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INSTALLATION RESTORATION PROGRAM (IRP)
RCRA FACILITY INVESTIGATION

SAMPLING AND ANALYSIS PLAN

Carswell Air Force Base, Fort Worth, Texas

December 1993

Final

PREPARED FOR

AIR FORCE BASE DISPOSAL AGENCY (AFBDA/SWH)
CARSWELL AIR FORCE BASE, TEXAS 76127

UNITED STATES AIR FORCE
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BASE CLOSURE RESTORATION DIVISION (AFCEE/ESB)
BROOKS AIR FORCE BASE, TEXAS 78235-5328

LAW
ENGINEERING AND ENVIRONMENTAL SERVICES

173002

December 29, 1993

Air Force Center for Environmental Excellence
AFCEE/ESB
Building 624 West
Brooks Air Force Base, TX 78235-5328

Attention: Chris Hobbins (Team Chief)

Subject: Carswell Air Force Base
Final Sample and Analysis Plan
Contract No. F33615-90-D-4008
Delivery Order No. 0011
Law Project No. 11-3517-0111

Dear Mr. Hobbins:

Law Environmental, Inc., Government Services Division is pleased to submit the enclosed eight (8) copies of the Final Sample and Analysis Plan to the Air Force Center for Environmental Excellence (AFCEE) for approval.

If you have questions or comments, please contact us at (404) 499-6800.

Sincerely,

John F. O'Brien
Project Manager

E. Fred Sharpe, Jr., P.E.
Principal

3517-0111.07

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INSTALLATION RESTORATION PROGRAM (IRP)
RCRA FACILITY INVESTIGATION
FINAL SAMPLING AND ANALYSIS PLAN
FOR
CARSWELL AFB
FORT WORTH, TEXAS 76127-5000

DECEMBER 1993

Prepared by:

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CONTRACTOR CONTRACT NO. F33615-90-D-4008 DELIVERY ORDER NO. 0011

United States Air Force
Air Force Center For Environmental Excellence
Base Closure Restoration Division (AFCEE/ESB)
Brooks Air Force Base, Texas 78235-5328
Mr. Chris Hobbins (Team Chief)

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LAW ENVIRONMENTAL INC., (LAW), WILL, INITIALLY, CONDUCT A RCRA FACILITY INVESTIGATION AT TWO SITES AT CARSWELL AIR FORCE BASE (CAFB), TEXAS, UNDER THE AIR FORCE INSTALLATION RESTORATION PROGRAM (IRP). THE PROJECT FOLLOWS THE REQUIREMENTS OF IRP, AND THE WORK DESCRIBED IN THIS SAMPLING AND ANALYSIS PLAN (SAP) IS DESIGNED TO CHARACTERIZE ENVIRONMENTAL CONDITIONS AT THE TWO SITES AND TO ENSURE SUBSEQUENT REMEDIAL DESIGN AND REMEDIAL ACTION CONSISTENT WITH THE OBJECTIVES OF THE BASE REALIGNMENT AND CLOSURE (BRAC) PROGRAM. THE TWO SITES TO BE INVESTIGATED INCLUDE: UNNAMED STREAM (IRP SITE SD-13/SWMU 64) AND POL TANK FARM (IRP SITE ST-14/SWMU 68).

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PURPOSE OF DOCUMENT

This Sampling and Analysis Plan (SAP) has been developed for the RCRA Facility Investigation (RFI) activities at Carswell Air Force Base (Carswell AFB). Procedures outlined in this plan are designed to describe the collection of geologic data, hydrologic data, environmental samples, laboratory analysis of those samples for potential contaminants, evaluation of the analytical results and field measurements with respect to quality control data and the interpretation and analysis of QA/QC reviewed data. The plan will be effective after final approval.

The success of Carswell AFB's Installation Restoration Program depends on team effort and total dedication from parties involved. Therefore, efforts will be focused on achieving and maintaining compliance with this Sampling and Analysis Plan and pertinent regulations.

The point of contact for this investigation is as follows:

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SAMPLING AND ANALYSIS PLAN (SAP)
DISCLAIMER NOTICE

This Sampling and Analysis Plan has been prepared for the United States Air Force by Law Environmental, Inc. for the purpose of aiding in the implementation of a final remedial action plan under the Air Force Installation Restoration Program (IRP). As the report relates to actual or possible releases of potentially hazardous substances, its release prior to an Air Force final decision on remedial action may be in the public's interest. The limited objectives of this plan and the ongoing nature of the IRP, along with the evolving knowledge of site conditions and chemical effects on the environment and health, must be considered when evaluating this report, since subsequent facts may become known which may make this plan premature or inaccurate. Acceptance of this sampling and analysis work plan in performance of the contract under which it is prepared does not mean that the Air Force adopts the conclusions, recommendations or other views expressed herein, which are those of the contractor only and do not necessarily reflect the official position of the United States Air Force.

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Cameron Station
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National Technical Information Service (NTIS)
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Springfield, VA 22161

3517-0111.07

SAMPLING AND ANALYSIS PLAN (SAP)
PREFACE

Law Environmental, Inc. (Law) was contracted by the U.S. Air Force Center for Environmental Excellence (AFCEE) to perform a RCRA Facility Investigation (RFI) at two sites at Carswell AFB, Texas. The two sites to be investigated include: Unnamed Stream (IRP Site SD-13/SWMU 64) and POL Tank Farm (IRP Site ST-14/SWMU 68). The primary objective of this field investigation is to investigate the extent of soil and ground water contamination at each site and assess the overall environmental status of the sites in order to support the recommendation of appropriate further actions. Project objectives will be achieved through the use of the following methods of investigation: geophysical and geochemical surveys; soil and ground water samples for field screening and laboratory analysis; and surface water and sediment samples for laboratory analysis.

The SAP outlines the site objectives, the data quality objectives, the field activities, sample collection, and laboratory analytical procedures required for the RFI at Carswell AFB.

The SAP is composed of two documents - the Quality Assurance Project Plan (QAPP) and the Field Sampling Plan (FSP).

The QAPP consists of detailed information on defining and assuring that the Data Quality Objectives (DQOs) are achieved. DQOs are considered through various project tasks, including writing of plans, field work, and laboratory analysis. The QAPP delineates the procedures necessary to achieve DQO goals.

The FSP describes field tasks necessary for implementing the project objectives. Field tasks are described in detail to ensure that the DQOs are achieved during field activities.

Mr. John O'Brien is the Project Manager for the RFI. Members of the field investigation team will be selected prior to commencement of field activities.

The QAPP was prepared by Ms. Darice Kurtzer and reviewed by Mr. Jerry Preston and Mr. Fred Sharpe. The FSP was prepared by Mr. Jim Beaver and Ms. Darice Kurtzer and reviewed by Mr. Jerry Preston and Mr. Fred Sharpe.

The support and assistance of Mr. Chris Hobbins (AFCEE) and personnel at Carswell AFB are greatly appreciated.

John F. O'Brien
Project Manager

E. Fred Sharpe, Jr., P.E.
Principal

Louis S. Karably, P.E.
Program Manager1

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APPENDIX E	SPECIFIC CONDUCTIVITY AND TEMPERATURE METER
APPENDIX F	TURBIDIMETER
APPENDIX G	MILLIPORE OPERATION AND MAINTENANCE INSTRUCTIONS

LIST OF ACRONYMS

AB	Ambient Condition Blank
ABB-ENV	ABB Environmental Services, Inc.
AFB	Air Force Base
AFCEE	Air Force Center for Environmental Excellence
ARAR	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
CA	Corrective Action
CF	Calibration Factor
CCB	Continuing Calibration Blank
CCC	Continuing Calibration Check
CCV	Continuing Calibration Verification
CE	Civil Engineering
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (PL-96-510) - SUPERFUND
CES	Civil Engineering Squadron
CEO	Chief Executive Officer
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CV	Coefficient of Variation
CVAA	Cold Vapor Atomic Absorption
DC	Drill Cuttings
DOT	Department of Transportation
DQCR	Daily Quality Control Report
DQO	Data Quality Objectives
EB	Equipment Blank (Rinsate)
EMSL	Environmental Monitoring Systems Laboratory
FS	Feasibility Study
FSP	Field Sampling Plan
GC/MS	Gas Chromatography/Mass Spectrometry
GFAA	Graphite Furnace Atomic Absorption
HNu	Photoionization Detector (trade name)
ICB	Initial Calibration Blank
ID	Sample Identification

LIST OF ACRONYMS
(Continued)

ICP	Inductively Coupled Plasma
IRP	Installation Restoration Program
IRPIMS	Installation Restoration Program Information Management System
ITIR	Informal Technical Information Report
Law	Law Environmental, Inc., Government Services Division
LEGS	Law Environmental, Inc. - Government Services Division
LENL	Law Environmental National Laboratories
LENL-P	Law Environmental National Laboratories - Pensacola, Florida
LCS	Laboratory Control Standards
MCL	Maximum Contaminant Level
MDL	Method Detection Limit
MITRE	MITRE Corporation
MQL	Maximum Quantitation Limit
MS	Matrix Spike
MSD	Matrix Spike Duplicate
MW	Monitoring Well
NCP	National Contingency Plan
NTU	Nephelometric Turbidity Unit
OSWER	Office of Solid Waste and Emergency Response
OVA	Organic Vapor Analyzer
PA	Preliminary Assessment
PARCC	Precision Accuracy Representativeness Completeness Comparability
PE	Professional Engineer
PID	Photoionization Detector
POC	Point of Contact
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAMS	Quality Assurance Management Staff
QCCS	Quality Control Check Samples

LIST OF ACRONYMS
(Continued)

QAPP	Quality Assurance Project Plan
QC	Quality Control
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RF	Response Factor
RI	Remedial Investigation
RLS	Registered Land Surveyors
RPD	Relative Percent Difference
RRF	Relative Response Factor
RRT	Relative Retention Time
RSD	Relative Standard Deviation
RT	Retention Time
SAP	Sampling and Analysis Plan
SB	Soil Boring
SC	Specific Conductance
SD	Surface Sediment
SI	Site Investigation
SOP	Standard Operating Procedures
SPCC	System Performance Check Compound
SPT	Standard Penetration Test
SW	Surface Water
TB	Trip Blank
TC	Team Chief
TEG	TransGlobal Environmental Geochemistry, Texas
TPM	Technical Project Manager
TWC	Texas Water Commission
USAF	United States Air Force
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey

1.0 QUALITY ASSURANCE PROJECT PLAN

1.1 INTRODUCTION

This RCRA Facility Investigation (RFI) Quality Assurance Project Plan (QAPP) is provided in support of the United States Air Force (USAF) Installation Restoration Program (IRP) for 2 sites located at Carswell Air Force Base (Carswell AFB), Texas. This investigation will adhere to those procedures specified by the RFI Guidance EPA 530/SW-89-031 and Provision VIII RCRA Facility Investigation of the permit issued to Carswell AFB by the Texas Water Commission (TWC) on February 7, 1991. This investigation will be supplemented by the Air Force Center for Environmental Excellence (AFCEE) in the Handbook to Support the Installation Restoration Program (IRP) Statements of Work: Volume I - Remedial Investigation/Feasibility Studies (RI/FS) (AFCEE, 1991).

1.1.1 The U.S. Air Force Installation Restoration Program

The objective of the Air Force IRP is to assess past hazardous waste disposal and spill sites at Air Force installations and to develop remedial actions consistent with the National Contingency Plan (NCP) for those sites which present a threat to human health and welfare or the environment. Additional information regarding the Air Force IRP is discussed in Section 1.0 of the Work Plan.

1.1.2 Purpose and Scope

The Sampling and Analysis Plan (SAP) describes those procedures necessary to perform a quality controlled sampling effort during the execution of the project's scope of work. The activities addressed by the SAP include:

- Installation of monitoring wells
- Soil borings
- Acquisition of ground-water, surface and subsurface soil, surface water and sediment samples
- Decontamination of equipment
- Calibration of field instruments
- Aquifer (slug) testing
- Maintenance of laboratory and field QA/QC
- Geophysical survey
- Chemical analysis
- Preventative maintenance
- Data quality assessment
- Corrective action
- Quality control (QC) checks
- Quality assurance (QA) audits and reports

Specific quality control requirements are specified in Appendix A.

1.2 PROJECT DESCRIPTION

Carswell AFB is located in northeastern Texas, in Tarrant County, six miles west of downtown Fort Worth, as shown in Figure 1-1. This RFI for Carswell AFB will investigate the 2 sites listed below:

- Unnamed Stream (IRP Site SD-13/SWMU 64)
- Petroleum, Oil, Lubricants (POL) Tank Farm (IRP Site ST-14/SWMU 68)

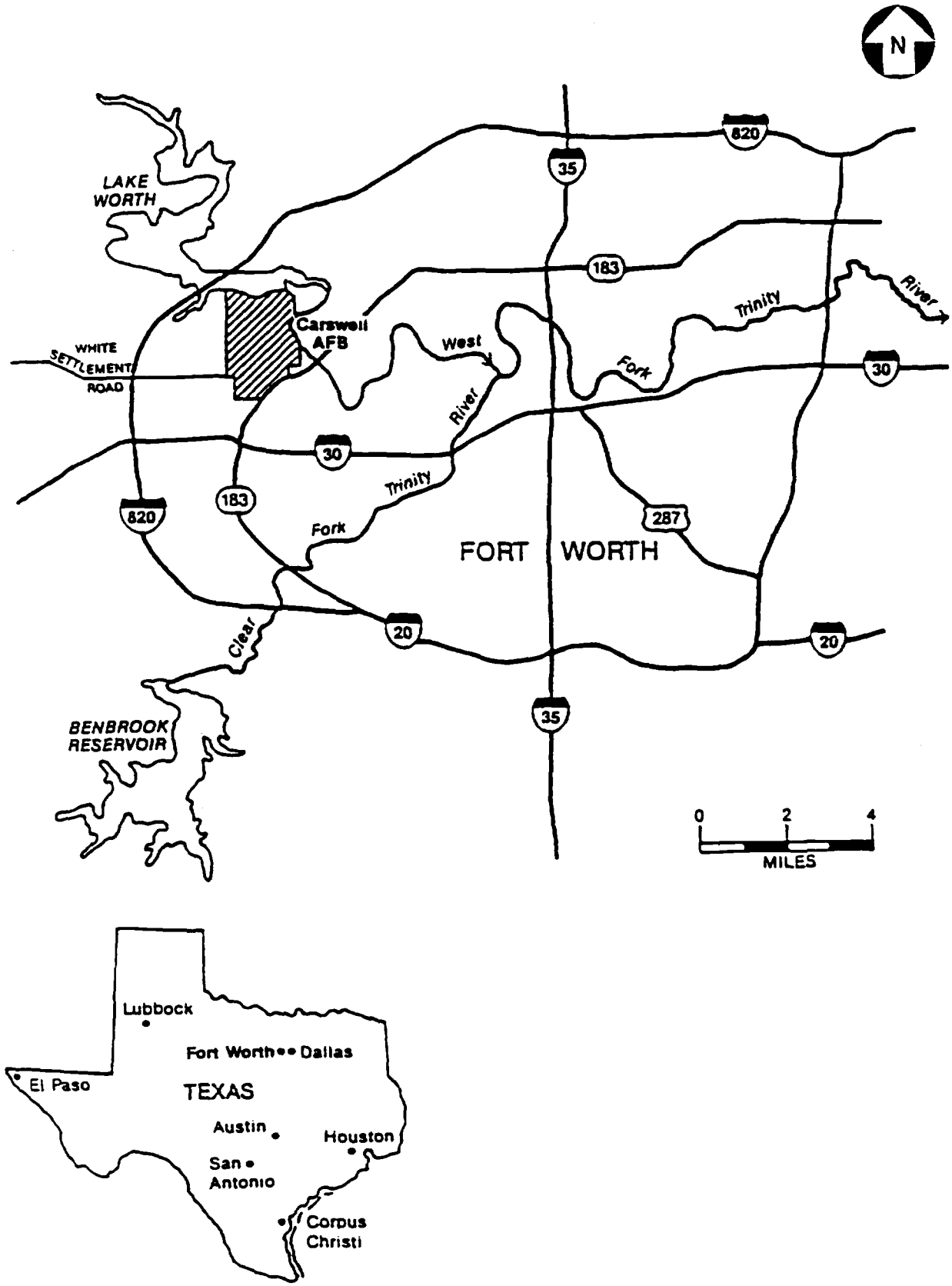
Detailed site maps are presented in Section 2.1. The RFI for each site is designed to evaluate the presence and extent of contamination. The following sections present the project background, scope and objectives.

173021

FIGURE 1-1

LOCATION MAP OF CARSWELL AFB

CARSWELL AFB, FORT WORTH, TEXAS



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1.2.1 Project Background

The 2 sites included under this RFI were identified as possibly contaminated sites through the efforts of 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 studies conducted by the Radian Corporation (Radian, 1986, 1991).

1.2.1.1 POL Tank Farm Site (IRP Site ST-14/SWMU 68) - The POL Tank Farm is located in the east area of Carswell AFB, west of and adjacent to Knight's Lake Road and north of Hobby Shop Road (Figure 1-2). The Fuel Loading Area is east of Knight's Lake Road.

Three above-ground POL storage tanks currently are in place at this site and an additional three tanks have been removed from the site. Leaking underground POL lines are suspected to have released an undetermined amount of fuel products into the soil and ground water at and south of the POL Tank Farm during the early 1960s. The leaking lines were reportedly located and replaced and no further fuel releases were documented after 1965. Previous studies (Radian, 1986, 1991) have found evidence of contamination by organic compounds, including ethylbenzene, benzene, chlorobenzene and total xylenes. Lead and chromium in excess of Maximum Containment Levels (MCLs) were also detected in the ground water at this site.

1.2.1.2 Unnamed Stream Site (IRP Site SD-13/SWMU 64) - The Unnamed Stream and Abandoned Service Station are located near the eastern boundary of the base, east of Rogner Drive and north of Farmer's Branch. This site consists of two locations, the paved area around the Abandoned Service Station and the intermittent stream flowing from an oil/water separator to Farmer's Branch (Figure 1-3).

173323

FIGURE 1-2

LOCATION OF EAST AREA SITES

CARSWELL AIR FORCE BASE, TEXAS

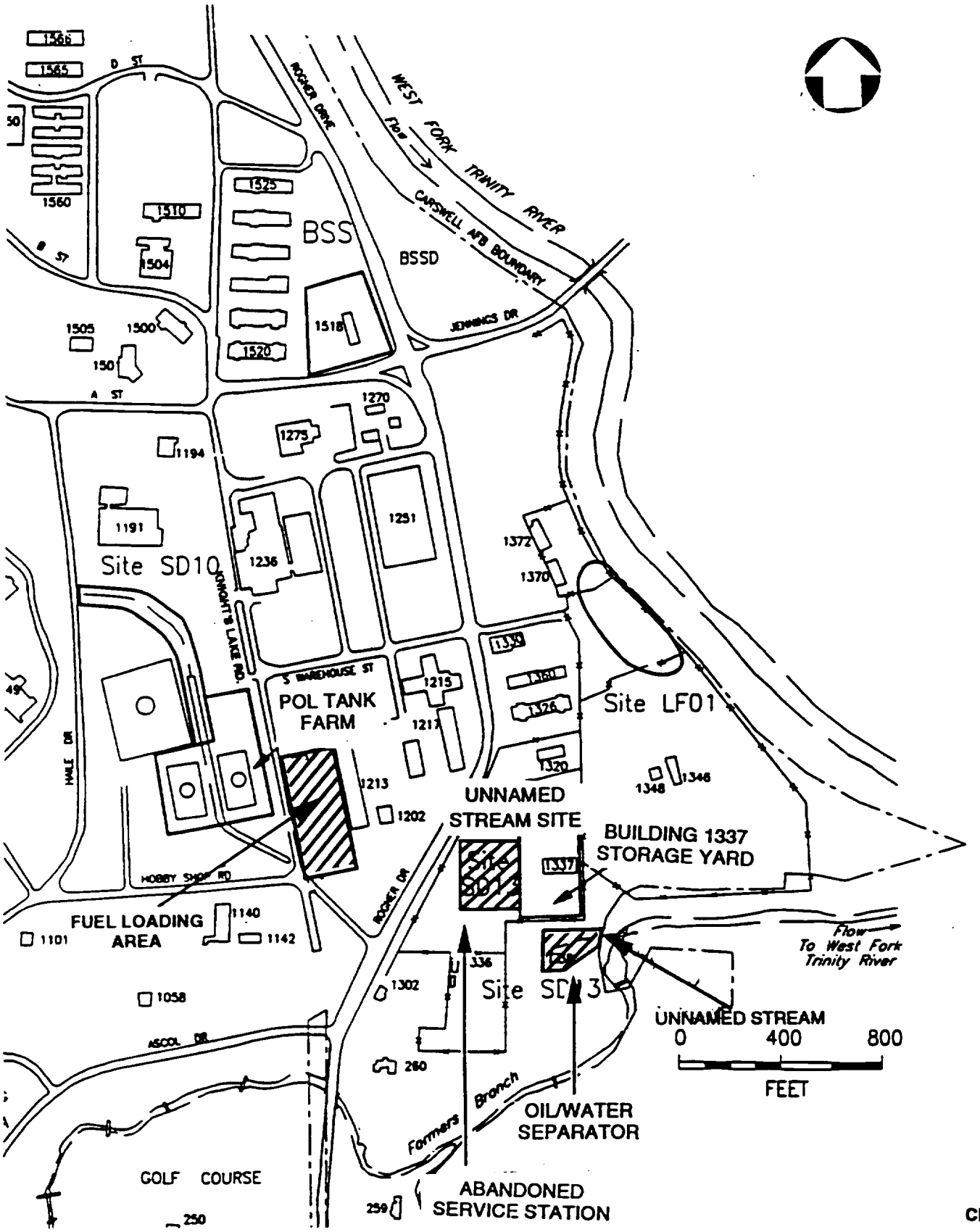
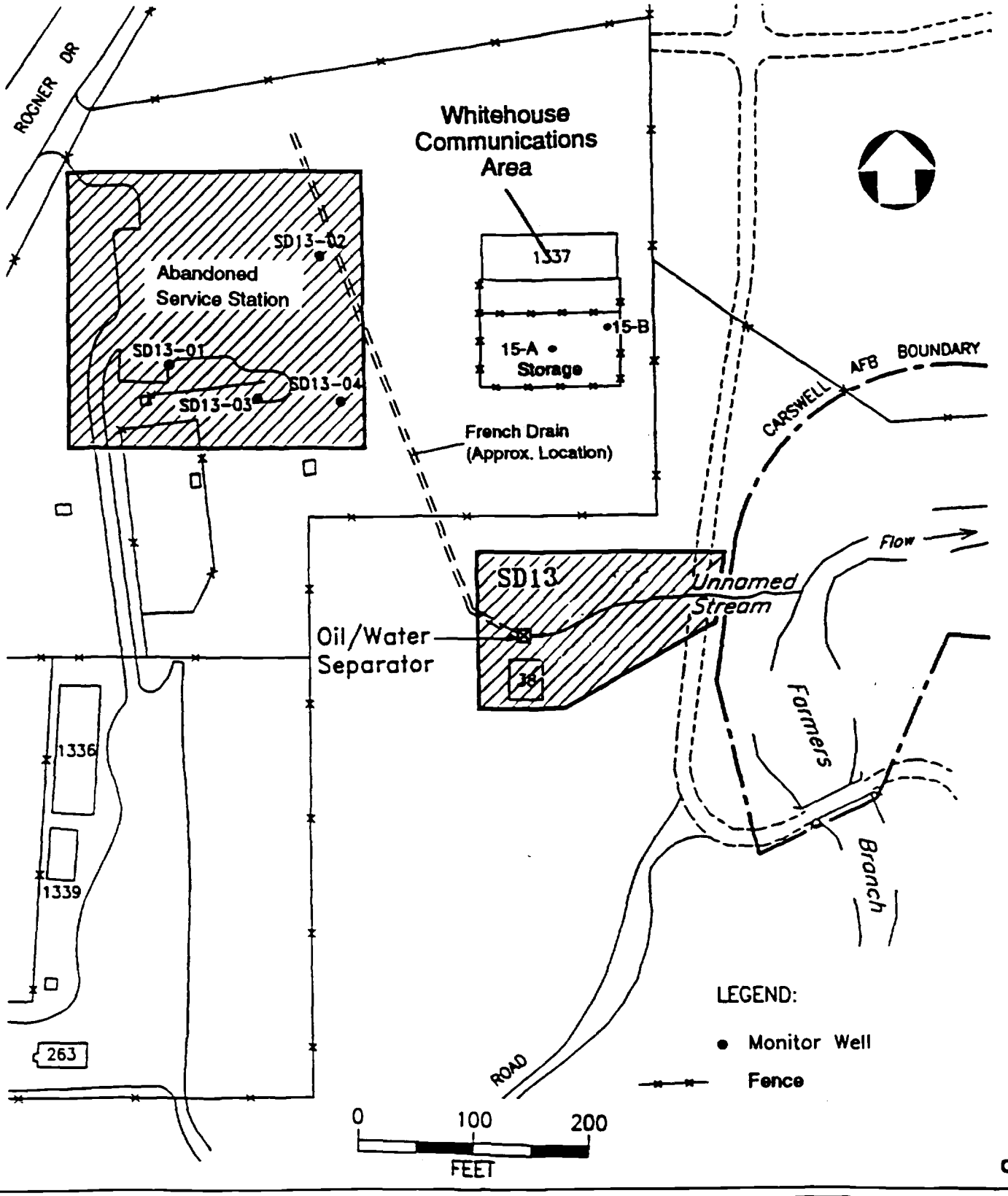


FIGURE 1-3

LOCATIONS OF FRENCH DRAIN AND OIL/WATER SEPARATOR, SITE SD13,

(AFTER RADIAN, 1991a)

CARSWELL AIR FORCE BASE, TEXAS



The Abandoned Service Station area may contain one or more USTs that may have leaked petroleum products. The Unnamed Stream flows from the oil/water separator that is the terminus of a french drain system installed in 1965, reportedly to recover fuel leaking from either the Abandoned Service Station USTs and/or the POL Tank Farm. Previous studies (Radian, 1986, 1991) detected low levels of organic contamination in the ground water at this site. Surface water samples contaminated with lead and arsenic in excess of MCLs were collected from the Unnamed Stream downstream from the oil/water separator.

1.2.2 Project Scope and Objectives

The following sections describe the site-specific scope and objectives. The objectives described below will be accomplished through the collection of geological data, hydrogeological data, and collection of environmental samples; the laboratory analysis of these samples for potential contaminants; the evaluation of the analytical results and field measurements with respect to quality control data; and the interpretation and analysis of valid data.

The data generated by this project must be of sufficient quality and quantity to meet the overall project objective, which is to improve site characterizations that would ultimately lead to remediation of the sites. The purpose of this RFI at Carswell AFB is to collect assessment data for ground water at POL Tank Farm and for soils, surface water, sediment, and ground water at the Unnamed Stream. This RFI will be prepared to meet requirements included in Part VIII of the RCRA Permit Number HW-50289, Attachment B. The focus of this work will be to characterize the spatial distribution of contamination at each site and its potential for transport. The findings of this RFI will be used to support the recommendation of appropriate further actions. The criteria established in the

Sampling Analysis Plan Will be used to determine the possible need for a corrective measures study to define and evaluate remedial action alternatives.

Health and Safety data will be used to establish the level of protection needed for the work party and other site-related personnel. These data will be gathered by the use of geophysical instruments, organic vapor analyzers (HNu), Draeger tubes, tri-gas monitors, and explosimeters utilized during non-intrusive and intrusive activities.

Table 1-1 presents a combined list of the potential contaminants at both sites. This table is compiled from the list of compounds in the SW846 EPA Test Methods for Evaluating Solid Waste. The compounds listed are based upon the parameters of interest for each of the sites at Carswell AFB. In order to further evaluate the sites, samples of surface and subsurface soil, ground water, surface water, and sediment will be collected. The parameters of interest for each site for each of these matrices are presented in Table 1-2. The number of samples to be collected are presented in Section 2.2. The collection and analysis of background soil and ground-water samples will be performed according to the AFCEE request on October 28, 1993. This AFCEE directive requested that background ground-water and soil samples be collected from the proposed upgradient monitoring well adjacent to Rogner Drive. The following subsections describe the background scope and objectives for each site.

1.2.2.1 <u>POL Tank Farm Site</u> - Field tasks to be performed at the POL Tank Farm site include a geophysical survey and geochemical survey.

A. <u>Geophysical Survey</u> - A surface geophysical survey will be performed to help characterize the near surface conditions and

TABLE 1-1

POTENTIAL CONTAMINANTS
RCRA Facility Investigation
Carswell Air Force Base, Texas

Volatile Organics (34)
Acetone
Benzene +
Bromodichloromethane
Bromoform
Bromomethane
2-Butanone (MEK)
Carbon Disulfide
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
Chloromethane
Dibromochloromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
trans-1,2-Dichloroethene
1,2-Dichloropropane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Ethylbenzene +
2-Hexanone
Methylene chloride
4-Methyl-2-pentanone
Styrene
1,1,2,2-Tetrachloroethane
Tetrachloroethene
Toluene +
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Vinyl acetate
Vinyl chloride
Xylenes +

+ = Aromatic

Extractable Organics (65)
Acenaphthene
Acenaphthylene
Anthracene
Benzo[a]anthracene
Benzo[b]fluoranthene
Benzo[k]fluoranthene
Benzoic Acid
Benzo[ghi]perylene
Benzo[a]pyrene
Benzyl alcohol
bis(2-Chloroethoxy)methane
bis(2-Chloroethyl)ether
bis(2-Chloroisopropyl)ether
bis(2-ethylhexyl)phthalate
4-Bromophenyl phenyl ether
Butyl benzyl phthalate
4-Chloro-3-methylphenol
2-Chloronaphthalene
2-Chlorophenol
4-Chlorophenyl phenyl ether
Chrysene
Dibenzo [a,h] anthracene
Dibenzofuran
Di-n-butylphthalate
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
2,4-Dichlorophenol
Diethylphthalate
3,3'-Dimethylphthalate
2,4-Dimethylphenol
Dimethylphthalate
4,6-Dinitro-2-methylphenol
2,4-Dinitrophenol
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octylphthalate
Fluoranthene
Fluorene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno[1,2,3-cd]pyrene
Isophorone
2-Methylnaphthalene
2-Methylphenol
4-Methylphenol
Naphthalene
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Nitrobenzene
2-Nitrophenol
4-Nitrophenol
n-Nitrosodiphenylamine
n-Nitrosodipropylamine
Pentachlorophenol
Phenanthrene
Phenol
Pyrene
1,2,4-Trichlorobenzene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

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TABLE 1-1

POTENTIAL CONTAMINANTS
RCRA Facility Investigation
Carswell Air Force Base, Texas

Metals (24)
Aluminum
Antimony
Arsenic
Barium
Beryllium
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Molybdenum
Mercury
Nickel
Potassium
Selenium
Silver
Sodium
Thallium
Vanadium
Zinc

Total Recoverable Petroleum Hydrocarbons
Oil
Grease

Purgeable Aromatic Volatiles
Benzene
Chlorobenzene
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Ethylbenzene
Toluene
Xylenes

Nonhalogenated Volatile Organics
Diethyl ether
Ethanol
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone (MIBK)

Total Recoverable Oil and Grease
Oil
Grease

Purgeable Halocarbons
Bromobenzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon tetrachloride
Chlorobenzene
Chloroethane
Chloroform
1-Chlorohexane
2-Chloroethyl vinyl ether
Chloromethane
Dibromochloromethane
Dibromoethane
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
trans-1,2-Dichloroethene
Cis-1,3-Dichloropropene
1,2-Dichloropropane
trans-1,3-Dichloropropene
Methylene chloride
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichlorofluoromethane
Trichloropropane
Vinyl Chloride

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TABLE 1-2

PARAMETERS OF INTEREST BY SITE
RCRA Facility Investigation
Carswell Air Force Base, Texas

		ORGANIC							INORGANIC					OTHER
No.	SITE NAME	AROMATIC VOLATILE ORGANICS	VOLATILE ORGANICS	EXTRACTABLE ORGANICS	TOTAL RECOVERABLE PETROLEUM HYDROCARBONS	PETROLEUM HYDROCARB.	OIL & GREASE	PURGEABLE HALOCARBONS	SCREEN FOR 24 METALS	ARSENIC	MERCURY	LEAD	SELENIUM	TCLP
GROUND WATER / HYDROPUNCH SURVEY														
1	Unnamed Stream		X		X		X	X	X	X	X	X	X	X
2	POL Tank Farm	X				X						X		
SURFACE WATER														
1	Unnamed Stream	X	X		X		X							
SUB-SURFACE SOIL														
1	Unnamed Stream	X	X		X									X
SEDIMENT														
1	Unnamed Stream								X					

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to locate utilities and abandoned tanks and pipechases. A single type of geophysical survey (ground penetrating radar) will be performed at the POL Tank Farm site during the field work.

B. Geochemical Survey - A geochemical survey will be conducted at the POL Tank Farm site as part of the RCRA facility investigation effort. Twenty-five survey points will be performed utilizing the Strataprobe™ System, which is a direct push method for ground-water investigation developed by Transglobal Environmental Geochemistry (TEG). These ground-water samples will provide supplemental analytical information in order to delineate the extent of contamination (see Figure 1-4).

1.2.2.2 Unnamed Stream - Field tasks to be performed at the Unnamed Stream include a geophysical survey, monitoring well installation, aquifer testing, soil sampling and surface water/sediment sampling.

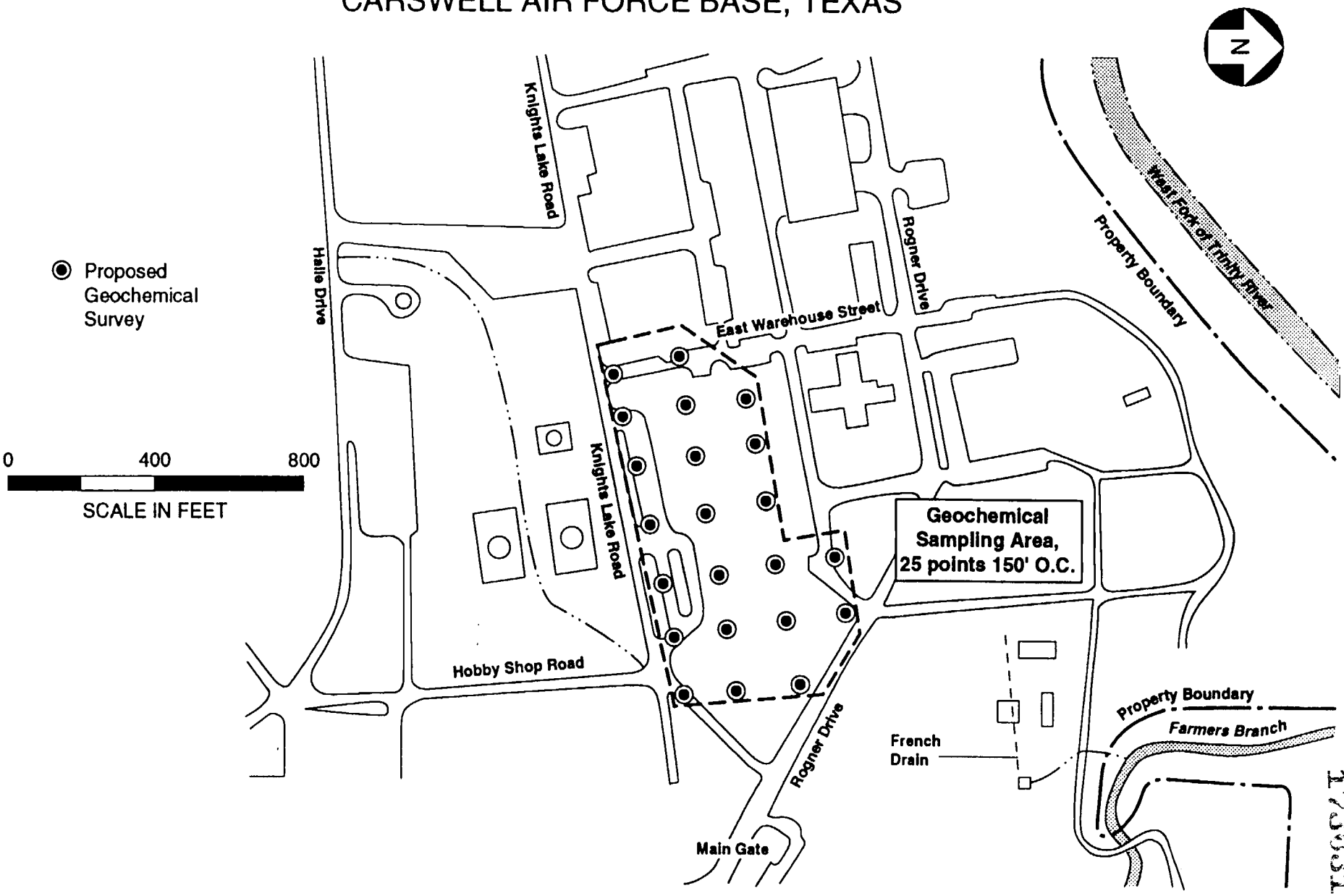
A. Geophysical Survey - A surface geophysical survey will be performed at both sites to help characterize the near surface conditions and to locate utilities and abandoned tanks and pipechases. A single type of geophysical survey (ground penetrating radar) will be performed at the Unnamed Stream during the field work.

B. Soil Sampling - Two soil samples will be collected from each of three soil borings. The samples will be screened by hand held portable organic vapor analyzer(s) (OVAs) used to screen the air vapors at the head of the augers, in the breathing zone and in the soil sample headspace. The OVAs will be equipped with photoionization detectors (PID). The PID equipment manual is presented in Appendix C. One soil sample

FIGURE 1-4

PROPOSED GEOCHEMICAL SAMPLING AREA

CARSWELL AIR FORCE BASE, TEXAS



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will be collected at the depth that has the highest OVA reading. The second sample will be collected at the ground-water interface. If the OVA screen results are nondetect, a default depth of five feet will be sampled.

Two additional soil samples will be collected from the soil boring located northwest of the French Drain and east of Rogner Drive for a total of four soil samples from this boring (See Figure 2-2). This upgradient soil boring will be completed as an upgradient monitoring well and this location will be used to establish background soil and ground-water data for the site. One surface soil sample will be collected at the 6 to 12 inch interval. And an additional sample will be collected at the depth with the second highest OVA reading.

Soil borings will be performed to allow installation of each monitoring well. The soil borings will provide subsurface information for well design and site stratigraphy as well as assessment of the presence of site constituents in surface and subsurface soils.

C. Monitoring Well Installation - Each of the three soil borings discussed above will be completed as shallow monitoring wells to assess the presence of site constituents in subsurface soils and the surficial aquifer. One monitoring well will be located upgradient of this site and will be used to establish background information for this site. Two monitoring wells will be located downgradient of this site.

D. Aquifer Testing - In-situ hydraulic conductivity tests will be performed on the new monitoring wells a minimum of 24 hours after ground-water sampling. The tests will be conducted to determine formation permeability. The results of the tests will be used to estimate ground-water flow rates.

E. Surface Water/Sediment Sampling - Three surface water/sediment samples will be collected at this site to assess if site constituents are affecting surface waters and underlying sediments in the area.

1.2.3 Subcontractors

The subcontractors to be utilized for this RFI investigation along with their service to be performed are identified in Section 1.3.

1.3 PROJECT ORGANIZATION AND RESPONSIBILITIES

Project organization and responsibilities for the RFI for the two sites at Carswell AFB are discussed in the following sections.

1.3.1 Project Organization

Law Environmental, Inc., Government Services Division (Law) will manage the project and provide services related to field samples, geophysics, data analysis, site characterization, and reporting.

- ATEC Environmental Services of Dallas, Texas will be subcontracted to perform the drilling services.

- Law Environmental National Laboratories - Pensacola, Florida (LENL-P) will be subcontracted as the primary laboratory to perform the chemical analysis of the soil and water samples.

- Transglobal Environmental Geochemistry (TEG) of Austin, Texas will be subcontracted to perform the ground-water reconnaissance technique at the POL Tank Farm area. TEG will perform a ground water field screening utilizing a

direct push cone penetrometer type sampling system. The TEG sampling technique, Strataprobe™ is described in Section 2.1.3. They will also perform on-site analysis of the ground water collected. The TEG QA information is in Appendix B-2.

- An OSHA-certified and Texas state licensed local surveying company will be subcontracted to survey the soil borings, monitoring wells, and other sampling locations. In addition, the surveyor will prepare a site map.

- Ensite, Inc., will be subcontracted to handle the transport and disposal of drummed soil cuttings, decontamination fluids, and development and purge water generated during investigative activities.

The project organization is shown on Figure 1-5.

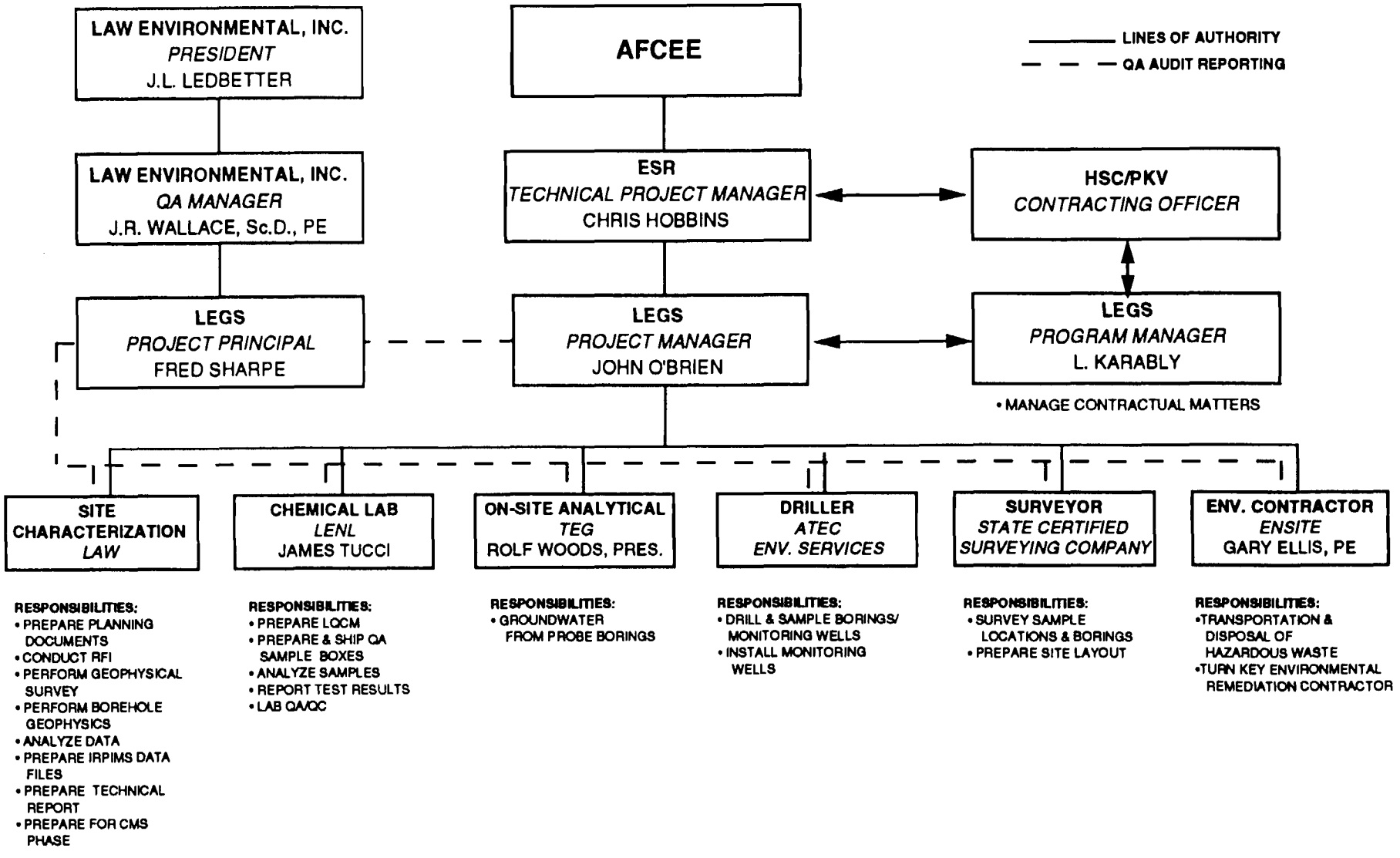
1.3.1.1 Law Environmental, Inc. - Law Environmental's Government Services Division will provide the project management, engineering and analysis, and sampling through its in-house resources. It is a branch of Law Environmental, Inc., which, in turn, is a wholly-owned subsidiary of Law Companies Group, Inc. Law Companies Group, Inc., is entirely employee owned.

