how heavy the work load is and the outside temperature in coordination with the drilling supervisor. Generally, workers conducting drilling activity in protective clothing need to break in the shade at least

10 minutes out of every hour during elevated temperatures. Rest time should also include fluid replacement with electrolytes (i.e., Gatorade or equivalent).

During conditions where the temperature, humidity, and solar radiation are high and the air movement is low, the following procedures should be followed whenever possible to prevent heat stress injury:

- Limit work activity periods to reduce the amount of heat the body produces.
- Workloads and/or duration of physical exertion should be less during the first days of exposure to heat and should be gradually increased to allow acclimatization.
- Schedule heavy work during the cooler periods of the day.
- Alternate work and rest periods in heat stress conditions; in moderately hot conditions, 5-minute rest periods in the shade alternating with 25-minute work periods in the sun may be desirable. Under severe conditions, the duration of rest periods should be increased.
- A heat stressed worker may lose up to a quart of water per hour. This loss must be replaced, or a rapid rise in body temperature will occur. In conditions of moderate heat, replace 5 to 7 quarts of water per worker per day. In severe conditions of heat stress, replace 9 to 13 quarts of water per worker per day.

6.2.2 Heat Stress Monitoring

The Radian Supervising Geologist should perform monitoring activities for heat stress when workers are using protective clothing in elevated temperatures. The heat stress monitoring plan includes:

- Measurement of worker heart rate (pulse beats 15 seconds x 4 or 30 seconds x 2);
- Measurement of body temperature with forehead fever strips; and
- Observation of the field team for signs and symptoms of heat stress which include:
  - pale, clammy skin progressing to hot, dry, and red skin,
  - profuse perspiration,
  - cramps,
  - headaches,
  - nausea, and
  - fainting.

The following criteria will be used to institute heat stress controls (increase resting breaks, stop work, etc.).

- Heart rate >110 bpm (beats per minute) at beginning of rest period; shorten next work cycle by one-third.
- Heart rate >90 bpm at 3 minutes into rest period; shorten next work cycle by one-third.
- Oral temperature >99.6°F at beginning of rest period; shorten next work cycle by one-third.

- Oral temperature >100.6°F at any time; remove impermeable clothing and begin rest period until temperature drops to 99.6°F.

### 6.3 Frostbite Control and Monitoring Program

During cold conditions, the Radian Supervising Geologist and members of the field team must be alert for the signs and symptoms of frostbite. Frostbite occurs when part of the body is affected by below freezing temperatures. The flow of blood to the affected area(s) stops, and skin cells may be permanently damaged in severe cases. It is possible that sudden weather changes may occur during the scheduled field activities with freezing temperatures, high winds and wind chill factors. Frostbite could easily result if proper precautions are not taken. The symptoms of frostbite are hard, pale, cold skin that becomes red and painful when thawed out. Hands, feet, nose and ears are most susceptible.

To avoid frostbite, it is important to wear several layers of warm clothes under a windproof outer garment such as the Tyvek coverall. Also make sure that the face, hands, and feet are protected. These precautions are also effective for prevention of hypothermia which may occur under similar conditions.

If frostbite occurs:

- Get the victim medical attention as soon as possible;
- Provide shelter from wind and administer warm drinks;
- Cover frozen areas with additional clothing or blankets;
- Encourage gradual, gentle movement, but do not allow the person to walk if the feet are frozen;



7.0 WORK ZONES AND DECONTAMINATION PROCEDURES

To minimize the transfer of possible hazardous substances from the site, contamination control procedures are needed. Contaminants must be removed from clothing, personnel, and equipment prior to relocation from a work zone. For drilling activities, a formal series of work zones, centering on the borehole and rig, will be established. These zones are described in the following subsections. For all other activities, the general sampling equipment and personal protection equipment decontamination procedures described in Section 7.2 will be followed. Decontamination will be fully completed prior to moving off site.

7.1 Work Zones

Prevention of exposure and spread of contamination will be controlled through establishment of work zones. Three work zones will be used in this project: 1) Exclusion Zone, 2) Decontamination Zone, and 3) Support Zone.

7.1.1 Exclusion Zone

The Exclusion Zone is the area where disturbance activities (monitor well installation or coring activity) are conducted and where contaminants and physical hazards may be present. Only properly trained individuals who are wearing appropriate personal protection equipment will be allowed to enter and work in this zone. The size of the Exclusion Zone will be established by the Radian Supervising Geologist based on site-specific conditions, but generally includes the area within a 25-foot radius of the drill site.

7.1.2 Decontamination Zone

The Decontamination Zone is a corridor which leads from the Exclusion Zone to the Support Zone. This corridor will contain wash buckets, solid

waste disposal containers, brushes, and equipment drop tarps. All decontamination activities will occur in this area.

7.1.3 Support Zone

The Support Zone is the area where the field team will reside when not performing site work. This area is to be used for eating, equipment storage, and staging. It is extremely important to locate the Support Zone in an area that is known to be free of contamination and as far upwind from the drill site as practical (at least 50 feet).