1.3.1.2 Drilling Subcontractor - ATEC Environmental Services, Dallas, Texas will be responsible for drilling soil borings and installation of monitoring wells. The drilling engineer will follow direction from the Site Manager during field activities and from the Project Manager prior to and after field work.

FIGURE 1-5

PROJECT ORGANIZATION AND QM RESPONSIBILITIES

PRELIMINARY ASSESSMENT/SITE INVESTIGATION
CARSWELL AIR FORCE BASE, TEXAS



1.3.1.3 Chemical Analysis Laboratories - The Law Environmental, Inc., National Laboratories facility in Pensacola, Florida (LENL-P), is the Law Environmental, Inc., chemical testing laboratory which was established in 1989. LENL-P will be the laboratory responsible for providing sample shipping containers, chain-of-custody documents, chemical analysis, reporting, and laboratory QA/QC. LENL-P will perform all analyses of soil, ground water, surface water and sediments and associated QC samples.
LENL-P will report directly to the Project Manager during the project. LENL-P has integrated Quality Assurance/Quality Control (QA/QC) procedures into their laboratory design and standard operating procedures. LENL-P is certified in several states. In order to perform analyses for AFCEE projects, LENL-P has undergone and complied fully with audits conducted under the auspices of the Air Force. LENL-P's key personnel and their positions and responsibilities are outlined in Appendix B-1.

1.3.1.4 Geochemical Survey - Transglobal Environmental Geochemistry, Texas (TEG), specializing in ground-water screening, will conduct the geochemical survey. They will perform on site sampling and analysis of the ground water generated during the ground-water screen. TEG's system has been recognized and approved by the Texas Water Commission (TWC) as a viable tool for studying ground water contaminated plumes.

1.3.1.5 Surveying Subcontractor - A local engineering and surveying firm, certified in the state of Texas, will be subcontracted to survey boring/sampling locations and elevations and prepare site maps. The firm will report directly to the Site Manager during their survey activities and to the Project Manager prior to and after field work. Their in-house Professional Engineer (PE)/Registered Land Surveyor (RLS) will perform the field

surveying and preparation of the final site map. These individuals will follow the AFCEE guidance documents, provided by Law, to prepare their draft and final site map.

1.3.1.6 Ensite - Environmental Contractor - Ensite will be contracted to perform services related to handling, transport and disposal of investigative derived wastes generated during the field investigation. Ensite, located in Atlanta, Georgia, is a wholly-owned subsidiary of Law Environmental and is a licensed site remediation contractor.

1.3.2 Key Project Individuals

Key project participants for this project include the project principal, project manager, project chemist, project geologist/site manager, health and safety officer, laboratory manager, and field work parties. The following paragraphs provide a description of the proposed project assignments and responsibilities, a list of individuals expected to serve in each capacity, and a brief synopsis of the participants' related experience.

1.3.2.1 Project Principal - The Project Principal provides technical quality control, oversight and direction for all aspects of the site investigation and data evaluation. Mr. E. Fred Sharpe, Jr. P.E. will serve as the Project Principal. Mr. Sharpe, a Principal with Law Environmental, will serve as the senior reviewer of Law's reports of the Carswell AFB RFI sites. Mr. Sharpe has over 24 years experience with Law Companies.

1.3.2.2 Project Manager - The Project Manager is responsible for the overall management of the Carswell AFB RFI. He coordinates between office and field personnel, manages administrative

requirements, and supervises schedules, technical approach, implementation, and report preparation. Mr. John O'Brien will serve as project manager. Mr. O'Brien has six years of professional experience in site and project management. He is presently managing projects under RCRA, CERCLA, and IRP guidance including Carswell AFB.

1.3.2.3 Site Manager - The Site Manager will coordinate and supervise the field investigation activities. The Site Manager may also serve as the Health and Safety Officer for the field operations, and will be responsible for the implementation of the Work Plans and Health and Safety Plans. The Site Manager's primary responsibility is the health and safety of the workers on site. Mr. Tom McComb will serve as the Site Manager for this project. Mr. McComb is a Professional Geologist with over seven years experience in site investigations and assessments.

1.3.2.4 Project Chemist - The Project Chemist is responsible for preparing and implementing the field sampling, preservation, chain-of-custody, and shipping activities. The Project Chemist also performs data evaluation on the chemical data. Ms. Darice Kurtzer will serve as the Project Chemist for this investigation. Ms. Kurtzer is a chemist with over three years of experience in environmental chemistry, Quality Assurance/Quality Control (QA/QC) and data evaluation.

1.3.2.5 Laboratory Project Manager - The Laboratory Project Manager is responsible for the handling and analysis of water and/or soil samples received by the laboratory. This person oversees sample travel through the lab, analytical procedures, quality control, reporting and sample disposal. Mr. James Tucci is LENL's Chemical Laboratory Manager. His areas of expertise include environmental field studies, laboratory analyses and personnel management.

1.3.2.6 Work Party - The work party performs on-site tasks contained in this plan, including drilling, monitoring well installation, and analytical sampling under the direction of the Site Manager.

1.3.2.7 Health and Safety Officer - The Health and Safety Officer oversees the Health and Safety Plan for Carswell AFB. The Health and Safety Officer conducts personnel training, administers company hazard assessment and surveillance medical program, and coordinates with the Site Manager for site safety. Dr. Jack Peng is Law Environmental's Environmental Health and Safety Officer and is available for consultation during the actual investigation. He is a Certified Industrial Hygienist with over 10 years experience in hazardous waste site investigations. Subcontractors working on the Carswell AFB sites under this project will receive a copy of the project Health and Safety Plan. The Law Environmental Site Manager or an assigned qualified Health and Safety Officer will review with subcontractor personnel the Health and Safety Plan prior to any field activities. Site personnel will be required to sign and date the master field logbook to ensure that they understand the safety regulations and procedures as outlined in the Health and Safety Plans.

1.3.2.8 Project Safety Officer - The Project Safety Officer is responsible for the project Site Safety and Health Plan requirements. Ms. Cindy Kahout will serve as the project Safety Officer for this investigation at Carswell AFB. Ms. Kahout is an Industrial Hygienist with nine years of experience in developing and auditing health and safety programs.

1.3.3 Project QA Responsibilities

Law Environmental, Inc. has established a strong internal QA program with an associated QA Manual, Engineering Procedures

Manual, Equipment Calibration Procedures Manual, and specialty manuals for hazardous waste site investigations and software documentation. Law Environmental employees use these manuals as the basis for conducting all company work within the QA program.

Mr. Leonard Ledbetter, the President of Law Environmental, Inc., has overall responsibility for Law's Corporate QA. The Corporate QA Office is directed by Dr. James R. Wallace, who is responsible for daily management and auditing of Law Environmental's QA Program. The Law Environmental lines of QA responsibility and audit flow from Corporate QA (Mr. Ledbetter and Dr. Wallace) to the Project Principal (Mr. E. Fred Sharpe). This line of QA is outside of the operational lines of authority for this project.

Our Quality Assurance Program is one of the most important factors contributing to client satisfaction and our continued success. The purpose of the program is to provide the client with confidence that services are performed correctly.

Our Principal Review System is an integral part of the Quality Assurance Program. Each project is assigned to a Principal Reviewer who is responsible for maintaining the required professional quality from beginning to completion of the project. Every proposal and report must be reviewed and signed by two people and at least one must be a Law Principal with credentials and experience relevant to the area of work.

In each office, the Chief Scientist or Engineer is responsible for operation of the Quality Assurance Program and for reviewing the performance of assigned Principals. The Chief Engineer conducts internal audits of projects and at least once each year a formal corporate audit is conducted by Chief Engineers and Principals from other offices. In addition to these internal and corporate audits, the company participates in laboratory and peer review programs

sponsored by organizations such as the National Bureau of Standards, U.S. Geological Survey, USEPA, AFCEE and the U.S. Army Corps of Engineers.

Law Companies encourages staff membership and participation in various relevant professional societies. We believe such involvement fosters individual professional growth and helps keep our staff up-to-date on current developments. Many Law Principals also serve on subcommittees or teach in sponsored workshops.

Law will control the quality of subcontractor furnished data and services by source evaluation and selection, evaluation of objective evidence of quality compliance to procurement documents furnished by the subcontractor, site and/or source inspections, audits, and/or examination of items or services upon delivery or completion. Prior to award of subcontract, potential suppliers of quality affecting items or services will be evaluated by Law personnel. The evaluation may be performed by any appropriate means, including but not limited to, surveys, inspections, audits, or surveillances, depending upon the complexity of the item or service being supplied. When the Project Principal determines it necessary, on-site audits of subcontractor facilities may be conducted under a quality assurance program. While the responsibility for quality remains with the subcontractor under his quality control program, Law will conduct certain quality assurance activities to determine the subcontractors compliance with their own quality program.

1.4 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Quality Assurance (QA) objectives for measurement data are expressed in terms of precision, accuracy, representativeness, completeness, and comparability (PARCC). QA objectives provide the mechanism for ongoing control and evaluation of measurement data

quality throughout the project and will ultimately be used to define data quality for the various measurement parameters. The achievement of these QA/QC objectives will be accomplished through the collection and analysis of field duplicates, rinsates, trip blanks, and field blanks. The analytical data will be assessed by the internal QC such as method blanks, surrogate recoveries, adherence to holding times, and matrix spike/matrix spike duplicate (MS/MSD) data.

1.4.1 Definitions of QA Criteria

The following sections define the Precision, Accuracy, Representativeness, Completeness, and Comparability (PARCC) parameters.

1.4.1.1 Precision - "Precision" refers to the reproducibility or degree of agreement among duplicate measurements of a single analyte. It is defined by the USEPA as "a measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of the relative percent difference (RPD). Various measures of precision exist depending upon the prescribed similar conditions" (USEPA, 1980). Analytical precision for a single analyte is expressed as a percentage of the difference between results of duplicate samples and matrix spike duplicates for a given analyte. Relative percent difference is calculated as shown in Section 1.10.2.

Precision will be determined through the collection of duplicates and matrix spikes and matrix spike duplicates for the analytical work performed at Carswell AFB. The sampling chemist will select 1 sample in 20 (or 1 per batch, whichever is fewer) for that matrix and split the sample into three aliquots. The first aliquot will

be analyzed routinely for the parameters of interest, while the other two aliquots will be spiked with known quantities of the parameters of interest prior to analysis. The relative percent difference (RPD) will be calculated and used as an indication of the precision for the analyses performed.

During the collection of data using field methods and/or instrumentation, precision is checked by reporting several measurements taken at one location and comparing the results. Precision will be reported as the RPD for two results and as the standard deviation for three or more results. Sample collection precision will be measured in the laboratory with the analysis of field replicates and laboratory duplicates.

1.4.1.2 Accuracy - "Accuracy" refers to the degree of difference between measured or calculated values and the true value. It is defined by the USEPA as "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, usually expressed as the difference between the two values, X - T, or the difference as a percentage of the reference or true value, 100 (X-T)/T, and sometimes expressed as a ratio, X/T. Accuracy is a measure of the bias in a system" (USEPA, 1980). The closer the numerical value of the measurement comes to the true value, or actual concentration, the more accurate the measurement. Analytical accuracy may be expressed as the percent recovery of an analyte which has been added to the environmental sample at a known concentration before analysis. For example, accuracy can be determined from the results of matrix spike analyses performed at the rate of one set every 20 samples or one per batch. The equation used to calculate percent recovery can be found in Section 1.13.1. The accuracy of simple, yet fundamental, field analyses is difficult to assess quantitatively. Sampling accuracy can be maximized, however, by the adoption and adherence to a strict QA program. Specifically,

all procedures will be documented as standard protocol and all equipment and instrumentation will be properly calibrated and well maintained. Trip blanks and equipment rinsates will be included in all sample batches to ensure all samples represent the particular site from which they were taken and to assess the potential for any cross-contamination that may have occurred. In addition to equipment operation and standard operating procedures, a high level of accuracy will be maintained by thorough and frequent review of field procedures. In this manner, any deficiencies will be quickly documented and corrected.

1.4.1.3 Representativeness - "Representativeness" indicates the degree to which a sample contains the characteristics of the whole from which it came. As defined by the USEPA, representativeness "expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition" (USEPA, 1980). Only qualitative goals for representativeness can be set.

1.4.1.4 Completeness - "Completeness" is a measure of the amount of data collected with respect to project requirements. It is defined by the USEPA as "a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions" (USEPA, 1980). Completeness refers to the project as a whole.

1.4.1.5 Comparability - "Comparability" is a measure of the consistency of the measurement process. It is defined by the USEPA as the parameter that "expresses the confidence with which one data set can be compared to another" (USEPA, 1980). Comparability is also only expressed in a qualitative manner. To ensure comparability, only established methods and protocols will be used to collect and analyze samples.

1.4.1.6 Analytical Levels - Different levels of quality are required for the analytical data depending upon the planned use of the data. The procedures and methods will vary depending on the level of analytical data required. The USEPA has defined five analytical levels (USEPA, 1987a); these levels are presented in Table 1-3.

1.4.2 Goals

Our goals for this project are designed to be realistic, achievable and ensure field and analytical data quality. Method-specific goals for precision and accuracy are presented in Section 1.10.3. Representativeness and comparability are qualitative goals. Soil representativeness will be maximized through the thorough mixing of the sample, during collection and agreement of best location before sample collection.

Comparability goals will be established by adhering to the use of standard, published sampling and analytical methods and the use of QC samples. The analytical methods completeness goals are 90%. However, parameter specific completeness goals for the soil samples collected at Carswell AFB during the RFI will not be stated because matrix interferences and their impact on these goals are unknown at this time. The overall completeness goal (valid data) for Carswell AFB data will be 90%. Failure to meet these goals may result in qualification of the data, non-use of the data, or resampling.

In establishing the goals for precision and accuracy for each parameter and matrix, the following were considered:

Precision

- precision of instrument calibration
- precision of duplicate spikes
- precision of field duplicates
- sampling and handling procedures

TABLE 1-3

ANALYTICAL LEVELS
RCRA Facility Investigation
Carswell Air Force Base, Texas

ANALYTICAL LEVEL	DATA USES	DATA QUALITY	LIMITATIONS	FIELD ACTIVITIES
Level I	– Site characterization – Monitoring during implementation	– If instruments calibrated and data interpreted correctly, can provide indication of contamination	– Instruments respond to naturally-occurring compounds	– HNu – Explosimeter – Draeger tubes – Geophysical survey – Geochemical survey
Level II	– Site characterization – Evaluation of alternatives – Engineering design – Monitoring during implementation	– Dependent on QA/QC steps employed – Data typically reported in concentration ranges	– Tentative ID – Techniques/instruments limited mostly to volatiles, metals	– Temperature – Turbidity – Water level – pH – Specific conductance
Level III	– Risk assessment – PRP determination – Site characterization – Evaluation of alternatives – Engineering design – Monitoring during implementation	– Similar detection limits to CLP – Less rigorous QA/QC	– Tentative ID in some cases – Can provide data of same quality as Level IV	– Ground-water samples – Soil samples: surface – Soil samples: subsurface – Surface water samples – Sediment samples – Containerized Waste Material
Level IV			– Tentative Identification of non-HSL parameters – Some time may be required for validation of packages	Not Applicable
Level V			– May require method development/modification – Mechanism to obtain services requires special lead time	Not Applicable

SOURCE: USEPA, 1987a

Accuracy

- proper instrument set-up
- accuracy and stability of the calibration
- recovery of spiked samples
- recovery of spiked blanks and/or control samples
- method contamination
- surrogate recoveries (if applicable)
- interferences
- field contamination
- sampling and handling procedures

The worst performer of all the QC processes for all analytes within each parameter was used to determine the first estimate of the overall goal for each parameter and matrix. In order to provide a realistic approach in case there are unanticipated matrix effects, this estimate of the goal was then relaxed slightly in order to set goals that are realistic and achievable. The overall goal is to allow the use of as much reliable data as possible during this investigation. Data for individual analytes for which any applicable QC result falls outside of the acceptance limits set by the method will be qualified.

Representativeness and comparability are qualitative goals. Representativeness will be dependent upon the careful selection of sampling locations. Comparability will be established by adhering to the use of standard, published sampling and analytical methods and reporting data in standard units.

1.5 SAMPLING PROCEDURES

Sampling procedures consist of sample collection, transport and storage protocols. These protocols which pertain to the field activities are presented in detail in the Field Sampling Plan (FSP) and are only referenced here.

1.5.1 Sampling Protocols

Sample collection, transport and storage guidance documents to be adhered to are listed below:

- Practical Guide for Ground-Water Sampling, EPA 600/2-85/104, September 1985 (USEPA, 1985).
- Test Methods for Evaluating Solid Wastes, Third Edition, EPA SW-846, November 1986 (USEPA, 1986).
- Handbook to Support the Installation Restoration Program (IRP) Statements of Work, May 1991 (AFCEE, 1991).

Detailed sampling protocols are presented in Section 2.0.

1.5.2 Sample Handling

The sample containers, sample volume, method of preservation, shipping and handling procedures are presented in Section 2.2.2.

1.6 SAMPLE CUSTODY

Sample custody procedures during the collection of samples in the field and sample receipt in the laboratory are discussed in the following subsections.

1.6.1 Field Operations

Maintenance of sample custody in the field starts with the collection, preservation and labeling of the sample. Documentation of field sampling activities will be performed. Specific procedures for the maintenance and documentation of the custody of the samples is discussed in detail in Section 2.2.3.

1.6.2 Laboratory Operations

Sample custody, handling, and identification in the laboratory is presented in Appendix B.

1.7 FIELD EQUIPMENT CALIBRATION PROCEDURES

Several instruments will be used in the field investigation. These instruments consist of a photoionization detector (Hnu), pH meter, combination temperature and specific conductance meter, and a turbidimeter. Each field meter will be calibrated before use. The calibration will be documented in the field book. Details of calibration and maintenance are presented in Section 2.3 of the FSP. The equipment manuals are presented in Appendices C, D, E and F.

1.8 ANALYTICAL PROCEDURES

The following sections identify the analytical methods to be utilized.

1.8.1 Identification of Methods

The analytical methods to be utilized are presented in Tables 1-4 (soil, sediment) and 1-5 (ground water, surface water).

1.8.2 Detection Limits and Quantitation Criteria

1.8.2.1 Terminology - Each analytical parameter concentration will be reported as a specific number or less than the Instrument Detection Limit for inorganic methods and less than the Practical Quantification Limit for organic methods. Water values will be

TABLE 1-4

ANALYTICAL REQUIREMENTS - SOIL AND SEDIMENT SAMPLES
RCRA Facility Investigation
Carswell Air Force Base, Texas

ANALYTICAL PARAMETER (a)	METHOD (b)	HOLDING TIME (c)
Volatile Organics	8240	A: 14d
Aromatic Volatile Organics	8020	A: 14d
Total Recoverable Petroleum Hydrocarbons	418.1	P: 14d A: 40d
Metals, total:		A: 6m (unless noted)
1. Aluminum	3050/6010	
2. Antimony	3050/6010	
3. Arsenic	3050/7060 (d)	
4. Barium	3050/6010	
5. Beryllium	3050/6010	
6. Cadmium	3050/6010	
7. Calcium	3050/6010	
8. Chromium	3050/6010	
9. Cobalt	3050/6010	
10. Copper	3050/6010	
11. Iron	3050/6010	
12. Lead	3050/7421 (d)	
13. Mercury	7471	A: 28d
14. Magnesium	3050/6010	
15. Manganese	3050/6010	
16. Molybdenum	3050/6010	
17. Nickel	3050/6010	
18. Potassium	3050/6010	
19. Selenium	3050/7740 (d)	
20. Silver	3050/6010	
21. Sodium	3050/6010	
22. Thallium	3050/7841 (d)	
23. Vanadium	3050/6010	
24. Zinc	3050/6010	

TABLE 1-4

ANALYTICAL REQUIREMENTS - SOIL AND SEDIMENT SAMPLES
RCRA Facility Investigation
Carswell Air Force Base, Texas

ANALYTICAL PARAMETER (a)	METHOD (b)	HOLDING TIME (c)
TCLP	1311	See Below

	From: Field Collection to: TCLP extraction	From: TCLP extraction to: Preparative extraction	From: Preparative extraction to: determinative analysis	Total elapsed time
Volatiles	14d	NA	14d	28d
Semivolatiles	14d	7d	40d	61d
Mercury	28d	NA	28d	56d
Metals, except Mercury	180d	NA	180d	360d

NOTES:

(a) For list of analytes and reporting limits, see Table 1-6.

(b) Test Methods for Evaluating Solid Waste SW-846, 3rd Edition, November 1986 (unless otherwise noted)

(c) holding time from date of sampling to preparation (P) or analysis (A)
d = days m = months h = hours

(d) Screening results by method 3050/6010 are acceptable if sample result is greater than 10 times the method detection limit (before correction to dry weight)

TABLE 1-5

ANALYTICAL REQUIREMENTS - GROUND AND SURFACE WATER SAMPLES
RCRA Facility Investigation
Carswell Air Force Base, Texas

ANALYTICAL PARAMETER (a)	METHOD (b)	HOLDING TIME (c)
Volatile Organics	8240	A: 14d
Aromatic Volatile Organics	8020	A: 14d
Extractable Organics	3010 or 3020/8270	P: 7d A: 40d (d)
Petroleum Hydrocarbons	8015 M	A: 14d
Total Recoverable Petroleum Hydrocarbons	418.1	A: 28d (d)
Oil and Grease	9071	A: 28d
Purgeable Halocarbons	5030/8010	A: 14d
Metals, total:		A: 6m (unless noted)
1. Aluminum	3005/6010	
2. Antimony	3005/6010	
3. Arsenic	7060 (e)	
4. Barium	3005/6010	
5. Beryllium	3005/6010	
6. Cadmium	3005/6010	
7. Calcium	3005/6010	
8. Chromium	3005/6010	
9. Cobalt	3005/6010	
10. Copper	3005/6010	
11. Iron	3005/6010	
12. Lead	3020/7421 (e)	
13. Mercury	7470	A: 28d
14. Magnesium	3005/6010	
15. Manganese	3005/6010	
16. Molybdenum	3005/6010	
17. Nickel	3005/6010	
18. Potassium	3005/6010	
19. Selenium	7740 (e)	
20. Silver	3005/6010	
21. Sodium	3005/6010	
22. Thallium	3020/7841 (e)	
23. Vanadium	3005/6010	
24. Zinc	3005/6010	

TABLE 1-5

ANALYTICAL REQUIREMENTS - GROUND AND SURFACE WATER SAMPLES
RCRA Facility Investigation
Carswell Air Force Base, Texas

ANALYTICAL PARAMETER (a)	METHOD (b)	HOLDING TIME (c)
TCLP	1311	See Below

	From: Field Collection to: TCLP extraction	From: TCLP extraction to: Preparative extraction	From: Preparative extraction to: determinative analysis	Total elapsed time
Volatiles	14d	NA	14d	28d
Semivolatiles	14d	7d	40d	61d
Mercury	28d	NA	28d	56d
Metals, except Mercury	180d	NA	180d	360d

NOTES:

(a) For list of analytes and reporting limits, see Table 1-7.
(b) Test Methods for Evaluating Solid Waste SW-846, 3rd Edition, November 1986 (unless otherwise noted)
(c) holding time from date of sampling to preparation (P) or analysis (A)
d = days m = months h = hours
(d) Extracts to be analyzed within 40 days of date of extraction.
(e) Screening results by method 3005/6010 are acceptable if sample result is greater than 10 times the method detection limit (before correction to dry weight)

reported in parts per billion (ppb, μg/L) concentrations for organics and in parts per million (ppm, mg/L) for inorganics. Soil values will be reported in parts per million (ppm, mg/kg) for all analyses. Method Detection Limits (MDLs) are defined below.

1.8.2.2 Procedures - The following procedures are used to establish limits of detection and quantification.

Method Detection Limits (MDL) limits are established using the required EPA procedure specified in 40 CFR Part 136 Appendix B. The MDL is the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. A data pool of at least seven standards analyzed at a concentration approximately 3X the anticipated MDL is generated. The MDL is estimated by employing the "t" distribution with a 99% confidence interval by the following equation:

$$MDL = (t)(S)$$

where

t = is a factor for n-1 degrees of freedom at the 99% confidence factor

S = is the standard deviation of the data pool

Instrument Detection Limits (IDL) are established by the EPA CLP protocol, which allows for generating a data pool by analyzing a minimum of seven standards at 3X the anticipated IDL on three non-consecutive days. The standard deviation (S) of the seven data for each of the three days is calculated and the IDL established by the following equation:

$$IDL = \frac{S1 + S2 + S3}{3} * 3$$

The Practical Quantitation Limit (PQL) is the lowest level that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. PQL is calculated as follows:

$$PQL = 10 * S$$

where

S = is the standard deviation of the data used to determine MDL

The matrix used for these studies is spiked reagent water processed through the appropriate analytical procedure.

The Maximum Quantitation Limit (MQL) is that limit established by AFCEE as being the maximum allowable quantitation limit of an analyte. These limits are based upon the results of spiking at the estimated quantitation limit in accordance with EPA SW-846 protocols, or the results of matrix spiking of past HSD/YAQ samples.

The Maximum Quantitation Limit (MQL) for each parameter is calculated as follows:

$$MQL = F * S$$

Where:

S - is the standard deviation of the data used to determine MDL

F - is a factor between 5 and 10 based on chromatographic behavior.

The matrix used for these studies is spiked reagent water processed through the appropriate analytical procedure.

1.8.2.3 Values - The reporting limits required for this project are presented in Tables 1-6 and 1-7 for soil and sediment and ground water and surface water. The laboratory established detection and quantitation limits are presented in Appendix A.

1.8.3 Method Calibration

The calibration procedures, preparation of calibration standards, and frequency of initial and continuing calibration checks are described for each analytical method in the following subsections.

At a minimum, all instruments and other equipment used by Law will be calibrated and maintained at the recommended intervals prescribed by the analytical method employed. In those cases where it has been demonstrated that more frequent calibration or maintenance is required, the base method will be enhanced as necessary. Calibration checks and preventive maintenance procedures are permanently recorded in a log book for future reference. Whenever possible, calibration checks on instruments and support equipment are performed using reference materials (e.g., weights) which are traceable to the EPA Environmental Monitoring Systems Laboratory (EMSL) or bear certificates of standardization from the National Institute of Standards and Technology.

All chemical standards used by Law are certified to have the highest reasonable purity with assays or certificates of analysis provided with material. All materials are purchased from established and reputable chemical suppliers. All standard materials are dated and stored under appropriate conditions in order to maintain chemical stability. Each time a specific standard is prepared, the material mass and dilution information is recorded in the standards record book. All prepared standards (stock and working) are labeled in reference to the book number,

TABLE 1-6

PROJECT-REQUIRED REPORTING LIMITS - SOIL/SEDIMENT
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

ANALYTICAL METHOD	COMPOUND	UNITS	REPORTING LIMIT IDL	REPORTING LIMIT MQL
6010 (SW846)	Aluminum	mg/kg	10	50
	Antimony	mg/kg	5.6	15
	Arsenic	mg/kg	4.2	30
	Barium	mg/kg	3	10
	Beryllium	mg/kg	0.2	1
	Cadmium	mg/kg	0.4	0.5
	Calcium	mg/kg	10.2	100
	Chromium	mg/kg	0.8	5
	Cobalt	mg/kg	1.3	5
	Copper	mg/kg	0.8	5
	Iron	mg/kg	5	5
	Lead	mg/kg	3.7	5
	Magnesium	mg/kg	11.7	100
	Manganese	mg/kg	0.6	2
	Molybdenum	mg/kg	3.6	10
	Nickel	mg/kg	2.5	15
	Potassium	mg/kg	13.4	100
	Selenium	mg/kg	7.9	50
	Silver	mg/kg	0.8	5
	Sodium	mg/kg	25.5	100
	Thallium	mg/kg	7	7
	Vanadium	mg/kg	1	10
	Zinc	mg/kg	0.7	2
7060 (SW846)	Arsenic	mg/kg	0.2	0.5
7421 (SW846)	Lead	mg/kg	0.1	0.5
7740 (SW846)	Selenium	mg/kg	0.1	0.5
7841 (SW846)	Thallium	mg/kg	0.1	7
7471 (SW846)	Mercury	mg/kg	0.02	0.1
1311/7060	Arsenic	mg/kg	0.2	0.5
1311/6010	Barium	mg/kg	3	10
1311/6010	Cadmium	mg/kg	0.4	0.5
1311/6010	Chromium	mg/kg	0.8	5
1311/7421	Lead	mg/kg	0.1	0.5
1311/7471	Mercury	mg/kg	0.02	0.1
1311/7740	Selenium	mg/kg	0.1	0.5
1311/6010	Silver	mg/kg	0.8	5

TABLE 1-6

PROJECT-REQUIRED REPORTING LIMITS - SOIL/SEDIMENT
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

ANALYTICAL METHOD	COMPOUND	UNITS	REPORTING LIMIT PQL	REPORTING LIMIT MQL
8240 (SW846)	Acetone	mg/kg	0.001	0.01
	Benzene	mg/kg	0.001	0.005
	Bromodichloromethane	mg/kg	0.001	0.005
	Bromoform	mg/kg	0.005	0.005
	Bromomethane	mg/kg	0.001	0.01
	2-Butanone (MEK)	mg/kg	0.01	0.01
	Carbon disulfide	mg/kg	0.005	0.005
	Carbon tetrachloride	mg/kg	0.005	0.005
	Chlorobenzene	mg/kg	0.005	0.005
	Chloroethane	mg/kg	0.005	0.01
	2-Chloroethyl vinyl ether	mg/kg	0.01	0.01
	Chloroform	mg/kg	0.005	0.005
	Chloromethane	mg/kg	0.001	0.01
	Dibromochloromethane	mg/kg	0.005	0.005
	1,1-Dichloroethane	mg/kg	0.005	0.005
	1,2-Dichloroethane	mg/kg	0.005	0.005
	1,1-Dichloroethene	mg/kg	0.005	0.005
	trans-1,2-Dichloroethene	mg/kg	0.005	0.005
	1,2-Dichloropropane	mg/kg	0.001	0.005
	cis-1,3-Dichloropropene	mg/kg	0.001	0.005
	trans-1,3-Dichloropropene	mg/kg	0.005	0.005
	Ethylbenzene	mg/kg	0.005	0.005
	2-Hexanone	mg/kg	0.005	0.01
	Methylene chloride	mg/kg	0.005	0.005
	4-Methyl-2-pentanone (MIBK)	mg/kg	0.01	0.01
	Styrene	mg/kg	0.005	0.005
	1,1,2,2-Tetrachloroethane	mg/kg	0.005	0.005
	Tetrachloroethene	mg/kg	0.005	0.005
	Toluene	mg/kg	0.005	0.005
	1,1,1-Trichloroethane	mg/kg	0.005	0.005
	1,1,2-Trichloroethane	mg/kg	0.005	0.005
	Trichloroethene	mg/kg	0.005	0.005
	Vinyl acetate	mg/kg	0.01	0.01
	Vinyl chloride	mg/kg	0.002	0.01
	Xylenes (total)	mg/kg	0.005	0.005
	1,2-Dichloroethane-d4 (surrogate)	mg/kg	NA	NA
	Toluene-d8 (surrogate)	mg/kg	NA	NA
	4-Bromofluorobenzene (surrogate)	mg/kg	NA	NA

TABLE 1-6

PROJECT-REQUIRED REPORTING LIMITS - SOIL/SEDIMENT
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

ANALYTICAL METHOD	COMPOUND	UNITS	REPORTING LIMIT PQL	REPORTING LIMIT MQL
8020 (SW846)	Benzene	mg/kg	0.0005	0.001
	Toluene	mg/kg	0.0005	0.002
	Ethylbenzene	mg/kg	0.0005	0.004
	Xylenes	mg/kg	0.001	0.002
	Fluorobenzene (surrogate)	mg/kg	NA	NA
	4-Chlorotoluene (surrogate)	mg/kg	NA	NA
9070/418.1 (EPA600)	Total Recoverable Petroleum Hydrocarbons	mg/kg	10	30
418.1	Total Recoverable Petroleum Hydrocarbons	mg/kg	10	30
1311/8240	Benzene	mg/kg	0.001	0.005
	Carbon tetrachloride	mg/kg	0.005	0.005
	Chlorobenzene	mg/kg	0.005	0.005
	Chloroform	mg/kg	0.005	0.005
	1,2-Dichloroethane	mg/kg	0.005	0.005
	2-Butanone (MEK)	mg/kg	0.01	0.01
	Vinyl Chloride	mg/kg	0.002	0.01
1311/8270	Pentachlorophenol	mg/kg	0.33	1
	2,4,5-Trichlorophenol	mg/kg	0.033	1.6
	2,4,6-Trichlorophenol	mg/kg	0.033	0.3
	1,4-Dichlorobenzene	mg/kg	0.033	0.3
	2,4-Dinitrotoluene	mg/kg	0.033	0.3
	Hexachlorobenzene	mg/kg	0.033	0.3
	Hexachlorobutadiene	mg/kg	0.033	0.3
	Hexachloroethane	mg/kg	0.033	0.3
	Nitrobenzene	mg/kg	0.033	0.3

NA - Not applicable.
NE - Not established at this time.
IDL - Instrument Detection Limit
MQL - Maximum Quantitation Limit

TABLE 1-7

PROJECT-REQUIRED REPORTING LIMITS - GROUND WATER/SURFACE WATER
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

ANALYTICAL METHOD	COMPOUND	UNITS	REPORTING LIMIT	
			IDL	MQL
6010 (SW846)	Aluminum	mg/L	0.1	0.5
	Antimony	mg/L	0.056	0.5
	Arsenic	mg/L	0.042	0.3
	Barium	mg/L	0.03	0.1
	Beryllium	mg/L	0.002	0.01
	Cadmium	mg/L	0.004	0.005
	Calcium	mg/L	0.102	1
	Chromium	mg/L	0.008	0.05
	Cobalt	mg/L	0.013	0.05
	Copper	mg/L	0.008	0.05
	Iron	mg/L	0.05	0.05
	Lead	mg/L	0.037	0.2
	Magnesium	mg/L	0.117	1
	Manganese	mg/L	0.006	0.02
	Molybdenum	mg/L	0.036	0.1
	Nickel	mg/L	0.025	0.15
	Potassium	mg/L	0.134	5
	Selenium	mg/L	0.079	1
	Silver	mg/L	0.008	0.05
	Sodium	mg/L	0.255	1
	Thallium	mg/L	0.072	0.4
	Vanadium	mg/L	0.01	0.1
	Zinc	mg/L	0.007	0.02
7060 (SW846)	Arsenic	mg/L	0.002	0.005
7421 (SW846)	Lead	mg/L	0.001	0.005
7740 (SW846)	Selenium	mg/L	0.001	0.005
7471 (SW846)	Mercury	mg/L	0.0002	0.001

TABLE 1-7

PROJECT-REQUIRED REPORTING LIMITS - GROUND WATER/SURFACE WATER
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

ANALYTICAL METHOD	COMPOUND	UNITS	REPORTING LIMIT		
			MDL	PQL	MQL
8240 (SW846)	Acetone	µg/L	7.5	10	10
	Benzene	µg/L	0.4	1	5
	Bromodichloromethane	µg/L	0.3	1	5
	Bromoform	µg/L	0.2	5	5
	Bromomethane	µg/L	0.7	1	10
	2-Butanone (MEK)	µg/L	2.8	10	10
	Carbon disulfide	µg/L	0.7	5	5
	Carbon tetrachloride	µg/L	0.4	5	5
	Chlorobenzene	µg/L	0.2	5	5
	Chloroethane	µg/L	0.3	5	10
	2-Chloroethyl vinyl ether	µg/L	8	10	10
	Chloroform	µg/L	0.3	5	5
	Chloromethane	µg/L	0.6	1	10
	Dibromochloromethane	µg/L	0.3	5	5
	1,1-Dichloroethane	µg/L	0.3	5	5
	1,2-Dichloroethane	µg/L	0.4	5	5
	1,1-Dichloroethene	µg/L	0.3	5	5
	trans-1,2-Dichloroethene	µg/L	0.4	5	5
	1,2-Dichloropropane	µg/L	0.6	1	5
	cis-1,3-Dichloropropene	µg/L	0.6	1	5
	trans-1,3-Dichloropropene	µg/L	0.2	5	5
	Ethylbenzene	µg/L	0.2	5	5
	2-Hexanone	µg/L	2.1	5	10
	Methylene chloride	µg/L	4.5	5	5
	4-Methyl-2-pentanone (MIBK)	µg/L	7	10	10
	Styrene	µg/L	0.5	5	5
	1,1,2,2-Tetrachloroethane	µg/L	0.7	5	5
	Tetrachloroethene	µg/L	0.2	5	5
	Toluene	µg/L	0.3	5	5

TABLE 1-7

PROJECT-REQUIRED REPORTING LIMITS - GROUND WATER/SURFACE WATER
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

ANALYTICAL METHOD	COMPOUND	UNITS	REPORTING LIMIT		
			MDL	PQL	MQL
	1,1,1-Trichloroethane	µg/L	0.4	5	5
	1,1,2-Trichloroethane	µg/L	0.7	5	5
	Trichloroethene	µg/L	0.2	5	5
	Vinyl acetate	µg/L	0.7	10	10
	Vinyl chloride	µg/L	0.6	2	10
	Xylenes (total)	µg/L	0.7	5	5
	1,2-Dichloroethane-d4 (surrogate)	µg/L	NA	NA	NA
	Toluene-d8 (surrogate)	µg/L	NA	NA	NA
	4-Bromofluorobenzene (surrogate)	µg/L	NA	NA	NA
8020 (SW846)	Benzene	µg/L	0.5	0.5	1
	Toluene	µg/L	0.5	0.5	2
	Ethylbenzene	µg/L	0.5	0.5	4
	Xylenes	µg/L	1	1	2
	Fluorobenzene (surrogate)	µg/L	NA	NA	NA
	4-Chlorotoluene (surrogate)	µg/L	NA	NA	NA
8015M (SW846)	Diesel	mg/L	0.072	0.2	1
	Gasoline	mg/L	0.074	0.5	1
9071 (SW846)	Oil & Grease	µg/L	NE	NE	NE
418.1	Total Recoverable Petroleum Hydrocarbons	mg/L	0.4	1	1

TABLE 1-7

PROJECT-REQUIRED REPORTING LIMITS - GROUND WATER/SURFACE WATER
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

ANALYTICAL METHOD	COMPOUND	UNITS	REPORTING LIMIT		
			MDL	PQL	MQL
	TCLP	µg/L			
1311/8240	Benzene	µg/L	0.4	1	5
	Carbon tetrachloride	µg/L	0.4	5	5
	Chlorobenzene	µg/L	0.2	5	5
	Chloroform	µg/L	0.3	5	5
	1,2-Dichloroethane	µg/L	0.4	5	5
	2-Butanone (MEK)	µg/L	2.8	10	10
	Vinyl chloride	µg/L	0.6	2	10
1311/8270	Pentachlorophenol	µg/L	0.6	10	30
	2,4,5-Trichlorophenol	µg/L	1	1	50
	2,4,6-Trichlorophenol	µg/L	0.7	1	10
	1,4-Dichlorobenzene	µg/L	0.7	1	10
	2,4-Dinitrotoluene	µg/L	0.8	1	10
	Hexachlorobenzene	µg/L	0.5	1	100
	Hexachlorobutadiene	µg/L	0.7	1	10
	Hexachloroethane	µg/L	0.9	1	10
	Nitrobenzene	µg/L	0.9	1	10

TABLE 1-7

PROJECT-REQUIRED REPORTING LIMITS - GROUND WATER/SURFACE WATER
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

			IDL	MQL
1311/6010	Barium	mg/L	0.030	0.1
1311/6010	Cadmium	mg/L	0.004	0.005
1311/6010	Chromium	mg/L	0.008	0.05
1311/7421	Lead	mg/L	0.001	0.005
1311/7471	Mercury	mg/L	0.0002	0.001
1311/7740	Selenium	mg/L	0.001	0.005
1311/6010	Silver	mg/L	0.008	0.05

NA - Not applicable.
NE - Not established at this time.
MDL - Method Detection Limit
MQL - Maximum Quantitation Limit
PQL - Practical Quantitation Limit
* Project - Required Reporting Limits for methodologies performed by TEG are listed in the TEG QA Manual in Appendix B-2.

page number, and entry number of the Analytical Standards Preparations Record Book. Additionally, the description, date, and analyst are given on the standard label.

1.8.3.1 Organics by Gas Chromatography (GC) with Second Column Confirmation - Analyses performed on the GC will follow EPA Methods. Second column confirmation is required for samples which exhibit a positive result. The confirmation system must contain a dissimilar column and is calibrated and subject to the same QC as the primary GC system. The primary or secondary result may be reported. The two results will not be averaged.

Prior to calibration, retention time windows for each standard on each GC column are determined whenever a new GC column is installed as follows.

Three injections of each standard are made over a 72-hour period at approximately equal intervals. A standard deviation is calculated from the three absolute retention times. For multi-response analytes, one major peak is chosen from the envelope for the retention time study. Retention time windows for each analyte are updated daily and are equal to the continuing calibration analyte retention time plus or minus three times the standard deviation determined in the study. If the retention time window for an analyte is zero, a standard deviation of a similar compound is used.

Tentative identification of an analyte occurs when a peak from a sample falls within the daily retention time window. Multi-response analytes are identified primarily by pattern recognition.

Calibration procedures for both systems are presented below.

1. GC system is checked daily prior to analysis of samples by reviewing temperatures to injector parts, detectors and columns, verifying that the system is method-specific to ensure reliability and reproducibility of analytical results.

2. GC is calibrated with five standards and a calibration blank using external standard technique.

3. If the %RSD of the RF (internal standard technique) or CF (external standard technique) for the 5 standards is ≤20%, then the average RF is used for quantitation. If the RF is >20%, a calibration curve is established by plotting response versus amount.

4. After development of each new five-point calibration and at the start of every analysis day, a mid-point daily initial calibration verification (ICV) containing all single peak analytes of interest is run. Pesticide/PCB standards also include Toxaphene, Chlordane, and Aroclors 1016/1260. The standard's RF or CF must agree with the initial calibration average RF or CF within ±15% D. For a calibration curve, the concentration of the mid-point initial calibration standard is compared to the ICV concentration. The percent recovery of the ICV is obtained using the following formula: ICV Found Value divided by Mid-point Initial Calibration True Value (calculated from the curve) X 100. The percent recovery of the ICV must be within ±15%.

5. After every 10 samples within the sequence and at the end of the sequence, a mid-level continuing calibration verification (CCV) is analyzed which must be within ±15% D of the ICV. For a calibration curve, the concentration of the ICV is compared to the concentration of the CCV. The percent recovery of the CCV must be within ±15%.

6. The retention time (RT) for all identified analytes in an analytical run must match the RT windows calculated for the analytical standards.

7. Second column confirmation is subject to the proceeding acceptance criteria.

1.8.3.2 Volatile and Semi-Volatile Organics by Gas Chromatography/ Mass Spectrometry (GC/MS) - Analyses performed on the GC/MS will follow EPA Methods. This includes the following calibration procedure:

1. Instrument calibration will be performed every 12-hour time period. The GC/MS will be tuned to meet ion abundance criteria given in Tables 1-8 and 1-9 for decafluorotriphenylphosphine (DFTPP) or 4-Bromo-fluorobenzene (BFB).

2. Initial calibration will be performed on calibration standards at five concentration levels containing each compound of interest and each surrogate standard.

   The relative retention time (RRT) of each compound in each calibration run should agree within 0.06 RRT units. The average relative response factor (RRF) and percent relative standard deviation (%RSD) is calculated for each compound. The RRF for the System Performance Check Compounds (SPCC: Volatiles: Chloromethane, 1,1-Dichloroethane, Bromoform, 1,2,2-Tetrachloroethane, Chlorobenzene. Semi-volatiles: N-nitroso-di-n-propylamine, Hexachlorocyclo-pentadiene, 2,4-Dinitrophenol, 4-Nitrophenol) must be ≥0.300 (0.250 for Bromoform) for volatiles and must be ≥0.050 for semi-volatiles. The %RSD for the Calibration Check compounds

TABLE 1-8

DFTPP KEY IONS AND ABUNDANCE CRITERIA*
Carswell Air Force Base, Texas

Mass	Ion Abundance Criteria
51	30-60% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	40-60% of mass 198
197	<1% of mass 198
198	Base peak, 100% relative abundance
199	5-9% of mass 198
275	10-30% of mass 198
365	>1% of mass 198
441	Present but less than mass 443
442	>40% of mass 198
443	17-23% of mass 442

*J.W. Eichelberger, L.E. Harris, and W.L. Budde. "Reference Compound to Calibrate Ion Abundance Measurement in Gas Chromatography-Mass Spectrometry," Analytical Chemistry, 47, 995 (1975).

TABLE 1-9

BFB KEY IONS AND ABUNDANCE CRITERIA*

MASS	ION ABUNDANCE CRITERIA
50	15-40% of mass 95
75	30-60% of mass 95
95	base peak, 100% relative abundance
96	5-9% of mass 95
173	less than 2% of mass 174
174	less than 50% of mass 95
175	5-9% of mass 174
176	greater than 95% but less than 101% of mass 174
177	5-9% of mass 176

* EPA Method 8240, SW-846, 3rd Edition, November 1986.

(CCC: Volatiles - Vinyl chloride, 1,1-Dichloroethene, Chloroform, 1,2-Dichloropropane, Toluene, Ethylbenzene; Semi-volatiles Base/Neutrals - Acenaphthene, 1,4-Dichlorobenzene, Hexachlorobutadiene, N-Nitroso-di-n-phenylamine, Di-n-octylphthalate, Fluoranthene, Benzo(a)pyrene; Acids - 4-Chloro-3-methylphenol, 2,4-Dichlorophenol, 2-Nitrophenol, Phenol, Pentachlorophenol, 2,4,6-Trichlorophenol) must be <30%. The %RSD for the other compounds should be less than 30%. If not, a notation is made in the sample documentation.

3. After the preparation of each new initial five-point calibration curve and after tune criteria are met for each 12-hour time period, the initial calibration is verified (using a midpoint calibration standard containing all analytes) prior to running any samples. This initial calibration verification (ICV) must satisfy the above SPCC criteria. In addition, the percent difference (%D) for the CCC must be ≤25% for the volatiles and ≤30% for the semi-volatiles. If these criteria are not met for any single CCC, corrective action must be taken or a new five point calibration must be performed.

4. Internal standards for GC/MS volatiles will be added to each sample, standard and reagent blank. The final concentration of each internal standard will be 50 μg/L. The internal standards are as follows:

- Bromochloromethane
- 1,4-Difluorobenzene
- Chlorobenzene-d_5

Table 1-10 presents the analytes quantitated by each internal standard.

TABLE 1-10

VOLATILE INTERNAL STANDARDS WITH CORRESPONDING ANALYTES ASSIGNED FOR QUANTITATION
Carswell Air Force Base, Texas

BROMOCHLOROMETHANE	1,4-DIFLUOROBENZENE	CHLOROBENZENE-d5
Acetone	Benzene	Bromofluorobenzene*
Acrolein	Bromodichloromethane	Chlorobenzene
Acrylonitrile	Bromoform	Ethylbenzene
Bromomethane	2-Butanone	Ethyl methacrylate
Carbon disulfide	Carbon tetrachloride	2-Hexanone
Chloroethane	Chlorodibromomethane	4-Methyl-2-pentanone
Chloroform	2-Chloroethyl vinyl ether	Styrene
Chloromethane	Dibromomethane	1,1,2,2-Tetrachloroethane
Dichlorodifluoromethane	1,4-Dichloro-2-butene	Tetrachloroethene
1,1-Dichloroethane	1,2-Dichloropropane	Toluene
1,2-Dichloroethane	cis-1,3-Dichloropropene	Toluene-d8*
1,2-Dichloroethane-d4*	trans-1,3-Dichloropropene	1,2,3-Trichloropropane
1,1-Dichloroethene	1,1,1-Trichloroethane	Xylene
trans-1,2-Dichloroethene	1,1,2-Trichloroethane	
Iodomethane	Trichloroethene	
Methylene chloride	Vinyl acetate	
Trichlorofluoromethane		
Vinyl chloride		

* Surrogate

Internal standards for GC/MS semi-volatiles will be added to each sample, standard, and reagent blank. The final concentration of each internal standard will be 40 nanograms per microliter (ng/μL). The internal standards are as follows:

- 1,4-Dichlorobenzene-d_4
- Naphthalene-d_8
- Acenaphthene-d_{10}
- Phenanthrene-d_{10}
- Chrysene-d_{12}
- Perylene-d_{12}

Table 1-11 presents the analytes quantitated by each internal standard.

1.8.3.3 Metals by Inductively Coupled Plasma (ICP) - Metal analyses on the ICP will follow current EPA SW846 method procedures. The instrument must be calibrated daily or once every 24 hours and each time the instrument is set up. This includes the following calibration procedure:

1. Verify instrument is operating satisfactorily by checking automatic gain setting and optical alignment.

2. Calibrate instrument with matrix matched mixed standards at four concentration levels and a blank. The correlation coefficient must be greater than or equal to 0.995.

3. Verify the calibration with a 2nd source Initial Calibration Verification (ICV) standard. The observed result must be ±10% of the expected value.

TABLE 1-11

SEMI-VOLATILE INTERNAL STANDARDS WITH CORRESPONDING ANALYTES ASSIGNED FOR QUANTITATION
Carswell Air Force Base, Texas

1,4-DICHLOROBENZENE-d4	NAPHTHALENE-d8	ACENAPHTHENE-d10
Aniline	Acetophenone	Acenaphthene
Benzyl alcohol	Benzoic acid	Acenaphthylene
Bis(2-chloroethyl)ether	Bis(2-chloroethoxy)methane	1-Chloronaphthalene
Bis(2-chloroisopropyl)ether	4-Chloroaniline	2-Chloronaphthalene
2-Chlorophenol	4-Chloro-3-methylphenol	4-Chlorophenyl phenyl ether
1,2-Dichlorobenzene	2,4-Dichlorophenol	Dibenzofuran
1,3-Dichlorobenzene	2,6-Dichlorophenol	Diethylphthalate
1,4-Dichlorobenzene	alpha,alpha-Dimethyl-phenethylamine	Dimethylphthalate
Ethyl methanesulfonate	2,4-Dimethylphenol	2,4-Dinitrophenol
2-Fluorophenol*	Hexachlorobutadiene	2,4-Dinitrotoluene
Hexachloroethane	Isophorone	2,6-Dinitrotoluene
Methyl methanesulfonate	2-Methylnaphthalene	Fluorene
2-Methylphenol	Naphthalene	2-Fluorobiphenyl*
4-Methylphenol	Nitrobenzene	Hexachlorocyclopentadiene
N-Nitrosodimethylamine	Nitrobenzene-d8*	1-Naphthylamine
N-Nitroso-di-n-propylamine	2-Nitrophenol	2-Naphthylamine
Phenol	N-Nitroso-di-n-butylamine	2-Nitroaniline
Phenol-d6*	N-Nitrosopiperidine	3-Nitroaniline
2-Picoline	1,2,4-Trichlorobenzene	4-Nitroaniline
		4-Nitrophenol
		Pentachlorobenzene
		1,2,4,5-Tetrachlorobenzene
		2,3,4,6-Tetrachlorophenol
		2,4,6-Tribromophenol*
		2,4,5-Trichlorophenol
		2,4,6-Trichlorophenol

* Surrogate

TABLE 1-11

SEMI-VOLATILE INTERNAL STANDARDS WITH CORRESPONDING ANALYTES ASSIGNED FOR QUANTITATION
Carswell Air Force Base, Texas

PHENANTHRENE-d10	CHRYSENE-d12	PERYLENE-d12
4-Aminobiphenyl	Benzidine	Benzo(b)fluoranthene
Anthracene	Benzo(a)anthracene	Benzo(k)fluoranthene
4-Bromophenyl phenyl ether	Bis(2-ethylhexyl)phthalate	Benzo(g,h,i)perylene
Di-n-butylphthalate	Butylbenzylphthalate	Benzo(a)pyrene
4,6-Dinitro-2-methylphenol	Chrysene	Dibenz(a,j)acridine
Diphenylamine	3,3'-Dichlorobenzidine	Dibenz(a,h)anthracene
1,2-Diphenylhydrazine	p-Dimethylaminoazobenzene	7,12-Dimethylbenz(a)-anthracene
Fluoranthene	Pyrene	Di-n-octylphthalate
Hexachlorobenzene	Terphenyl-d14*	Indeno(1,2,3-cd)pyrene
N-Nitrosodiphenylamine		3-Methylcholanthrene
Pentachlorophenol		
Pentachloronitrobenzene		
Phenacetin		
Phenanthrene		
Pronamide		

* Surrogate

4. Verify the calibration blank. The observed result must be less than three times the detection limit.

5. Verify high-level standard calibration.

6. Every 10 samples, a Continuing Calibration Verification (CCV)/Continuing Calibration Blank (CCB) pair is run which must be ±10% of expected value and less than three times detection limit, respectively.

7. Check for interferences. An interference check solution must be analyzed at the beginning and at the end of the run (or at least every eight hours); refer to EPA Methods for acceptable limits which are ±20%. The interference check solution contains aluminum, calcium, iron, and magnesium.

1.8.3.4 Cold-Vapor Atomic Absorption - Mercury is analyzed using cold-vapor atomic absorption (CVAA). An aliquot of sample is acidified and then undergoes a heated, oxidation digestion with potassium permanganate and potassium persulfate. After digestion, a solution of sodium chloride-hydroxylamine sulfate is added to the sample digestate to reduce excess permanganate and remove free chlorine. A reducing agent (stannous chloride) is then added to the solution, resulting in a reduction of the mercury to an elemental state. The elemental mercury is aerated from the solution in a closed system and the mercury vapor content is measured as it passes through a cell positioned in the light path of an atomic absorption spectrophotometer. The calibration procedure is as follows:

1) Optimize instrument setting and alignment by maximizing the energy setting.

2) Align cell minimizing absorbance reading.

3) Calibrate instrument with standards at five concentration levels and a blank. The correlation coefficient must be greater than or equal to 0.995.

4) Verify calibration by running an initial calibration verification standard (ICV) and a calibration blank (ICB). The observed result of the ICV must be within ±20% of the expected value and the observed result of the calibration blank must be less than three times the detection limit.

5) Analyze a CCV/CCB pair every 10 samples. The response must be within 20 percent of the initial response and less than three times the detection limit, respectively.

1.8.3.5 Method E 418.1, Total Recoverable Petroleum Hydrocarbons - Total recoverable petroleum hydrocarbons (TRPH) are defined by the method used for their determination. The sample is extracted with trichlorofluoroethane, passed through a silica gel adsorption process, and measured by infrared spectrophotometry. This procedure is based upon EPA's Method E 418.1 and SW-846 9073 (Test Methods For Evaluating Solid Waste, Physical/Cemical Methods, SW-846 3rd Edition, Proposed Update II, June 1990) for TRPHs and 413.2 and SW-846 9071A for oil and grease.

1.8.3.5.1 Calibration - Calibrate the infrared instrument, using the appropriate series of working standards, using a 1 cm cell for water samples and a 5 cm cell for soil samples. It is not necessary to add silica gel to the standards. Determine absorbance directly for each solution at 2930 cm^{-1}. Prepare a calibration plot of absorbance vs. mg petroleum hydrocarbons per 100 ml solution on a calculator.

1.8.3.6 <u>Metals by Graphite Furnace Atomic Absorption (GFAA)</u> - Metal analyses performed on the GFAA will follow current EPA SW 846 Methods. Instrument must be calibrated daily or once every 24 hours and each time the instrument is set up. This includes the following calibration procedures:

1. The lamp must be peaked for position and for wavelength (the temperature of the furnace is automatically calibrated at 2600 degrees centigrade).

2. After the proper conditions for each element are programmed for furnace operation, distilled water is injected and run as a sample. This is done several times until the instrument response produces a steady base line absorbance.

3. Verify instrument is operating satisfactorily by checking the energy output of the lamp and by checking the characteristic mass on the midpoint standard, which must be ±10% of the true value for that standard.

4. Calibrate instrument with four standards and a calibration blank. The calibration curve must have a correlation coefficient of greater than or equal to 0.995.

5. Verify the calibration with a second source Initial Calibration Verification (ICV) standard. The observed result must be within ±10% of the expected result.

6. Verify the calibration blank. The blank must be less than three times detection limit.

7. Verify low level standard calibration.

8. Every 10 samples, a Continuing Calibration Verification (CCV) and Continuing Calibration Blank (CCB) pair is run and must be ±10% of expected value and less than three times the detection limit, respectively.

1.9 DATA REDUCTION, VALIDATION, AND REPORTING

The following sections describe the reduction, validation, and reporting of data employed after samples are analyzed.

1.9.1 Data Management

Analytical data are collected and processed in accordance with the requirements of the laboratory's protocols. These requirements include sample documentation and data collection. Sample/data flow is outlined in Appendix B for each laboratory.

1.9.2 Data Reduction

Raw data are to be reduced as specified by each method to produce results in the following units:

	SOLID	AQUEOUS
Organic parameters	mg/kg	µg/L
Inorganic parameters	mg/kg	mg/L

Note that for the organic and inorganic parameters, solid and sediment results will be corrected for the percentage of solids in the sample ("dry weight").

1.9.3 Data Quality Assessment

The parameters of precision, accuracy, representativeness, completeness, and comparability (PARCC) are indicators of data

quality (USEPA, 1987a). Establishing goals for these parameters serves to guide the choice of the analytical methodology. It also establishes a strategy for the evaluation of the data once they have been acquired to determine whether the goals of the project have been met. Upon their receipt from the laboratory, the chemical analysis data will be evaluated by experienced personnel against pre-determined criteria to determine whether their quality meets the requirements of the project. The laboratory quality control (QC) data and the field QC data will be evaluated to objectively ascertain the level of quality of the data. Any issues requiring clarification by the laboratory or the samplers will be identified and pursued at this point. The data quality level will then be compared to that required by the project. If problems are found, qualification of the affected data points will be recommended. Upon determination of the level of quality for each data point, interpretation of the data can then be performed. The following sections describe the data quality evaluation and data qualification processes.

1.9.3.1 Data Quality Evaluation - The objective of the evaluation of the quality of the chemical data is to determine if qualifications of the data are necessary. This evaluation will be based upon the evaluation of the laboratory QC data, the field QC data, and the project DQOs presented in Section 1.4. The first step will be to perform an evaluation of the laboratory QC data, a process often termed "data validation." This will provide a rating of the quality of each data point produced by the laboratory. The second part will provide an overall rating of each data point based upon the field QC data. The final step in the evaluation will compare the quality of the data acquired to the project's DQOs to determine whether the data are useful. These three steps are described in the following sub-sections. Each step will be completely documented. The overall goal of the data quality evaluation is to determine whether the data can be used to satisfy the objectives of the project.

Evaluation of Laboratory QC Data - Laboratory QC data for an analytical parameter fall within one of eight categories for evaluation purposes. These categories are listed in Table 1-12 in the order in which they will be considered. All QC data provided will be evaluated against the criteria established by each method after modification as presented in this document to achieve the objectives of this project. Each review will be completely documented to indicate the criteria used and the results and recommendations of the evaluation. For this investigation the evaluation of the calibration will be performed by the Law Environmental National Laboratory in Pensacola. This laboratory verification of method calibration is in compliance with an AFCEE Level I data package.

Evaluation of Field QC Data - Field QC data for an analytical parameter fall within one of eight categories for evaluation purposes. These categories are also listed in Table 1-12 in the order in which they will be considered. QC data provided will be evaluated to assure the objectives of this project are achieved. Each review will be completely documented to indicate the criteria used and the results and recommendations of the evaluation.

Usability Determination - Once the laboratory and field QC data have been evaluated, the uncertainty associated with each data point can be estimated. The estimated accuracy and precision of each data point can then be compared to the data quality objectives of the project to determine its usefulness for evaluating the site. Recommendations for the qualification of a data point can also be made when necessary.

Precision will be determined by evaluation of the RPDs for the laboratory and field duplicates. The laboratory and field blank data, MS/MSD and surrogate (if applicable) recoveries, and other applicable QC data will be used to determine the accuracy of the data. The evaluator will use their judgement based upon

TABLE 1-12

DATA EVALUATION CATEGORIES
RCRA Facility Investigation
Carswell Air Force Base, Texas

CATEGORY	QC DATA EVALUATED
LABORATORY QC:	
1. Sample Integrity	Sample container condition; preservation performance and applicability; condition upon receipt at laboratory
2. Instrument Set-up/Method Applicability	Correct method; detection/quantitation limits achieved; method applicability for analytes and matrix, instrument set-up
3. Calibration Accuracy and Precision *	Standard preparation; accuracy verification, precision achieved
4. Calibration Stability *	Stability verification; frequency of performance
5. Laboratory Contamination	Laboratory blanks
6. Method Accuracy and Precision	Method accuracy and precision data
7. Sample Preparation	Procedures; holding times
8. Sample Analysis	Procedures and sequences; holding times; sample-specific accuracy and precision; interferences; dilutions
FIELD QC:	
1. Sample Integrity	Sample container condition; preservation performance and applicability; condition prior to shipment; custody
2. Location Installation	Sampling location installation
3. Sampling Procedures	Sampling protocols
4. Contamination From Sampling	Rinsates
5. Contamination From Site	Field blanks (volatile organics only)
6. Contamination From Shipping	Trip blanks (volatile organics only)
7. Sampling Precision	Field duplicates
8. Miscellaneous +	Blind QC samples; performance evaluation data; split sample data

* These categories are assumed to be correct and will not be provided for evaluation.
\+ No blind data for QC samples, blind performance evaluation samples, or split samples will be collected.

established principles and the guidelines described in this document in the assignment of qualifications to the data.

The completeness parameter will be evaluated after the determination of the usability of each data point; it will be expressed in quantitative terms and then compared to the project objectives to determine whether enough data were collected. Representativeness will be determined through an evaluation of sampling procedures and locations utilized and will be expressed in qualitative terms. Comparability will be determined by the evaluation of data quality analytical methodologies, reporting units, and the traceability of standards and will also be expressed in qualitative terms.

1.9.3.2 Data Qualification - Each data point will essentially be graded as falling into one of the following categories:

- Usable as reported
- Usable with qualifications
- Unusable

These categories correspond to the three established for the DQOs in Section 1.4. Data for which the laboratory and field QC data are all within acceptance limits will be assigned the grade "usable as reported." Data for which slight QC problems are indicated but the QC data are still within the action limits will be assigned the grade "usable with qualifications." These data may still be used if the QC problems are not excessive. Data for which the corresponding QC data are outside the action limits will be assigned the grade "unusable" and will not be used. Each data point will receive a flag indicating its level of quality. The flags to be used are presented in Table 1-13.

TABLE 1-13

DATA QUALIFICATION FLAGS
RCRA Facility Investigation
Carswell AFB, Texas

FLAG	POSITIVE RESULTS	NEGATIVE RESULTS
FLAGS FOR DATA WITHIN ACCEPTANCE LIMITS (Usable as Reported)		
(no flag)	{Use datum without qualification}	{Use datum without qualification}
FLAGS FOR DATA WITHIN ACTION LIMITS (Usable With Qualifications)		
J	Estimated quantitation based upon QC data	Estimated quantitation based upon QC data
JB	Estimated quantitation: possible biased high or false positive based upon blank data	(Not applicable)
JH	Estimated quantitation-possibly biased high based upon QC data	(Not applicable)
JL	Estimated quantitation-possibly biased low based upon QC data	Possible false negative based upon QC data
Jd	Estimated result due to dilution	Reporting limit raised due to dilution
FLAGS FOR DATA OUTSIDE OF ACTION LIMITS (Unusable)		
R	Datum rejected based upon QC data: do not use	Datum rejected based upon QC data: do not use
MISCELLANEOUS FLAGS		
t	Tentatively identified compound; identity not confirmed with standard and quantitation estimated*	(Not applicable)

* Applicable to GC/MS data only

1.9.4 Data Reporting

Data reports will be included in the technical reports preparation. The data will be presented as tables or in the appendices of the report. Tables will include the following information:

- Sampling dates
- Extraction and analysis dates
- Surrogate recovery (if applicable)
- MS/MSD results
- Duplicate/replicate results
- Rinsate results
- Positive results
- Field characterization data (Ph, SC, temp)
- Control limits (surrogates, MS/MSD, duplicates)

1.10 INTERNAL QUALITY CONTROL CHECKS

The following sections describe the quality control checks employed in the field and laboratory.

1.10.1 Field Quality Control

Quality control of field measurements will be utilized through the calibration of instruments. The control parameters, control limits, and corrective actions are outlined in Section 2.4.

1.10.2 Laboratory Quality Control

The minimum requirements of the laboratory quality control consist of an initial demonstration of laboratory capability and an ongoing analysis of quality control samples to evaluate and document data quality. The laboratory must maintain records to document the

quality of the data generated. Ongoing data quality checks are compared with established performance criteria to determine if the results of analyses meet the performance characteristics of the method. When results of quality control samples indicate atypical method performance, a quality control check standard must be analyzed to confirm that the measurements were performed in an in-control mode of operation. Calibration stability will be assessed and documented utilizing the procedures and at the frequency specified in each method.

Before processing any samples, the analyst should demonstrate, through the analysis of a reagent water blank, that interferences from the analytical system, glassware, and reagents are under control. Each time a set of samples is extracted or there is a change in reagents, whichever is more frequent, a reagent water blank should be processed as a safeguard against chronic laboratory contamination. The blank samples should be carried through the stages of the sample preparation and measurement steps.

If any analyte fails the acceptance criteria for recovery, a QC check standard for each analyte that failed must be prepared and analyzed. As part of the QC program for the laboratory, method accuracy for each matrix studied must be assessed and records must be maintained.

The types and numbers of laboratory quality control samples to be used are presented in Tables 1-4 through 1-18 by matrix and parameters. They are defined as follows:

Method blanks. Method blanks consist of organic-free or deionized water that is carried through the analytical scheme like a sample. They serve to measure contamination associated with laboratory storage, preparation, or instrumentation. For most analyses, a method blank is analyzed for each batch and at a frequency of 1 per 20 samples if more than 20 samples are run in a given batch. If

TABLE 1-14

SAMPLING AND ANALYSIS PLAN SUMMARY: SUB-SURFACE SOIL FROM BORINGS
RCRA Facility Investigation - Carswell Air Force Base, Texas

PARAMETER	TOTAL NO. FIELD LOCATIONS	SAMPLES PER LOCATION	TOTAL NO. FIELD SAMPLES	LAB QC SAMPLES				2ND (c) COLUMN CONFIRM. ANALYSES	TOTAL NO. LAB SAMPLES
				MS	MSD	Lab Duplicate	Spiked Blank (b)		
Volatile Organics (SW 8240)									
Unnamed Stream: Downgradient (d)	2	2	8	1	1	0	1	1	12
Unnamed Stream: Upgradient (e)	1	4	8	0	0	0	0	1	9
TOTALS	3		16	1	1	0	1	2	21
Aromatic Volatiles (SW 8020)									
Unnamed Stream: Downgradient	2	2	8	1	1	0	1	1	12
Unnamed Stream: Upgradient	1	4	8	0	0	0	0	1	9
TOTALS	3		16	1	1	0	1	2	21
Total Recoverable Petroleum Hydrocarbons (E 418.1)									
Unnamed Stream: Downgradient	2	2	6	1	1	0	1	0	9
Unnamed Stream: Upgradient	1	4	6	0	0	0	0	0	6
TOTALS	3		12	1	1	0	1	0	15
ICP Screen for Metals (gas 3050/6010)									
Unnamed Stream: Downgradient	2	2	6	1	1	0	1	0	9
Unnamed Stream: Upgradient	1	4	6	0	0	0	0	0	6
TOTALS	3		12	1	1	0	1	0	15
Toxicity Characteristic Leaching Procedure (SW 1311) (f)									
Unnamed Stream	3	1	5	1	1	0	0	0	7
TOTALS	3		5	1	1	0	0	0	7

Note: Analytical methodologies are presented in Section 1.8.1 of the Sampling and Analysis Plan.
(a) Volatile Organics only; number to be initiated will depend upon number of shipments.
(b) Estimated; number to be determined by batch preparation.
(c) Methods SW 8240 and SW 8020 will have 2nd column confirmation performed on all samples exhibiting positive results.
(d) Soil samples from oil/water separator and Unnamed Stream monitoring well locations.
(e) Soil samples from single upgradient monitoring well installation.
(f) TCLP analyses will be performed on the containerized waste material generated from the drill cuttings.

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TABLE 1–15

ANALYSIS SUMMARY: GROUND WATER – MONITORING WELLS
RCRA Facility Investigation – Caswell Air Force Base, Texas

PARAMETER		TOTAL NO. FIELD LOCATIONS	TOTAL NO. SAMPLING EPISODES	TOTAL NO. FIELD SAMPLES	LAB QC SAMPLES				2ND (b) COLUMN CONFIRM. ANALYSES	TOTAL NO. LAB SAMPLES
					MS	MSD	Lab Duplicate	Spiked Blank (a)		
Volatile Organics (SW 8240)										
Unnamed Stream		9	3	27	3	3	0	3	0	36
	TOTALS	9	3	27	3	3	0	3	0	36
Total Recoverable Petroleum Hydrocarbons (418.1)										
Unnamed Stream		9	3	27	3	3	0	3	0	36
	TOTALS	9	3	27	3	3	0	3	0	36
Oil and Grease (SW 9071)										
Unnamed Stream		9	3	27	3	3	0	3	0	36
	TOTALS	9	3	27	3	3	0	3	0	36
Screen for 24 Metals (SW 6010)										
Unnamed Stream: Total		9	3	27	3	3	0	3	0	36
Unnamed Stream: Dissolved		9	3	27	3	3	0	3	0	36
	TOTALS	18	6	54	6	6	0	6	0	72
Arsenic (SW 7060)										
Unnamed Stream: Total		9	3	27	3	3	0	3	0	36
Unnamed Stream: Dissolved		9	3	27	3	3	0	3	0	36
	TOTALS	18	6	54	6	6	0	6	0	72

173087

TABLE 1-15

ANALYSIS SUMMARY: GROUND WATER – MONITORING WELLS
RCRA Facility Investigation – Caswell Air Force Base, Texas

PARAMETER		TOTAL NO. FIELD LOCATIONS	TOTAL NO. SAMPLING EPISODES	TOTAL NO. FIELD SAMPLES	LAB QC SAMPLES				2ND (b) COLUMN CONFIRM. ANALYSES	TOTAL NO. LAB SAMPLES
					MS	MSD	Lab Duplicate	Spiked Blank (a)		
Mercury (SW 7470)										
Unnamed Stream: Total		9	3	27	3	3	0	3	0	36
Unnamed Stream: Dissolved		9	3	27	3	3	0	3	0	36
	TOTALS	18	6	54	6	6	0	6	0	72
Selenium (SW 7740)										
Unnamed Stream: Total		9	3	27	3	3	0	3	0	36
Unnamed Stream: Dissolved		9	3	27	3	3	0	3	0	36
	TOTALS	18	6	54	6	6	0	6	0	72
Lead (SW 7421)										
Unnamed Stream: Total		9	3	27	3	3	0	3	0	36
Unnamed Stream: Dissolved		9	3	27	3	3	0	3	0	36
	TOTALS	18	6	54	6	6	0	6	0	72
Toxicity Characteristic Leaching Procedure (SW 1311)										
Unnamed Stream (c)		5	1	5	1	1	0	0	0	7
	TOTALS	5	1	5	1	1	0	0	0	7

Note: Analytical methodologies are presented in Section 1.8.1 of the Sampling and Analysis Plan.
(a) Estimated; number to be determined by preparation batch.
(b) Method SW 8240 will have 2nd column confirmation performed on all samples exhibiting positive results.
(c) The purge water will be analyzed for the parameters of concern in the TCLP list.

173083

TABLE 1–16

SAMPLING AND ANALYSIS PLAN SUMMARY: GROUND WATER – FIELD SCREEN
RCRA Facility Investigation – Carswell Air Force Base, Texas

PARAMETER		TOTAL NO. FIELD LOCATIONS	TOTAL NO. FIELD SAMPLES	LAB QC SAMPLES MS	MSD	Lab Duplicate	Spiked Blank (b)	2ND (c) COLUMN CONFIRM. ANALYSES	TOTAL NO. LAB SAMPLES
Aromatic Volatiles (SW 8020)									
POL Tank Farm		22	26	2	2	0	1	10	41
Reserve (d)		3	5	1	1	0	0	1	8
	TOTALS	25	31	3	3	0	1	11	49
Petroleum Hydrocarbons (SW 8015M)									
POL Tank Farm		22	26	2	2	0	1	10	51
Reserve (d)		3	5	1	1	0	1	1	8
	TOTALS	25	31	3	3	0	2	11	59
Lead (SW 6010)									
POL Tank Farm		22	24	2	2	0	1	0	29
Reserve (d)		3	3	1	1	0	0	0	5
	TOTALS	25	27	3	3	0	1	0	34

Note: Analytical methodologies are presented in Section 1.8.1 of the Sampling and Analysis Plan.

(a) Volatile Organics only; number to be initiated will depend upon number of shipments.

(b) Methods SW 8020 and SW 8015M will have ten percent of all samples sent to an off–site laboratory for confirmatory analyses.

(c) Three ground–water sampling locations will be reserved for discretionary use during the implementation of the field work.

TABLE 1–17

ANALYSIS SUMMARY: SURFACE WATER
RCRA Facility Investigation – Carswell Air Force Base, Texas

PARAMETER		TOTAL NO. FIELD LOCATIONS	TOTAL NO. FIELD SAMPLES	LAB QC SAMPLES				2ND (b) COLUMN CONFIRM. ANALYSES	TOTAL NO. LAB SAMPLES
				MS	MSD	Lab Duplicate	Spiked Blank (a)		
Volatile Organics (SW 8240)									
Unnamed Stream		3	3	1	1	0	1	0	6
	TOTALS	3	3	1	1	0	1	0	6
Total Recoverable Petroleum Hydrocarbons (418.1)									
Unnamed Stream		3	3	1	1	0	1	0	6
	TOTALS	3	3	1	1	0	1	0	6
Oil and Grease (SW 9071)									
Unnamed Stream		3	3	1	1	0	1	0	6
	TOTALS	3	3	1	1	0	1	0	6

Note: Analytical methodologies are presented in Section 1.8.1 of the Sampling and Analysis Plan.
(a) Estimated; number to be determined by preparation batch.
(b) Method SW 8240 will have 2nd column confirmation performed on all samples exhibiting positive results.

TABLE 1-18

ANALYSIS SUMMARY: SEDIMENT
RCRA Facility Investigation – Carswell Air Force Base, Texas

PARAMETER	TOTAL NO. FIELD LOCATIONS	TOTAL NO. FIELD SAMPLES	LAB QC SAMPLES				TOTAL NO. LAB SAMPLES
			MS	MSD	Lab Duplicate	Spiked Blank (a)	
ICP Screen for Metals (SW 3050/6010)							
Unnamed Stream	3	3	1	1	0	1	6
TOTALS	3	3	1	1	0	1	6

Note: Analytical methodologies are presented in Section 1.8.1 of the Sampling and Analysis Plan.
(a) Estimated; number to be determined by preparation batch.

the analyte of interest is above the reporting detection limit, corrective action should be taken except for common solvents such as methylene chloride, acetone, toluene, 2-butanone and phthalates.

Sample blanks. Sample blanks are used when characteristics like color or turbidity interfere with a determination. In a spectrophotometric method, for example, the natural absorbance of the sample is measured and subtracted from the absorbance of the developed sample. Sample blanks are run only as necessary.

Calibration blanks. Calibration blanks are prepared with standards to create a calibration curve. They differ from the other standards only by the absence of analyte and provide the "zero-point" for the curve.

Internal standards. Internal standards are measured amounts of certain compounds added after preparation or extraction of a sample. They are used in an internal standard calibration method to correct sample results suffering from capillary column injection losses, purging losses, or viscosity effects. Internal standard calibration is currently used for volatile organics, chlorinated pesticides and GC/MS extractables.

Surrogates. Surrogates are measured amounts of certain compounds added before preparation or extraction of a sample. The recovery of a surrogate is measured to determine systematic extraction problems. Surrogates are added to all samples analyzed for chlorinated pesticides, GC/MS extractables and volatiles, and GC volatiles.

Spikes. Spikes are aliquots of samples to which known amounts of analyte have been added. They are subjected to the sample preparation or extraction procedure and analyzed as samples. The stock solutions used for spiking are purchased or prepared independently of calibration standards.

The spike recovery measures the effects of interferences in the sample matrix, and reflects the accuracy of the determination. Spike recoveries are calculated as follows:

Check Standard
Method Standard
Check Sample

$$\text{Percent Recovery} = \frac{\text{Observed}}{\text{Expected}} \times 100$$

Matrix Spike

$$\text{Percent Recovery} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Where:

SSR = Spike Sample Result
SR = Sample Result
SA = Spike added from Spiking Mix

Spikes are prepared and analyzed for all method analytes with each batch and at a frequency of at least one MS and one check standard per 20 samples if more than 20 samples are run in a given batch, or as required by the specific analytical method.

Spike recoveries are stored in the laboratory database and are retrievable for statistical analysis. Laboratory control limits are calculated for individual matrix types when 20 data points become available.

Duplicate or Duplicate Spikes. Duplicate spikes are additional spiked aliquots of samples subjected to the same preparation and analytical scheme as the original spike sample. The relative percent difference (RPD) between duplicates or duplicate spikes measures the precision of a given analysis. RPDs are calculated as follows:

$$\%RPD = \frac{R1 - R2}{Rav} \times 100$$

or

$$\%RPD = \frac{S1 - S2}{Sav} \times 100$$

Where:

R1 and R2	=	duplicate determinations of the analyte in the sample
S1 and S2	=	the observed concentrations of analyte in the spike and its duplicate
Rav	=	the average determination of the analyte concentration in the original sample
Sav	=	the average of the observed analyte concentrations in the spike and its duplicate

Duplicates or duplicate spikes are prepared and analyzed for each method analyte with each batch, or at a frequency of at least one per 20 samples if more than 20 samples are run in a given batch.

RPDs are stored in the laboratory database and are retrievable for statistical analysis.

Laboratory Control Standards. Laboratory Control Standards (LCSs) and Quality Control Check Samples (QCCSs) are aliquots of organic-free or deionized water to which known amounts of analyte have been added. They are subjected to the sample preparation or extraction procedure and analyzed as samples. The stock solutions used for LCSs are purchased or prepared independently of calibration standards. The LCS recovery tests the function of analytical methods and equipment. For inorganic and metals analyses, the percent recovery for LCSs is compared to method specific criteria,

and the analytical system is considered to be in control when these analyte specific criteria are met. When a result of an organic method aqueous matrix spike and/or matrix spike duplicate indicates atypical method performance, a quality control check standard will be analyzed to confirm that the measurements were performed in an in-control mode of operation for that analyte.

The acceptance criteria for the LCS is a recovery range of 80-120%. The acceptance criteria for the QCCS is stated in each method.

LCSs are prepared and analyzed for all method analytes with each batch or at a frequency of one per 20 samples if more than 20 samples are run in a given batch. Laboratory control limits are calculated when 20 data points become available.

The LCS is used to monitor overall performance of all steps in analysis, including sample preparation. If the LCS results fall within 20% of the expected or true value calibration curve, this verifies that instrument performance, calibration and sample preparation are satisfactory. When the LCS is used in conjunction with matrix spikes, matrix spike recovery evaluation can be better interpreted as either matrix interference, sample preparation error or matrix spiking solution preparation error.

1.10.3 Control Limits

Control limits for this project are method specific and laboratory established. Control limits for each analytical method will be experimentally established and reevaluated at regular intervals. Control limits are developed by the laboratory based on historical data. If historical data are not complete then control limits are set based on those established by the method. Appendix A presents the control limits for each analytical method including frequency, acceptance criteria, and corrective action.

1.11 PERFORMANCE AND SYSTEM AUDITS

Law views quality assurance as the means by which the effectiveness and quality of its various participating departments are gauged as they carry on day-to-day operations under the QA/QC program. The major goals associated with the QA/QC program are listed below:

- QA reviews should help ensure compliance with mandated QC procedures
- QA reviews provide a structured means of communicating problems between the technical and administrative portions of the company
- QA procedures are designed to ensure operating regularity between the various branches of Law
- QA audits provide a mechanism by which our QC procedures are constantly being reviewed and updated in an orderly fashion

1.11.1 Systems Audits

Systems audits are qualitative evaluations of each component of field and laboratory QC measurement systems. A systems audit will be performed periodically and will consist of inspecting the following procedures:

- Sampling
- Sample custody
- Sample storage and preservation
- Standard preparation
- Sample preparation

- Analytical methodology
- Data management
- Preventative maintenance
- Personnel qualifications
- Corrective actions, reporting and documentation of out-of-control events
- Recordkeeping

Law will submit to on-site external systems audits by AFCEE or any other appropriate regulating agency.

1.11.2 Performance Audits

A performance audit is a quantitative evaluation of a measurement system. Law participates in the following performance evaluation programs:

- EPA, Environmental Monitoring Support Laboratory - Cincinnati
- Florida Department of Environmental Regulation (DER)
- EPA Inorganic and Organic CLP
- U.S. Army Corps of Engineers, Missouri River Division
- Florida Department of Health and Rehabilitative Services (FDHRS)
- MITRE Performance Audit, in support of AFCEE

Periodically, blind QC samples are entered into the samples flow scheme. Since blind QC samples are difficult to enter into the laboratory without the knowledge of the analysts, the QA Manager relies heavily on the performance evaluation programs by outside sources and QC samples such as matrix spikes, duplicates and surrogates.

1.11.3 Certifications

Law Environmental National Laboratories located in Pensacola, Florida currently holds certifications with several states for various matrices and parameters. They are also certified with the COE, USAF, and USEPA.

1.12 PREVENTIVE MAINTENANCE

Equipment maintenance is the responsibility of the analyst and the Department Manager. All repairs and/or modifications are recorded in bound maintenance logbooks. Daily equipment checks include visual and/or manual inspections of cooling fans, pumps, indicator readings, detectors, gas supplies, and other method-specific inspections. Service schedules are established for performing routine preventive maintenance on all major equipment. Tables 1-19 through 1-23 list the maintenance required for each instrument.

1.13 FIELD AND LABORATORY PROCEDURES USED TO ASSESS DATA QUALITY INDICATORS

1.13.1 Formulas

Accuracy - Accuracy is a measure of the bias in a system. Accuracy is defined as the degree of agreement of a measurement with an accepted reference or true value. To determine the accuracy of an analytical method, a sample spiking program will be conducted. The results of sample spiking will be used to calculate the quality control parameter for accuracy evaluation, the Percent Recovery (%R). The Percent Recovery is defined as the observed concentration, minus the sample concentration, divided by the true concentration of the spike, multiplied by 100.

TABLE 1-19

ROUTINE MAINTENANCE SCHEDULE FOR GC
Carswell Air Force Base, Texas

	Maintenance	Frequency
1.	Check carrier gas supply	Daily
2.	Check head pressure	Daily
3.	Change septums	As needed
4.	Change carrier gas filters	As needed
5.	Check baseline and detector response at highest sensitivity	Quarterly
6.	Air dust electronics and main frame	Annually

TABLE 1-20

ROUTINE MAINTENANCE SCHEDULE FOR GC/MS
Carswell Air Force Base, Texas

	Maintenance		Frequency
1.	System Diagnostics		
	a.	Scan box I/O test	Daily
	b.	Scan box DMA test	Daily
	c.	MS I/O test	Daily
	d.	Filament test	Daily
	e.	RF power test	Daily
	f.	Electromultiplier test	Daily
	g.	Background signal noise test	Daily
2.	Vacuum/Carrier Flow Check		
	a.	Column headpressure check	Daily
	b.	Vacuum check	Daily
	c.	Replace septum	As needed
	d.	Leak check and tighten fittings	As needed
3.	Instrument Tune Check		
	a.	BFB/DFTPP tune check	Daily
	b.	PFTBA tuning	As needed
4.	Calibration Check		
	a.	VOA standards check	Daily
	b.	BNA standards check	Daily
		Replace inlet liner	As needed
5.	Clean source		As needed
6.	Clean quadrupole rods		As needed
7.	Replace column (or remove front end)		As needed

TABLE 1-21

ROUTINE MAINTENANCE SCHEDULE FOR ICP
Carswell Air Force Base, Texas

	MAINTENANCE	FREQUENCY
1.	Check Argon pressure at tank and at nebulizer.	Daily
2.	Inspect cooling water supply.	Daily
3.	Inspect vacuum pump.	Daily
	a. Oil level b. Vacuum monochromator gauge	
4.	Inspect peristaltic pump windings and capillary tubing.	Daily
5.	Check ICP ignition sequence.	Daily
	a. Argon to torch b. Preignition discharge c. Ignition	
6.	Disassemble and clean ICP nebulizer, spray chamber and torch assembly.	Weekly
7.	Check peak resolution and monochromator stability using profile routines and internal Hg lamp.	Weekly
8.	Change pump windings and all capillary tubing to nebulizer.	Monthly
9.	Change vacuum pump oil.	Monthly

TABLE 1-22

ROUTINE MAINTENANCE SCHEDULE FOR AA SPECTROPHOTOMETER
Carswell Air Force Base, Texas

Maintenance
1. Contact cylinders, tube, and platform should be cleaned and checked each day before running samples. Use cotton swab and methanol for cleaning.
2. Contact cylinders should be checked for cracks and pitting. Tubes should be checked for pitting, peeling pryolitic coating and burn marks around sample port hole. Any of the above indicate a worn tube or cylinder.
3. Furnace/spectrometer windows should be checked and cleaned daily.
4. Check coolant level in recirculator and temperature setting daily.
5. Spectroscopy lab should be wet mopped, counters dusted, and exterior of instruments cleaned on a weekly basis to ensure a dust-free environment.
6. Consult instrument operations manual for further maintenance instructions.
7. All maintenance is to be recorded in the Maintenance Log Book.
8. Argon gas pressure to furnace should be 60 psi. Check regulator to ensure proper pressure.

TABLE 1-23

ROUTINE MAINTENANCE SCHEDULE FOR IR SPECTROPHOTOMETER
Carswell Air Force Base, Texas

MAINTENANCE	FREQUENCY
1. Check air filter.	Depends on use
2. Remove cuvette from sample compartment.	Daily
3. Keep instrument clean from spills.	Daily

$$\%R = \frac{X - T}{K} \times 100$$

where

X = Analytical result from the spiked sample

T = Analytical result from the unspiked aliquot

K = Known value of the spike

%R = Percent Recovery

To determine accuracy, surrogate, matrix spike and matrix spike duplicates (MS/MSD), and internal standards will be analyzed. The control limits will be based on the mean percent recovery ±3 standard deviations of the mean using a population of 20 recovery values.

Precision - Precision is the measure of mutual agreement among individual measurements of the same property, usually under prescribed similar conditions. Precision is best expressed in terms of standard deviation or Relative Percent Difference (RPD) Precision is inferred through the use of duplicate samples. RPD for each component is calculated using the following equation:

$$RPD = \frac{A - B}{(A + B)/2} \times 100$$

where:

A = Replicate Value 1

B = Replicate Value 2

RPD = Relative Percent Difference

The calculated Percent Recovery and RPD will be summarized. The RPD data will be used to evaluate the long term precision of the analytical method.

To determine precision, matrix spikes and matrix spike duplicates will be analyzed. The control limits will be based on a population of 10 RPD values. They are calculated by determining the mean RPD plus 3 times the standard deviation for the upper limit and zero as the lower limit.

Completeness - Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct or normal conditions. The result is expressed as a percentage.

$$\text{Percent completeness} = \frac{\text{Number of valid measurements}}{\text{Total number of measurements}} \times 100$$

The percent completeness for this project is 90%.

1.13.2 Control Limits

Control limits for analytical methods are presented in Appendix A. Control limits are developed by the laboratory based on historical data. If historical data are not complete then control limits are set based on those established by the method.

1.13.3 Documentation

Completeness and comparability of data are insured by adherence to a standard data-set protocol and checklist of data required to be available on laboratory report sheets for each type of analysis

conducted. Each parameter data book must contain all data and calculations associated with each independent determination. These include such things as sample weight(s), dilution factor(s), applicable determinative measurements such as titration values, spectrometer readings, injection quantities, and standard(s) identity and concentrations, as well as all calculations related to each final value reported. Each laboratory report sheet will be checked and initialed by a second competent scientist other than the person who did the analysis to insure completeness of data and correctness of all calculations in the report. For the occasional project involving very critical samples on which serious action is contemplated, the entire set of analyses on the same sample(s) will be independently audited by a special project quality assurance officer, (for example, the analysis of drinking water samples from residential wells where compounds were found to exceed the MCL). Samples collected at Carswell AFB are not considered to be in this category. Work sheets, chromatograms, spectra, etc., associated with every analysis will be present in the parameter data book. These will give instrument operation parameters and details of instrument set-up, such as columns used, mobile and stationary phases and concentrations, temperatures, detectors, spectrometer type, wavelengths, etc., as applicable for the type analysis. Work sheets will bear a unique laboratory number identifying that sample, relating the laboratory data sheets to the sample. Each sheet will be recorded with dates and times and bear the laboratory analyst's initials.