7.2 Decontamination Procedures

Equipment Decontamination Procedures

Equipment (spades, bailers, shovels) must be decontaminated before they may be used at other sites. Usually, a water washing in a detergent solution followed by a potable water and distilled water rinse will be sufficient to remove contaminants. Occasionally, washing with acetone or other solvents may be required. Remember, some solvents are toxic or extremely flammable and should be used with caution.

Rig Decontamination Procedures

1. Use a high pressure water wash to remove site contaminants from the drill rig and associated equipment (auger flights).
2. Set up wooden pallets and lay flights down to wash with the high pressure water. Remember to wear splash goggles during this activity.

7-2

Personal Protective Equipment Decontamination Procedures

1. Remove outer gloves and dispose in trash container. Hard hats, safety glasses, and boots should be cleaned at the end of the day. Set up wash and rinse stations within the Decontamination Zone using detergent, potable water, and brushes.
2. Remove and dispose Tyvek. Continue wearing boots, undergloves, and respirator.
3. Remove undergloves and respirator in the Support Zone.
4. Respirators must be disassembled and washed with detergent at the end of each work shift.
5. Disposable garments and spent respirator cartridge should be deposited in covered containers for eventual disposal.

8.0 EMERGENCY RESPONSE AND COMMUNICATION PLAN

The objective of the emergency response and communication plan is to ensure that the field team knows how to contact emergency help quickly. The Radian Supervising Geologist will determine how to access the base emergency response network by coordinating with the Air Force Point of Contact.

8.1 Emergency Medical Response

Before beginning site activities make sure that each field team member knows where the nearest emergency medical facility is and how to get there.

- Locate the closest telephone;
- Post the telephone number of the nearest ambulance service (private or military);
- Make sure that the field team is aware of the location of a first aid kit and eyewash; and
- The Radian Supervising Geologist should be prepared to handle minor injuries.

8.2 Fire Emergency Procedures

The threat of fire on this particular project is considered slight because any contaminated material will be aqueous or solid. Fire hazards will, however, exist in the following activities:

- Equipment refueling;
- High pressure water cleaning fuel storage and refueling activities;

ATTACHMENT A: EQUIPMENT SUPPLIES LIST

| ITEM   | DESCRIPTION   | PART NUMBER  | VENDOR  | PRICE   |
|--|---|--|---|---|
| Respirators<br>(Use: 1/project)                                  | MSA half face<br>Comfo II   | 479531   | MSA<br>226 South Enterprise<br>Corpus Christi, Texas 78405<br>800-672-2222        | \$14.65   |
|  | MSA full face<br>Mitratwin  | 471286   | MSA<br>226 South Enterprise<br>Corpus Christi, Texas 78405<br>800-672-2222        | \$86.75   |
| Tyvek Coveralls<br>(Use: 2/day)                                  | Tyvek coverall, No<br>boots, hood, or elastic   | 1681040-L<br>1681040-RL  | Vallen Safety Supply<br>3913 Todd Lane<br>Austin, Texas 78744<br>512-440-1919     | \$ 2.50/ea.   |
| Hand Protection<br>(Use: 3/pr/wh)                                | Pioneer Nitrile gloves<br>Biodegradable PVC Under<br>gloves   | AP-18<br>213512  | Vallen Safety Supply<br>Vallen Safety Supply                                      | \$2.00/pr.<br>\$0.25/pr.                            |
| Foot Protection<br>(Use: 1/project)                              | Neoprene rubber boots   | M8924810<br>steel toe,<br>calf length  | Vallen Safety Supply  | \$35.00   |
| Head Protection<br>(Use: 1/project)                              | Class B helmet (White)  | 302-WT   | Vallen Safety Supply  | \$ 6.10   |
| Detector Tubes<br>(Use: 1 hr/wh)                                 | Drager tubes<br>- Benzene 0.5-10<br>- Trichloroethylene<br>- Perchloroethylene<br>- Vinyl Chloride<br>- Toluene | 3-478-128561<br>3-478-128541<br>3-478-126699<br>3-478-128061<br>3-478-128061 | Scott Specialty Gases<br>3714 Lepas Drive<br>Houston, Texas 77023<br>713-644-4820 | \$27.00<br>\$26.00<br>\$26.00<br>\$26.00<br>\$26.00 |
| Organic Vapor Analyzer<br>(Use: 1/project)                       | Radian Equipment Supply<br>(Contact David Ramus)  |  |   |   |
| Calibration Gases<br>(Benzene 10 ppm in<br>Hydrocarbon Free Air) | Certified Working Standard<br>Cylinder Size A (226 ft.)   |  | Scott Specialty Gases<br>3714 Lepas Drive<br>Houston, Texas 77023<br>713-644-4820 | \$151.00  |
| Decontamination<br>Supplies                                      | Wash buckets (large)<br>Bristle brushes<br>detergent  | MA   | Supermarkets  |   |

**FINAL PAGE**

**ADMINISTRATIVE RECORD**

**FINAL PAGE**

**FINAL PAGE**

**ADMINISTRATIVE RECORD**

**FINAL PAGE**

00000000