1.14 CORRECTIVE ACTION

An effective QC program requires rapid and thorough correction of the QC problems. Rapid corrective action (CA) minimizes the possibility of questionable data on any project. The need for corrective action originates when an inadequacy is found in the method of analysis (e.g., inappropriate calibration) or a

determinate error occurs (e.g., calibration error due to standards failure). Failures of the first kind are precluded by LENL and Regulator/Contractee audits which evaluate analytical SOPs. The analytical SOPs incorporate mechanisms to detect the existence of determinate errors and specify the procedures to correct them.

Depending on the nature of the CA, it is classified as one of two types, immediate and long-term. Immediate corrective actions are the correction of procedures or repair of instrumentation that is working improperly. Long-term corrective actions are the correction of systematic errors, such as the detector on a GC becoming dirty and losing sensitivity. Corrective actions associated with field activities are presented in Section 2.4.3.

1.14.1 Response

Many times the source of a nonsystematic problem is obvious to the analyst and can be corrected immediately. Immediate corrective action routinely made by field technicians or laboratory analysts should be documented as normal operating procedures in instrument log books or personal notebooks. The Supervisor and analyst should compile a list of commonly encountered problems and the appropriate routine corrective actions (in addition to manufacturer's troubleshooting guides). The Operations Manager and QA/QC Coordinator are responsible for approving all corrective actions. Appendix A lists the corrective actions necessary for each analytical method.

1.14.2 Reestablishment of Control

Corrective action is not complete until the problem has been effectively and permanently solved. Follow-up action to ensure that the problem remains corrected is a vitally important step in

the corrective action procedure. Routine corrective actions, such as recalibrating the instrument, are incorporated into the Standard Operating Procedures (SOPs). Major corrective actions, such as a systems failure, are handled in the following manner: Once a problem has been technically defined, the Operations Manager and the QA/QC Coordinator discuss the problem and jointly take the following steps:

1. Determine that specific corrective action is needed to eliminate the problem and assign responsibility for investigating, implementing, and documenting the situation;

2. Set a time schedule for determining the required action;

3. Assign responsibility and time schedule to implement the desired action;

4. Establish desired effectiveness of the corrective action and implement the correction; and

5. Verify that the corrective action has eliminated the problem and document.

1.14.3 Documentation

To provide a complete record of QC activities, QC problems and corrective actions applied must be documented. Historical records assist laboratory management in identifying long-term corrective actions, such as personnel training, replacement of instrumentation, improvement of sampling procedures, etc. Corrective action documentation forms for laboratory operations are presented in Appendix B. Corrective action documentation

associated with field activities are recorded on Daily Quality Control Forms. These forms are presented in Section 2.5.

1.15 QUALITY ASSURANCE REPORTS

The management is informed of QA activities in three ways: (1) by immediate verbal notification of QA problems, (2) by interim QA reports, and (3) written QA reports. The following subsections discuss the reporting procedures to be followed and report contents.

1.15.1 Reporting Procedure

An Analytical Data Informal Technical Information Report (ITIR) will be prepared by the Project Chemist, reviewed by the Project Manager and submitted by Law Environmental Government Services Division at the end of the sampling and analysis activities to the AFCEE TC. The data will also be submitted to the USAF TPM in a format compatible with the USAF's Installation Restoration Program Information Management System (IRPIMS) data base.

1.15.2 Report Content

The format of the Analytical Data ITIR will substantially follow the format specified by the USAF (AFCEE, 1991). The format of the IRPIMS deliverable will correspond exactly to the format specified by the USAF (AFCEE, 1991; AFCEE, 1993a; AFCEE, 1993b). The internal management of these deliverables is performed by a QA audit between the LENL-P Chemical Lab Manager and the LEGs Project Manager (See Figure 1-5). The QA audit reporting function is facilitated by direct correspondence between the LEGS Chemistry Program Lab Coordinator and the lab.

2.0 FIELD SAMPLING PLAN (FSP)

Field tasks to be conducted at the Carswell AFB RFI sites are explained in detail in the following text.

2.1 FIELD OPERATIONS

The field investigations at the Unnamed Stream and POL Tank Farm sites which are located in the east area of Carswell AFB (Figures 2-1 and 2-2) will include the following activities:

- Geophysical surveys
- Geochemical survey
- Installation of new monitoring wells
- Aquifer testing
- Soil, sediment, ground-water sampling (3 rounds), and surface water sampling

The proposed Geochemical locations for the POL Tank Farm are presented in Figure 2-3. The proposed monitoring well location for the Unnamed Stream is presented in Figure 2-2. The methods for conducting the field operations and activities are discussed in the following sections.

2.1.1 Site Reconnaissance, Preparation and Restoration

The two sites under this RFI were visited on April 14th, 1993, by representatives of Law, AFCEE, and Carswell AFB. During the site visit, AFCEE representatives outlined the RFI field tasks at each site.

Prior to commencement of field operations, all sites will be inspected and new monitoring well locations will be staked. The sites will also be inspected for access routes.

173111

FIGURE 2-1

LOCATION OF EAST AREA SITES

CARSWELL AIR FORCE BASE, TEXAS

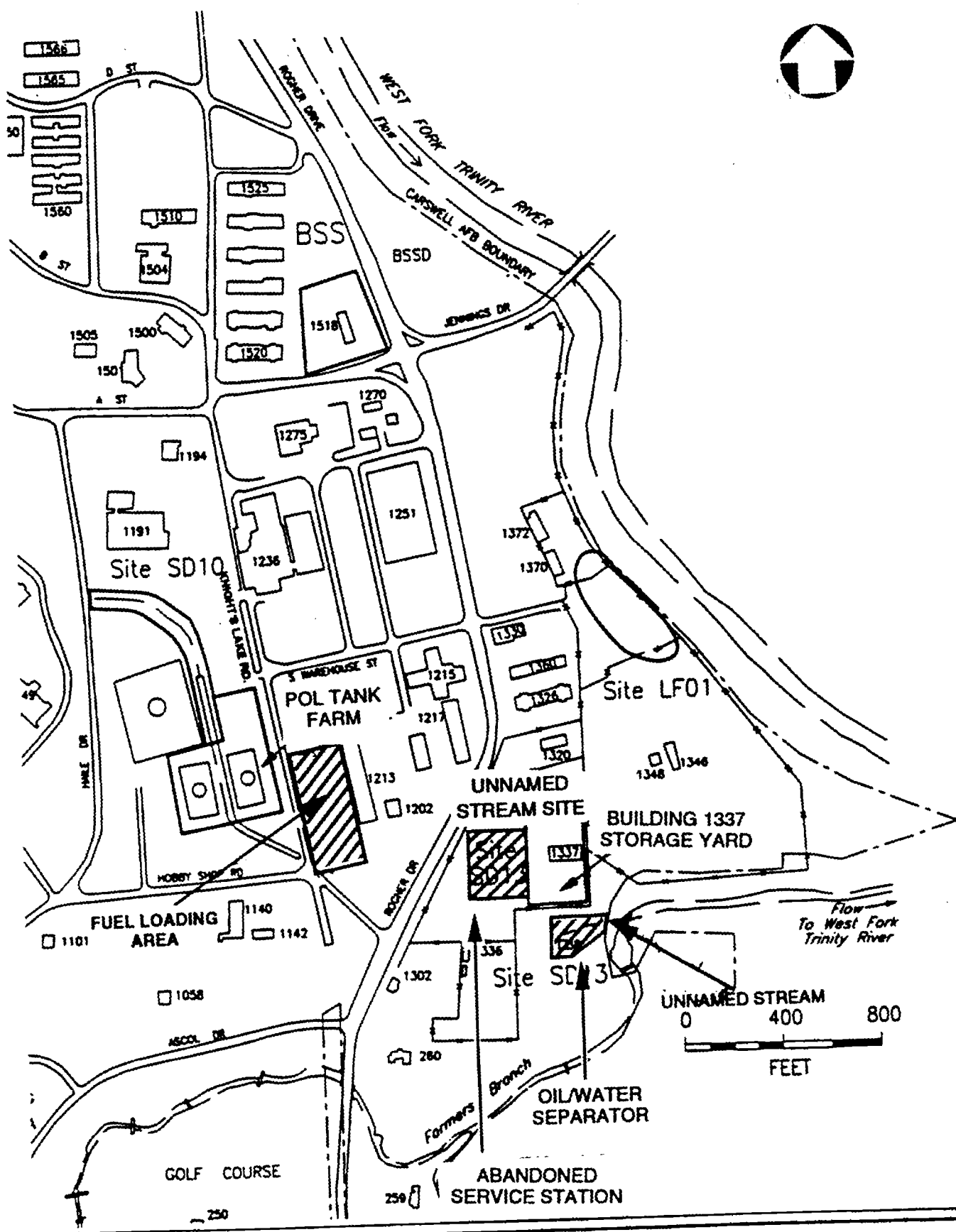

FIGURE 2-2

LOCATION OF WELLS AND SURFACE WATER SAMPLING LOCATIONS AND APPROXIMATE LOCATIONS OF FRENCH DRAINS AND OIL/WATER SEPARATOR

(AFTER RADIAN, 1991a)

CARSWELL AIR FORCE BASE, TEXAS

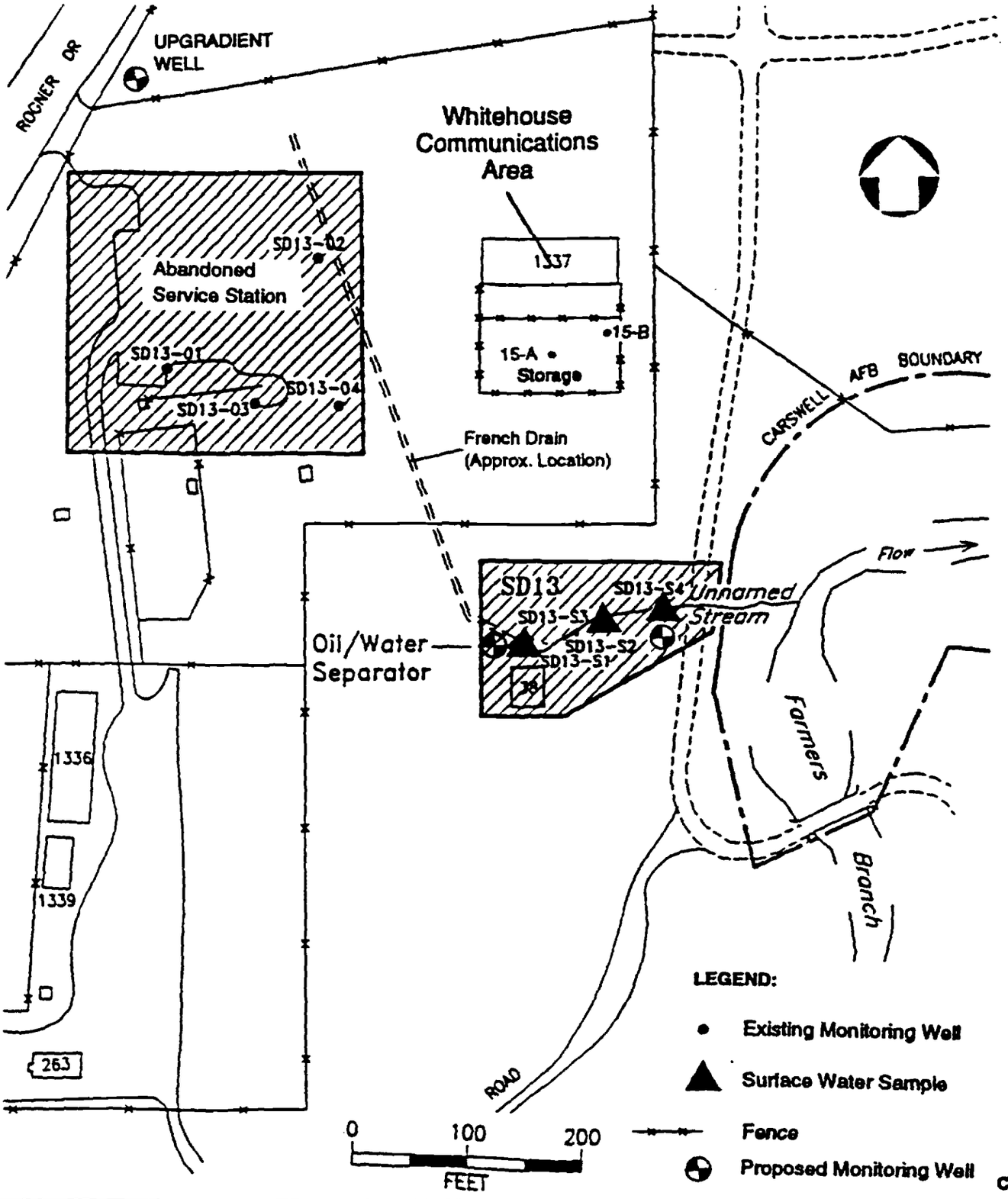

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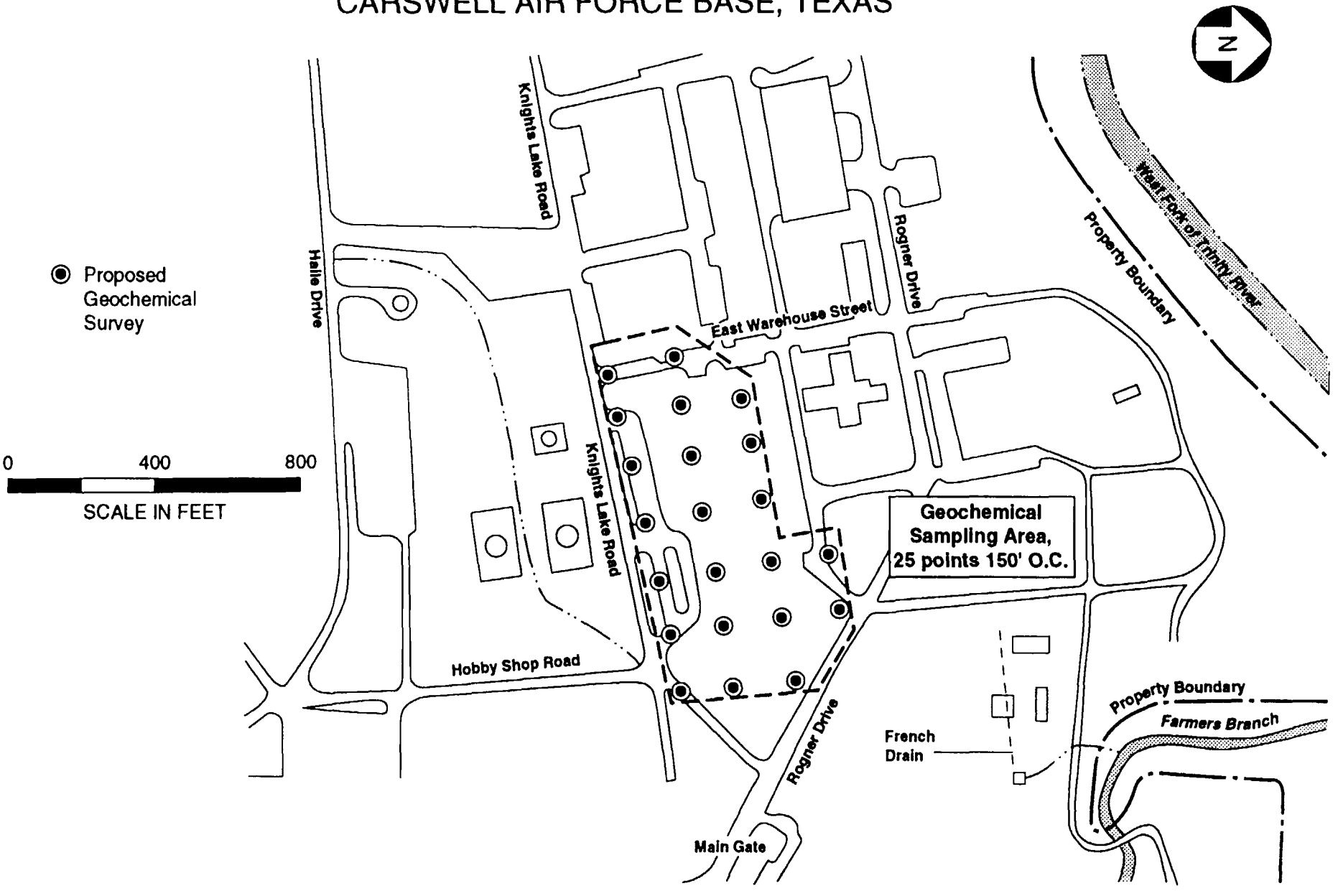
FIGURE 2-3

PROPOSED GEOCHEMICAL SAMPLING AREA

CARSWELL AIR FORCE BASE, TEXAS



Site preparation will include removal of obstructions (if needed) and utility clearances by base personnel. Specific information concerning field office space, decontamination area, and drum staging areas will be coordinated with base personnel.

Upon completion of field activities, each site will be restored to a condition that as closely as possible approximates the condition of the site prior to field activities.

2.1.2 Surface Geophysical Survey

A geophysical survey will be performed at both sites to help characterize the near surface conditions and to locate utilities and abandoned tanks and pipechases. A single type of geophysical survey (ground penetrating radar) will be performed at Carswell AFB during the field work.

2.1.2.1 Ground Penetrating Radar - GPR is a geophysical technique which can provide high resolution data on surficial geology. The technique is used in general to map shallow bedrock, soil and water table features, and locate underground pipes and tanks. At hazardous waste sites, ground penetrating radar is also used to locate trenches, lagoons, buried drums, contaminant plumes and other structural and contaminant-related features. The depth of penetration is dependent upon the types of soil and the electrical properties of the subsurface. In silts and clays the depth of penetration may be on the order of only a few feet, while in dry sands the depth of penetration may extend to tens of feet.

A high frequency signal (typically in the 100 to 1000 Mhz range) is transmitted into the subsurface through a transmitting antenna and the resulting signal is received by a second antenna. The received signal may include an air wave, a ground wave, and reflected signals from subsurface boundaries, all in superposition.

The particular frequency range at which the radar operates is determined by radio frequency electronics and the specific antennas used. Typically in geologic materials, the lower the frequency range of the radar the greater the penetration range, assuming the transmitter output power and receiver sensitivity are not varied. The ability to resolve variations in electrical properties which have small spatial extent increases as the frequency increases, assuming a constant center-frequency to system-bandwidth ratio. It is necessary, therefore, to use antennas having the optimum frequency range and bandwidth characteristics to see the desired electrical variations in the particular geologic medium.

A GEODAR-I, Model-2441, or equivalent unit, will be used at the Carswell sites. A typical radar unit consists of a timing control unit which synchronizes all timing for the transmitter, receiver, data recorder, and data display. The transmitter and receiver electronics are located in the respective antenna modules. They are connected to the control unit through cables. Only the timing signals, the audio frequency facsimile of the received signal, and the DC voltage are carried on this cable.

The receiver has a sampling head similar to a sampling oscilloscope. The sampling head uses the repetitive nature of the received signal to transform the radio frequency signal into audio frequency facsimile. The transmitter sends out pulses and the receiver samples the received pulse for a small interval of the pulse duration. After each transmitter pulse, the sample window is moved in time and this is repeated until a complete scan of the pulse is obtained. The rapid rate at which the data is collected presents a virtually continuous record. During the survey, the antennas can be moved continuously over the line of interest. The sampled audio frequency signal is sent to the control unit where it is amplified, filtered and then monitored on an oscilloscope. The signal is recorded on an electrostatic recorder.

The electrostatic recorder uses a variable gray scale to display the data. Each scan draws a line across the paper in the direction of increasing signal travel time with the intensity dependent upon the radar signal amplitude.

The received radar signals are filtered before recording using audio frequency analog filters located in the control unit. Analog filtering helps to remove some of the equipment-generated noise.

For a routine reconnaissance map of reflections in the ground, the antennas are mounted rigidly at a known separation and moved along the profile line. The resultant trace shows reflection travel time versus position along the profile. In the profile mode, the travel time is related to the reflector depth and signal propagation velocity.

2.1.3 Geochemical Survey

A ground-water field screening will be performed at the POL Tank Farm.

Ground-water samples will be collected for screening and analyses using a cone penetrometer type sampling system at Carswell AFB as part of the RCRA facility investigation effort. The intent of this activity is to conduct an evaluation of the nature and extent of ground-water contamination at Carswell AFB. The contaminants of concern are petroleum hydrocarbons. This screening and analyses will be conducted by Transglobal Environmental Geotechemistry (TEG), Texas located in Austin, Texas. TEG utilizes hydraulic drivepoint rigs to perform the ground-water screening. The Strataprobe™ is a cone penetrometer type sampling system developed by TEG.

2.1.3.1 Strataprobe™ - The Strataprobe™ ground-water field screening will be performed at the POL Tank Farm. The POL Tank Farm is located in the east area of Carswell AFB, west of and adjacent to Knight's Lake Road and north of Hobby Shop Road (Figure 2-1). Twenty-two Strataprobe™ samples will be collected at the POL Tank Farm to provide supplemental geochemical information in order to delineate the extent of the ground-water contamination. Three Strataprobe™ locations will be held in reserve for discretionary reasons once the ground-water field screening is implemented.

The sampling tool of the Strataprobe™ will be hydraulically pushed to the water table, which is estimated to be at ten feet. Collection of the ground-water samples will be performed with a cone penetrometer equipped with a screened intake and sample chamber (Figure 2-4). The tool is advanced to the target depth and the outside drive casing is retracted one foot to expose the screen. Upon filling of the sample chamber, the tool can be withdrawn from the boring, and the sample transferred to the appropriate containers. These water samples will be analyzed in the field by TEG for the parameters listed in Table 2-5. Approximately 10 percent of these samples will be sent to an off-site laboratory for confirmation. The cone penetrometer will be decontaminated after each sample is containerized. Equipment decontamination procedures are described in Section 2.1.8.

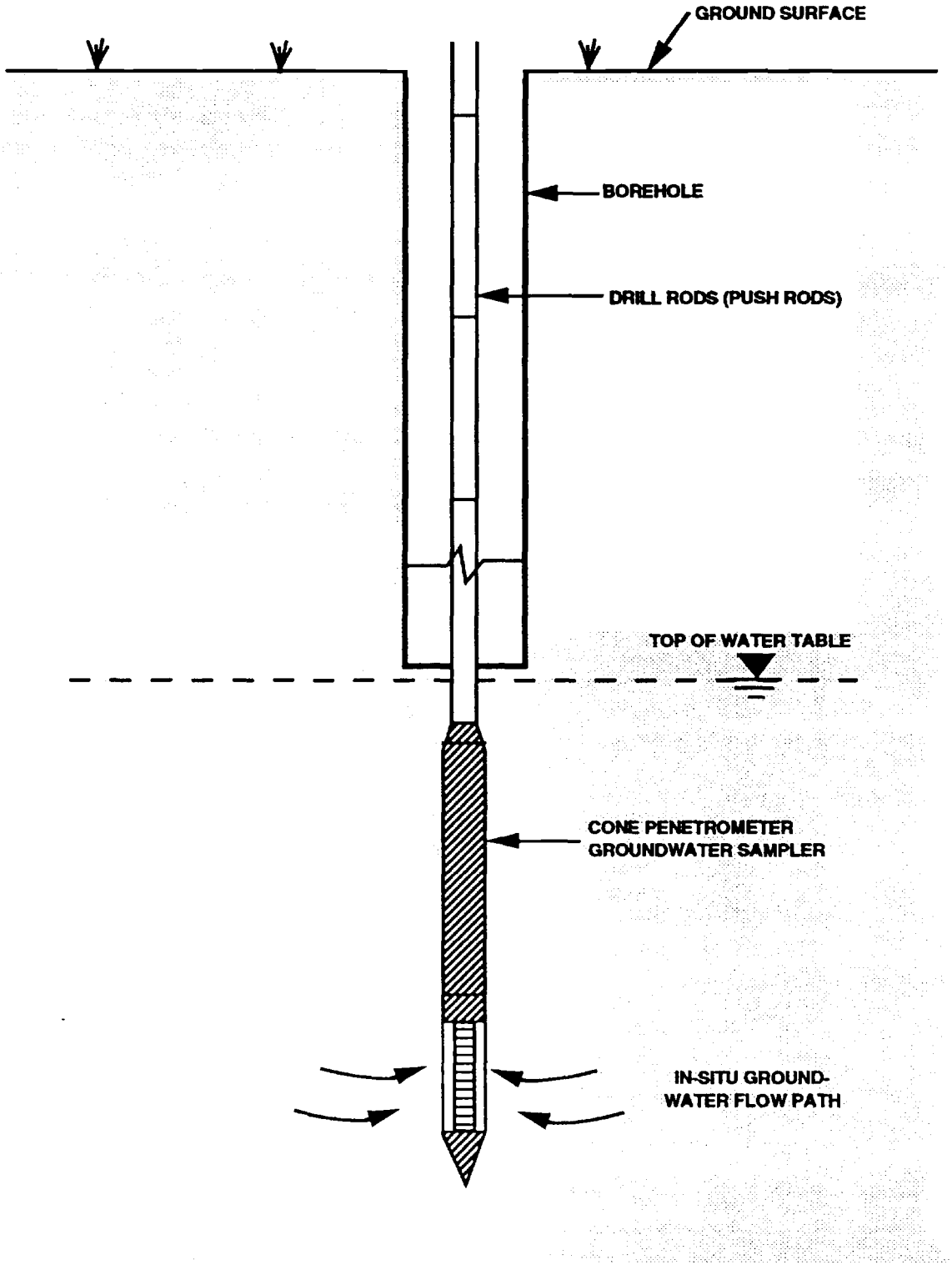
2.1.4 Borehole Construction, Lithologic Sampling and Logging

A soil boring will be performed to allow installation of each monitoring well. The soil boring will provide subsurface information for well design and site stratigraphy. The soil boring will be observed by a qualified geologist or geotechnical engineer. The geologist/engineer will log the subsurface conditions encountered in the boring, and record the information on a soil boring log. An example of a soil boring log is shown in Figure 2-5. Any other additional information concerning the boring will

FIGURE 2-4

CONE PENETROMETER SAMPLER DIAGRAM

CARSWELL AFB, TEXAS



NOT TO SCALE

3517-0111.03

FIGURE 2-5

173119

SOIL TEST BORING RECORD

JOB NO. _____	BORING NO. _____
JOB NAME _____	G.S. ELEV. _____
DATE: _____	HOURS MOVING _____
WEATHER _____	HOURS DRILLING _____
DRILLER _____	PAGE _____ OF _____

DEPTH (FEET)	STRATA DESCRIPTION	#	"N" 1	2	3	4	N	PID	REC	SOIL CLASSIFICATON AND REMARKS	DEPTH (FEET)

BORING TERMINATED: _____	METHOD OF ADVANCING BORING	DEPTH
BORING REFUSAL: _____	POWER AUGER	TO
WATER TOB DEPTH _____	HAND CHOP: W/MUD: W/WATER	TO
WATER 24 HR.: DEPTH _____	ROTARY DRILL: W/MUD: W/WATER	TO
WATER LOSSES _____	DIAMOND CORE	TO
CASING: SIZE _____ LENGTH _____		

QA / QC INSTALLED BY: _____ CHECKED BY: _____ DISCREPANCIES: _____

HF

also be recorded on the log. Soils will be classified using the Unified Soil Classification System (ASTM D 2488-69).

Hollow-stem augering will be the preferred technique for all soil borings. The augers will have a minimum inner diameter (I.D.) of 6.25 inches to allow installation of the wells as described in subsequent report sections. It is anticipated that use of the hollow-stem augers will provide a sufficiently stable hole for soil sampling and monitoring well installation. If drilling fluids are to be utilized, a sample of the fluids introduced to the borehole will be analyzed to evaluate potential constituents introduced into the monitoring well.

2.1.5 Monitoring Well Construction and Installation

2.1.5.1 Construction - The monitoring wells will be installed to accomplish the following objectives: to collect representative ground-water samples; to prevent contamination of the aquifer by the drilling equipment; to prevent inter-aquifer contamination; and to prevent vertical seepage of surface water into the monitoring well water-intake zone. The equipment, procedures and personnel that will be used at the Carswell AFB to accomplish these objectives are discussed below.

The monitoring wells will be designed to intercept the upper portion of the water-table aquifer. The screen will be placed so that it intercepts the maximum upper fluctuation of the water table. Vertical fluctuation of the surficial aquifer water table at Carswell AFB generally does not exceed five feet over the course of a 12-month period (personal communication, J. Bartelino, U.S. Geological Survey, 1993). Seasonal fluctuations in the water table will be taken into account in placing the screen for each well. The screen will extend a minimum of one foot and a maximum of five feet above the water level encountered during drilling.

The screen and riser pipe will be installed through the hollow stem auger. The pipe will be centered and suspended prior to placing the filter pack. Sand for the filter pack will be tremied into the annular space between the well casing and hollow stem augers using a tremie pipe. The hollow stem auger extensions will be withdrawn as the sand is placed into the well. The sand will be placed to a minimum of two feet above the top of the screen. If wells are installed so that the top of screen is at a depth of two feet or less, the sand pack will be installed to six inches above the screen. The sand will be continuously tamped to prevent bridging. The depth of the sand pack and the amount of sand used will be continuously monitored. After the filter pack has been installed to a level of at least two feet above the top of the screen, the well will be surged for ten minutes using a surge block. Additional sand will be added to bring the level back up to two feet above the screen. The well will then be surged for an additional five minutes. More sand will be added if necessary to return the level of the sand to two feet above the screen. Following placement of the sand, three feet of bentonite pellets will be placed above the sand pack. The remainder of the open hole will be sealed with a cement-bentonite grout. The grout will be placed using a tremie pipe equipped with a side discharge. A Type II Well Completion Diagram is shown in Figure 2-6.

2.1.5.2 Materials and Installation - All monitoring well surface casing and riser pipe will consist of new, threaded, and flush joint, Schedule 40 polyvinylchloride (PVC). The pipe will conform to ASTM F-480-88A standards. The pipe will bear markings identifying the material as that which is specified. Each section will be joined by threaded flush-joint couplings to form water-tight seals. No organic solvents or glue will be used in joining the pipe.

FIGURE 2-6

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MONITORING WELL INSTALLATION DIAGRAM

JOB NAME _____

WELL NO. _____ JOB NO. _____

DATE _____ TIME _____

WELL LOCATION _____

GROUND SURFACE ELEVATION _____

TOP OF SCREEN ELEVATION _____

REFERENCE POINT ELEVATION _____

TYPE SAND PACK _____ GRADATION _____

SAND PACK MANUFACTURER _____

SCREEN MATERIAL _____

MANUFACTURER _____

RISER MATERIAL _____

MANUFACTURER _____

RISER DIAMETER _____

DRILLING TECHNIQUE _____

AUGER SIZE AND TYPE _____

BENTONITE TYPE _____

MANUFACTURER _____

CEMENT TYPE _____

MANUFACTURER _____

BOREHOLE DIAMETER _____

SCREEN DIAMETER _____ SLOT SIZE _____

LAW ENVIRONMENTAL, INC.

FIELD REPRESENTATIVE _____

DRILLING CONTRACTOR _____

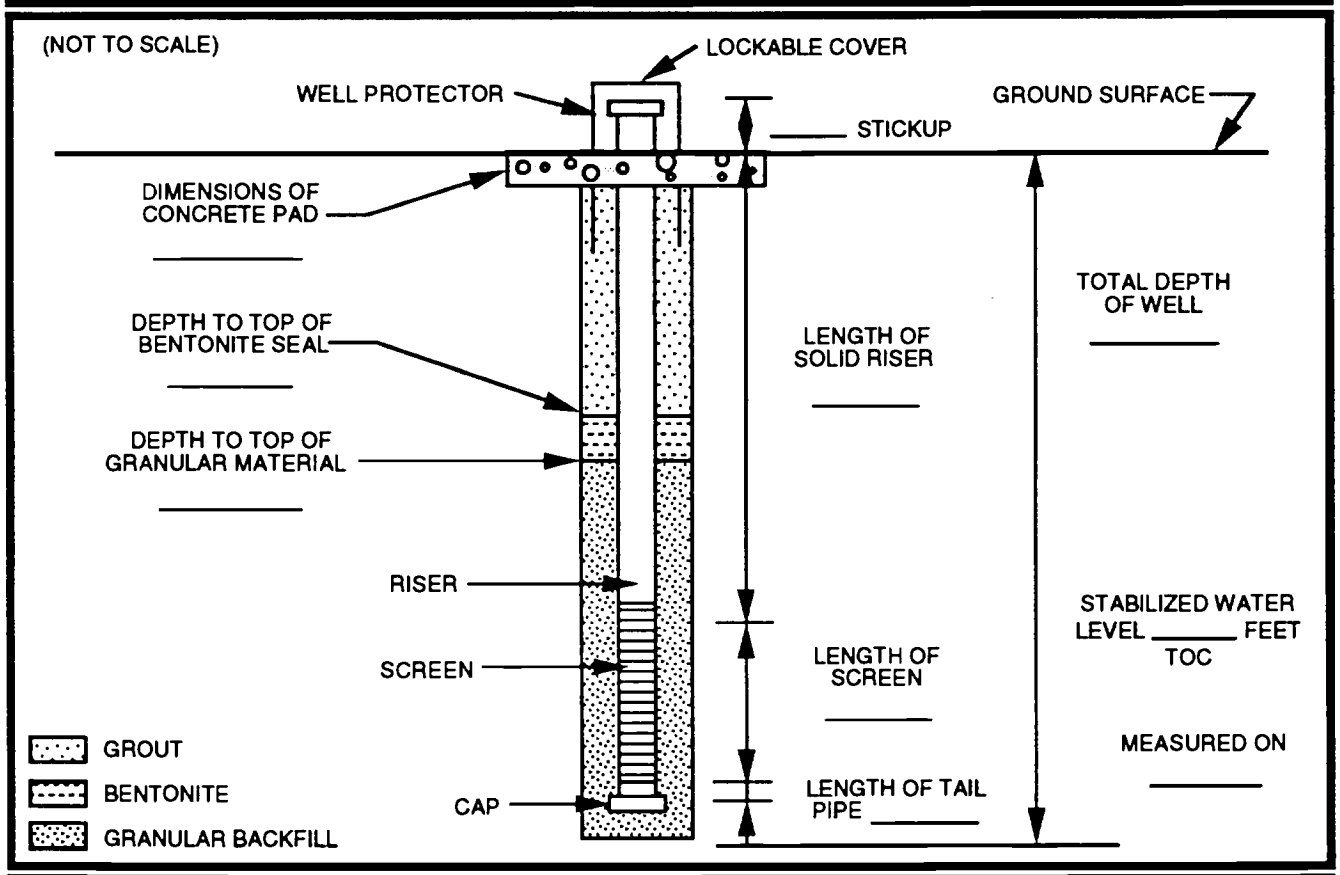
AMOUNT BENTONITE USED _____

AMOUNT CEMENT USED _____

AMOUNT SAND USED _____

STATIC WATER DEPTH (after dev.) _____

REMARKS _____



QA / QC	INSTALLED BY: _____ INSTALLATION OBSERVED BY: _____
	DISCREPANCIES: _____

HF

All well screens will consist of new, commercially fabricated, threaded 10-foot, flush joint, 4-inch PVC, factory slotted; slot size .010. A threaded PVC plug or short sand sump section will be provided for the bottom of the well.

A sand pack will be installed in the annulus between the boring and the well screen. The sand filter pack will extend two feet above the top of the screen. The sand pack will consist of clean, inert, non-carbonate materials. A "20/40" sand, or its equivalent, will be used in the wells to be installed at the sites.

A three-foot thick bentonite seal will be placed in the annulus above the filter pack and will be allowed to hydrate to prevent intrusion of the grout into the filter sand. A cement grout will be placed in the annular space between the well casing and boring from the top of the bentonite seal to the ground surface. The cement mixture will consist of Portland cement (ASTM-C150), and water added in the proportion of no less than five to no more than seven gallons per 94-pound bag of cement. Additionally, three percent by weight of bentonite powder will be added to the mixture to help reduce shrinkage, if permitted by state regulations.

Upon completion of the well, a vented cap will be installed to prevent material from entering the well. The PVC riser will be surrounded by a larger diameter steel casing rising approximately 24 to 36 inches above ground level. The steel casing will be provided with a locking cap and lock. A three-foot square, four-inch thick concrete pad, sloped away from the well, will be constructed around the well casing at the final ground level elevation. Three steel posts, with three-inch diameters and five foot lengths, will be equally spaced around the well outside of the concrete pad. Monitoring wells will be identified on the outside of the casing.

All wells will be checked for plumbness after installation. A ten-foot length of pipe, one half-inch less in diameter than the I.D of the riser pipe, will be run through the entire length of the well. This pipe section will be steam cleaned prior to use at each location. If the pipe does not run freely through the full length of the well, the well will be replaced or repaired.

2.1.5.3 Well Development - The monitoring wells will be developed no sooner than 48 hours after grouting is completed. Development protocol will be as follows:

a. Measure static water level. Water levels will be measured using an interface probe capable of detecting both petroleum product and water levels.

b. Measure total well depth.

c. Develop the well using a combination of surging, bailing and pumping. Begin by surging the well with a surge block for a period of not less than fifteen minutes. Then use either a bailer or a pump to evacuate the well. Continue pumping/bailing and periodically surging until: 1) the suspended sediment content of the water is less than 0.75 mL/L as measured in an Imhoff Cone according to Method E160.5; 2) the turbidity remains within a ten nephelometric turbidity unit (NTU) range for at least 30 minutes; and 3) the temperature, pH and conductivity have stabilized. Stabilization criteria are as follows: temperature ± 1 degree celsius, pH ± 0.1 units, conductance ± 5%.

d. All fluids introduced into the well will be removed during development. Therefore in addition to the above

criteria at least three times the total quantity of fluids added during drilling will be removed during development.

e. In the event that the well goes dry during development, the following steps will be used:

1) Immediately after the well is purged dry, check the static water level and note the time of the reading. Suspend the probe of the static water level indicator six inches above the last static water level reading and record the time it takes the monitoring well to recharge to that level six inches above the last reading. Note the time again.

2) Repeat this procedure over the next six inch interval to verify accuracy.

3) If the recharge rate is sufficient to recover to at least eighty percent of the original static water level in one hour purge the well dry two additional times. Development will be completed after three purged dry cycles.

4) If the recharge rate is not sufficient to recover the eighty percent of the original static water level in one hour, notify the Law Project Manager for further guidance.

f. Denote physical characteristics of water throughout well development (color, odor, turbidity, etc.).

g. Record the total quantity of water removed.

h. Measure static water level after at least 24 hours.

i. Measure total well depth.

j. After final development collect approximately one liter of water from the well in a clear glass jar. Label and photograph the water jar. The photo will be suitably backlit to show the clarity of the water.

Well development data will be recorded on Monitoring Well Development Sheet, Figure 2-7.

2.1.6 Aquifer Tests (Slug Tests)

In-situ hydraulic conductivity tests will be performed on the new monitoring wells a minimum of 24 hours after ground-water sampling. Decontamination of downhole testing equipment will be performed in accordance with Section 2.1.8. The tests will be conducted to determine formation permeability. The results of the tests will be used to estimate ground-water flow rates.

The tests which will be performed are known as rising head tests. The rising head test involves removing a solid rod which was previously inserted into the water column in the well. The rising head test is performed once the water level has returned to static after the initial insertion of the rod. Removal of the rod causes an immediate lowering of water level. The water level recovery to static is recorded over time using an automatic data logger. Water level readings will be measured and recorded continuously until the recovery is 90 percent of the original static water level. The rate of recovery is controlled by formation characteristics.

The data results of the hydraulic conductivity test are then calculated. The following formula (Bouwer, 1989) is utilized to calculate hydraulic conductivity (K):

FIGURE 2-7

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JOB NAME _____ JOB No. _____

BY _____ CHECKED _____ SHEET _____ OF _____

WELL DEVELOPMENT DATA

1. Well No. _____
2. Date of Installation : _____
3. Date of Development : _____
4. Static Water Level : Before Development _____ ft.: 24 Hours After _____ ft
5. Quantity of Water Loss During Drilling, If Used _____ Gal.
6. Quantity of Standing Water in Well and Annulus Before Development _____ Gal.

	Start	During		End
7. Specific Conductance (umhos/cm)	_____	_____	_____	_____
Temperature (c°)	_____	_____	_____	_____
pH (s.u.)	_____	_____	_____	_____

8. Depth From Top of Well Casing to Bottom of Well _____ ft. (from Well Installation Diagram)
9. Well Diameter _____
10. Screen Length _____ ft.
11. Minimum Quantity of Water to be Removed (5 Well Volumes) _____
12. Depth to Top of Sediment : Before Development _____ ft.; After Development _____ ft.
13. Physical Character of Water: _____

_____

14. Type and Size of Well Development Equipment : _____

_____

15. Description of Surge Technique, If Used : _____

_____

16. Height of Well Casing Above Ground Surface : _____ ft. (from Well Installation Diagram)
17. Quantity of Water Removed : _____ Gal. Time for Removal : _____ Hr./Min.
18. 1-Liter Water Sample Collected : _____ (Time)
19. Turbidity in Nephelometric Units _____ NTUs

*Development Conditions : 1) Well Water if Reasonably Clear
2) Sediment Thickness 5% of Screen Length
3) Removal of 5 Well Volumes, Including Saturated Filter Annulus
4) Stabilization of Specific Conductance and Water Temperature

HF WDDR-7

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FIGURE 2-7 (CONT'D)
WELL DEVELOPMENT DATA

JOB NAME _____ JOB No. _____

BY _____ CHECKED _____ SHEET 2 OF 2

Well No. _____

Date/ Time	Hrs Dev/ Cum Hrs Dev	Gals Purged/ Cum Gals Purged	pH	Temp	Cond	Remarks

HF WDDR-New Pg.2

$$K\ (ft/sec) = \frac{r^2{}_c \ln (R_e/r_w)}{2\ L_e} * \frac{1}{t} * \frac{\ln Y_0}{Y_t}$$

Where:	r_2 (ft)	=	well radius
	R_e (ft)	=	effective radial distance over which the head difference is dissipated
	r_w (ft)	=	radial distance between well center and undisturbed aquifer
	L_e (ft)	=	height of saturated screen
	Y_0 (ft)	=	water level Y at time zero
	Y_t (ft)	=	water level Y at time t
	t (sec)	=	time since Y_0

Analysis of the data will be performed utilizing a commercially-available computer program such as AQTESOLV®. Because we expect the screen will extend above the water table, only the rising head data will be used to calculate K.

2.1.7 Surveying

Upon completion of the wells, a state of Texas certified surveying crew will locate by standard surveying methods each new monitoring well and sampling location. A vertical survey will be conducted to establish the elevation of each permanent monitoring well. Vertical control will be to the National Geodetic Vertical Datum. The horizontal grid coordination of each monitoring well to within 0.1 foot and the ground elevation to within 0.01 foot and the elevation for each well within 0.01 foot will be recorded. The survey will be tied to the state plane system.

2.1.8 Equipment Decontamination

The following decontamination procedures will apply to split spoons, hand augers, stainless-steel bowls and spoons, and ground-water bailers. The decontamination steps are as follows:

1) Hand wash with bristle brush and a solution of Alconox (or equivalent);
2) Rinse with copious quantities of potable water;
3) Rinse with deionized (Reagent Grade II) water;
4) Spray-rinse with pesticide grade methanol;
5) Spray-rinse with pesticide grade hexane;
6) Air dry.

The following procedure shall be used to decontaminate large pieces of equipment such as drill rigs, auger flights, and casing.

1) Wash the external surface of equipment or materials with high-pressure hot water and Alconox or equivalent, and scrub with brushes if necessary until all visible dirt, grime, grease, oil, loose paint, rust flakes, etc., have been rinsed from the equipment.

2) Rinse with potable water.

3) Air dry. The sampling equipment will be cleaned prior to each use in accordance with this procedure. All decontamination solutions will be stored on site until analyses have been completed.

The following procedure will apply to the decontamination procedure for the Strataprobe™ sampling equipment used for the Geochemical survey:

1) Remove all loose dirt;
2) Wash with Alconox;

3) Rinse with potable water;
4) Rinse with deionized (Reagent Grade II) water

2.1.9 Waste Handling

All drill cuttings, drilling fluid and other investigation derived wastes (IDW) will be containerized in clean, Department of Transportation (DOT), 17 H drums. All drums of IDW will be adequately labeled and moved to a staging area designated by the base. Each drum of IDW will be marked at the start of waste accumulation with the following information documented on the drum:

- Date upon which accumulation begins
- Site identification
- Boring identification number
- Drum contents (soil, wash, water, etc.)

Upon completion of the field program, a drum log (inventory) will be prepared that accounts for all drums and wastes generated drums site activities.

Law will analyze a maximum of one composite sample from the drums for each area to be analyzed for TCLP. The analytical information will be used to prepare a manifest for ultimate shipment of the drums to a disposal facility. Law will be responsible for off-site disposal of any drums.

Development water will be drummed and moved to a staging area on base following the procedure outlined in the drill cutting disposal section above. Drummed development water will not be analyzed, but the results of water analysis after monitoring well sampling will be used to prepare a manifest for ultimate shipment of the drums to a disposal facility. Law will be responsible for off-site disposal of any drums.

TABLE 2-1

FIELD TASKS
RCRA Facility Investigation
Carswell Air Force Base, Texas

SITE	FIELD TASKS	RATIONALE
POL TANK FARM	1. Perform geophysical survey	1. Determine the location of any pipechase or utilities.
	2. Perform ground-water screening. Perform geochemical survey using Strataprobe™, a direct push method utilizing a core penetrometer. Collect twenty five upper zone ground-water samples and screen for contamination.	2. Determine the extent of ground-water contamination from fuel and expand ground-water data base.
UNNAMED STREAM	1. Perform geophysical survey	1. Determine locations of USTs, piping and utilities.
	2. Install three new monitoring wells (MW-01 through MW-03). Screen soils with OVA/PID. Collect two soils samples per boring for lab analyses, one from the zone of the highest OVA/PID reading and one from the ground-water interface.	2. Assess the hydrocarbon impact to native soils.
	3. Sample ground water on the three new monitoring wells and sample six existing wells for a total of three rounds of ground-water sampling.	3. Determine the nature and extent of ground-water contamination and expand the ground-water data base.
	4. Surface water/sediment sampling.	4. Determine the extent of contamination related to the oil/water separator
	5. Aquifer Testing (In-Situ hydraulic conductivity)	5. Determine hydraulic characteristics of the upper zone aquifer.

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TABLE 2-2

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FIELD EQUIPMENT CHECKLIST
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

General

_____ 1. Investigation Work Plan
_____ 2. Sampling and Analysis Plan
_____ 3. Health and Safety Plan
_____ 4. Site base map
_____ 5. Hand calculator
_____ 6. Brunton compass
_____ 7. Personal clothing and equipment

Safety Equipment

_____ 1. Work gloves
_____ 2. Barrier rope
_____ 3. Plastic flagging tape
_____ 4. Drinking water container
_____ 5. Gatorade or equivalent
_____ 6. First aid kit
_____ 7. Eyewash kit
_____ 8. Spill control (Vermiculite)
_____ 9. Knife
_____ 10. Flashlight or lantern
_____ 11. Personal locator beacon (sound, radio or light)
_____ 12. Radio, two-way
_____ 13. Safety belt, harness, and lifeline

Personal Protective Equipment

_____ 1. Long cotton underwear
_____ 2. Coveralls, cotton
_____ 3. Coveralls, Tyvek
_____ 4. Surgical gloves
_____ 5. Protective gloves (polypropylene/nitrile/viton)
_____ 6. Protective boots (rubber, steel toe/shank)
_____ 7. Hard hat
_____ 8. Face shield
_____ 9. Safety glasses
_____ 10. Air-purifying respirator
_____ 11. Respirator spectacle kit

TABLE 2-2

FIELD EQUIPMENT CHECKLIST
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

Sampling Equipment

_____ 1. Tool box with assorted tools (pipe wrenches, screwdrivers, socket set and driver, open and box end wrenches, hacksaw, hammer, vise grips)
_____ 2. Geologic hammer
_____ 3. Trowel
_____ 4. Stainless steel and/or Teflon spatula
_____ 5. Hand auger
_____ 6. Dames & Moore Type U split-spoon sampler with liners (stainless steel, brass)
_____ 7. Engineer's tape
_____ 8. Steel tape
_____ 9. Electric water level sounder
_____ 10. Petroleum interface probe
_____ 11. Batteries
_____ 12. Bailers (Teflon, stainless steel, acrylic, PVC)
_____ 13. Slug test water displacement tube
_____ 14. Vacuum hand pump
_____ 15. Electric vacuum pump
_____ 16. Displacement hand pump
_____ 17. Mechanical pump (centrifugal, submersible, bladder)
_____ 18. Portable generator
_____ 19. Gasoline for generator
_____ 20. Hose
_____ 21. Calibrated buckets
_____ 22. Stop watch
_____ 23. Orifice plate or equivalent flow meter
_____ 24. Data logger and pressure transducers
_____ 25. Sample bottles
_____ 26. Sample preservatives (nitric, hydrochloric, sodium hydroxide)
_____ 27. Heavy-duty aluminum foil
_____ 28. Coolers
_____ 29. Ice (not reusable ice packs ["Blue Ice"])
_____ 30. Large "Ziploc" freezer bags
_____ 31. Miscellaneous garbage bags
_____ 32. Duct tape
_____ 33. Strapping tape
_____ 34. Paper towels
_____ 35. "Bubble" pack
_____ 36. Vermiculite
_____ 37. Clear tape
_____ 38. Containers for field tests (pH, SC, temp.)
_____ 39. Transfer pipets (glass) and bulbs
_____ 40. Polyethylene rope for bailers
_____ 41. Teflon tubing to cover bailer rope

TABLE 2-2

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FIELD EQUIPMENT CHECKLIST
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

Environmental Monitoring Equipment

_____ 1. Shovels
_____ 2. Keys to well caps
_____ 3. pH meter (with calibration solutions)
_____ 4. pH paper
_____ 5. Thermometer
_____ 6. Conductivity meter (with calibrating solution)
_____ 7. Organic vapor analyzer or photoionization detector with calibration gas
_____ 8. Explosimeter
_____ 9. Oxygen meter
_____ 10. Turbidimeter

Decontamination Equipment

_____ 1. Potable water
_____ 2. Alconox, Liquinox, or equivalent
_____ 3. Methanol, pesticide-grade
_____ 4. Hexane, pesticide-grade
_____ 5. Nitric acid
_____ 6. Distilled, deionized water, Type II reagent grade
_____ 7. Teflon squeeze bottles
_____ 8. Stainless steel garden sprayers
_____ 9. Buckets and containers for decontamination fluids
_____ 10. Scrub and bottle brushes
_____ 11. Waste containers (plastic trash cans/55-gallon hazardous waste containment drums)
_____ 12. Steam cleaner (generally provided by subcontractor)

Documentation Supplies

_____ 1. Field log book
_____ 2. Daily quality control report
_____ 3. Soil test boring record
_____ 4. Monitoring well installation log forms
_____ 5. Well development data forms
_____ 6. Aquifer test data forms
_____ 7. Sample chain-of-custody forms
_____ 8. Custody seals
_____ 9. Cooler labels ("This side up," "Hazardous Material," "Fragile")
_____ 10. Courier labels/airbills
_____ 11. Request for analysis forms
_____ 12. Sample bottle labels
_____ 13. Camera and film
_____ 14. Paper
_____ 15. Pens/pencils
_____ 16. Indelible ink pens

TABLE 2-3

SAMPLING AND ANALYSIS PLAN SUMMARY: SUB-SURFACE SOIL FROM BORINGS
RCRA Facility Investigation - Carswell Air Force Base, Texas

PARAMETER	TOTAL NO. FIELD LOCATIONS	SAMPLES PER LOCATION	FIELD QC SAMPLES				TOTAL NO. FIELD SAMPLES
			Field Duplicate	Equipment Blank	Amb Cond Blank	Trip Blank (a)	
Volatile Organics (SW 8240)							
Unnamed Stream: Downgradient (d)	2	2	1	1	1	1	8
Unnamed Stream: Upgradient (e)	1	4	1	1	1	1	8
TOTALS	3		2	2	2	2	16
Aromatic Volatiles (SW 8020)							
Unnamed Stream: Downgradient	2	2	1	1	1	1	8
Unnamed Stream: Upgradient	1	4	1	1	1	1	8
TOTALS	3		2	2	2	2	16
Total Recoverable Petroleum Hydrocarbons (E 418.1)							
Unnamed Stream: Downgradient	2	2	1	1	0	0	6
Unnamed Stream: Upgradient	1	4	1	1	0	0	6
TOTALS	3		2	2	0	0	12
ICP Screen for Metals (gas 3050/6010)							
Unnamed Stream: Downgradient	2	2	1	1	0	0	6
Unnamed Stream: Upgradient	1	4	1	1	0	0	6
TOTALS	3		2	2	0	0	12
Toxicity Characteristic Leaching Procedure (SW 1311) (f)							
Unnamed Stream	3	1	1	1	0	0	5
TOTALS	3		1	1	0	0	5

Note: Analytical methodologies are presented in Section 1.8.1 of the Sampling and Analysis Plan.
(a) Volatile Organics only; number to be initiated will depend upon number of shipments.
(b) Estimated; number to be determined by batch preparation.
(c) Methods SW 8240 and SW 8020 will have 2nd column confirmation performed on all samples exhibiting positive results.
(d) Soil samples from oil/water separator and Unnamed Stream monitoring well locations.
(e) Soil samples from single upgradient monitoring well installation.
(f) TCLP analyses will be performed on the containerized waste material generated from the drill cuttings.

123130

TABLE 2-4

SAMPLING SUMMARY: GROUND WATER – MONITORING WELLS
RCRA Facility Investigation – Carswell Air Force Base, Texas

PARAMETER		TOTAL NO. FIELD LOCATIONS	TOTAL NO. SAMPLING EPISODES	TOTAL NO. FIELD SAMPLES	FIELD QC SAMPLES				TOTAL NO. LAB SAMPLES
					Field Duplicate	Equipment Blank	Ambient Blank	Trip Blank (a)	
Volatile Organics (SW 8240)									
Unnamed Stream		9	3	27	3	3	3	3	39
	TOTALS	9	3	27	3	3	3	3	39
Total Recoverable Petroleum Hydrocarbons (E418.1)									
Unnamed Stream		9	3	27	3	3	0	0	33
	TOTALS	9	3	27	3	3	0	0	33
Oil and Grease (SW 9071)									
Unnamed Stream		9	3	27	3	3	0	0	33
	TOTALS	9	3	27	3	3	0	0	33
Screen for 24 Metals (SW 6010)									
Unnamed Stream: Total		9	3	27	3	3	0	0	33
Unnamed Stream: Dissolved		9	3	27	3	3	0	0	33
	TOTALS	18	6	54	6	6	0	0	66
Arsenic (SW 7060)									
Unnamed Stream: Total		9	3	27	3	3	0	0	33
Unnamed Stream: Dissolved		9	3	27	3	3	0	0	33
	TOTALS	18	6	54	6	6	0	0	66

123137

TABLE 2-4

SAMPLING SUMMARY: GROUND WATER – MONITORING WELLS
RCRA Facility Investigation – Carswell Air Force Base, Texas

PARAMETER		TOTAL NO. FIELD LOCATIONS	TOTAL NO. SAMPLING EPISODES	TOTAL NO. FIELD SAMPLES	FIELD QC SAMPLES				TOTAL NO. LAB SAMPLES
					Field Duplicate	Equipment Blank	Ambient Blank	Trip Blank (a)	
Mercury (SW 7470)									
Unnamed Stream: Total		9	3	27	3	3	0	0	33
Unnamed Stream: Dissolved		9	3	27	3	3	0	0	33
	TOTALS	18	6	54	6	6	0	0	66
Selenium (SW 7740)									
Unnamed Stream: Total		9	3	27	3	3	0	0	33
Unnamed Stream: Dissolved		9	3	27	3	3	0	0	33
	TOTALS	18	6	54	6	6	0	0	66
Lead (SW 7421)									
Unnamed Stream: Total		9	3	27	3	3	0	0	33
Unnamed Stream: Dissolved		9	3	27	3	3	0	0	33
	TOTALS	18	6	54	6	6	0	0	66
Toxicity Characteristic Leaching Procedure (SW 1311)									
Unnamed Stream (b)		5	1	5	1	1	0	0	7
	TOTALS	5	1	5	1	1	0	0	7

Note: Analytical methodologies are presented in Section 1.8.1 of the Sampling and Analysis Plan.
(a) Volatile organics only; number to be initiated will depend upon number of shipments.
(b) The purge water will be analyzed for the parameters of conern in the TCLP list.

123133

TABLE 2–5

SAMPLING AND ANALYSIS PLAN SUMMARY: GROUND WATER – FIELD SCREEN
RCRA Facility Investigation – Carswell Air Force Base, Texas

PARAMETER		TOTAL NO. FIELD LOCATIONS	FIELD QC SAMPLES				TOTAL NO. FIELD SAMPLES
			Field Duplicate	Equipment Blank	Ambient Blank	Trip Blank (a)	
Aromatic Volatiles (SW 8020)							
POL Tank Farm		22	1	1	1	1	26
Reserve (d)		3	1	1	0	0	5
	TOTALS	25	2	2	1	1	31
Petroleum Hydrocarbons (SW 8015M)							
POL Tank Farm		22	2	2	0	0	26
Reserve (d)		3	1	1	0	0	5
	TOTALS	25	3	3	0	0	31
Lead (SW 6010)							
POL Tank Farm		22	1	1	0	0	24
Reserve (d)		3	0	0	0	0	3
	TOTALS	25	1	1	0	0	27

Note: Analytical methodologies are presented in Section 1.8.1 of the Sampling and Analysis Plan.
(a) Volatile Organics only; number to be initiated will depend upon number of shipments.
(b) Estimated; number to be determined by preparation batch.
(c) Methods SW 8020 and SW 8015M will have ten percent of all samples sent to an off–site laboratory for confirmatory analyses.
(d) Three ground–water sampling locations will be reserved for discretionary use during the implementation of the field work.

123139

TABLE 2–6

SAMPLING SUMMARY: SURFACE WATER
RCRA Facility Investigation – Carswell Air Force Base, Texas

PARAMETER	TOTAL NO. FIELD LOCATIONS	TOTAL NO. FIELD SAMPLES	FIELD QC SAMPLES				TOTAL NO. LAB SAMPLES
			Field Duplicate	Equipment Blank	Ambient Blank	Trip Blank (a)	
Volatile Organics (SW 8240)							
Unnamed Stream	3	3	1	1	1	1	7
TOTALS	3	3	1	1	1	1	7
Total Recoverable Petroleum Hydrocarbons (E418.1)							
Unnamed Stream	3	3	1	1	0	0	5
TOTALS	3	3	1	1	0	0	5
Oil and Grease (SW 9071)							
Unnamed Stream	3	3	1	1	0	0	5
TOTALS	3	3	1	1	0	0	5

Note: Analytical methodologies are presented in Section 1.8.1 of the Sampling and Analysis Plan.
(a) Volatile organics only; number to be initiated will depend upon number of shipments.

173160

TABLE 2-7

SAMPLING SUMMARY: SEDIMENT
RCRA Facility Investigation – Carswell Air Force Base, Texas

PARAMETER	TOTAL NO. FIELD LOCATIONS	TOTAL NO. FIELD SAMPLES	FIELD QC SAMPLES				TOTAL NO. LAB SAMPLES
			Field Duplicate	Equipment Blank	Ambient Blank	Trip Blank (a)	
ICP Screen for Metals (SW 3050/6010)							
Unnamed Stream	3	3	1	1	0	0	5
TOTALS	3	3	1	1	0	0	5

Note: Analytical methodologies are presented in Section 1.8.1 of the Sampling and Analysis Plan.
(a) Volatile organics only; number to be initiated will depend upon number of shipments.

173141

will brief the sampling team on safety, decontamination stations and any other sampling protocols necessary. Each sampling team member will wear the appropriate level of safety gear as specified for each site in the Health and Safety Plan.

2.2.1.1 Ground-Water Sampling - Ground-water samples will be collected from newly-installed wells. Ground-water samples will be obtained using cleaned and dedicated Teflon® bailers. Bailers will be decontaminated as outlined in Section 2.1.8. After the bailer has air-dried it will be wrapped in aluminum foil to prevent contamination. Polyethylene rope will be used to lower the bailer into the well. A Teflon® leader will precede the rope attached to the bailer to prevent the rope from entering the well during sampling.

Ground-water sampling will be conducted in a manner which minimizes interaction of the sample and the surface environment. The sampling protocol will be as follows:

a. Floating Hydrocarbon Measurement - An electronic interface probe will be used to test for the presence of floating product in the newly-installed and existing wells. The probe will be lowered into the wellbore and if product is present, its thickness will be recorded. Its presence will be confirmed by withdrawing a sample. The probe will be decontaminated after each use by the protocol described in Section 2.1.8.

b. Measure Water Level - An electronic water level indicator will be used to measure the static water level in the well prior to purging. The water level probe will be lowered into the wellbore and the water level will be recorded. The volume of water in the wellbore and filter pack will be calculated using the equation in subpart c.

Decontamination of the probe will be performed as per Section 2.1.8 to minimize the potential for cross-contamination between wells as the probe is being withdrawn from the well.

c. Purge the well until the pH, specific conductance, and temperature have stabilized within ±0.1 pH units, ±5 percent, and ±1 degree celsius, respectively. Remove a minimum of three fluid casing volumes, checking the above mentioned parameters after each casing volume is removed. If, after three fluid casing volumes have been removed, the parameters have not been stabilized, remove well casing volumes until the parameters stabilize or until six volumes have been purged. If the well is purged to dryness and does not recharge within a reasonable time to permit three volumes to be removed, record the volume removed and sample as soon as sufficient recharge has occurred. The calculation for well volume is presented below:

<u>CALCULATING WATER VOLUME</u>

VOLUME OF WATER IN WELL

$$H_1 \pi 7.48 [(R_1^2 - R_2^2) .\varnothing + R^2_2]$$

Volume of hole with filter pack — Volume of PVC with filter pack

H_1	=	height of water in well screen and filter pack in feet
π	=	3.14159
R_1	=	radius of borehole in feet
R_2	=	radius of PVC in feet
7.48	=	amount of water in 1 cubic ft.
$\varnothing$	=	porosity of filter pack

d. Label Sample - Label the sample container as outlined in Section 2.2.2.

e. Collect Sample - Ground-water sampling will be conducted by using dedicated bailers. The collection procedure is described below.

After purging the well and sufficient recharge has been allowed, samples for volatile organics should be collected using the first bailer volume. Lower the bailer slowly until it contacts the water surface, and allow the bailer to sink to the desired depth and fill, with a minimum of surface disturbance. Slowly withdraw the bailer, taking care to prevent contact of the bailer line with the ground. Slowly discharge the contents into the appropriate sample containers. Repeat the process as necessary to fill each container to the required volume (see Section 2.2.2.1). Vials for volatile analysis will be completely filled, leaving no air space above the liquid portion (to minimize volatilization). Check that the Teflon on the Teflon®-lined silicone septum is toward the sample in the caps and secure the cap tightly. If semi-volatile compounds are to be sampled for, collect these samples next. Proceed to the collection of samples for the remaining analyses. Care will be taken for all pre-preserved bottles. If acids are present, the bottle will be opened downwind of and away from the body. All samples for dissolved metals should be collected last and filtered through a 0.45 μm filter within 15 minutes after collection. A Millipore filtration system will be utilized for this procedure. The procedure for Millipore filtering is as follows:

1) Assemble the Millipore filtration unit. Assembly procedures can be found in Appendix G.

2) Using a funnel, pour test material to be filtered into the unit through the Tri-Clamp opening. Attach the TC hose adaptor (fitted with 1½" gasket) to the TC connection of top plate, using the stainless steel TC clamp provided.

3) Place appropriate receiving vessel below TC sanitary outlet or attach PVC hose to TC adaptor and run hose to appropriate container.

4) Slowly increase pressure on nitrogen tank. When liquid flow begins from outlet of assembled holder, immediately turn regulatory valve handle a few turns to lower pressure. Bleed air from top-plate vent valve slowly until pressure gauge reads between 10-15 psi. Close vent valve and (if necessary) readjust regulatory valve to set pressure between 10-15 psi. Continue filtration until flow ceases.

5) Increase inlet pressure stepwise in 10 psi increments to 75 psi and continue filtration until flow ceases. No leaks should be apparent.

6) Shut off pressure from nitrogen tank regulator outlet valve, then open vent valve gradually to release pressure from cylinder.

7) Remove inlet TC hose connector and handwheel bolts, then remove top plate and extension cylinder of holder.

8) Acidify the sample with nitric acid to a pH of ≤2. Test with pH paper.

9) Decontaminate the filtration apparatus as outlined in Section 2.3.4.

f. Measure pH, Temperature and Specific Conductance -Follow procedure as outlined in Section 2.3.

g. Custody, Handling and Shipping - Complete the procedures as outlined in Sections 2.2.2 and 2.2.3.

h. Measure Water Level - After samples have been collected, the well cap should be replaced. Static water level will be measured again after sufficient recharge has been allowed (24 hours). This additional measurement of the water level will follow the procedure outlined in Section 2.2.1.1.b.

2.2.1.2 Soil Sampling - Soil samples will be collected from soil borings of the newly-installed monitoring wells. The following section discusses soil sampling and collection procedures. Included are discussions of soil sampling protocol and equipment.

Subsurface soil samples from borings will be collected using a 3-inch, carbon-steel, split-barrel sampler with California brass ring inserts. Care has been taken to determine the best practical sampling procedure that will result in obtaining representative samples. The samples must maintain the integrity of the original medium through collection, transportation, and delivery to the analyst. The soil samples will be collected and containerized as described in the following paragraphs.

Subsurface soil samples from soil borings - The auger will encase an 24-inch long, carbon-steel split barrel sampler which will, in turn, encase four 6-inch California brass rings. Each boring will be advanced using hollow-stem augers. The sampling device will be

placed on a sheet of aluminum foil upon retrieval from the auger. Each end of the sampling device will be opened by unscrewing the end caps. Samples from certain borings are to be collected at depths which exhibit the highest organic vapor readings. A portable organic vapor analyzer (OVA) will be used to screen the individual boring samples. The sampling device will be opened and the end of each brass ring screened. After the boring samples have been screened for organic vapor, the brass rings will be sealed with a Teflon® patch and plastic cap, thus encasing the sample in the brass ring. The middle 6-inch brass ring sample will be sent to the laboratory for volatile organic compound analysis. In the event that soil recoveries are low, the selection of brass rings used for volatile analysis will be made on the basis of which rings contain 100% recovery to send to the laboratory. If none of the rings have 100% recovery, then the ring with the most soil will be capped and labeled, indicating it is less than 100%. Soil from the remaining two brass rings will be removed and placed into a stainless-steel mixing bowl. The sample will be thoroughly mixed with a stainless-steel spoon and placed into the appropriate pre-cleaned jars (see Section 2.2.2.1). All sampling equipment will be decontaminated as presented in Section 2.1.8.

2.2.1.3 Surface Water Sampling - Surface water samples will be collected with stainless-steel beakers in "low-flow" areas to avoid the loss of volatile organics. Each beaker will be cleaned using the method described in Section 2.1.8 before sample collection. Collect samples from the downstream to the upstream locations. Slowly submerge the beaker into the water. When the beaker is full, slowly pour the contents down the side and into the sample bottles. Completely fill volatile vials first, leaving no headspace. Fill sample containers for the remaining analyses. Surface water samples should be collected from downstream to upstream and should be collected before sediment samples collected at the same location.

2.2.1.4 Sediment Sampling - Sediment samples will be collected with stainless-steel hand augers. The sample will be obtained by driving the hand auger through the water and into the sediments. Rotate the auger as necessary to reach a sample depth of 6 inches, avoiding excess disturbance of surface sediment particles. Retrieve the auger by lifting upward and empty the contents of the auger bucket into a stainless-steel mixing bowl. Completely fill sample containers to be submitted for analysis with volatile parameters first, leaving no headspace. Once the volatile organic samples have been collected, mix the remaining sediment thoroughly and fill sample containers for the remaining analyses. Sediment samples should be collected from downstream to upstream and should be collected after surface water samples have been collected at the same location.

2.2.2 Sample Handling

The following sections describe the proper way to containerize, label, identify, ship, and preserve samples.

2.2.2.1 Sample Containers, Amounts and Preservation - Samples will be placed in appropriate containers as required by AFCEE (AFCEE, 1991). The amounts to be collected and preservation procedures to be followed specified by AFCEE (AFCEE, 1991) will be followed. These requirements are specified in Tables 2-8 (soil, sediment) and 2-9 (ground water, surface water).

2.2.2.2 Sample Labels - Field sampling personnel must properly identify all samples taken in the field with an adhesive sample label attached to the sample container. The sample label must contain the site name, field identification number; the date, time, and location of sample collection; designation of the sample as a grab or composite; notation of the type of sample (e.g., ground-

TABLE 2-8

SAMPLE CONTAINERS, AMOUNTS, AND PRESERVATION
SOIL AND SEDIMENT SAMPLES
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

PARAMETER (a)	SAMPLE CONTAINER (b)	AMOUNT	PRESERVATION
Volatile Organics (SW 8240) (includes samples for Aromatic Volatiles analysis (SW 8020))	Two 2 oz. G septa jars	Full; no headspace	Cool to 4°C
Total Recoverable Petroleum Hydrocarbons (418.1)	One 8 oz. G jar (c)	Full	Cool to 4°C
Metals, total (SW 6010)	One 8 oz. G jar	Full	Cool to 4°C
Toxicity Characteristic (SW 1311) Leaching Procedure	One 8 oz. G jar (c)	Full	Cool to 4°C

NOTES:

(a) Hold times are presented in Section 1.8

(b) All containers to have Teflon®-lined lids except for vials for volatile organics which will have Teflon®-lined septa. Container codes: G = glass AG = amber glass P = polyethylene

(c) Samples chosen for MS/MSD and/or Laboratory Duplicate require double the number of containers indicated.

TABLE 2-9

SAMPLE CONTAINERS, AMOUNTS, AND PRESERVATION-
GROUND WATER AND SURFACE WATER SAMPLES
Remedial Investigation/Feasibility Study
Carswell Air Force Base, Texas

PARAMETER (a)	SAMPLE CONTAINER (b)	AMOUNT	PRESERVATION
Volatile Organics (SW 8240) (includes samples for Aromatic Volatiles analysis (SW 8020))	Three 40 mL G vials	Full; no headspace	HCl to pH < 2; Cool to 4°C
Petroleum Hydrocarbons (SW 8015M)	Three 40 mL G vials	Full; no headspace	H_2SO_4 to pH <2; Cool to 4°C
Total Recoverable Petroleum Hydrocarbons (418.1)	Two 1 L AG bottles(c)	7/8 full	H_2SO_4 to pH <2; Cool to 4°C
Metals, total & dissolved (SW 6010)	One 1 L P bottle	7/8 full	HNO_3 to pH<2; Cool to 4°C
Arsenic (SW 7060)	One 1 L P bottle (c)	7/8 full	HNO_3 to pH<2; Cool to 4°C
Mercury (SW 7471)	One 1 L P bottle	7/8 full	HNO_3 to pH<2; Cool to 4°C
Selenium (SW 7740)	One 1 L P bottle	7/8 full	HNO_3 to pH<2; Cool to 4°C
Lead (SW 7421)	One 1 L P bottle	7/8 full	HNO_3 to pH<2; Cool to 4°C
Oil and Grease (SW 9071)	One 1 L G bottle (c)	7/8 full	H_2SO_4 to pH<2; Cool to 4°C
Toxicity Characteristic (SW 1311) Leaching Procedure	One 1 L G bottle (c)	7/8 full	Cool to 4°C

NOTES:

(a) Hold times are presented in Section 1.8
(b) All containers to have Teflon®-lined lids except for vials for volatile organics which will have Teflon®-lined septa. Container codes: G = glass AG = amber glass P = polyethylene
(c) Samples chosen for MS/MSD and/or Laboratory Duplicate require double the number of containers indicated.

water, soil boring, etc.); identification of preservatives used; any remarks; and the initials of the sampler. The sample labels will be placed on the bottles so as not to obscure any QA/QC data, and sample information will be legibly printed with waterproof ink. Field identification must be sufficient to allow easy cross-reference with the site logbook. Clear tape will be placed over the label to prevent removal or damage.

2.2.2.3 Sample Identification - The following section describes how each sample will be identified and what this identification signifies. Note that all sample IDs shall be no more than 10 characters long to facilitate input into the IRPIMS database.

For field samples, the following sample ID scheme shall be followed:

N	N	N	C	C	#	#	-	?	?
1	2	3	4	5	6	7	8	9	10

The "NNN" portion of the sample ID shall consist of the unique IRPIMS site code for the site. The "CC" portion of the sample ID shall consist of a two character location code, as follows:

MW - Monitoring well
SW - Surface water
SB - Soil boring in which no monitoring well was installed
SD - Sediment
SS - Surface soil
DC - Drill cuttings

The "##" portion of the sample ID shall consist of a number that is unique for each site and matrix, starting with "01". Characters 9 and 10 are optional for water samples and shall signify the upper depth of sample collection for soil and sediment samples. If

characters 9 and/or 10 of the sample ID are used, character 8 shall be a dash. If characters 9 and 10 are not used, character 8 shall also not be used. Note that field duplicate samples will be given a false sample ID and date and time of sampling to hide their true identity from the laboratory.

For field QC samples, the following sample ID scheme shall be followed:

C	C	#	-	D	D	M	M	Y	Y
1	2	3	4	5	6	7	8	9	10

The "CC" portion of the sample ID shall consist of the appropriate two letter IRPIMS code for the type of QC sample, as follows:

AB - Ambient conditions blank
EB - Equipment blank
TB - Trip blank

Character 3 shall be a unique number for that QC sample type and for the day of collection, starting with "1". Character 4 shall be a dash. Characters 5 through 10 shall indicate the date of collection, where "DD" is the day, "MM" is the month (01=January, etc.), and "YY" is the last two digits of the year.

2.2.2.4 Handling and Shipping - The properly labeled and sealed sample containers will be placed in plastic "Ziploc" type bags and sealed. Bagged sample containers will be placed in the bottom of the cooler. Bagged sample containers will be arranged in the cooler so that they do not touch, and will be packed in double-bagged ice and additional packing material to prevent breakage. Samples should be packed so as to maintain a temperature of 4°C during shipment.

Analytical Request forms, as shown on Figure 2-8, and chain-of-custody documents (see Section 2.2.3) will be sealed in air-tight plastic bags and taped to the inside of the cooler lid. The lid of the container will be taped shut and sealed with custody seals (see Section 2.2.3). Samples will be shipped directly to the laboratory by overnight courier on the day they are collected, if at all possible. The laboratory will be notified by phone of the sample shipment schedule. No samples will be held more than 24 hours on site, unless special arrangements are made with the laboratory.

2.2.3 Sample Custody

Documentation of sample custody from the time of collection will be maintained. Custody within the laboratory is described in Appendix B. Custody in the field is described in the following paragraphs. Chain-of-Custody records will be prepared for each shipping container. The custody record will be fully completed, in triplicate, by the field technician designated as responsible for sample shipment to the laboratory. The information specified on the chain-of-custody record will contain the same level of detail found in the site logbook, with the exception that on-site measurement data will not be recorded. The custody record will include the following information: name of person(s) collecting the samples, date samples were collected, the sample identification code (ID), type of sampling conducted (composite/grab), and number and type of containers used. Figure 2-9 presents an example of a Chain-of-Custody record.

Transfer of sample custody shall be indicated by the signatures of the sampler(s) and the person receiving the samples on the chain-of-custody record, with date and time noted. Prior to sealing the shipping container, the original and first copy of the chain-of-custody record shall be placed in a plastic bag that will be attached to the inside of the shipping container lid. The second

FIGURE 2-8

REQUEST FOR ANALYTICAL FORM

Project: _____

Project #: _____

Manager: _____

Chemist: _____

SAMPLE ID: _____

ANALYSIS REQUEST

Container	No.	Preservation	Parameter	Method

COMMENT: _____

PLEASE RETURN A COPY OF THIS FORM WITH THE DATA PACKAGE

HF

FIGURE 2-9

CHAIN OF CUSTODY RECORD

4636

SAMPLING INFORMATION	
NAME OF FACILITY:	
STREET ADDRESS:	
CITY/STATE:	ZIP:

PROJECT NAME	JOB NO.
SAMPLERS (SIGNATURE)	
SAMPLING DATE	

TIME	GRAB	COMP.	SOURCE CODE*	SAMPLE STATION DESCRIPTION	TOTAL NO. OF CONTAINERS	CONTAINER TYPE: 40 ml/G ($Na_2S_2O_3$) • $5H_2O$	1 L G, P (HNO_3)	1 L G, P (NaOH)	1 L G, P (H_2SO_4)	1 L G, P	1 L P, (NaOH + Ascorbic Acid)	1 L, Teflon	1 L G, P (Zn Acetate + NaOH)	8oz. G, P	1 L G - Amber	1 L P - Opaque	250 ml/G - Amber

RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	RELINQUISHED BY:	DATE / TIME	RECEIVED BY:
(SIGNATURE)		(SIGNATURE)	(SIGNATURE)		(SIGNATURE)
RELINQUISHED BY:	DATE / TIME	RECEIVED BY:	RELINQUISHED BY:	DATE / TIME	RECEIVED AT LABORATORY:
(SIGNATURE)		(SIGNATURE)	(SIGNATURE)		(SIGNATURE)

DISTRIBUTION: ORIGINAL AND PINK COPIES ACCOMPANY SAMPLE SHIPMENT TO LABORATORY. PINK COPY RETAINED BY LABORATORY. YELLOW COPY RETAINED BY SAMPLERS.

REMARKS: _____

* SOURCE CODES:
- RECOVERY WELL - RW
- RCRA MONITORING WELL - MW
- SOIL/SEDIMENT - SO
- SLUDGE - SL
- NPDES DISCHARGE - ND
- DRINKING WATER - DW

HF

copy remains with the sampler(s). If a courier service is to be used, the signature of the receiving person will be replaced by the shipper's airbill number. Receipt at the laboratory shall be indicated by signature of the laboratory's Sample Custodian, with the date and time recorded.

To allow a means of determining whether sample integrity was maintained, custody seals will be placed on the shipping containers. Custody seals will be pre-printed, adhesive-backed seals with security slots designed to break if disturbed. Sample shipping containers (coolers, cardboard boxes, etc., as appropriate) will be sealed in as many places as necessary to ensure security. Seals will be signed and dated before use. Upon receipt by the laboratory, the Sample Custodian will check and document whether the custody seals are intact and will also record the cooler temperature by measuring the temperature of the temperature vial. Any other sample integrity information will be recorded on the Chain of Custody and Cooler Receipt Forms.

2.2.4 QC Samples

Quality control (QC) samples are collected and analyzed for the purpose of assessing the quality of the sampling effort and the analytical data. QC samples include duplicates and replicates of field samples, equipment blanks, trip blanks, and ambient condition blanks. The type, description, preparation and collection of field QC samples are discussed in the following section.

- QC Samples - Samples initiated and analyzed to identify and diagnose problems related to sampling analysis.

- Replicate - A single sample divided into two equal parts for analysis in order to provide precision data. Replicates are applicable to soil and sediment samples.

- Duplicate - Two samples collected independently at a sampling location during a single act of sampling in order to provide precision data. Duplicates are applicable to water samples.

- Equipment Blank - Samples consisting of reagent water collected from a final rinse of sampling equipment after the decontamination procedure has been performed. The purpose of rinsate blanks is to determine whether the sampling equipment is causing cross contamination of samples.

- Trip Blank - Containers of Type II reagent grade water that are kept with the field sample containers from the time they leave the laboratory until the time they are returned to the laboratory. The purpose of the trip blank is to determine whether samples are being contaminated during transit to and from the laboratory. Trip blanks pertain only to volatile organic analyses; therefore, the containers must contain no headspace. Only one trip blank is required per sampling day and shall satisfy trip blank requirements for all water matrices for that day if the volatile samples are shipped in the same cooler. However, if more than one cooler contains volatile samples, then a trip blank will be placed in each cooler containing volatile samples.

- Ambient Conditions Blank - Samples consisting of Type II reagent grade water that are prepared at the site. Ambient condition blanks are used to measure the influence of ambient volatile conditions at a particular set of sampling locations. Ambient condition blanks will not necessarily be collected every time volatile samples are collected. They will be collected when samples are collected downwind of possible volatile sources such as active runways or an adjacent highway.

2.2.5 Sample Analysis Summary

Tables summarizing the environmental samples and the proposed QC samples to be analyzed by parameter by site are as follows:

Matrix	Table No.
Subsurface Soil from borings	2-3
Ground Water - Monitoring Wells	2-4
Ground Water - Geochemical Survey	2-5
Surface Water	2-6
Sediments	2-7

2.3 FIELD MEASUREMENTS

2.3.1 Parameters for Field Characterization of Samples

Certain measurements must be performed as soon as possible after sampling in order to get accurate results. These parameters include pH, temperature and specific conductivity. These parameters will be measured in the field when the samples are obtained during sampling. Other field parameters include safety measurements of air vapors and turbidity during well development.

2.3.2 Equipment Calibration

All equipment will be calibrated according to manufacturers instructions or a generally accepted practice. Calibration of all instruments will be recorded in the field book. The following subsections describe calibration procedures. Additional detail is provided in Appendix A.

- Measurement of pH will be done on site with a pH meter. The instrument will be field-calibrated with two buffer solutions

at the beginning of each day's use. Accuracy of the measurement is maintained by selecting a standard buffer with a pH as close as possible to that of the sample (preferably within three pH units). The pH of the buffers used will be dependent upon the pH of the sample, but in each case will "bracket" the range of measurement. The stability of the calibration will be verified through the analysis of one standard periodically throughout the day as deemed necessary by the site manager, but at least once every five hours. Refer to Appendix A for calibration procedures.

- Temperature and specific conductivity will be measured with a portable meter. Calibration of the instrument is periodically performed at the factory as part of Law's internal QA program. The instrument probe will be rinsed with reagent water between each use and the calibration of the specific conductivity probe checked at the beginning and end of each day's use, using reagent grade water and two potassium chloride (KCl) solutions with known conductances that bracket the expected sample conductivities.

- The hand held portable organic vapor analyzer (OVA) with a photoionization detector (PID) used to screen the air vapors at the head of the augers and in the breathing zone will be calibrated daily with a 100 ppm level of isobutylene.

- Turbidity will be measured with a nephelometer (also known as a turbidimeter). The instrument will be calibrated with three standards of concentrations at 0.1, 0.2, and 0.5 NTUs at the beginning of each day's use. The stability of the calibration will be verified through the analysis of one standard periodically throughout the day as deemed necessary by the site manager, but at least once every five hours. A complete calibration procedure is described for the nephelometer in Appendix D.

2.3.3 Equipment Maintenance

Equipment used in the field is located in a central store room. The equipment must be "signed in" upon return and "signed out" when removed for use in the field. All equipment must be returned decontaminated and any malfunctions reported to the project manager. The project manager will incorporate any actions necessary for the repair or replacement of the equipment. Equipment maintenance logs are kept on file. Battery powered instruments will have their power supplies checked daily. Rechargeable instruments will be recharged daily.

2.3.4 Decontamination of Field Instruments

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

2.4 FIELD QA/QC PROGRAM

2.4.1 Control Parameters

Control parameters of the field procedures consist of the same controls that govern analytical data. Control parameters consist of the following:

- Collection of field and QC samples
- Calibration of field equipment
- Decontamination of field equipment
- Development of wells

- Purging a minimum of 3 well volumes before sampling
- Record keeping

2.4.2 Control Limits and Corrective Actions

Appendix A presents a summary of field quality control procedures and acceptance criteria for field measurements. Corrective action requirements are presented in this summary.

2.5 RECORD KEEPING

Pertinent information concerning all aspects of sampling and field measurements will be recorded in hard-bound field notebooks, and all chain-of-custody documents completed in order to completely reconstruct the activities. The bound field notebook will have prenumbered pages, and entries will be made in indelible ink. Environmental conditions will also be characterized. Each sampling site will be characterized by the following criteria.

1. Location of work
2. Weather
3. Rainfall
4. Temperature - minimum and maximum
5. Wind direction
6. Ongoing activities that may influence or disrupt sampling efforts
7. Accessibility to the sampling locations, e.g., rough terrain, fallen trees, flooding, etc.

Each day the site manager will prepare a Daily Quality Control Report (DQCR) and send it to the AFCEE TC. The DQCR will include weather information at the time of sampling, samples collected, field instruments and calibrations and will reflect any problems that occurred in the field. A DQCR is shown in Figure 2-10.

FIGURE 2-10

DAILY QUALITY CONTROL REPORT

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REPORT No. _____ CONTRACT No. _____ DATE _____

LOCATION OF WORK _____

DESCRIPTION OF WORK _____

WEATHER _____ RAINFALL (INCHES) _____ TEMPERATURE _____ MIN _____MAX

WIND DIRECTION _____

1. WORK PERFORMED _____

2. SAMPLES COLLECTED _____

3. PERSONNEL AND VISITORS AT SITE _____

SITE MANAGER: _____

HF

2.6 SITE MANAGEMENT

The AFCEE Team Chief (TC) for the Carswell AFB RFI is Mr. Chris Hobbins. Mr. Hobbins' address and phone number are:

AFCEE/ESB
Bldg. 624W
Brooks AFB, TX 78235-5000
(210) 536-5261

The Carswell AFB Point of Contact (POC) is Mr. Frank Grey. Mr. Grey's address and phone number are:

Air Forc Base Disposal Agency
Chief Environmental Engineer
AF BOA/SWH
Building 1215
Carswell AFB, TX 76127-5000
(817) 782-6311

Carswell AFB personnel (Civil Engineering) will assist in base cooperation for the following:

- Personnel identification and vehicle passes
- Utility clearances and permits
- Temporary field office
- A water supply for large quantities of potable water to be used in equipment cleaning, etc.
- Rights of easement and access to all Air Force and private property to perform all required field investigations

All field personnel will adhere to the procedures as described in the work plans. The site manager will supervise all field activities and constantly update Mr. Hobbins and Law's Project Manager, John O'Brien, of the daily activities. Any major problems that occur during field activities will be brought to the attention of the TC for his input into the resolution of the problem. Emergency contacts for medical assistance are discussed in the Health and Safety Plan.

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APPENDIX A

QUALITY CONTROL REQUIREMENTS

AND

REPORTING LIMITS

APPENDIX A-1

QUALITY CONTROL REQUIREMENTS

FOR

CHEMICAL ANALYSIS

Method	Parameter
120.1	Specific conductance (field analysis)
150.1	pH (field analysis)
170.1	Temperature (field analysis)
+	Metals by GFAA/CVAA
6010	Metals by ICP
8240	Volatile Organic compounds by GC/MS
8020	Volatile Organic Compounds by GC
8270	Extractable Organics by GC/MS
8010	Purgeable Halocarbons
8015	Petroleum Hydrocarbons
9070	Oil and grease
418.1	Total Recoverable Petroleum Hydrocarbons
1311	Toxicity Characteristic Leaching Procedure

\+ Methods 7060, 7421, 7740, 7470/7471

TABLE A-1

SUMMARY OF QUALITY CONTROL REQUIREMENTS AND ACCEPTANCE CRITERIA
RCRA Facility Investigation
Carswell Air Force Base, Texas

PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Specific Conductance 120.1 (field analysis) (EPA-600/4-79-020)	INSTRUMENT QC:			
	Calibration	Prior to trip	± 25 umhos/cm	1. Check system as per manufacturer's instructions. 2. Check standard. 3. Replace instrument.
	Calibration Stability	At beginning and end of day	± 25 umhos/cm	1. Check standard. 2. Check system as per manufacturer's instructions. 3. Replace instrument.
	SAMPLE QC:			
	Duplicate	1 per day	± 50 units	1. Analyze 3rd aliquot of sample. 2. Flag Data.
	Rinsate	1 per day	≤ detection limit	Flag Data.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
"MHETL" = Maine Health and Environmental Testing Laboratory

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Carswell Air Force Base, Texas

PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
pH 150.1 (field analysis) (EPA-600/4-79-020)	INSTRUMENT QC:			
	Calibration	1 per day at two levels	± 0.1 units	1. Check system as per manufacturer's instructions. 2. Check standard. 3. Replace instrument.
	Calibration Stability	1 per hour at two levels	± 0.2 units	1. Check standard. 2. Check system. 3. Recalibrate.
	SAMPLE QC:			
	Duplicate	1 per day	± 0.5 units	1. Analyze 3rd aliquot of sample. 2. Flag data.
	Rinsate	1 per day	≤ detection limit	Flag data.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
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PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Temperature 170.1 (field analysis) (EPA-600/4-79-020)	INSTRUMENT QC:			
	Calibration	Prior to trip	± 2 °C	1. Check against precision thermometer certified by NIST. 2. Replace instrument.
	SAMPLE QC:			
	Duplicate	1 per day	± 2 °C	1. Analyze 3rd aliquot of sample. 2. Flag data.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
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Carswell Air Force Base, Texas

PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Metals by GFAA and CVAA **Arsenic (GFAA: 7060)** **Lead (GFAA: 7421)** **Selenium (GFAA: 7740)** **Mercury (CVAA: 7470/7471)** (SW-86)	FIELD QC:			
	Duplicate	1 for every 10 field samples collected	Above 10x detection limit, % RPD must be less than current control limits: Aqueous samples - RPD < 20% Non-aqueous samples - RPD < 35%	Review lab QC data to determine if they are in control. If not in control, flag data. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate (c)	1 for every 10 field samples collected	Less than reported detection limits	Qualify data.
	LABORATORY QC:			
	ICV/CCV	ICV - prior to analysis CCV - after every 10 samples and end of analytical batch	5 pt. calibration; Measured value within 10% of true value (20% for Hg)	Terminate analysis, solve problem, recalibrate and reanalyze samples analyzed since last good CCV.
	ICB/CCB	ICB - after initial calibration verification CCB - after every 10 samples and end of analytical batch	Absolute value < MDL	Terminate analysis, solve problem, recalibrate and reanalyze samples analyzed since last good CCB.
	Prep Blank	1 per batch of samples, minimum of 1 per 20 samples	Absolute value < MDL	Redigest and reanalyze all samples less than 10X the MDL.
	MS/MSD	1 per batch of samples, minimum of 1 per 20 samples	See Appendix B	Perform post digest spike and qualify all associated data.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
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Carswell Air Force Base, Texas

PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Metals by ICP 6010 (SW-846)	FIELD QC:			
	Duplicate	1 for every 10 field samples collected	No more than 4 target compounds, each with a concentration exceeding 3 times the method detection limit can be present.	Review lab QC data to determine if they are in control. If not in control, flag data. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate (c)	1 for every 10 field samples collected	Above 10x detection limit, % RPD must be less than current control limits: Aqueous samples - RPD < 30% Non-aqueous samples - RPD < 40%	Qualify data.
	LABORATORY QC:			
	Initial (ICV) and Continuing (CCV) Calibration Verification	ICV - prior to sample analysis CCV - after every 10 samples and end of analytical batch	4 pt. calibration; Measured value within 10% of true value	Terminate analysis, solve problem, recalibrate and reanalyze samples analyzed since last good CCV.
	Initial (ICB) and Continuing (CCB) Calibration Blank	ICB - after initial calibration verification CCB - after every 10 samples and end of analytical batch	Absolute value ≤ Method Detection Limit (MDL)	Terminate analysis, solve problem, recalibrate and reanalyze samples analyzed since last good CCB.
	Prep Blank	1 per batch of samples, minimum 1 per 20 samples	Absolute value ≤ Method Detection Limit (MDL)	Redigest and reanalyze all samples greater than the MDL but less than 10x the blank concentration.
	MS/MSD	1 per batch of samples, minimum 1 per 20 samples	See Appendix B	Perform a post-digestion spike and qualify data appropriately.
	Laboratory Control Sample (LCS)	1 per batch of samples, minimum 1 per 20 samples	80 - 120% recovery: waters 75 - 125% recovery: sol/sed.	Rerun. If still out of control, solve problem and reanalyze batch.
	Interference Check	Beginning and end of run or per 8 hour shift	80-120% recovery	Terminate analysis, solve problem, recalibrate and reanalyze samples analyzed since last good ICS.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
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RCRA Facility Investigation
Carswell Air Force Base, Texas

PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Volatile Organic Compounds by GC/MS 8240 (SW-846)	FIELD QC: Trip Blank	1 for each batch of samples shipped to laboratory	No more than 4 target compounds, each with a concentration exceeding 3 times the method detection limit can be present.	Review lab QC data to determine if there is a laboratory problem. If not, and same compounds are found in field samples at similar concentrations, resample entire batch.
	Ambient Blank	Collected when samples are collected downwind of possible volatile sources.	No more than 4 target compounds, each with a concentration exceeding 3 times the method detection limit can be present.	Review lab QC data to determine if there is a laboratory problem. If not, and same compounds are found in field samples at similar concentrations, resample entire batch.
	Duplicate	1 for every 10 field samples collected	Above 10x detection limit, % RPD must be less than current control limits: Aqueous samples - RPD < 30% Non-aqueous samples - RPD < 40%	Review lab QC data to determine if they are in control. If not in control, flag data. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate (c)	1 for every 10 field samples collected	Less than reported detection limits	Qualify data.
	LABORATORY QC:			
	Sensitivity Check with BFB	Every 12 hours of operation	Ion abundance criteria; see method	Tune instrument; repeat.
	Mass Calibration	Every 12 hours of operation	See Method SW846	Tune instrument; repeat.
	Initial Calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration; SPCCs exceed 0.300; CCCs response factor deviates < 30% from average	Recalibrate instrument.
	Continuing Calibration	Every 12 hours of operation	SPCCs exceed 0.300 with the exception of bromoform which must exceed 0.250; CCCs response factor deviates < 25% from average of initial calibration	Rerun continuing calibration. If still out of control, recalibrate instrument.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
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Carswell Air Force Base, Texas

PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Volatile Organic Compounds by GC/MS 8240 (SW-846) (Cont'd)	Method Blank	1 for every 20 samples, or every day	Less than reported detection limit	Qualify results <10 times that found in the blank.
	Surrogate Recovery	Every sample	See Appendix B	Reanalyze sample; flag data.
	MS/MSD	1 for every 20 samples	See Appendix B	Reanalyze samples. If still out of control, qualify the data.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
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RCRA Facility Investigation
Carswell Air Force Base, Texas

PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Volatile Organic Compounds by GC 8020 (SW-846)	FIELD QC: Trip Blank	1 for each batch of samples shipped to laboratory	No more than 4 target compounds, each with a concentration exceeding 3 times the method detection limit can be present.	Review lab QC data to determine if there is a laboratory problem. If not, and same compounds are found in field samples at similar concentrations, resample entire batch.
	Ambient Blank	Collected when samples are collected downwind of possible volatile sources.	No more than 4 target compounds, each with a concentration exceeding 3 times the method detection limit can be present.	Review lab QC data to determine if there is a laboratory problem. If not, and same compounds are found in field samples at similar concentrations, resample entire batch.
	Duplicate	1 for every 10 field samples collected	Above 10x detection limit, % RPD must be less than current control limits: Aqueous samples - RPD < 30% Non-aqueous samples - RPD < 40%	Review lab QC data to determine if they are in control. If not in control, flag data. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate (c)	1 for every 10 field samples collected	Less than reported detection limits	Qualify data.
	LABORATORY QC:			
	Initial Calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration: RSD ≤ 20% of RFs or correlation coefficient ≥ 0.995 (use avg. RF is RFD ≤ 20%, otherwise use calibration curve)	Recalibrate instrument.
	Continuing Calibration	Every 12 hours of operation	Measured value within 15% of true value	Rerun continuing calibration. If still out of control, recalibrate instrument.
	Method Blank	1 for every 20 samples, or every day	Less than reporting detection limit	Qualify results <10 times that found in the blank.
	Surrogate Recovery	Every sample	See Appendix B	Reanalyze sample; flag data.
	MS/MSD	1 for every 20 samples	See Appendix B	Reanalyze samples. If still out of control, qualify the data.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
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RCRA Facility Investigation
Carswell Air Force Base, Texas

PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
Extractable Organic Compounds by GC/MS 8270 (SW-846)	FIELD QC:			
	Duplicate	1 for every 10 field samples collected	Above 10x detection limit, % RPD must be less than current control limits: Aqueous samples - RPD < 20% Non-aqueous samples - RPD < 35%	Review lab QC data to determine if they are in control. If not in control, flag data. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	Rinsate (c)	1 for every 10 field samples collected	Less than reporting limit	Qualify data.
	LABORATORY QC:			
	Sensitivity Check with DFTPP	Every 12 hours of operation	Ion abundance criteria; see method	Tune instrument; repeat.
	Mass Calibration	Every 12 hours of operation	See Method SW846	Tune instrument; repeat.
	Initial Calibration	Before analysis and when continuing calibration fails criteria	5 pt. calibration; SPCCs exceed 0.050; CCCs response factor deviates < 30% from average	Recalibrate instrument.
	Continuing Calibration	Every 12 hours of operation	SPCCs exceed 0.050; CCCs response factor deviates < 25% from average of initial calibration	Rerun continuing calibration; if still out of control, recalibrate instrument.
	Method Blank	1 for every 20 samples	Less than reporting detect limit	Reanalyze blank, then re-extract, qualify all results < 10 times that found in blank (for blanks contaminated with common laboratory chemicals) and qualify all results <5 times that found in blank (for blanks contaminated with compounds not commonly found in the laboratory).
	Surrogate Recovery	Every sample	See Appendix B	Rerun sample. If still out of control, re-extract, reanalyze, qualify data.
	MS/MSD	1 for every 20 samples	See Appendix B	Rerun sample. If still out of control, qualify data.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
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Carswell Air Force Base, Texas

PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
SW846 8015M Total Petroleum Hydrocarbons (TPH)	FIELD QC:			
	Duplicate	1 for every 10 field samples collected	Water samples - RPD < 20% Soil samples - RPD < 30%	Review lab QC data to determine if they are in control. If not in control, flag data. Use data to evaluate whether proper collection procedures were followed.
	Rinsate	1 for every 10 field samples collected	Less than reporting detection limits	Qualify data.
	Trip Blank (applies to volatile fraction only)	1 for each batch of samples shipped to laboratory	Less than reported detection limit	Qualify data.
	LABORATORY QC:			
	Initial Calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration %RSD must be < 20% for all analytes	Recalibrate instrument.
	Continuing Calibration	Daily	Response factor must be < 15% from average of initial calibration	Rerun continuing calibration; if still out of control, recalibrate instrument.
	Method Blank	Daily	Compounds must be below respective detection limits	Step 1: Reanalyze Step 2: If second blank exceeds criteria, clean the analytical system. Step 3: Document the corrective action taken and qualify all associated data.
	MS/MSD	1 per every 20 samples	See Table 1-32 for current control limits	Rerun samples. If still out of control, qualify data.
	LCS	1 per every 20 samples	Aqueous MS/MSD criterion apply	Rerun. If still out of control, solve problem and reanalyze batch.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
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PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
SW 1311 TCLP	FIELD QC:			
	Duplicate	1 for every 10 field samples collected	% RPD must be ≤ 40%	Review label QC data to determine if they are in control. If not, qualify data. Use data to evaluate proper collection procedures were followed. If not, determine further corrective action.
	Rinsates	1 for every 10 field samples collected	Less than reported method detection limits	Qualify data.
	LABORATORY QC:			
	Blank	1 per batch of samples, minimum 1 per 20 samples	Value must be less than reported detection limit	Reanalyze all samples greater than MDL but less than 10x blank concentration.
	MS/MSD	1 per matrix type, minimum 1 per 20 samples	See Table 1-32 for current control limits	Rerun. If still out of control, reanalyze. Qualify data.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
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PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
SW 9071/EPA 418.1 Petroleum Hydrocarbons	FIELD QC:			
	Equipment Blank	1 for every 10 field samples	Less than reporting detection limit	Review lab QC data to determine if there is a laboratory problem. If not, review field decontamination procedures to either validate or invalidate data. If invalid, determine further corrective action.
	Duplicate	1 for every 10 field samples	Above 10x detection limit, % RPD must be less than current control limits: Aqueous samples - RPD < 30% Non-aqueous samples - RPD < 40%	Review lab QC data to determine if they are in control. If not in control, flag data. Use data to evaluate whether proper collection procedures were followed. If not, determine further corrective action.
	LABORATORY QC			
	Calibration Curve	Each batch	0.995 correlation with a 3 point calibration	Rerun calibration standards.
	Method Blank	1 for every 20 samples or extraction batch	Less than reporting detection limit	Document and report to client.
	Spiked Sample	1 for every 20 samples	Within current control limits	Rerun spike; if still out of control, reanalyze spike.
	Duplicate Spike	1 for every 20 samples	Above 10x detection limit; see Table 13-1 for %RSD	Reprep duplicates and reanalyze.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
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RCRA Facility Investigation
Carswell Air Force Base, Texas

PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
SW846 8010 Halogenated Volatile Organics	FIELD QC:			
	Trip Blank	1 for each batch of samples shipped to laboratory	No more than 4 target compounds each with a concentration exceeding 3 times the method detection limit can be present.	Review lab QC data to determine if there is a laboratory problem. If not, and same compounds are found in field samples at similar concentrations, resample entire batch.
	Duplicate	1 for every 10 field samples collected	Water Samples - RPD < 20% Soil Samples - RPD < 30%	Review lab QC data to determine if they are in control. If not in control, flag data. Use data to evaluate whether proper collection procedures were followed.
	Rinsate (c)	1 for every 10 field samples collected	Less than reported detection limits	Qualify data.
	LABORATORY QC:			
	Initial Calibration	Prior to analysis and when continuing calibration fails criteria	5 pt. calibration; % RSD must be < 20% for all analytes	Recalibrate instrument.
	Continuing Calibration	Daily	Response factors must be < 15% from average of initial calibration	Rerun continuing calibration. If still out of control, recalibrate instrument.
	Method Blank	Daily	Compounds must be below respective detection limits	Step 1: Reanalyze. Step 2: If second blank exceeds criteria, clean the analytical system. Step 3: Document the corrective action taken and qualify all associated data.
	Surrogate Spike	All blanks, standards, QC samples, field samples	See Appendix D for current control limits	Step 1: Reanalyze. Step 2: If recovery still outside control limits, qualify the data.
	MS/MSD	1 per every 20 samples	See Appendix D for current control limits	Rerun samples. If still out of control, qualify data.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
"MHETL" = Maine Health and Environmental Testing Laboratory

TABLE A-1

SUMMARY OF QUALITY CONTROL REQUIREMENTS AND ACCEPTANCE CRITERIA
RCRA Facility Investigation
Carswell Air Force Base, Texas

PARAMETER/ METHOD (a)	QUALITY CONTROL CHECK	FREQUENCY	ACCEPTANCE CRITERIA	CORRECTIVE ACTION
SW9070 Oil and Grease	FIELD QC:			
	Duplicate	1 for every 10 field samples collected	% RPD $\leq$ 35%	Review lab QC data to determine if they are in control. If not, qualify data. Use data to evaluate proper collection procedures were followed. If not, determine further corrective action.
	Rinsate (c)	1 for every 10 field samples collected	Less than reported detection limits	Qualify data.
	LABORATORY QC:			
	Calibration of the instrument	According to the instrument service manual	All measures must be accurate.	Check balance maintenance, qualify data.
	Method Blank	1 per batch of 20 samples	Less than reported detection limits	Reanalyze all samples greater than MDL but less than 10 x blank concentration.
	Duplicates	1 per batch of 20 samples	RPD $\leq$ 20%	Qualify data.

(a) References: "SW-846" = Test Methods for Evaluating Solid Waste, SW-846, USEPA, November 1986
"EPA-600/4-79-020" = Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, USEPA, March 1979, Revised March 1983
"MHETL" = Maine Health and Environmental Testing Laboratory

Table A-2

PROJECT REQUIRED REPORTING LIMITS – SOIL/SEDIMENT
LAW ENVIRONMENTAL, INC. – NATIONAL LABORATORIES – PENSACOLA (LENL-P)
June 1993

ANALYTICAL METHOD	COMPOUND	UNITS	REPORTING LIMIT IDL	REPORTING LIMIT MQL	SPIKE CONCENTRATION	CONTROL LIMITS RECOVERY %	CONTROL LIMITS RELATIVE % DIFFERENCE %
6010 (SW846)	Aluminum	mg/kg	10	50	*	75-125 **	20
	Antimony	mg/kg	5.6	15	50	78-117	18
	Arsenic	mg/kg	4.2	30	200	75-123	19
	Barium	mg/kg	3	10	200	85-121	20
	Beryllium	mg/kg	0.2	1	5	80-116	20
	Cadmium	mg/kg	0.4	0.5	5	87-123	20
	Calcium	mg/kg	10.2	100	*	75-125 **	20
	Chromium	mg/kg	0.8	5	20	82-124	18
	Cobalt	mg/kg	1.3	5	50	88-124	17
	Copper	mg/kg	0.8	5	25	89-125	20
	Iron	mg/kg	5	5	*	75-125 **	20
	Lead	mg/kg	3.7	5	50	76-125	18
	Magnesium	mg/kg	11.7	100	*	75-125 **	20
	Manganese	mg/kg	0.6	2	50	88-124	20
	Molybdenum	mg/kg	3.6	10	50	75-125 **	20
	Nickel	mg/kg	2.5	15	50	85-125	19
	Potassium	mg/kg	13.4	100	*	75-125 **	20
	Selenium	mg/kg	7.9	50	200	76-124	20
	Silver	mg/kg	0.8	5	5	80-125	18
	Sodium	mg/kg	25.5	100	*	75-125 **	20
	Thallium	mg/kg	7	7	200	76-121	20
	Vanadium	mg/kg	1	10	50	81-123	19
	Zinc	mg/kg	0.7	2	50	80-122	20
			PQL				
8240 (SW846)	Acetone	mg/kg	0.001	0.01	0.05	D-208	40
	Benzene	mg/kg	0.001	0.001	0.05	32-171	40
	Bromodichloromethane	mg/kg	0.001	0.001	0.05	16-198	40
	Bromoform	mg/kg	0.005	0.005	0.05	30-186	40
	Bromomethane	mg/kg	0.001	0.001	0.05	9-213	40
	2-Butanone (MEK)	mg/kg	0.01	0.01	0.05	D-213	40
	Carbon disulfide	mg/kg	0.005	0.005	0.05	D-222	40
	Carbon tetrachloride	mg/kg	0.005	0.005	0.05	34-161	40
	Chlorobenzene	mg/kg	0.005	0.005	0.05	20-186	40
	Chloroethane	mg/kg	0.005	0.005	0.05	19-208	40
	2-Chloroethyl vinyl ether	mg/kg	0.01	0.01	0.05	D-278	40
	Chloroform	mg/kg	0.005	0.005	0.05	27-152	40
	Chloromethane	mg/kg	0.001	0.001	0.05	18-201	40
	Dibromochloromethane	mg/kg	0.005	0.005	0.05	30-179	40
	1,1-Dichloroethane	mg/kg	0.005	0.005	0.05	37-162	40
	1,2-Dichloroethane	mg/kg	0.005	0.005	0.05	25-192	40
	1,1-Dichloroethene	mg/kg	0.005	0.005	0.05	7-229	40
	trans-1,2-Dichloroethene	mg/kg	0.005	0.005	0.05	51-143	40
	1,2-Dichloropropane	mg/kg	0.001	0.001	0.05	2-225	40
	cis-1,3-Dichloropropene	mg/kg	0.001	0.001	0.05	8-233	40
	trans-1,3-Dichloropropene	mg/kg	0.005	0.005	0.05	1-206	40
	Ethylbenzene	mg/kg	0.005	0.005	0.05	24-192	40
	2-Hexanone	mg/kg	0.005	0.01	0.05	D-229	40
	Methylene chloride	mg/kg	0.005	0.005	0.05	D-192	40
	4-Methyl-2-pentanone (MIBK)	mg/kg	0.01	0.01	0.05	D-226	40
	Styrene	mg/kg	0.005	0.005	0.05	6-196	40
	1,1,2,2-Tetrachloroethane	mg/kg	0.005	0.005	0.05	24-179	40
	Tetrachloroethene	mg/kg	0.005	0.005	0.05	38-175	40

NA = Not Applicable
NS = Not Spiked
NE = Not Established at this time
* Project – Required Reporting Limits for methodologies performed by TEG are listed in the TEG QA Manual in Appendix B-2.
** = Precision and accuracy limits are based on method limits
IDL = Investment Detection Limit
MQL = Maximum Quantitation Limit
PQL = Practical Quantitation Limit

Table A-2

PROJECT REQUIRED REPORTING LIMITS - SOIL/SEDIMENT
LAW ENVIRONMENTAL, INC. - NATIONAL LABORATORIES - PENSACOLA (LENL-P)
June 1993

ANALYTICAL METHOD	COMPOUND	UNITS	REPORTING LIMIT IDL	REPORTING LIMIT MQL	SPIKE CONCENTRATION	CONTROL LIMITS RECOVERY %	CONTROL LIMITS RELATIVE % DIFFERENCE %
8240 (SW846)	Toluene	mg/kg	0.005	0.005	0.05	18-177	40
	1,1,1-Trichloroethane	mg/kg	0.005	0.005	0.05	31-174	40
	1,1,2-Trichloroethane	mg/kg	0.005	0.005	0.05	29-171	40
	Trichloroethene	mg/kg	0.005	0.005	0.05	37-171	40
	Vinyl acetate	mg/kg	0.01	0.01	0.05	5-239	40
	Vinyl chloride	mg/kg	0.002	0.002	0.05	6-215	40
	Xylenes (total)	mg/kg	0.005	0.005	0.05	7-211	40
	1,2-Dichloroethane-d4 (surrogate)	mg/kg	NA	NA	0.05	72-117	NA
	Toluene-d8 (surrogate)	mg/kg	NA	NA	0.05	87-116	NA
	4-Bromofluorobenzene (surrogate)	mg/kg	NA	NA	0.05	75-107	NA
8020 (SW846)	Benzene	mg/kg	0.0005	0.0005	0.01	23-171	40
	Toluene	mg/kg	0.0005	0.0005	0.01	61-142	40
	Ethylbenzene	mg/kg	0.0005	0.0005	0.01	15-178	40
	Xylenes	mg/kg	0.001	0.001	0.03	50-156	40
	Fluorobenzene (surrogate)	mg/kg	NA	NA	0.04	77-125	NA
	4-Chlorotoluene (surrogate)	mg/kg	NA	NA	0.04	79-124	NA
6010 (SW846)	Aluminum	mg/L	0.1	0.5	2000	77-123	20
	Antimony	mg/L	0.056	0.5	500	78-121	15
	Arsenic	mg/L	0.042	0.3	2000	78-122	17
	Barium	mg/L	0.03	0.1	2000	75-124	20
	Beryllium	mg/L	0.002	0.01	50	76-124	16
	Cadmium	mg/L	0.004	0.005	50	80-122	18
	Calcium	mg/L	0.102	1	NS	75-125 **	20
	Chromium	mg/L	0.008	0.05	200	76-121	15
	Cobalt	mg/L	0.013	0.05	500	75-123	14
	Copper	mg/L	0.008	0.05	250	76-124	18
	Iron	mg/L	0.05	0.05	1000	81-121	20
	Lead	mg/L	0.037	0.2	500	77-122	17
	Magnesium	mg/L	0.117	1	NS	75-125 **	20
	Manganese	mg/L	0.006	0.02	500	78-125	17
	Molybdenum	mg/L	0.036	0.1	500	75-123	16
	Nickel	mg/L	0.025	0.15	500	75-123	18
	Potassium	mg/L	0.134	5	NS	75-125 **	20
	Selenium	mg/L	0.079	1	2000	76-124	17
	Silver	mg/L	0.008	0.05	50	75-123	17
	Sodium	mg/L	0.255	1	NS	75-125 **	20
	Thallium	mg/L	0.072	0.4	2000	75-123	17
	Vanadium	mg/L	0.01	0.1	500	77-125	18
	Zinc	mg/L	0.007	0.02	500	78-125	16
7060 (SW846)	Arsenic	mg/L	0.002	0.005	40	75-118	18
7421 (SW846)	Lead	mg/L	0.001	0.005	20	75-123	16
7740 (SW846)	Selenium	mg/L	0.001	0.005	10	79-125	18
7471 (SW846)	Mercury	mg/L	0.0002	0.001	1	78-123	19
		PQL					
8270 (SW846) (acids)	Benzoic acid	µg/L	36	50	50	D-500	40
	4-Chloro-3-methylphenol	µg/L	0.8	10	50	25-144	40
	2-Chlorophenol	µg/L	1	10	50	23-128	40
	2,4-Dichlorophenol	µg/L	0.9	10	50	40-124	40
	2,4-Dimethylphenol	µg/L	1	10	50	38-126	40
	4,6-Dinitro-2-methylphenol	µg/L	0.6	50	50	D-166	40
	2,4-Dinitrophenol	µg/L	3.3	50	50	D-190	40
	2-Methylphenol	µg/L	0.8	10	50	22-147	40
	4-Methylphenol	µg/L	0.9	10	50	22-147	40

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PROJECT REQUIRED REPORTING LIMITS - SOIL/SEDIMENT
LAW ENVIRONMENTAL, INC. - NATIONAL LABORATORIES - PENSACOLA (LENL-P)
June 1993

ANALYTICAL METHOD	COMPOUND	UNITS	REPORTING LIMIT IDL	REPORTING LIMIT MQL	SPIKE CONCENTRATION	CONTROL LIMITS RECOVERY %	CONTROL LIMITS RELATIVE % DIFFERENCE %
8270 (SW846) (acids)	2-Nitrophenol	µg/L	0.9	10	50	10-181	40
	4-Nitrophenol	µg/L	2	50	50	D-128	40
	Pentachlorophenol	µg/L	0.6	30	50	10-171	40
	Phenol	µg/L	0.8	10	50	11-83	40
	2,4,5-Trichlorophenol	µg/L	1	50	50	D-250	40
	2,4,6-Trichlorophenol	µg/L	0.7	10	50	41-142	40
	2-Fluorophenol (surrogate)	µg/L	NA	NA	100	25-99	NA
	Phenol-d6 (surrogate)	µg/L	NA	NA	100	17-93	NA
	2,4,6-Tribromophenol (surrogate)	µg/L	NA	NA	100	16-118	NA
8270 (SW846) (base/neutral)	Acenaphthene	µg/L	0.4	10	50	56-135	40
	Acenaphthylene	µg/L	0.6	10	50	40-137	40
	Anthracene	µg/L	0.6	10	50	40-131	40
	Benzo(a)anthracene	µg/L	0.4	10	50	36-133	40
	Benzo(b)fluoranthene	µg/L	0.8	10	50	31-148	40
	Benzo(k)fluoranthene	µg/L	0.6	10	50	17-149	40
	Benzo(ghi)perylene	µg/L	0.6	10	50	8-187	40
	Benzo(a)pyrene	µg/L	0.3	10	50	18-148	40
	Benzyl alcohol	µg/L	1.7	10	50	D-250	40
	bis(2-Chloroethoxy)methane	µg/L	0.5	10	50	34-163	40
	bis(2-Chloroethyl)ether	µg/L	0.9	10	50	19-147	40
	bis(2-Chloroisopropyl)ether	µg/L	0.6	10	50	42-154	40
	bis(2-Ethylhexyl)phthalate	µg/L	1.3	10	50	15-149	40
	4-Bromophenyl phenyl ether	µg/L	0.6	10	50	55-116	40
	Butylbenzylphthalate	µg/L	0.5	10	50	52-124	40
	4-Chloroaniline	µg/L	4.8	10	50	D-250	40
	2-Chloronaphthalene	µg/L	0.4	10	50	63-112	40
	4-Chlorophenyl phenyl ether	µg/L	0.4	10	50	34-144	40
	Chrysene	µg/L	0.5	10	50	23-153	40
	Dibenzo(a,h)anthracene	µg/L	0.6	10	50	6-194	40
	Dibenzofuran	µg/L	0.4	10	50	D-250	40
	Di-n-butylphthalate	µg/L	1	10	50	16-116	40
	1,2-Dichlorobenzene	µg/L	0.7	10	50	34-125	40
	1,3-Dichlorobenzene	µg/L	0.6	10	50	5-160	40
	1,4-Dichlorobenzene	µg/L	0.7	10	50	21-112	40
	3,3'-Dichlorobenzidine	µg/L	2	20	50	14-213	40
	Diethylphthalate	µg/L	0.5	10	50	14-97	40
	Dimethylphthalate	µg/L	0.3	10	50	D-112	40
	2,4-Dinitrotoluene	µg/L	0.8	10	50	35-124	40
	2,6-Dinitrotoluene	µg/L	0.8	10	50	55-143	40
	Di-n-octylphthalate	µg/L	0.7	10	50	3-143	40
	Fluoranthene	µg/L	0.6	10	50	30-130	40
	Fluorene	µg/L	0.5	10	50	59-119	40
	Hexachlorobenzene	µg/L	0.5	10	50	6-144	40
	Hexachlorobutadiene	µg/L	0.7	10	50	24-111	40
	Hexachlorocyclopentadiene	µg/L	1.8	10	50	7-86	40
	Hexachloroethane	µg/L	0.9	10	50	41-100	40
	Indeno[1,2,3-cd]pyrene	µg/L	1.6	10	50	2-140	40
	Isophorone	µg/L	0.5	10	50	26-196	40
	2-Methylnaphthalene	µg/L	0.5	10	50	D-250	40
	Naphthalene	µg/L	0.5	10	50	32-123	40
	2-Nitroaniline	µg/L	0.7	50	50	D-250	40
	3-Nitroaniline	µg/L	1	50	50	D-500	40
	4-Nitroaniline	µg/L	4	50	50	D-500	40
	Nitrobenzene	µg/L	0.9	10	50	42-160	40

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LAW ENVIRONMENTAL, INC. – NATIONAL LABORATORIES – PENSACOLA (LENL-P)
June 1993

ANALYTICAL METHOD	COMPOUND	UNITS	REPORTING LIMIT IDL	REPORTING LIMIT MQL	SPIKE CONCENTRATION	CONTROL LIMITS RECOVERY %	CONTROL LIMITS RELATIVE % DIFFERENCE %
8270 (SW846) (base/neutral)	n-Nitrosodiphenylamine	µg/L	1	10	50	13-143	40
	n-Nitrosodipropylamine	µg/L	1	10	50	9-171	40
	Phenanthrene	µg/L	0.4	10	50	55-113	40
	Pyrene	µg/L	0.7	10	50	60-113	40
	1,2,4-Trichlorobenzene	µg/L	0.5	10	50	46-140	40
	Nitrobenzene-d5 (surrogate)	µg/L	NA	NA	50	39-104	NA
	2-Fluorobiphenyl (surrogate)	µg/L	NA	NA	50	46-110	NA
	Terphenyl-d14 (surrogate)	µg/L	NA	NA	50	38-137	NA
			PQL				
8240 (SW846)	Acetone	µg/L	7.5	10	50	32-199	40
	Benzene	µg/L	0.4	5	50	46-147	40
	Bromodichloromethane	µg/L	0.3	5	50	49-150	40
	Bromoform	µg/L	0.2	5	50	66-163	40
	Bromomethane	µg/L	0.7	10	50	28-156	40
	2-Butanone (MEK)	µg/L	2.8	10	50	29-156	40
	Carbon disulfide	µg/L	0.7	5	50	21-184	40
	Carbon tetrachloride	µg/L	0.4	5	50	78-132	40
	Chlorobenzene	µg/L	0.2	5	50	49-152	40
	Chloroethane	µg/L	0.3	10	50	35-177	40
	2-Chloroethyl vinyl ether	µg/L	8	10	50	9-244	40
	Chloroform	µg/L	0.3	5	50	56-126	40
	Chloromethane	µg/L	0.6	10	50	32-162	40
	Dibromochloromethane	µg/L	0.3	5	50	60-143	40
	1,1-Dichloroethane	µg/L	0.3	5	50	68-139	40
	1,2-Dichloroethane	µg/L	0.4	5	50	29-153	40
	1,1-Dichloroethene	µg/L	0.3	5	50	32-192	40
	trans-1,2-Dichloroethene	µg/L	0.4	5	50	81-119	40
	1,2-Dichloropropane	µg/L	0.6	5	50	12-192	40
	cis-1,3-Dichloropropene	µg/L	0.6	5	50	19-194	40
	trans-1,3-Dichloropropene	µg/L	0.2	5	50	19-177	40
	Ethylbenzene	µg/L	0.2	5	50	47-155	40
	2-Hexanone	µg/L	2.1	10	50	17-191	40
	Methylene chloride	µg/L	4.5	5	50	8-173	40
	4-Methyl-2-pentanone (MIBK)	µg/L	7	10	50	19-186	40
	Styrene	µg/L	0.5	5	50	27-148	40
	1,1,2,2-Tetrachloroethane	µg/L	0.7	5	50	49-140	40
	Tetrachloroethene	µg/L	0.2	5	50	71-142	40
	Toluene	µg/L	0.3	5	50	60-144	40
	1,1,1-Trichloroethane	µg/L	0.4	5	50	56-150	40
	1,1,2-Trichloroethane	µg/L	0.7	5	50	61-140	40
	Trichloroethene	µg/L	0.2	5	50	77-139	40
	Vinyl acetate	µg/L	0.7	10	50	26-200	40
	Vinyl chloride	µg/L	0.6	10	50	26-188	40
	Xylenes (total)	µg/L	0.7	5	150	14-181	40
	1,2-Dichloroethane-d4 (surrogate)	µg/L	NA	NA	50	77-113	NA
	Toluene-d8 (surrogate)	µg/L	NA	NA	50	90-110	NA
	4-Bromofluorobenzene (surrogate)	µg/L	NA	NA	50	87-114	NA
8020 (SW846)	Benzene	µg/L	0.5	1	NE	38-155	40
	Toluene	µg/L	0.5	2	NE	76-125	40
	Ethylbenzene	µg/L	0.5	4	NE	32-159	40
	Xylenes	µg/L	1	2	NE	67-138	40
	Fluorobenzene (surrogate)	µg/L	NA	NA	NE	NE	NA
	4-Chlorotoluene (surrogate)	µg/L	NA	NA	NE	NE	NA
418.1 (EPA 600)	Total Recoverable Petroleum Hydrocarbons	µg/L	0.001	0.001	41	80-120	50

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APPENDIX B

QUALITY ASSURANCE PROGRAMS

FOR

CHEMICAL ANALYSIS LABORATORIES

B-1 Law Environmental, Inc. - National Laboratories Branch (LENL), Pensacola, Florida

B-2 Transglobal Environmental Geochemistry, Texas

173180

APPENDIX B-1

QUALITY ASSURANCE PROGRAMS

Law Environmental, Inc.
National Laboratories Branch (LENL)
Pensacola, Florida

Law Environmental, Inc.

173139

INTEROFFICE MEMORANDUM

TO: Chemistry Department

FROM: Jerry S. Preston JSP

DATE: September 28, 1992

SUBJECT: Certifications held by LENL-P Laboratory

Attached please find a listing of the certifications held by the LENL-Pensacola laboratory. This list will be useful during proposal and planning activities.

CERTIFICATION BY STATE

STATE	PARAMETERS	CERT. NO.	EXP. DATE
Alabama	Drinking Water	40600	6/30/93
Florida	Drinking Water	HRS#81351	6/30/93
Florida	Environmental Water	HRS#E81234	6/30/93
Florida	Water	HRS#81351	6/30/93
Kansas	Drinking Water and/or Pollution Control Samples	E-184	7/31/93
Kansas	Solid or Hazardous Waste Samples	E-1161	7/31/93
Louisiana	Drinking Water	92-16	12/31/92
North Carolina	Wastewater	287	12/31/92
South Carolina	Wastewater	96008	Exp/Pending

A80.02

173191

STATE	PARAMETERS	CERT. NO.	EXP. DATE
Tennessee	BTX and TPH		7/01/93
Virginia	Water	00170	6/30/93
COE	Soil and Groundwater		2/20/94
USAF	Soil and Groundwater		9/25/93
U.S. Navy	Soil and Groundwater	Pending	
U.S. EPA	SAS Contracts	68-D9-0135	9/19/94

cc: Becky Pridgeon

/dsl

LAW ENVIRONMENTAL, INC.
NATIONAL LABORATORIES DIVISION
PENSACOLA ORGANIZATION CHART

173192

J. TUCCI
Laboratory Manager

Administrative
- K. Emmons-Branch Admin.
- S. Waite-Receptionist

B. Fuson
QA/QC Officer

Client Services
- K. Silvia-C.S. Rep
- C. Hooper-Data Mgt. Spec

Facilities Engineer
B. Schwerdtfager

Sample Rec/Mgt
- S. Taber-Supervisor
- N. Ginkel-Tech
- N. Upton-Tech
- N. Hinton-Tech

Inorganic Lab
- G. St. Pere-Supervisor
- M. Cortez-Prep Tech/Analyist
- C. High-ICP Operator
- J. MacAuley-Fum. Operator
- F. Deang-Fum. Operator
- R. Forbes-CV Mercury
- R. Gonzalez-Prep Tech

GC/MS Lab
- B.D. Hunt-Supervisor
- K. Greene-Chemist
- J. Moore-Chemist
- D. Harmn-Chemist
- W. Drew-Chemist
- J. Jernigan-Tech

MIS Dept
- D. Abbott-Supervisor
- C. Hatcher-Proj. Mgr CERCLA/CLP
- J. Hendrix-Data Mgt Spec
- J. Gregory-Proj. Mgr-USACE
- P. Harmon-Data Mgt. Spec
- A. Harber-Proj Mgr. AFCEE
- C. Lightner-Word/Data Proc
- T. Sartain-Word/Data Proc

GC Lab
- C.B. Causey-Supervisor
- E. Austin-Chemist
- L. Oetinger-Chemist
- J.M. Rossing-Chemist
- T. Parker-Chemist
- G. Tacheny-Chemist
- A. Phelps-Chemist

Organic Prep Group
- C. Oliver-Supervisor
- T. Willard-Tech
- S. Braatz-Tech
- M. Fant-Tech
- M. Gillette-Tech
- B. Jordan-Tech
- B. Blanchard-Tech

HF

LENL KEY PERSONNEL AND RESPONSIBILITIES

Position/Key Personnel	Responsibilities
Laboratory Manager James M. G. Tucci	- Implement methodologies and procedures consistent with the generation of legally defensible data; - Provide overall management and operation of the lab; - Provide a safe working environment for employees; - Provide resolutions to items requiring corrective actions; - Provide training programs for employees; - Interact with QA/QC Coordinator to resolve analytical, methodological and QA/QC problems; - Obtain laboratory accreditations; - Schedule work in a manner consistent with personnel and instrumentation; - Implement procedures consistent with and building upon our philosophy of honesty, trust and ethics; and - Implement actions required to establish our lab as a premier laboratory.

Position/Key Personnel	Responsibilities
QA/QC Coordinator Burnie D. Fuson	- Implement the branch QA program; - Develop the QA/QC manual; - Establish and maintain safety standards and operating procedures; - Coordinate and audit the technical review of deliverables; - Issue recommendations and corrective actions required for any aspect of laboratory operations inconsistent with established policies and procedures; - Monitor and identify out-of-control or potentially out-of-control situations to Operations Manager, Supervisors, and Branch Manager; - Provide guidance for the chemistry QA/QC program development; - Interact with external QA personnel concerning the lab's certifications and QA policies/procedures and coordinating QA compliance as required; - Keep abreast of new techniques and programs for QA and safety and inform Branch Manager and Operations Manager; - Coordinate the development of project QA plans as required; - Provide historical QA reports for each method to the Branch Manager; and - Perform QA/QC audits, provide blind check samples and monitor results.

LENL KEY PERSONNEL AND RESPONSIBILITIES

173195

Position/Key Personnel	Responsibilities
Management Information Systems Department Damon Abbott	- Establish and maintain the computer systems, the network, and the LIMS (Laboratory Information Management System); - Provide data deliverables in U.S. EPA CLP format with hard copy and disc deliverable formats; - Develop software necessary to meet other client's deliverable formats; - Interpret U.S. EPA CLP Statements of Work - Organics and Inorganics for requirements and deliverables; - Interface analytical instruments' data systems with our IBM Token Ring Network and develop software required at the interface; - Train department personnel in various data entry software packages purchased or developed internally; - Provide guidance and direction to other departments where required or requested or as determined by Branch Manager; - Provide support to QA/QC Coordinator where necessary to automate, archive and generate QC trends from historical records; and - Provide support and guidance for entire laboratory operation, from sample receiving through the generation of data deliverable packages, to streamline and increase productivity through computer automation.

LENL KEY PERSONNEL AND RESPONSIBILITIES

Position/Key Personnel	Responsibilities
Lab Supervision C. Oliver (Organics) B. D. Hunt (GC/MS) Carl Causey (GC) Gary St Pere (Inorganics)	- Provide overall supervision of department/section operations; - Implement procedures consistent with the generation of legally defensible data; - Provide QC activities consistent with the branch QC procedures; - Provide additional QC activities, as needed, which are consistent with the Branch QA philosophies; - Provide final report review before releasing; - Provide work assignments to departmental personnel; - Provide analytical job training and cross-training within the department and between departments where applicable and warranted; - Provide corrective action for deficiencies; - Provide quarterly instrument detection limit (IDL) studies; - Maintain maintenance logs on all instruments; - Maintain all standards logs; - Provide leadership and management philosophies consistent with those of the Branch; and - Provide legally defensible data from each department.

LENL KEY PERSONNEL AND RESPONSIBILITIES

173197

Position/Key Personnel	Responsibilities
Sample Receiving and Shipment Sharon Taber	- Provide sample control via entry of all parameters to be analyzed per sample in LIMS when sample arrives; - Provide chain-of-custody receipt of samples externally, and internal from our walk-in cooler to analysts and prep; - Provide sample analysis report daily for all samples in-house; - Provide prepared sample bottles in refrigerated shippers; - Provide for sample disposal/return to sender; and - Keep track of supplies, order when needed, bill clients for those used.

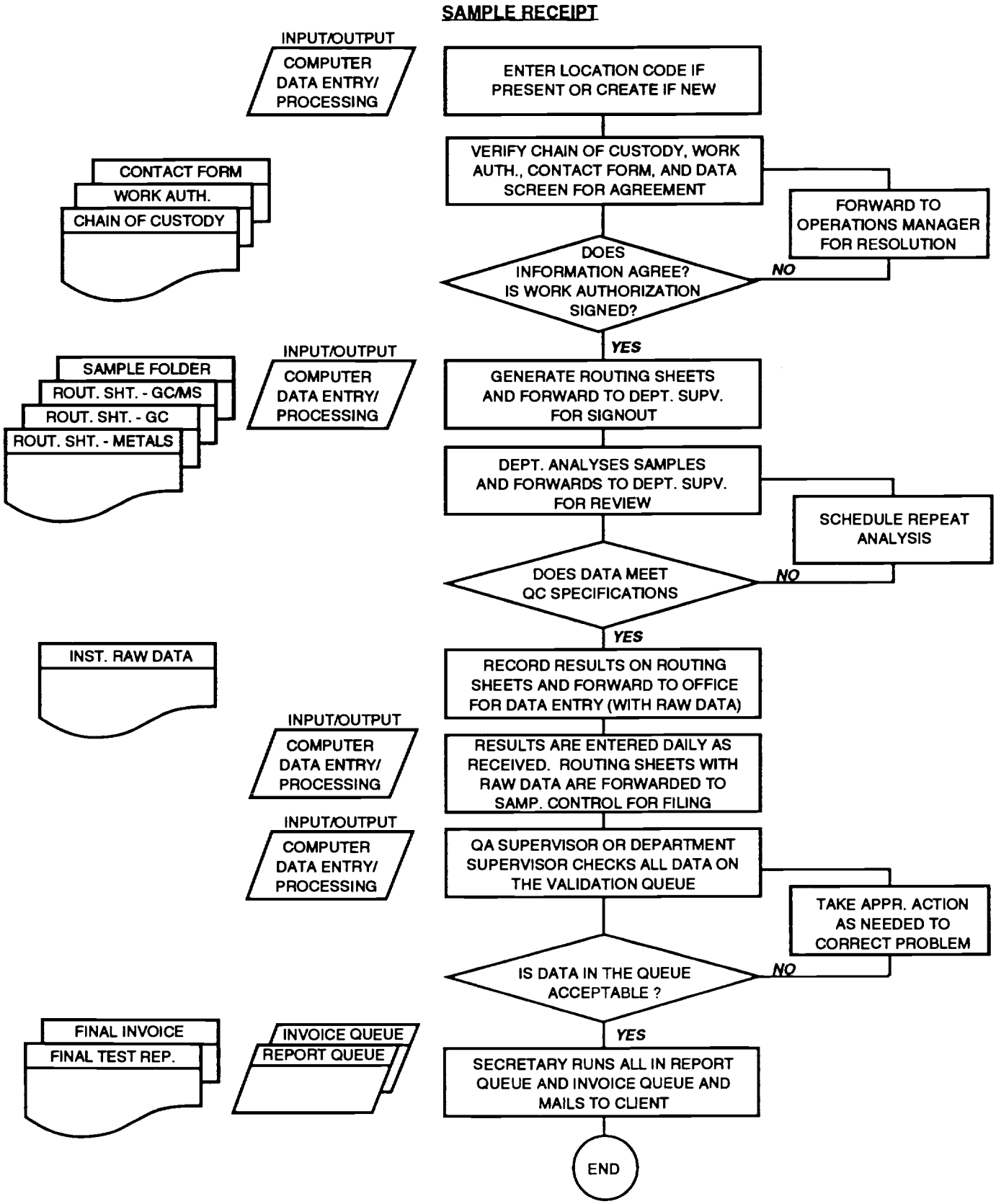
LENL SAMPLE FLOW AND DOCUMENTATION CHART

173193

Sample Flow		Documentation
A.	Incoming Samples	- Chain of Custody - Request for Analysis - Work Authorization
B.	Log-In and Assignment	- Master Logbook - Test Entry Form
C.	Sample Handling and QC	
	(1) Organics Prep Lab	- Extraction Record - Percent Moisture - Standards Prep Logs - QC Sample Logs
	(2) GC Lab	- Chromatograms - Bench Sheets - Condition Reports - Linearity Checks - Surrogate Recovery Logs - Blank, Standard and Spike Results - Standards Logbook
	(3) GC/MS Lab	- Instrument Maintenance Logs - Sample Logbook - Quantitation Reports - Chromatograms - Initial Calibration Forms - Continuing Calibration Checks - Surrogate Recovery Logs - Blank, Standard and Spike Results - Computer Streamer Tapes - Instrument Maintenance Logs
	(4) Metals Lab	- Digestion Log - Bench Sheets - Blank, Standard and Spike Results - Percent Moisture - Standards Prep Logs - QC Sample Logs
D.	Reporting	- Transmittal Letters - Test Data Reports - GC/MS Data Reports
E.	Sample Disposal	- Internal Sample Disposal Forms

LENL-PENSACOLA
LABWORKS SAMPLE/DATA FLOW

173199



NOTE: SPECIAL DELIVERABLES, IF REQUESTED ARE ALSO GENERATED AFTER VALIDATION STEP IS COMPLETED

HF

ANALYTICAL REQUEST FORM

173[illegible]

LAW ENVIRONMENTAL , INC.
7215 PINE FOREST ROAD
PENSACOLA FLORIDA 32536
904/944-9772

To: _____ Attn.: _____

From: _____ (Branch/Company Name) _____ (Dept. or Name)

COC Number: _____ Project Number: _____

Date Shipped: _____ Date Results Requested: _____

Sample ID	Analysis Requested	Detection Limits Req.	Sample Type	Method

Comments:

HF

INORGANIC SAMPLE CHECKOUT FORM

Page ____ of ____

173201

Contract: _____ Case: _____ SAS: _____ SDG: _____

Location: _____ Calib. Ref: _____ Form Initiated: ____/____/____

	CHECKED OUT					CHECKED IN				
Sample Types S/D	Date	Time	Removal Purposes	Removed By	Custodian Approval	Date	Time	Returned By	Custodian Approval	Complete Y/N

Sample Types S = Sample D = Digestate

Removal Purpose

Preparation	Analysis	Disposition
A - Solids	F - Flame AAS	L - Storage
B - AA/ICP Digestion	G - ICP	M - Submission
C - GFAAS Digestion	H - GFAAS	N - Disposal
D - Hg Digestion	I - Hg	
E - Other	J - CN	
	K - Other	

SAMPLES CONSTITUTING THIS BATCH

Matrix: _____ Level: _____ # of Physical Samples: _____

Sample ID	Sample ID	Sample ID
1 _____	8 _____	15 _____
2 _____	9 _____	16 _____
3 _____	10 _____	17 _____
4 _____	11 _____	18 _____
5 _____	12 _____	19 _____
6 _____	13 _____	20 _____
7 _____	14 _____	21 _____

ORGANIC SAMPLE CHECKOUT FORM

Page _____ of _____

Contract: _____ Case: _____ SAS: _____ SDG: _____

Location: _____ Calib. Ref: _____ Form Initiated: ____/____/____

	CHECKED OUT					CHECKED IN				
Sample Types S/X	Date	Time	Removal Purpose	Removed By	Custodian Approval	Date	Time	Returned By	Custodian Approval	Complete Y/N

Sample Types S = Sample X = Extract

Removal Purpose

Preparation	Analysis	Disposition
A - pH / % Moisture	G - Screening GC	
B - Extraction of SV	H - VOA GC/MS	M - Storage
C - Extraction of PEST/PCB	I - SV GC/MS	N - Submission
D - Clean-up of SV	J - PEST/PCB GC/ECD	O - Disposal
E - Clean-up of PEST/PCB	K - GC/MS Confirmation	
F - Other	L - Other	

SAMPLES CONSTITUTING THIS BATCH

Matrix: _____ Level: _____ # of Physical Samples: _____

Sample ID	Sample ID	Sample ID
1 _____	8 _____	15 _____
2 _____	9 _____	16 _____
3 _____	10 _____	17 _____
4 _____	11 _____	18 _____
5 _____	12 _____	19 _____
6 _____	13 _____	20 _____
7 _____	14 _____	21 _____

173203

QA/QC CORRECTIVE ACTION REQUEST FORM

LENL-PENSACOLA, FL

CA # _____ Originator _____ DATE _____

PROBLEM:

SECTION: _____ DISCOVERER: _____ DATE: _____

DATA/DATES IMPACTED: _____

DESCRIPTION: _____

REQUIRED ACTION:

DETERMINATION

ASSIGNED TO: _____ DATE: _____ DUE DATE: _____

IMPLEMENTATION

ASSIGNED TO: _____ DATE: _____ DUE DATE: _____

ACTION: _____

EFFECTIVENESS EVALUATION (S):

ASSIGNED TO: _____ DATE: _____ DUE DATE: _____

ASSIGNED TO: _____ DATE: _____ DUE DATE: _____

CC: QA OFFICER _____

OPERATIONS MANAGER: _____

GROUP LEADER: _____

SECTION SUPERVISOR: _____

HF

SUMMARY: DEFICIENT INCIDENT REPORTS

STATUS AS OF _____

		INITIAL				FINAL			
ORIGINATOR INT. & DATE	BRIEF DESCRIPTION	CORRECTIVE ACTION DESCRIPTION	DUE DATE	DATE COMPLETED	INT.	CORRECTIVE ACTION DESCRIPTION	DUE DATE	DATE COMPLETED	INT.

HF

173275

APPENDIX B-2

QUALITY ASSURANCE PROGRAMS

Transglobal Environmental Geochemistry, (TEG)
Austin, Texas

TRANSGLOBAL
ENVIRONMENTAL
GEOCHEMISTRY, TEXAS

173298

December 16, 1993

Ms. Darice Kurtzer
Project Manager
LAW ENVIRONMENTAL & ENGINEERING

SUBJECT: QUALITY CONTROL LIMITS FOR 8020/8015 & LEAD FOR CARSWELL AFB PROJECT

Dear Ms. Kurtzer:

The following pages are the information that you requested. The control limits based on the historical data obtained from our mobile labs. If you have any questions regarding this data, please feel free to contact me.

Sincerely

Dr. Dernsing Luu
President
TEG/Texas

DL/ml

173297

1. BTEX:

a. Quality Control Check (QCC)

Concentration (mg/L)	UCL*	LCL*
1.00	1.15	0.85

UCL: Upper Control Limits
LCL: Lower Control Limits

b. Method Detection Limits (5020/8020)

0.01 mg/L (Benzene, Toluene, & Ethylbenzene)
0.03 mg/L (Xylenes)

c. Matrxi Spike and Matrix Spike Duplicate

Spiked Concentration (mg/L)

1.00

Normal Range of %Recovery

80 - 120

Accceptable % Relative Deviation

± 25

2. TPH (Modiifed 8015):

Gasoline:

a. Quality Control Check (QCC)

Concentration (mg/L)	UCL*	LCL*
200	230	170

UCL: Upper Control Limits
LCL: Lower Control Limits

b. Method Detection Limits

1.0 mg/L

c. Matrxi Spike and Matrix Spike Duplicate

Spiked Concentration (mg/L)

200

Normal Range of %Recovery

75 - 125

Accceptable % Relative Deviation

± 27

Diesel:

a. Quality Control Check (QCC)

Concentration (mg/L)	UCL*	LCL*
500	565	435

UCL: Upper Control Limits
LCL: Lower Control Limits

b. Method Detection Limits

2 mg/L

c. Matrxi Spike and Matrix Spike Duplicate

Spiked Concentration (mg/L)

500

Normal Range of %Recovery

85 - 115

Accceptable % Relative Deviation

± 25

3. Total Lead (3051/7421):

a. Quality Control Check (QCC)

Concentration (mg/L)	UCL*	LCL*
1.0	1.3	0.7

UCL: Upper Control Limits
LCL: Lower Control Limits

b. Method Detection Limits

0.1 mg/L

c. Matrxi Spike and Matrix Spike Duplicate

Spiked Concentration (mg/L)

1.0

Normal Range of %Recovery

65 - 135

Accceptable % Relative Deviation

± 28

TRANSGLOBAL
ENVIRONMENTAL GEOCHEMISTRY, TEXAS

173811

December 16, 1993

Ms. Darice Kurtzer
Project Manager
LAW ENVIRONMENTAL & ENGINEERING

SUBJECT: QUALITY CONTROL LIMITS FOR 8020/8015 & LEAD FOR CARSWELL AFB PROJECT

Dear Ms. Kurtzer:

The following pages are the information that you requested. The control limits based on the historical data obtained from our mobile labs. If you have any questions regarding this data, please feel free to contact me.

Sincerely

Dr. Dernsing Luu
President
TEG/Texas

DL/ml

1. BTEX:

a. Quality Control Check (QCC)

Concentration (mg/L)	UCL*	LCL*
1.00	1.15	0.85

UCL: Upper Control Limits
LCL: Lower Control Limits

b. Method Detection Limits (5020/8020)

0.01 mg/L (Benzene, Toluene, & Ethylbenzene)
0.03 mg/L (Xylenes)

c. Matrxi Spike and Matrix Spike Duplicate

Spiked Concentration (mg/L)

1.00

Normal Range of %Recovery

80 - 120

Accceptable % Relative Deviation

± 25

173213

TRANSGLOBAL
ENVIRONMENTAL
GEOCHEMISTRY, TEXAS

TRANSGLOBAL ENVIRONMENTAL GEOSAMPLING

STRATAPROBE™

METHODOLOGY & REFERENCES

obile and Laboratory Analytical Services Environmental Subconsulting Geochemical R & D Soil Vapor Surveys Air Monitoring

408 University Place Corpus Christi, Texas 78412 512-991-7975 / 991-1078 Fax

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I *STRATAPROBE$_{TM}$*

The *STRATAPROBETM* is the basic element of a sophisticated hudraulic drive-point system developed by TEGeoSampling. TEG's *STRATAPROBETM* is designed to perform discrete soil sampling, groundwater sampling, soil vapor sampling, and the installation of multi-depth vapor wells for the Environmental Industry. The *STRATAPROBETM* is one of the most versatile units of its kind, capable of driving an assortment of sampling tools to depths of 50 feet, or greater, in most soil formations.

The *STRATAPROBETM* carrier vehicle is a four-wheel-drive, one ton truck, equipped with a reliable diesel-powered, PTO hydraulic system. The powerful, rear mounted unit is fitted with dual rams and a hydraulic hammer. High frequency impact energy coupled with 5000 pounds of static reaction weight and a 15000 pound pull-back capacity, provide ample force to overcome the most demanding geologic conditions. The 5' working stroke of the machine enables efficient penetration and retrieval of the sampling tools. Additionally, the low, 12' mast allows for operations within buildings, and the fully articulated boom provides a full range of positioning and directional boring capabilities. The custom-designed drive rods are constructed of high strength 11/2" threaded steel tubing.The *STRATAPROBETM* is a low profile unit that is fully enclosed in the utility bed of the truck while in transit. TEGeoSampling also offers hand-held, portable equipment for sampling in locations where truck access is not possible.

STRATAPROBE$_{TM}$ SYSTEM

STRATAPROBE$_{TM}$ CARRIER VEHICLE
Ford F350 Utility Truck

SPECIFICATIONS
* Four Wheel Drive
* All Terrain
* Dimensions: 7.5' x 21'
* Low Profile Bed
* Diesel Powered PTO

ACCESSORY EQUIPMENT
* Steam Cleaner
* Concrete Corer
* Decontamination Area
* Sample Prep & Waste Staging Area

STRATAPROBE$_{TM}$ DRIVE POINT UNIT
Rear-Mounted Hydraulic Unit

SPECIFICATIONS
* Dual 5' Stroke Hydraulics
* High Frequency 100psi Impact Hammer
* 5000lb Static Drive Weight
* 15000lb Pull-Back Capacity
* Custom Drive Rods: 5' Threaded, High-Strength Steel Tubing
* 25° Directional Boring with Articulated Boom

II SOIL VAPOR SAMPLING PROCEDURES

A) SOIL VAPOR COLLECTION

TEG's experienced field personnel, equipped with hydraulic & vibrational insertion and recovery equipment, concentrate solely on vapor collection. TEG's probe design allows insertion/recovery using either heavy duty, 4-wheel drive truck mounted *STRATAPROBE$_{TM}$* equipment or portable (vehicle-independent) equipment. No change-over time is required between the two methods, meaning both methods can be deployed simultaneously, depending upon site access. Our soil vapor probe design and methodology have been fully approved and endorsed by the California EPA and the Los Angeles Regional Water Quality Control Board (LA-RWQCB). The TEG system has been used on state lead projects for the TWC (references follow).

TEG's probe design has only 5cc dead-volume within an inert tube, which affords the following advantages:

* Minimal vapor need be withdrawn, thereby eliminating the need for vacuum pumps.
* Full length inert tubing prevents atmospheric contamination from leakage into probe body. This is a *crucial* consideration in arid environments.
* Soil vapor does not contact the metal probe body. Thus, decon procedures are *fast* and *simple*.

Probe Construction

TEG's soil vapor probes are constructed of 7/8" or 1 1/2" OD (*STRATAPROBE$_{TM}$*) stainless steel, equipped with a hardened, reverse-thread steel tip. Nominal lengths are 5', although additional lengths may be used. An inert 1/8 inch nylaflow tube runs down the center of the probe to the sampling ports beneath the tip (fig A).

Probe Insertion

The probe is driven into the ground by the force of 5,000 lb of static weight and a high frequency hydraulic hammer with the *STRATAPROBE$_{TM}$* system, or by a portable electric rotary hammer. Once inserted to the desired depth, the probe is rotated 3 to 5 times in a clockwise direction, which opens the tip and exposes the vapor sampling ports. This design prevents clogging of the sampling ports and cross-contamination from soils during insertion.

Field Collection Log

The field technician completes a logsheet summarizing time of sampling event, depth of pene-tration or refusal, which probe is used on each sampling location, when tubing is replaced, any visual contamination on the probe, OVM readings as applicable, and any other unusual occurences at a particular sampling location.

Gas Sampling

Soil vapor is withdrawn from the nylaflow tubing using a syringe connected via an on-off valve. The first 40cc of gas is discarded to flush out the dead volume of the tubing and fill with insitu soil vapor. The next 20cc of gas are drawn in a syringe, plugged, and immediately transferred to the mobile lab for analysis within minutes of collection. Additional soil vapor volumes may be collected and stored in gas-tight containers as desired.

FIG. A 173217

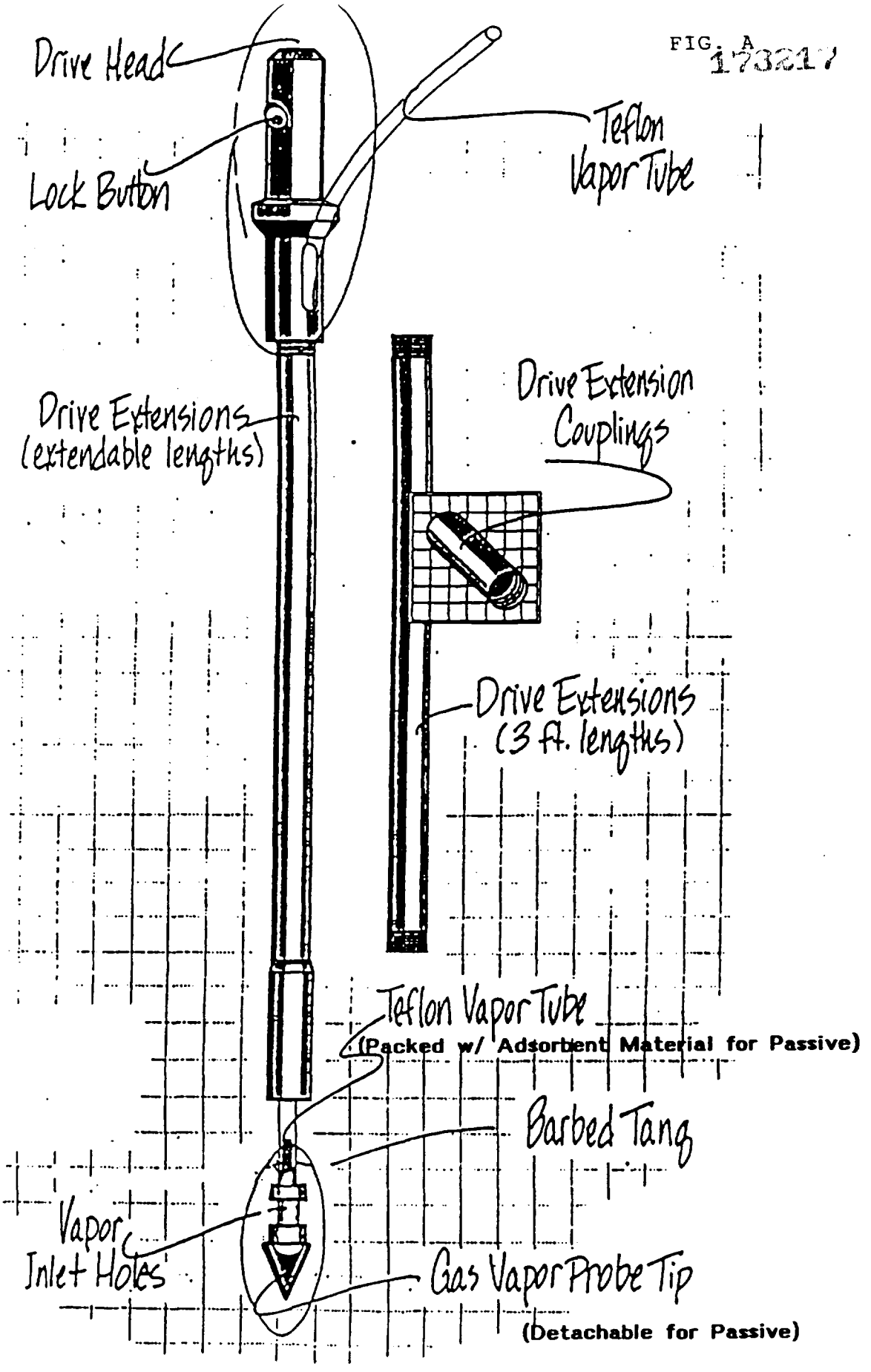


Diagram of TEG's Soil Gas Sampling Probe

Flushing & Decontamination Procedures

To minimize the potential for cross-contamination between sites, all probe parts are cleaned of excess dirt and moisture prior to insertion. The nylaflow tubing and sampling ports are flushed with hundreds of cc's of ambient air or inert gas between samples. If dirt, water or any material is observed in the tubing, it is discarded and replaced with new nylaflow. If concentrations greater than 100ppmv are detected for any compound (except methane), the tubing is replaced. Sampling syringes are opened and exposed to outside air on a clean surface to allow any volatiles to escape after each use. If concentrations greater than 100ppmv are detected for any compound (except methane) the syringe is discarded, unless glass syringes are used.

Access to Difficult Sites

TEG's probes may be deployed either with a truck-mounted system or by hand. The truck mounted *STRATAPROBE$_{TM}$* system is deployed on a 4-wheel drive truck, thus enabling access to rough terrain sites. The portable unit may be used in and around buildings, inside tank farm fire walls, or in environmentally sensitive areas.

Abandonment Procedures

With only a 3/4" to 1 1/2" hole and no tailings remaining after recovering the probe, the hole is typically backfilled and grouted and the pavement or slab is patched accordingly.

B) MULTI-DEPTH (Nested) VAPOR WELLS

Well Construction

TEG's semi-permanent, multi-depth soil vapor wells are constructed with individual sample tubes set at multiple depths below the ground surface (Fig. B). An inert 1/8" polypropylene nylaflow tube extends to the desired depth and is connected to a machined, stainless steel tip containing multiple intake ports.

The 1/8" diameter nylaflow consists of one continuous lenght of tubing, which eliminates couplings or joints, and therefore, potential leakage. Using the 1/8" tubing also results in an extremely low dead volume of space within the tube and tip which must be purged prior to obtaining a sample. This low dead volume eliminates the need for purging large vloumes of air, which ensures sample integrity.

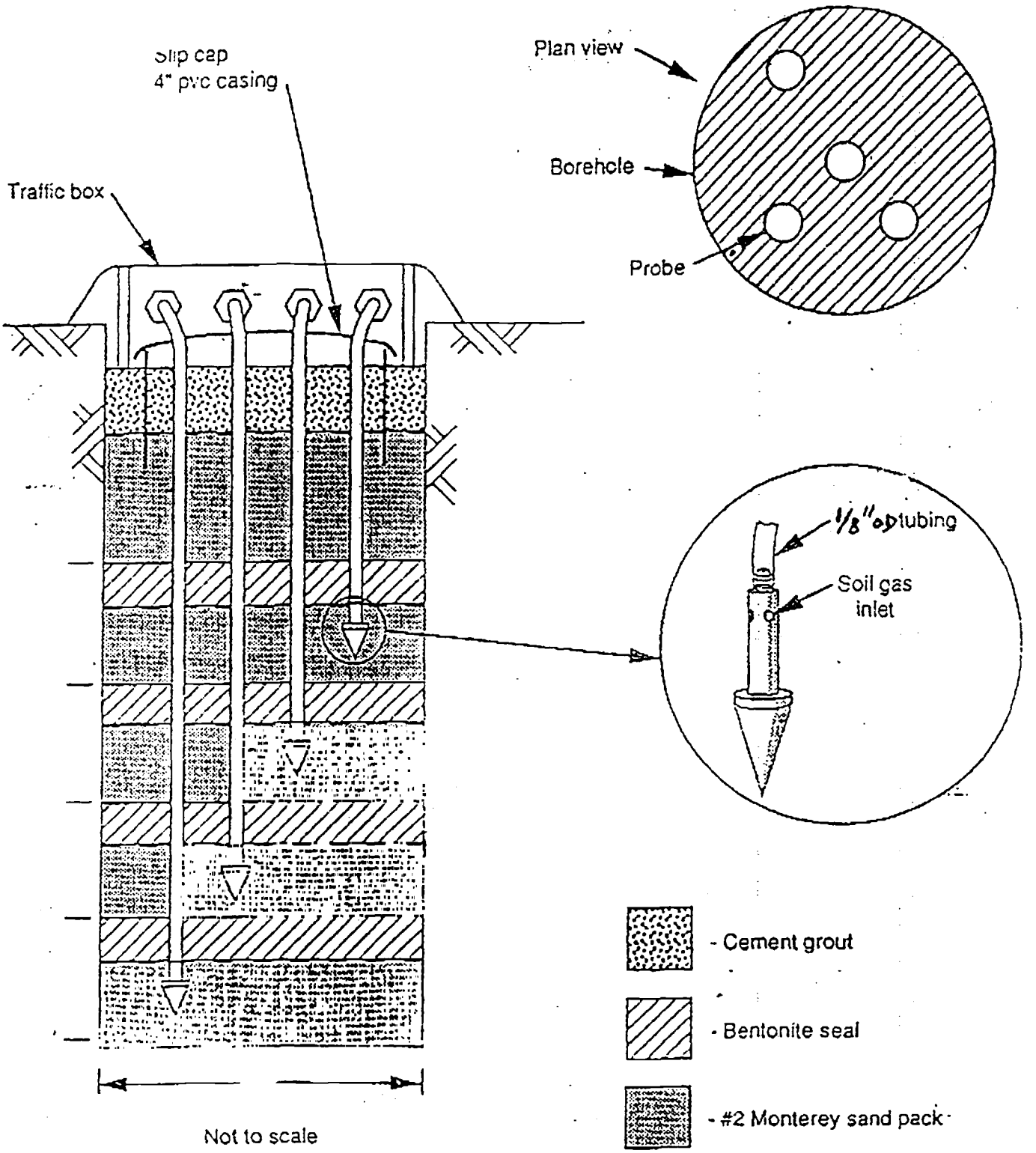
Tube Insertion

The 1/8' nylaflow tubing and tips can be inserted either using the *STRATAPROBE$_{TM}$* to depths up to 50' or may be deployed at deeper depths in larger diameter borings. The *STRATAPROBE$_{TM}$*, equipped with a detachable, vapor slotted, drive point, is initially driven to the depth of the deepest vapor well. The probe is then withdrawn approximately 1', leaving the drive point with attached tubing in place. Clean sand is poured into the probe to provide a sand-pack around the vapor point, and bentonite grout is then pumped into the hole to insure a annular seal from the overlying strata. The probe is further removed and additional vapor wells are installed in the same manner, except the shallower wells are equipped with a screen instead of the vapor point.

Fig. B

173219

NESTED VAPOR WELL



Transglobal Environmental Geochemistry
432 N. Cedros Ave., Solana Beach, CA 92075 Ph: (619) 793-0401 Fax: (619) 793-0404

C) SOIL VAPOR ANALYSIS

Soil Vapor is collected from each probe in a gas-tight syringe, brought to the TEG mobile laboratory, and analyzed *immediately*. Vapor will not be collected until the lab is ready for the sample, thus there is *no lag time* between gas collection and analysis (Very Important!).

Because there is some uncertainty about the types of contamination that might be present, it is *Imperative* that the analytical equipment be *Sensitive* enough and also *Specific* enough to differentiate between the different types of potential compounds. For example, FID and ECD detectors are sensitive enough, but used alone are not specific enough to differentiate between all of the aromatic and halogenated VOC's. To ensure proper identification and achieve adequate detection levels, a combination of 3 different types of detectors is often necessary: FID, Hall (ELCD), and PID.

Utilizing the *Appropriate* State of the Art Laboratory Grade analytical instrumentation ***With EPA Required Detectors,*** TEG's fully self-supported (power, water, etc.), CA DOHS Certified and TWC Approved Mobile Laboratories are equipped for the analyses of the following volatile organic compounds (VOC's) found in soil vapors:

Aromatic Hydrocarbons *(BTEX, etc.), EPA modified 602, 8020*
Gas Chromatograph with PID
Detection levels: 10-50 ppbv (0.1 ug/l) for each compound

Chlorinated & Halogenated Hydrocarbons *(Solvents), EPA modified 601, 8010*
Gas Chromatograph with ECD or Hall (ELCD) detector coupled with a 60m capillary column
Detection levels: 10-50 ppbv (0.1 ug/l)

Total Petroleum Hydrocarbons *(TPH) , EPA modified 8015*
Gas Chromatograph with FID
Detection level: 1ppmv

Fixed/Biogenic Gases (available at selected TEG offices)
Gas Chromatograph with combination TCD/FID

Detection levels:	fixed gases, 10ppm	CO_2, 10ppm
	methane, 1ppm	CO, 10ppm
	O_2, 0.5%	

Nominal Throughput
Depending upon sampling depth and which analyses are required, 15 to 30 samples can be collected and analyzed in a 8 to 10 hour work day.

QA/QC Procedures
TRANSGLOBAL utilizes modified EPA protocols. Three point calibration curves will be run prior to the program and re-run when the daily continuing calibration falls outside of the limits (+/- 15%) as required by EPA protocols.

D) DATA HANDLING & PROCESSING

Data from each detector is processed by a chromatographic software system. The resulting values for each compound is entered into a spreadsheet file on a multi-tasking, 486/33 MHz PC. Print-outs of the data are available daily. An example print-out is enclosed.

The spreadsheet data is read into a contouring program (Surfer) and displayed graphically in both 2-D (contour) and 3-D (raised surface) projections. The lab is equipped with a color printer for onsite hardcopy output (examples follow). These projections are available on a real time basis.

Data is also be available to the client on computer disks in an ASCII format.

E) VAPOR PERMEABILITY STUDIES

Relative vapor permeabilities in the soil can easily be determined by attaching a small vacuum pump to the individual vapor probes and measuring the flow rate while maintaining a constant vacuum pressure of 20 to 40 inches of water. According to emperical results performed by our associates at sites in California, the radius of influence for this type of test is approximately 5'.

III SOIL & GROUNDWATER SAMPLING PROCEDURES

A) DISCRETE SOIL SAMPLER

The TEG *STRATAPROBE$_{TM}$* obtains high quality discrete soil samples using a retractable piston, combined with a standard split-spoon sampler.

Sampler Construction
The *STRATAPROBE$_{TM}$* split-spoon sampler is 12" long and has an outside diameter of 2.5". The internal piston assembly consists of a hardened steel tip, steel connecting rod and a teflon ring that prevents metal to metal contact between the piston and the sample liners. The split-spoon contains two or three 2" x 4" stainless steel, brass or aceatate retainer sleeves. During initial probe insertion, the piston is locked into place in the sampler body.The piston prevents the sampler from filling as it is advanced to depth.

Probe Insertion & Sample Recovery
The probe is driven into the ground using the heavy-duty rear-mounted hydraulic "direct push" rig. Once the target depth is reached, the piston is unlocked by a control rod and the sampler is driven 1' deeper, allowing the cored material to enter the sample tube as the piston retracts. The *STRATAPROBE$_{TM}$* is then returned to the surface, where the sleeves are recovered from the split-spoon and sealed for delivery to TEG's "state approved" on-site mobile laboratory for immediate analysis.

Decontamination Procedures
EPA recommended protocol is the basis for all decontamination on TEG *STRATAPROBE$_{TM}$* operations. The actual procedures are tailored for each particular project. The primary deciding factors used in determining the decontamination procedures are types of contaminants and the site conditions. The sampling tools are decontaminated and certified clean with the appropriate documentation provided.

B) WATER SAMPLER

Water Sampler Construction
The *STRATAPROBE$_{TM}$* system water sampler consists of a detachable drive tip which is attached to a 24" retractable stainless steel well screen. The unit is encased in the lead probe tube. For water recovery the system can accomodate either a 20" bailer, capable of recovering 50ml of sample, or tubing that can be run into the probe after insertion and is connected to a peristalic pump at the surface.

Water Sampler Operation & Sample Recovery
After the water sampler is advanced into the water bearing zone the probe is withdrawn 2' to allow the retractable assembly to open to the formation. The water level is monitored by an electrical conductivity instrument and when the water has reached hydrostatic equlibrium within the well screen, the sample is ready to be taken. Depending upon the hydraulic conductivity of the formation and the constituents of concern, the sample will be taken with either the bailer or the post-run-tubing/peristalic pump system. At the surface the samples will be placed in VOA vials or other approved containers, chilled and perservatives added, as EPA protocol dictates.

IV RESUMES OF LEAD PERSONNEL

TEXAS & MEXICO

Mr. Rolf Woods, CPG, President
TRANSGLOBAL SOUTH
Mr. Woods will run and/or supervise the day to day GeoSampling operation as well as market the services. In concert with these efforts, Mr. Woods will continue to promote mobile laboratory services for sister TEG operations on a commission basis.

Mr. Woods' professional career began as a well site geologist for UNOCAL where he worked in California, Thailand and Louisiana. During this time he was directly responsible for sampling and logging operations. Mr. Woods moved to Texas with Texas Oil & Gas Corporation in 1979 and became a consulting geologist in 1980. During the 1980's Mr. Woods generated drilling prospects and marketed these ideas to industry. In 1991 Mr. Woods performed soil vapor field operations on an exploration project for a consortium of independent oil and gas operators.

Since joining TEG in February, 1992 Mr. Woods has been instrumental in developing the mobile laboratory market in Texas. Due to his influence, TEG/TEXAS has also become a major player in the soil vapor surveying business. In the first 15 months of business Mr. Woods has developed a client list of over 600 companies in 27 states and Mexico.

Mr. Woods holds a BS degree from The University of Southern California in Geology and he is a Certified Petroleum Geologist.

SOUTHERN CALIFORNIA

Mr. Jeffrey S. Martineau, President
TRANSGLOBAL ENVIRONMENTAL GEO-SAMPLING
Mr. Martineau is responsible for research and development of the geo-sampling equipment and technical support for field operations. He will also play a primary role in developing a marketing and pricing strategy for TRANSGLOBAL ENVIRONMENTAL GEO-SAMPLING.

Prior to joining the TEG family, Mr. Martineau was Western Operations Manager for TARGET ENVIRONMENTAL SERVICES. In this capacity, Mr. Martineau accumulated over 5 years of environmental site assessment experience and was the principal designer and builder of TARGET's sampling systems, which included deep soil vapor, soil and water sampling. He was instrumental in the construction of 2 innovative hydraulic drive point rigs. Mr. Martineau has completed more than 1000 geochemical surveys with special emphasis on difficult and varied sampling conditions throughout the United States.

Mr. Martineau holds a BS degree in Geography (Minor in Geology) from James Madison University.

SOUTHERN CALIFORNIA

Dr. Blayne Hartman, Ph.D., President
TRANSGLOBAL ENVIRONMENTAL GEOCHEMISTRY
Dr. Hartman's daily responsibilities with respect to TEG include direction of laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review and method development, and direction of corporate development.

Dr. Hartman's academic research included a variety of chemical oceanography projects including: petroleum tracing using stable and radiogenic compounds as tracers; process controls across the air-water interface; and gas chromatography of dissolved gases in water and sediments.

Prior to founding Transglobal Exploration, Dr. Hartman was chief marine geochemist with InterOcean Systems where his responsibilities included direction of marine sediment and bottom-water geochemical exploration programs. As a research geochemist with Unocal Research, Dr. Hartman was responsible for development of geochemical prospecting techniques in onshore and offshore applications. These research operations included extensive method development and use of a variety of gas chromatography. Other research included use of stable metal isotopes as correlation parameters for organic materials. As founder and president of Transglobal Exploration & Geoscience in 1988, Dr. Hartman has been personally responsible for directing geochemical technical development, equipment design and maintenance, applications development, and implementation of exploration programs, analyses, and reporting.

TEXAS

Dr. Derhsing Luu, Ph.D., President
TRANSGLOBAL ENVIRONMENTAL GEOCHEMISTRY / TEXAS
Dr. Luu's daily responsibilities with respect to TEG/TEXAS include direction of laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review and method development.

Dr. Luu's academic research included a variety of novel automated analytical instruments development including: methanol analyzer and hydrocarbon analyzer. Prior to founding TEG/Texas, Dr. Luu was R&D senior scientist with Global Geochemistry Corp. where his responsibility included development of methanol analyzer for CARB (California Air Resource Board) and hydrocarbon analyzer for Schlumberger. As a senior chemist for Air Toxic Lab with ENSR, Dr. Luu was responsible for daily laboratory operations and method development for air toxic laboratory. As an environmental laboratory manager and corporate QA officer with TRI (Texas Research Institute), Dr. Luu was responsible for supervising, performing GC/MS analysis, training, method developing for indoor air monitoring, and devising corporate QA/QC policy.

WASHINGTON

Michael Korosec, M.S., President
TRANSGLOBAL ENVIRONMENTAL GEOCHEMISTRY / NW
Mr. Korosec's daily responsibilities with respect to TEG Northwest include direction of all laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review, marketing, and contract negotiations.

While with TEG, Korosec has developed unique preparation methods and analytical techniques for on-site analysis of PAH's, PCB's and chlorinated pesticides in soils, and PAH's and BTEX in tars.

Korosec's academic research included studies of the chemical and physical controls on the transport of dissolved nutrients across the sediment-water interface, using UV spectrophotometry and gas chromatography.

Prior to founding TEG/Northwest, Korosec was in charge of the state of Washington, Division of Geology and Earth Resources' Geothermal Exploration Program. The work included the development of a water analysis laboratory for the determination of dissolved cat ions, an ions and trace metals in thermal and mineral waters. Instrumentation included AA spectrophotometer, UV spectrophotometer, mercury analyzer and specific ion meters. Additional work included drilling programs for temperature gradient and heat-flow studies, whole rock geochemistry, age dating, and geologic mapping. As program manager, Korosec was responsible for all contracting, subcontracting and reporting to the U.S. Department of Energy.

NORTHERN CALIFORNIA

Mark Jerpbak, M.S., R.G., President
TRANSGLOBAL ENVIRONMENTAL GEOCHEMISTRY / SACRAMENTO
Mr. Jerpbak's daily responsibilities with respect to TEG/Sacramento includes direction of all laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review, marketing, and contract negotiations.

Since 1981, Mr. Jerpbak has worked with several companies and agencies in geology and geochemistry in the United States and overseas, including: Ascension Island, Papau New Guinea and Japan. His work has included gas chromatography in the petroleum industry, gas and vapor analyses and wet chemical titration in the geothermal industry, injection tests in active geothermal areas, and gas chromatography by EPA methods in the environmental industry. He has worked extensively in the field and in the mobile lab environment.

Mr. Jerpbak holds a M.S. degree from the University of Iowa in geology and geophysics. He is a California State Registered Geologist and also consults for the Yolo County Department of Public Health, and Environmental Health Services in California.

V GEOSAMPLING REFERENCES

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TRANSGLOBAL'S soil vapor sampling and analytical methodology have been fully approved by the LA County Regional Water Quality Control Board (RWQCB). TRANSGLOBAL has performed state lead soil vapor projects for the TWC. Selected references with contact numbers (we encourage you to contact them) for specific projects are:

CLIENT	CONTACT	PHONE #
AIRCRAFT STAMPING	Mr. Mike Nolan	818-443-2713
ALTON GEOSCIENCE	Mr. Ron Kofron	619-587-0682
CALIFORNIA ENV.	Mr. Charles Buckley	818-991-1542
CHEM WASTE MGMT	Ms. Sue Goss	714-826-0604
CERES ENVIRONMENTAL	Mr. Nick Patz	310-907-4088
COASTAL REMEDIATION	Mr. John Thomas	713-297-1708
DAMES & MOORE (Houston)	Mr. Jeff Borem	713-688-4541
DAMES & MOORE (LA)	Ms. Deborah Stott	213-683-1560
DAMES & MOORE (Tustin)	Mr. Essi Essamali	714-433-2000
DAMES & MOORE (San Ber.)	Mr. Brian Wynne	714-381-2004
DuPONT ENVIRON. REM. SERVICES	Mr. John Leetham	713-586-5600
ENSAFE	Mr. Ted Blahnik	214-642-1665
HARDING LAWSON ASSOC.	Mr. Dale Tischmak	303-292-5365
W.W. IRWIN	Mr. David A. Williams	714-699-6120
IT CORPORATION (Irvine)	Ms. Mary Parker	714-660-5466
IT CORPORATION (SD)	Mr. Peter Merz	619-554-0510
JACOBS ENGINEERING	Ms. Riz Sarmiento	818-568-7001
KLEINFELDER	Mr. Ed Trosper	310-860-5559
LOCKMAN & ASSOC	Mr. Razmik Gozalian	213-724-0250
MICHAEL BRANDMAN ASSOC	Ms. Susan Kline	619-260-1800
NINYO & MOORE	Mr. Steve Geyer	619-457-0400
OGDEN ENVIRONMENTAL	Mr. Eric Wetzstein	619-458-9044
MALCOLM PIRNIE	Mr. Dave Morley	713-840-1511
REIDEL ENVIRONMENTAL	Mr. Joe Koutski	310-327-4428
ROBERT PRATER ASSOC	Mr. Larry Jansen	619-453-5605
SEACOR	Mr. John Wainwright	714-335-6116
SIMON HYDROSEARCH	Mr. Roy Marroquin	714-891-7446
TETRA TECH	Mr. J.R. Hollingsworth	619-450-0365
TRAIL CHEMICAL	Mr. Bill Peters	818-442-4140
WEST COAST ENVIRONMENTAL	Ms. Carol Means	805-644-7976
WOODWARD-CLYDE	Mr. Tom Zep	714-835-6886
CA-RWQCB (LA)	Mr. Phil Chandler	213-266-7500
	Mr. Craig Christmann	213-266-7531

VI GEOSAMPLING PROJECT DESCRIPTIONS

Facility: Vought Aircraft, NWIRP, Dallas
Goals: Delineate contamination of aromatic and halogenated hydrocarbons
Number of Sampling Points: 600
Required Time to Complete Job: 7 weeks
Consultant: EnSafe (Ted Blahnik, 214-642-1665)

Facility: Beale AFB, Sacramento
Goals: Delineate contamination of aromatic and halogenated hydrocarbons
Number of Sampling Points: 300
Required Time to Complete Job: 3 weeks
Consultant: Law Environmental (James Kozakowski, 916-649-2424)

Facility: Electronics Plant, Colorado Springs
Goals: Delineate contamination of aromatic and halogenated hydrocarbons
Number of Sampling Points: 75
Required Time to Complete Job: 4 days
Consultant: Harding Lawson (Dale Tischmak, 303-292-5365)

Facility: Schofield Army Barracks, Honolulu
Goals: Delineate contamination of aromatic and halogenated hydrocarbons
Number of Sampling Points: 400
Required Time to Complete Job: 25 days
Consultant: Harding Lawson (Kathrin Cain, 303-292-5365)

Facility: March AFB, Riverside
Goals: Delineate contamination of aromatic and halogenated hydrocarbons
Number of Sampling Points: 500
Required Time to Complete Job: 25 days
Consultant: Tetra Tech (Steve Williams, 714-660-5407)

Facility: 15 Service Station Sites in Rio Grande Valley
Goals: Delineate contamination of aromatic hydrocarbons
Number of Sampling Points: 330
Required Time to Complete Job: 20 days
Consultant: Malcolm Pirnie (TWC state lead) (Dave Morley, 713-840-1511)

Facility: Tank Farm
Goals: Delineate contamination of aromatic hydrocarbons
Number of Sampling Points: 250
Required Time to Complete Job: 11 days
Consultant: Coastal Remediation (John Thomas, 713-297-1708)

Facility: Chemical Plant
Goals: Delineate contamination of aromatic hydrocarbons
Number of Sampling Points: 60
Required Time to Complete Job: 3 days
Consultant: DuPont Environ. Rem. Services (John Leetham, 713-586-5600)

Facility: Camp Pendleton Marine Corps Base
Goals: Delineate contamination of aromatic and halogenated hydrocarbons
Number of Sampling Points: 1500
Required Time to Complete Job: 43 days
Consultant: IT Corp. (Mary Parker, 714-660-5407)

Facility: Camp Naval Base, Guam
Goals: Delineate contamination of aromatic and halogenated hydrocarbons
Number of Sampling Points: 60
Required Time to Complete Job: 4 days
Consultant: Ogden Env. (David Bjostad, 619-458-9044))

Facility: Chemical Plant
Goals: Delineate contamination of aromatic and halogenated hydrocarbons
Number of Sampling Points: 110
Required Time to Complete Job: 7 days
Consultant: Monsanto Chemical (Larry Adams)

Facility: Commercial Properties
Goals: Delineate contamination of aromatic and halogenated hydrocarbons
Number of Sampling Points: 225
Required Time to Complete Job: 15 days
Consultant: Dames & Moore (Nancy Darigo, 213-683-1560)

VII LIST OF TRANSGLOBAL OFFICES / AFFILIATES

TRANSGLOBAL SOUTH
408 University Place
Corpus Christi, TX 78412
512-991-7975
512-991-1078 Fax
Directors: Mr. Rolf Woods, CPG
Units: 1 *STRATAPROBE*
Personnel: 1

TEG Labs/GeoSampling
432 Cedros Avenue
Solana Beach, CA 92075
619-793-0401
619-793-0404 Fax
Director: Dr. Blayne Hartman
Labs: 5 mobile
Units: 1 *STRATAPROBE*
Personnel: 15

TEG - TEXAS
10805 Metric Blvd.
Austin, Texas 78758
512-835-9299
512-835-4726 Fax
Directors: Dr. Derhsing Luu
Labs: 1 Fixed Base, 2 Mobile
Personnel: 4

TEG - Pacific Northwest
7110 38th Drive, S.E.
Lacey, WA 98503
206-459-4670
206-459-3432 Fax
Director: Mr. Michael Korosek.
Labs: 3 mobile
Personnel: 3

TEG - Hawaii
770 Mokapu Road
Kailua, HI 96734
808-254-0046
808-254-0243 Fax
Director: Mr. Tim Fitzpatrick
Labs: 2 mobile
Personnel: 3

TEG - Northern California
P.O. Box 162580
Sacramento, CA 95816
916-736-3233
916-452-5806 Fax
Director Mr. Mark Jerpak, M.S.
Labs: 2 mobile
Personnel: 4

TEG - Georgia
5064 Laurel Bridge Drive
Smyrna, GA 30082
404-433-8195
Director: Mr.Mark Hankinson
Labs: 1 mobile
Personnel 3

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COMPREHENSIVE QUALITY ASSURANCE PLAN (COMPQAP)

Prepared by

TRANSGLOBAL ENVIRONMENTAL GEOCHEMISTRY, TEXAS
10805 METRIC BLVD.
AUSTIN, TEXAS 78758
(512) 835-9299

Derhsing Luu, Ph.D.
President

01/01/93
Date

Sallie Cordell
Vice-President

01/01/93
Date

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	Dr. Blayne Hartman, Ph.D.		
	Dr. Derhsing Luu, Ph.D.		
	Mr. Michael Korosec, M.S.		
	Mr. Mark Jerpbak, M.S., R.G.		

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3.0 STATEMENT OF POLICY

This document has been prepared for the purpose of providing detailed information to regulatory agencies and clients regarding the quality assurance (QA) and quality control (QC) program which is utilized at Transglobal Environmental Geochemistry, Inc. (TEG). The format of this Comprehensive Quality Assurance Plan is generally based on United States Environmental Protection Agency (EPA) guidelines for preparation of Quality Assurance Program and Project Plans (QAMS-004/80 and QAMS-005/80) and the Quality Control portions of EPA Document SW 846, "Test Methods for Evaluating Solid Waste." Changes to those formats have been incorporated to expand this document into a non-project specific outline of TEG operating procedures.

The purpose of TEG's quality assurance program is to establish methods by which problems in the data acquisition process may be detected and corrected within a framework of statistical control. This approach is designed to result in reduction of measurement errors to within accepted standards with results being of acceptable and verifiable quality. The TEG quality assurance program is concerned with, but is not limited to, the following subjects:

- development and use of techniques commonly accepted as good laboratory practice;
- standard operating procedures used with consistency;
- adherence to protocol for specific analyses;
- continuity and consistency of personnel involved with all phases of the analytical program;
- consistent use and maintenance of equipment;
- application of proper calibration protocol and use of standards; and
- integration of senior technical and management personnel in supervision, evaluation, and implementation of the QA program.

By using the techniques outlined in this plan, the quality of the analytical process and resulting data is continually evaluated. In maintaining sound QA management practices, TEG is able to maintain its commitment to generating data of verifiable quality.

4.0 ORGANIZATION AND RESPONSIBILITY

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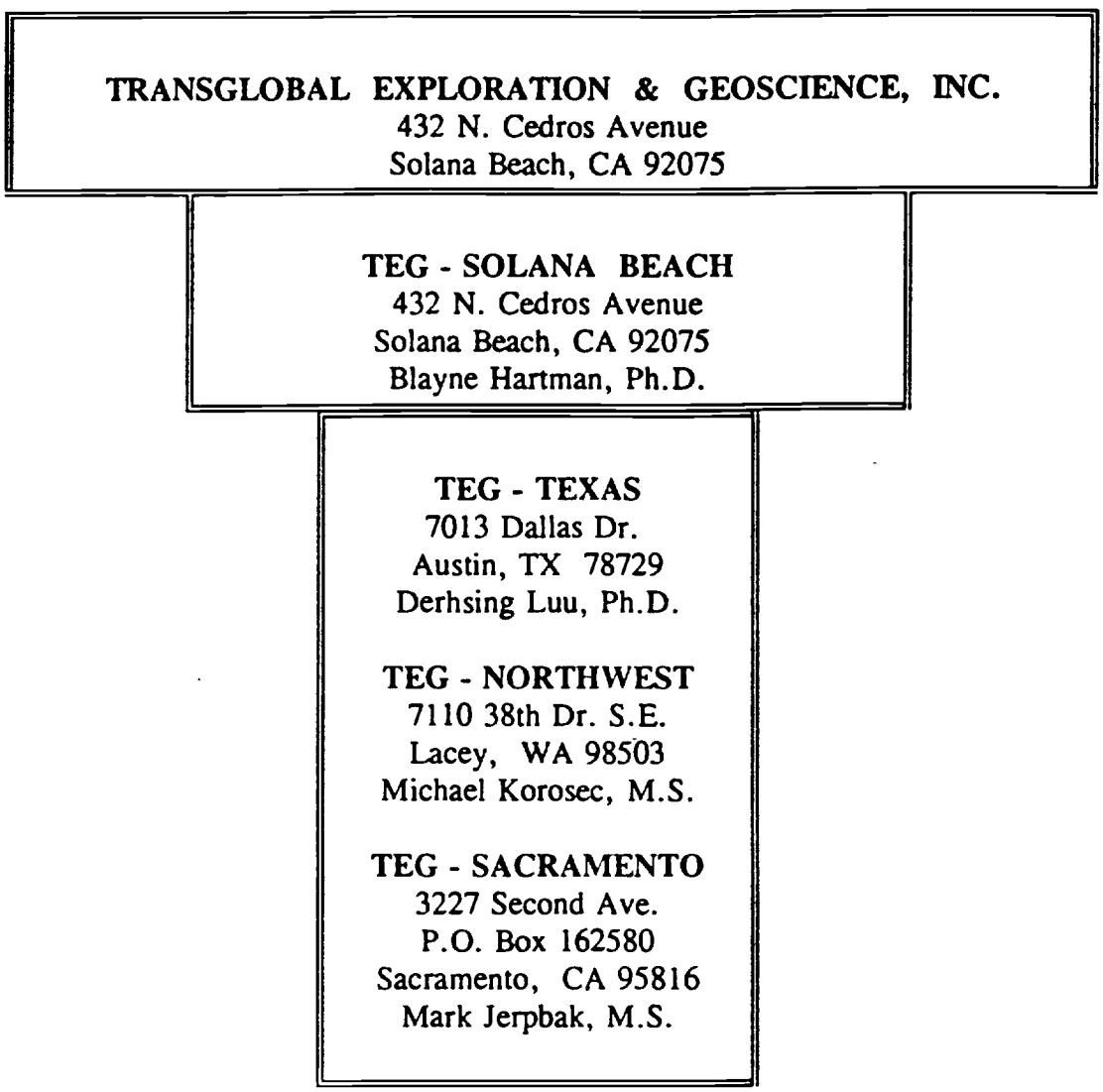
4.1 PURPOSE

Transglobal Environmental Geochemistry, Inc. (TEG) is seeking full and unconditional DER approval of laboratory services for on-site testing of soils, water, sediments, wastes, air, soil vapor, and air emissions for the EPA and DER methods described in Section 5.0 of this document.

4.2 CORPORATE PROFILE

Transglobal Environmental Geochemistry is a fully-owned subsidiary of Transglobal Exploration & Geoscience, Inc., a California Corporation based in Solana Beach, California. TEG has formed joint partnerships in five (5) additional locations outside of southern California as shown in Figure 4-1.

Figure 4-1. CORPORATE ORGANIZATION CHART



4.3 KEY PERSONNEL

At each location, all aspects are under the supervision of a CADOHS-certified director. This director is responsible for all aspects of laboratory operations, analytical methods, technical development, and supervision of analysis. The Director for each location is provided (Figure 4.1) and a brief description of these key personnel is provided in the following paragraphs.

SOUTHERN CALIFORNIA

Dr. Blayne Hartman, Ph.D.

Dr. Hartman's daily responsibilities with respect to TEG include direction of laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review and method development, and direction of corporate development. Additional discussion of responsibility is presented in Section 4.4.

Dr. Hartman's academic research included a variety of chemical oceanography projects including: petroleum tracing using stable and radiogenic compounds as tracers; process controls across the air-water interface; and gas chromatography of dissolved gases in water and sediments.

Prior to founding Transglobal Exploration, Dr. Hartman was chief marine geochemist with InterOcean Systems where his responsibilities included direction of marine sediment and bottom-water geochemical exploration programs. As a research geochemist with Unocal Research, Dr. Hartman was responsible for development of geochemical prospecting techniques in onshore and offshore applications. These research operations included extensive method development and use of a variety of gas chromatography. Other research included use of stable metal isotopes as correlation parameters for organic materials. As founder and president of Transglobal Exploration & Geoscience in 1988, Dr. Hartman has been personally responsible for directing geochemical technical development, equipment design and maintenance, applications development, and implementation of exploration programs, analyses, and reporting.

TEG - TEXAS

Dr. Derhsing Luu, Ph.D.

Dr. Luu's daily responsibilities with respect to TEG/Texas include direction of laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review and method development.

Dr. Luu's academic research included a variety of novel automated analytical instruments development including: methanol analyzer and hydrocarbon analyzer.

Prior to founding TEG/Texas, Dr. Luu was R&D senior scientist with Global Geochemistry Corp. where his responsibility included development of methanol analyzer for CARB (California Air Resource Board) and hydrocarbon analyzer for Schlumberger. As a senior chemist for Air Toxic Lab with ENSR, Dr. Luu was responsible for daily laboratory operations and method development for air toxic laboratory. As an environmental laboratory manager and corporate QA officer with TRI (Texas Research Institute), Dr. Luu was responsible for supervising, performing GC/MS analysis, training, method developing for indoor air monitoring, and devising corporate QA/QC policy.

TEG - NORTHWEST

Michael Korosec, M.S.
Mr. Korosec's daily responsibilities with respect to TEG Northwest include direction of all laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review, marketing, and contract negotiations.

While with TEG, Korosec has developed unique preparation methods and analytical techniques for on-site analysis of PAH's, PCB's and chlorinated pesticides in soils, and PAH's and BTEX in tars.

Korosec's academic research included studies of the chemical and physical controls on the transport of dissolved nutrients across the sediment-water interface, using UV spectrophotometry and gas chromatography.

Prior to founding TEG/Northwest, Korosec was in charge of the state of Washington, Division of Geology and Earth Resources' Geothermal Exploration Program. The work included the development of a water analysis laboratory for the determination of dissolved cat ions, an ions and trace metals in thermal and mineral waters. Instrumentation included AA spectrophotometer, UV spectrophotometer, mercury analyzer and specific ion meters. Additional work included drilling programs for temperature gradient and heat-flow studies, whole rock geochemistry, age dating, and geologic mapping. As program manager, Korosec was responsible for all contracting, subcontracting and reporting to the U.S. Department of Energy.

TEG - SACRAMENTO

Mark Jerpbak, M.S., R.G.
Mr. Jerpbak's daily responsibilities with respect to TEG/Sacramento includes direction of all laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review, marketing, and contract negotiations.

Since 1981, Mr. Jerpbak has worked with several companies and agencies in geology and geochemistry in the United States and overseas, including: Ascension Island, Papau New

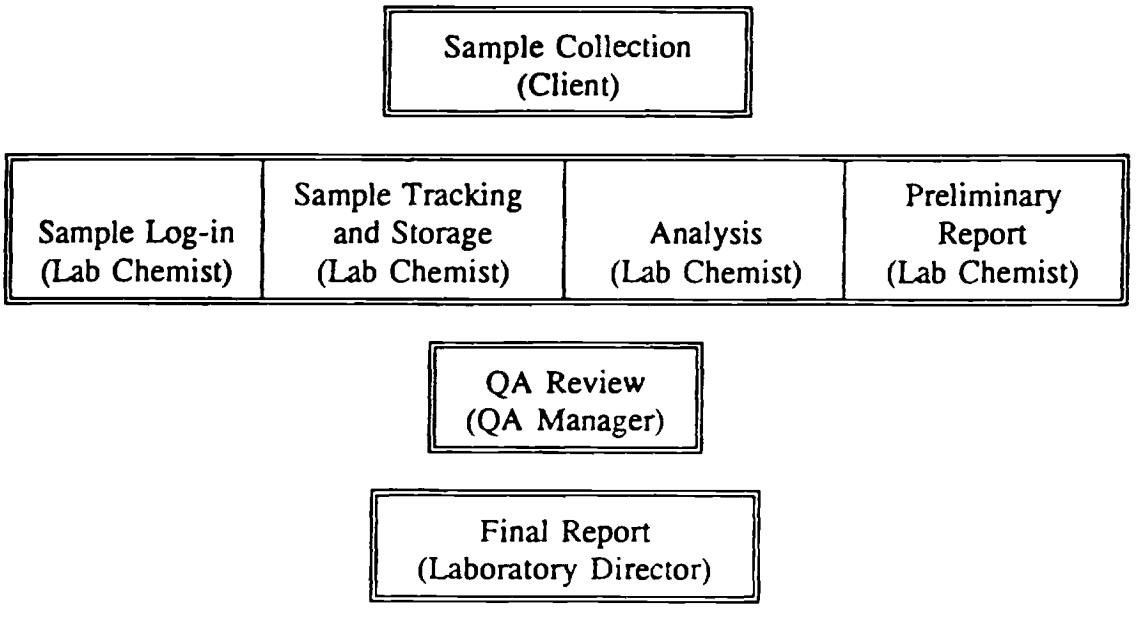
Guinea and Japan. His work has included gas chromatography in the petroleum industry, gas and vapor analyses and wet chemical titration in the geothermal industry, injection tests in active geothermal areas, and gas chromatography by EPA methods in the environmental industry. He has worked extensively in the field and in the mobile lab environment.

Mr. Jerpbak holds a M.S. degree from the University of Iowa in geology and geophysics. He is a California State Registered Geologist and also consults for the Yolo County Department of Public Health, and Environmental Health Services in California.

4.4 RESPONSIBILITIES

The mobile laboratories based in each location are personally supervised by one of the laboratory directors with the assistance of trained and experienced technicians. It is the responsibility of each director to maintain the QA/QC protocol or SOP set forth in this document. In order to review adherence to these procedures, periodic meetings are established to review project data and related QA concerns. Additional discussion of responsibilities regarding each position is presented in following paragraphs. A sample and data flow chart is provided below.

Figure 4-2. SAMPLE OF DATA FLOW CHART



The responsibility for maintaining the QA/QC program is divided into separate designated tasks, each with differing requirements as follows:

Lab Chemist. The lab chemist, or chemical analyst/technician, is responsible for implementing QA/QC procedures and record keeping in the preparation and analysis of samples, and for providing the initial review and interpretation of data within the framework of the QA/QC plan. In field situations, the lab chemist is also responsible for monitoring sampling activities, sample receipt, and sample control. Sample control duties include:

- sample receipt, unpacking, inspection, and verification;
- Chain-of-Custody Report completion;
- log-in of samples on proper tracking forms;
- placing samples in proper storage;
- notification of analysts and managers; and
- disposal or return of samples to client.

Analytical duties of the Lab Chemist include:

- daily maintenance, start-up and calibration of analytical equipment;
- daily monitoring of quality control protocol, such as refrigerator temperature calibration;
- preparation of standards for linearity checks;
- documentation of analyses, problems, QA, and maintenance of project files; and
- preparation of preliminary analytical report.

QA Manager. The QA Manager, is responsible for: establishing QA/QC procedures and specifications for each project; reviewing data and protocol; initiating and supervising audits; recommending appropriate corrective actions, and reporting to the directors. Specifically, the QA Manager is responsible for:

- data assembly, general review of project;
- verification of data completeness;
- verification of QA/QC compliance;
- verification of client requirements;
- review of preliminary report;
- preparation of QA report to include: technical difficulties, QA/QC results and conclusions; and
- implementation of the TEG QA program and technical training of personnel.

Health and Safety Officer. The Health and Safety (H&S) Officer at TEG is responsible for administrating the following duties:

- coordination of training programs in first aid, CPR, hazardous materials handling, emergency contingency planning, and right-to-know compliance;
- review and implementation of in-house and site-specific H&S Plans;

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- labeling and storage of hazardous materials;
- maintenance of Material Safety Data Sheets (MSDS) files;
- Resource Conservation Recovery Act small quantity generator record keeping; and
- H&S equipment ordering, maintenance, and record keeping.

Laboratory Director. It is the responsibility of the director to implement and maintain the overall quality assurance program at TEG. The director must meet regularly with the QA Manager to discuss general adherence to the program as well as specific QA problems or projects which require additional review and corrective action. Additional responsibilities of the Director include:

- preparation or review of SOPs and QA/QC protocol;
- implementation, updating and distribution of SOPs;
- training of key personnel;
- document control, security and confidentiality;
- technical application and development;
- resolution of QA and technical problems; and
- overall business management.

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5.0 QUALITY ASSURANCE OBJECTIVES

This section summarizes the quality assurance objectives for precision, accuracy, and method detection limit. These criteria are listed in Table 5-1 for each analytical parameter. The listed criteria are objectives for analysis of typical samples under nominal conditions and may not apply to samples in complex interfering matrices or to measurement of concentrations less than the listed detection limit for the method.

Precision, the measurement of mutual agreement among individual measurements of the same property under similar conditions, is expressed in terms of the percent maximum allowable relative difference, as standard deviation, within a set of replicate results and is assessed from duplicate and replicate analyses of the same sample. Accuracy goals are expressed as a range of acceptable recovery from the true value as assessed from standard deviation of reference samples and percent recoveries from matrix spikes and spike duplicates. Additional information regarding calculations for QA objectives may be found in Section 11.

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TABLE 5-1
QUALITY ASSURANCE OBJECTIVES

COMPONENT	MATRIX	METHOD	[1]PRECISION %RPD (Max.)	[2]ACCURACY %Recovery	MDL
PURGEABLE AROMATICS	Groundwater Surface Water Effluents	EPA 5030/602			ug/L
Benzene		15	75-110	0.30	
Toluene			15	75-110	0.30
Chlorobenzene			15	75-110	0.30
Ethylbenzene			15	75-110	0.30
1,3-Dichlorobenzene			15	75-110	0.30
1,2 and 1,4-Dichlorobenzene			15	75-110	0.30
m&p-Xylene			15	75-110	0.30
o-Xylene			15	75-110	0.30
PURGEABLE AROMATICS	Soils Sediments Solid Waste	EPA 3550/5030/8020			mg/kg
Benzene		15	75-110	0.005	
Toluene			15	75-110	0.005
Chlorobenzene			15	75-110	0.005
Ethylbenzene			15	75-110	0.005
1,3-Dichlorobenzene			15	75-110	0.005
1,2 and 1,4-Dichlorobenzene			15	75-110	0.005
m&p-Xylene			15	75-110	0.005
o-Xylene			15	75-110	0.005
TOTAL RECOVERABLE PETROLEUM HYDROCARBONS	Water	EPA 3510/418.1			mg/L 5.0
TOTAL RECOVERABLE PETROLEUM HYDROCARBONS	Soils	EPA 3550/418.1			mg/kg 0.5
TOTAL PETROLEUM HYDROCARBON**	Groundwater Surface Water Effluents	EPA 3510/5030/8015 modified	15	65-110	mg/L 0.5
TOTAL PETROLEUM HYDROCARBON**	Soils Sediments Solid Waste	EPA 3550/8015 modified	15	65-110	mg/kg 5.0

Modifications are discussed in Section 8.3.
Listed MDLs are from published EPA methods or based on historical TEO data.
** CA-DOHS modified EPA 8015 for fuels
1. Refer to Section 11.2 for definition of Precision.
2. Refer to Section 11.2 for definition of Accuracy, listed values from in-house data. Values also apply to surrogates.

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TABLE 5-1 (continued)
QUALITY ASSURANCE OBJECTIVES

COMPONENT	MATRIX	METHOD	[1]PRECISION %RPD (Max)	[2]ACCURACY %Recovery*	MDL
PURGEABLE HALOCARBONS	Groundwater Surface water Effluents	EPA 5030/601			ug/L
Bromoform			15	13-159	0.3
Bromomethane			15	D-144	0.3
Carbon Tetrachloride			15	43-143	0.3
Chlorobenzene			15	38-150	0.3
Chloroethane			15	46-137	0.3
Chloroform			15	49-133	0.3
Chloromethane			15	D-193	0.3
Dibromochloromethane			15	24-191	0.3
1,3-Dichlorobenzene			15	7-187	0.3
2-and 1,4-Dichlorobenzene				15	42-1430.3
1,1-Dichloroethane			15	47-132	0.3
1,2-Dichloroethane			15	51-147	0.3
1,1 Dichloroethene			15	28-167	0.3
trans-1,2-Dichloroethene			15	38-155	0.3
1,2-Dichloropropane			15	44-156	0.3
cis-1,3-Dichloropropene			15	22-178	0.3
trans-1,3-Dichloropropene		15	22-178		0.3
Ethylene Dibromide			15	50-150	0.3
Methylene Chloride			15	25-162	0.3
1,1,2,2-Tetrachloroethane			15	8-184	0.3
Tetrachloroethane			15	26-162	0.3
1,1,1-Trichloroethane			15	41-138	0.3
1,1,2-Trichloroethane			15	39-136	0.3
Trichloroethane			15	35-146	0.3
Trichlorofluoromethane			15	21-156	0.3
Vinyl Chloride			15	28-163	0.3

* Recovery limits taken from SW 846.

Listed MDLs are from published EPA methods or based on historical TEG data.

1. Refer to Section 11.2 for definition of Precision.
2. Refer to Section 11.2 for definition of Accuracy, listed values from in-house data. Values also apply to surrogates.

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TABLE 5-1 (continued)
QUALITY ASSURANCE OBJECTIVES

[1]PRECISION COMPONENT	[2]ACCURACY MATRIX	METHOD	%RPD (Max)	%Recovery	MDL
PURGEABLE HALOCARBONS	Soils and Sediments	EPA 3550/5030/8010			mg/kg
Bromoform			15	60-125	0.005
Bromomethane			15	60-125	0.005
Carbon Tetrachloride			15	65-120	0.005
Chlorobenzene			15	65-120	0.005
Chloroethane			15	65-120	0.005
Chloroform			15	65-120	0.005
Chloromethane			15	65-120	0.005
Dibromochloromethane			15	65-120	0.005
1,3-Dichlorobenzene			15	65-120	0.005
1,2 and 1,4-Dichlorobenzene				15	65-1200.005
1,1-Dichloroethane			15	65-120	0.005
1,2-Dichloroethane			15	65-120	0.005
1,1-Dichloroethene			15	65-120	0.005
trans-1,2-Dichloroethene			15	60-125	0.005
1,2-Dichloropropane			15	60-125	0.005
cis-1,3-Dichloropropene			15	60-125	0.005
trans-1,3-Dichloropropene		15	60-125		0.005
Ethylene Dibromide					0.005
Methylene Chloride			15	60-125	0.005
1,1,2,2-Tetrachloroethane			15	60-125	0.005
Tetrachloroethane			15	60-125	0.005
1,1,1-Trichloroethane			15	60-125	0.005
1,1,2-Trichloroethane			15	60-125	0.005
Trichloroethane			15	60-125	0.005
Trichlorofluoromethane			15	60-125	0.005
Vinyl Chloride			15	50-125	0.005

Listed MDLs are from published EPA methods or based on historical TEG data.

1. Refer to Section 11.2 for definition of Precision.
2. Refer to Section 11.2 for definition of Accuracy, listed values from in-house data. Values also apply to surrogates.

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TABLE 5-1 (continued)
QUALITY ASSURANCE OBJECTIVES

COMPONENT	MATRIX	METHOD	[1]PRECISION %RPD (Max)	[2]ACCURACY %Recovery	MDL
POLYNUCLEAR AROMATIC HYDROCARBONS	Groundwater Surface water Effluents	EPA 3510/610			ug/L
Acenapthene			20	65-125	10
Acenapthylene			20	65-125	10
Anthracene			20	65-125	10
Benzo(a)anthracene			20	65-125	20
Benzo(a)pyrene			20	65-125	20
Benzo(b)fluoranthene			20	65-125	20
Benzo(ghi)perylene			20	65-125	20
Benzo(k)fluoranthene			20	65-125	20
Chrysene			20	65-125	20
Dibenzo(a,h)anthracene			20	65-125	30
Fluoranthene			20	65-125	10
Fluorene			20	65-125	10
Indeno(1,2,3-cd)pyrene			20	65-125	30
Napthalene			20	65-125	10
Phenanthrene			20	65-125	10
Pyrene			20	65-125	10
POLYNUCLEAR AROMATIC HYDROCARBONS	Soils and Sediments	EPA 3550/8100			mg/kg
Acenapthene			20	65-125	0.1
Acenapthylene			20	65-125	0.1
Anthracene			20	65-125	0.1
Benzo(a)anthracene			20	65-125	0.1
Benzo(a)pyrene			20	65-125	0.1
Benzo(b)fluoranthene			20	65-125	0.1
Benzo(ghi)perylene			20	65-125	0.1
Benzo(k)fluoranthene			20	65-125	0.1
Chrysene			20	65-125	0.1
Dibenzo(a,h)anthracene			20	65-125	0.5
Fluoranthene			20	65-125	0.2
Fluorene			20	65-125	0.2
Indeno(1,2,3-cd)pyrene			20	65-125	0.5
Napthalene			20	65-125	0.2
Phenanthrene			20	65-125	0.2
Pyrene			20	65-125	0.2

Listed MDLs are from published EPA methods or based on historical TEG data.

1. Refer to Section 11.2 for definition of Precision.
2. Refer to Section 11.2 for definition of Accuracy, listed values from in-house data. Values also apply to surrogates.

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TABLE 5-1 (continued)
QUALITY ASSURANCE OBJECTIVES

COMPONENT	MATRIX	METHOD	[1]PRECISION %RPD (Max)	[2]ACCURACY %Recovery	MDL
PHENOLS	Groundwater Surface water Effluents	EPA 3510/604			ug/L
2,3,4-Trichlorophenol			20	65-125	.01
2,4,6-Trichlorophenol			20	65-125	.01
2,4-Dichlorophenol			20	65-125	.01
2,4-Dimethylphenol			20	65-125	.01
2,4-Dinitrophenol			20	65-125	.03
2,6-Dichlorophenol			20	65-125	.03
2 - Methylphenol		20	65-125		.01
2 - Chlorophenol			20	65-125	.01
2 - Methyl 4,6 - Dinitrophenol			20	65-125	.03
2 - Nitrophenol			20	65-125	.01
4 - Methylphenol		20	65-125		.03
4 - Chloro 3 - Methylphenol			20	65-125	.01
4 - Nitrophenol			20	65-125	.03
Pentachlorophenol			20	65-125	.01
Phenol			20	65-125	.01
PHENOLS	Soils and Sediments	EPA 3550/8040			mg/kg
2,3,4-Trichlorophenol			20	65-125	.2
2,4,6-Trichlorophenol			20	65-125	.2
2,4-Dichlorophenol			20	65-125	.2
2,4-Dimethylphenol			20	65-125	.2
2,4-Dinitrophenol			20	65-125	.5
2,6-Dichlorophenol			20	65-125	.5
2 - Methylphenol		20	65-125		.2
2 - Chlorophenol			20	65-125	.2
2 - Methyl 4,6 - Dinitrophenol			20	65-125	.5
2 - Nitrophenol			20	65-125	.2
4 - Methylphenol		20	65-125		.5
4 - Chloro 3 - Methylphenol			20	65-125	.2
4 - Nitrophenol			20	65-125	.5
Pentachlorophenol			20	65-125	1.0
Phenol			20	65-125	.2

Listed MDLs are from published EPA methods or based on historical TEG data.

1. Refer to Section 11.2 for definition of Precision.
2. Refer to Section 11.2 for definition of Accuracy, listed values from in-house data. Values also apply to surrogates.

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TABLE 5-1 (continued)

COMPONENT	MATRIX	METHOD	[1]PRECISION %RPD (Max)	[2]ACCURACY %Recovery	MDL
PCB'S	Groundwater Surface water Effluents	EPA 3510/608			ug/L
PCB 1016			20	65-125	20
PCB 1221			20	65-125	50
PCB 1232			20	65-125	20
PCB 1242			20	65-125	15
PCB 1248			20	65-125	15
PCB 1254			20	65-125	10
PCB 1260			20	65-125	10
4,4 -DDD			20	65-125	0.05
4,4 -DDE			20	65-125	0.05
4,4 -DDT			20	65-125	0.05
Aldrin			20	65-125	0.05
alpha -BHC			20	65-125	0.05
beta -BHC			20	65-125	0.05
gamma -BHC			20	65-125	0.05
delta -BHC			20	65-125	0.05
Dieldrin		20	65-125		0.05
Endosulfan I			20	65-125	0.05
Endosulfan II			20	65-125	0.05
Endosulfan sulfate			20	65-1[illegible]	0.05
Endrin			20	65-12[illegible]	0.05
Endrin aldehyde			20	65-125	0.05
Heptachlor			20	65-125	0.05
Heptachlor epoxide			20	65-125	0.05
PCB'S	Soils and Sediments	EPA 3550/8080			mg/kg
PCB 1016			20	65-125	300
PCB 1221			20	65-125	800
PCB 1232			20	65-125	300
PCB 1242			20	65-125	200
PCB 1248			20	65-125	200
PCB 1254			20	65-125	100
PCB 1260			20	65-125	100
4,4 -DDD			20	65-125	0.5
4,4 -DDE			20	65-125	0.5
4,4 -DDT			20	65-125	0.5
Aldrin			20	65-125	0.5
alpha -BHC			20	65-125	0.5
beta -BHC			20	65-125	0.5
gamma -BHC			20	65-125	0.5
delta -BHC			20	65-125	0.5
Dieldrin		20	65-125		0.5
Endosulfan I			20	65-125	0.5
Endosulfan II			20	65-125	0.5
Endosulfan sulfate			20	65-125	0.5
Endrin			20	65-125	0.5
Endrin aldehyde			20	65-125	0.5
Heptachlor			20	65-125	0.5
Heptachlor epoxide			20	65-125	0.5

Listed MDLs are from published EPA methods or based on historical TEC data.

1. Refer to Section 11.2 for definition of Precision.
2. Refer to Section 11.2 for definition of Accuracy, listed values from in-house data. Values also apply to surrogates.

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6.0 SAMPLING PROCEDURES

6.1 SAMPLE CONTAINERS, PRESERVATION, HOLDING

Sample collection activities will not be performed by TEG. TEG prepares sampling packages consisting of appropriate containers with preservatives, coolers with ice, and chain-of-custody records. Sampling guidance documents are posted and available for reference at the fixed-base laboratory and mobile laboratories. Of key importance are procedures designed to reduce the potential for cross contamination of samples and volatilization of purgeables. A list of sampling containers and volumes, preservatives, and holding times is provided below in Table 6-1.

TABLE 6-1
CONTAINERS, PRESERVATION, AND HOLDING TIMES

PARAMETER	MATRIX	CONTAINER	PRESERVATION	HOLDING TIME
Organic Extractables	Soil/Waste	Glass Jar[1]	4°C	14 Days Until Extract.
	Water	100mL Glass Bottle	4°C	14 Days Until Extract. (30 Days extract to Analysis)
Purgeables (aromatics and halocarbons)	Soil/Waste	Glass Jar[1]	4°C,	14 Days (ASAP)
	Water	2x40mL VOA[2]	4°C, HCl[3] to pH<2	14 Days (ASAP)

1 Approximately 250mL capacity jar with Teflon®-lined cap or drive-sample core tube with Teflon®-lined cap.
2 Volatile Organic Analysis Vials.
3 Reagent grade HCl is used for preservation.

6.2 CLEANING

Most of TEG's glassware is of the disposable type and is not reused. For the small amount that is reused, the following cleaning procedures are used:

- wash with Alconox detergent and hot water;
- rinse thoroughly with tap water;
- rinse thoroughly with distilled water;
- rinse with reagent grade purge-and-trap methanol (retain rinsate);
- air dry;
- visually inspect; and
- analyze methanol rinsate for potential remnant contamination, as appropriate.

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6.3 WASTE DISPOSAL

TEG is classified as a conditionally-exempt small quantity generator of hazardous wastes according to 40CFR Part 261. TEG generates less than 100 kg of hazardous waste per month. This hazardous waste is composed mostly of analytical solvents which are stored in acceptable containers and recycled by an approved facility.

Environmental samples analyzed by the laboratory are the property of the client, and in most cases involving on-site analysis, the samples are retained at the site. Samples which are analyzed at the laboratory are returned to the client with chain-of-custody report unless specific arrangements are made for disposal. Samples retained by TEG are disposed of by a licensed hazardous soil firm.

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7.0 SAMPLE CUSTODY PROCEDURES

7.1 SAMPLE CUSTODY OBJECTIVES

The purpose of this section is to provide an outline of sample custody protocol. This protocol is established for the purpose of providing traceability of samples and containers from point of origin to final disposition of the samples and to identify parties responsible for handling and transport of samples.

7.2 FIELD CUSTODY

TEG does not engage in field sampling services. Sampling is the responsibility of the consultant or client. The chain of custody protocol for the laboratory begins when sample containers are released by the laboratory for the sampler's use. If the client provides their own containers, TEG's chain-of-custody begins with sampling by the client. A TEG chain of custody record (Figure 7-1) is prepared by the TEG field chemist and provided to the sampler with the containers. A note regarding origin of sample containers is made under the "special instructions" heading on the form. The TEG chain of custody record is a three-color triplicate form. The bottom copy is retained by the sampler. The original (top) form and one copy are delivered to the laborat ' with the samples. The completed original is then returned to the client with the analytical report. A copy of the completed original is maintained in the project file by the laboratory.

7.3 LABORATORY CUSTODY

Sample Receipt. Samples are received at TEG by the field chemist who is in charge of documentation for the job. Sample receipt and verification protocol is as follows:

- note presence, absence, and condition of the shipping container tape and custody seals;
- remove samples and documents from shipping vessel;
- organize samples by client ID numbers; and
- make notes regarding: temperature; breakage or opening; headspace in VOAs; septa orientation; labeling.

Sample Log-In. The following protocol is used for sample log-in:

- each batch of samples is assigned a project number;
- each sample is verified and matrix confirmed with the chain-of-custody record (Chain of Custody Record, Figure 7-1.);
- completeness of chain-of-custody report is noted;
- each sample is assigned a unique laboratory identification number;
- notes regarding condition received, integrity, seals, preservation, and any peculiarities are entered;

- the Chain-of-Custody Report is signed, discrepancies noted, reasons for sample rejection noted;
- the samples are then stored in a limited access area and stored on ice or refrigerated, as appropriate; and
- samples are stored separately from standards, VOC samples are stored separately from other samples and standards.

The chemist logging in the samples, is responsible for noting irregularities and rejection of samples. Criteria for sample rejection include:

- elevated temperature, if cooling necessary;
- breakage or leakage;
- evidence of seal tampering;
- missing or duplicate samples;
- incomplete chain of custody record;
- missing labels;
- lack of preservation;
- insufficient sample for specified analyses;
- improper sample containers; and
- headspace in VOAs for VOC analysis.

Sample Security. Samples are stored in a limited access area of the mobile laboratory. Samples requiring cooling are stored in a refrigerator.

Sample Distribution and Tracking. Samples are signed out from storage by the field chemist or analyst. An Extraction Log (Figure 7-2) and an Analysis Log (Figure 7-3) are maintained by the analyst. On completion of analysis, or taking an aliquot from the sample, the remaining sample, and any excess extract or digest, is returned to storage.

Each form used in tracking and handling the sample requires time, date and initials or signature of persons performing the work. In the TEG mobile laboratory setting, the same field chemist is generally in charge of all phases of sample tracking from receipt to analysis. Although most samples are analyzed within a few hours of receipt, it is the responsibility of the field chemist to meet holding time constraints in the extraction and analysis of samples. Laboratory analytical reports include dates and time of sampling, extraction, and analyses subject to review by the QA Manager to assure that timing criteria have been achieved.

Samples and extracts are retained for 15 days following reporting, at which point they are returned to the client, via chain-of-custody record, or disposed of in an approved manner consistent with the nature of the sample. Longer storage may occur by prior arrangement with the client. Sample disposition is conducted in accordance with waste disposal guidelines described in Section 6.3.

Samples transferred to other laboratories are packaged at appropriate temperatures and shipped with chain-of-custody record. The same information required in the above-listed protocol for sample custody applies to samples and extracts shipped to other laboratories.

Document Control. TEG maintains a document control program to provide guidelines in reducing the potential for document loss and mix-ups. The data generator (field chemist) is responsible for initiating a file for each batch of samples on delivery to the laboratory. The following procedures are implemented as part of the document control process:

- a job file is labeled with job number and client name;
- a Project / Report Checklist Form (Figure 7-4) is initialized in duplicate;
- on completion of each task, or at the end of each day, all paperwork and forms generated for the project are transferred to the master file with the contents noted on the inventory form;
- all magnetic computer media is to be backed up to a floppy disk which is stored with the job file; and
- on completion of the project, the report preparer will close the file by verifying all contents are present and sending the file on for signature.

7.4 ELECTRONIC DATA RECORDS

TEG uses microcomputers for data storage and reporting purposes. Initial chromatographic data gathering is performed by integrators which print a chromatogram and report integration. Parameters of integration are established for each analysis. It is the responsibility of the field chemist to evaluate each chromatogram with regard to correct integration, peak identification, and calibration. Verified numeric data from the chromatogram is then manually entered into a spreadsheet on the microcomputer. A spreadsheet file is created from a generic starter file for each project and analytical method. The spreadsheet data is saved on a floppy disk which is stored in the job file.

Figure 7-1. Chain of Custody Record

TRANSGLOBAL ENVIRONMENTAL GEOCHEMISTRY, INC.

CHAIN-OF-CUSTODY RECORD

CLIENT: _____ DATE: _____ PAGE _____ OF _____

ADDRESS: _____ TEG PROJECT #: _____

PHONE: _____ FAX: _____ LOCATION: _____

CLIENT PROJECT #: _____ PROJECT MANAGER: _____ COLLECTOR: _____ DATE OF COLLECTION: _____

Sample Number	Depth	Time	Sample Type	Container Type	ANALYSES: VOA 601/8010	VOA 602/8020	VOA 624/8240	Semi Vol 625/8270	TPH 418.1	TPH 8015	TPH 8015	TPH 8015	PNA 610/8100	PEST/PCBs 8080	HEX CHROME	ORGANIC LEAD	TOTAL LEAD	pH	ASBESTOS					FIELD NOTES	Total Number Of Containers	Laboratory Note Number

RELINQUISHED BY (Signature) DATE/TIME RECEIVED BY (Signature) DATE/TIME

RELINQUISHED BY (Signature) DATE/TIME RECEIVED BY (Signature) DATE/TIME

SAMPLE DISPOSAL INSTRUCTIONS

☐ TEG DISPOSAL @ $2.00 each ☐ Return ☐ Pickup

SAMPLE RECEIPT	
TOTAL NUMBER OF CONTAINERS	
CHAIN OF CUSTODY SEALS Y/N/NA	
SEALS INTACT? Y/N/NA	
RECEIVED GOOD COND./COLD	
NOTES:	

LABORATORY NOTES:

Figure 7-2. Extraction Log

____of____

TEG EXTRACTION LOG

CLIENT: _____ CLIENT PROJECT #: _____

DATE: _____ TEG #: _____ ANALYST/S: _____

LOCATION: _____

EPA Method:	Matrix:	Solvent:	Method:
8010/601 ____	Water ____	Methylene Cl ____	Hand Shake ____
8020/602 ____	Soil ____	Carbon S2 ____	Cont. Liq/Liq ____
8015 ____	Sludge ____	Hexane ____	Sonication ____
418.1 ____	Other ____	Methanol ____	Soxhlet ____
Other ____		Freon-113 ____	Other ____

SAMPLE #	TIME	ESTIMATED CONCENTRATION				SPIKE			INITIAL ALIQUOT	SOLVENT
		Hi	Med	Lo	Unk	ID	Con	Vol	gms	mls

Figure 7-3. Analysis Logs

173057

teg

TRANSGLOBAL ENVIRONMENTAL GEOCHEMISTRY, INC.

EPA METHOD 601/8010 AND 602/8020 ANALYSES LOG

TEG JOB#: _____ CLIENT: _____ CLIENT JC _____

DATE: _____ ANALYST: _____ INSTRUM.: _____

SAMPLE:										
MATRIX:										
RUN #:										
ANALYTE: TIME:										
1,1 DICHLOROETHENE										
METHYLENE CHLORIDE										
,2 trans DICHLOROETHENE										
,1 DICHLOROETHANE										
CHLOROFORM										
1,2 cis DICHLOROETHENE										
1,1,1 TRICHLOROETHANE										
CARBON TETRACHLORIDE										
,2 DICHLOROETHANE										
TRICHLOROETHENE										
1,2 DICHLOROPROPANE										
BROMODICHLOROMETHA										
DICHLOROPROPENE										
,1,2 TRICHLOROETHANE										
TETRACHLOROETHENE										
TETRACHLOROETHANE										
CHLOROBENZENE										
ENZENE										
OLUENE										
ETHYLBENZENE										
M&P XYLENE										
O XYLENE										
OTAL XYLENES										

Figure 7-3. Analysis Logs Continued

teg

EPA METHOD 608/8080 AND PCB ANALYSES LOG

TRANSGLOBAL ENVIRONMENTAL GEOCHEMISTRY, INC.

TEG JOB#: _____ CLIENT: _____ CLIENT JOB# _____

DATE: _____ AN. ST: _____ INSTRUM.: _____

SAMPLE:										
MATRIX:										
RUN #:										
TE: TIME:										
-BHC										
-BHC										
CHLOR										
N										
IC										
-BHC										
ACHLOR EPOXIDE										
SULFAN I										
E										
RIN										
N										
-DDD										
SULFAN II										
T										
N ALDEHYDE										
SULFAN SULFATE										
UTYL CHLORENDATE										
PE IDENTIFIED:										
PE IDENTIFIED:										

Figure 7-3. Analysis Logs Continued

17325

____of____ TEG ANALYSIS LOG EPA 418.1 TRPH

CLIENT: _____ CLIENT PROJECT #: _____

DATE: _____ TEG #: _____ ANALYST/S: _____

LOCATION: _____

CONDITIONS: _____ INSTRUMENT: BUCK IR

EQTNS: Hi_____>_____ Lo_____<_____

SAMPLE #	TIME	RUN	ABS	DIL	CONC	COMMENTS

Figure 7-3. Analysis Logs Continued

173260

____of____ TEG ANALYSIS LOG EPA 8015 FID #: _____

CLIENT: _____ CLIENT PROJECT #: _____

DATE: _____ TEG #: _____ ANALYST/S: _____

LOCATION: _____

CONDITIONS: _____ INSTRUMENT: SHIMADZU GC14A

Gas Factor: _____ Diesel Factor: _____

SAMPLE #	TIME	RUN	VOL	GAS AREA	GAS CONC	DIESEL AREA	DIESEL CONC	COMMENTS

173261

Figure 7-3. Analysis Logs Continued

____of____ TEG ANALYSIS LOG EPA 8020 BTEX

CLIENT: _____ CLIENT PROJECT #: _____

DATE: _____ TEG #: _____ ANALYST/S: _____

LOCATION: _____

CONDITIONS: _____ INSTRUMENT: SHIMADZU GC8A

SAMPLE #	Time	Run	Vol	Benz	Tol	Clbnz	Eth	M&P Xyl	O Xyl	Comments

Figure 7-4. Project / Report Checklist Form

173264

PROJECT / REPORT CHECKLIST

NEED	DONE	
☐	☐	*Preliminary Data*
		☐ To Client on-site ☐ Faxed to client
☐	☐	TEG *additional* analyses
		☐ 8010 ☐ 8015 ☐ 8020 ☐ 418.1 ☐ Other_____
☐	☐	Outside analyses: _____
		☐ ATI ☐ CAL ☐ Other lab _____
☐	☐	Spreadsheet transferred to current floppy disk
☐	☐	Data tables completed
☐	☐	QA/QC-Matrix Spike & Method Blank data included
☐	☐	Cover letter
☐	☐	Certification number - correct/match
☐	☐	Invoice - copy for:
		☐ Client ☐ Other party ☐ Accounting ☐ File-copy
☐	☐	Chain-of-Custody - signed & completed
☐	☐	Final Review
☐	☐	Report to client:
		☐ Mail ☐ Deliver
☐	☐	*Additional Report(s) to:*
		☐ DCHS ☐ HMMD ☐ Orange Co. CHS ☐ Other_____
☐	☐	Report/Data to be added/included with:
		TEG Project # _____
		Client/Company _____

173263

8.0 ANALYTICAL PROCEDURES

8.1 METHOD REFERENCES

The analytical methods used at TEG are based on procedures in the following references:

- **U.S. EPA Document SW-846**, Test Methods for Evaluating Solid Waste, Third Edition, November, 1986, and Draft Revision 1, December 1987;
- **U.S. EPA Document 600/4-79-020**, Methods for Chemical Analysis of Water and Wastes, March 1983;
- **U.S. Code of Federal Regulations 40**, Protection of Environment, Part 136, Guidelines Establishing Test Procedures for the Analysis of Pollutants, July 1, 1989;
- **U.S. Code of Federal Regulations 40**, Protection of Environment, Part 141, National Primary Drinking Water Regulations, July 1, 1989; and
- **California State Water Resources Control Board**, Division of Water Quality, Leaking Underground Fuel Tank Field Manual, December 17, 1987.

This section of the document provides an outline of the analytical methods referenced in Table 5-1. Data packages generated by TEG for certification of EPA methods are available upon request.

8.2 EPA METHODS 601 and 8010

Introduction. The purpose of this procedure is to describe the GC method for determination of purgeable halogenated hydrocarbons in soils, solid wastes, and waters using the Hall Detector. Details of the method are found in EPA Document SW-846. Presented below is an overview of the method in terms of calibration, operating conditions, compound identification, and calculations. This method can be modified to include analysis of EDB with an electron capture detector in accordance with the requirements of certain states.

Calibration. Calibration may be accomplished by either internal or external standard techniques. Standards are prepared at five concentrations spanning the linear range of the instrument. The standards are then analyzed and the response factor evaluated for linearity. If linearity is not achieved a second set of analyses is run. If linearity is still not achieved, a second set of standards is prepared and the process repeated. Linearity is acceptable when response factor values are within 15% standard deviation for internal standard calculations or if the mean residual from the linear regression is within 15%.

Water Sample Preparation. For aqueous samples, a 5mL aliquot is generated and spiked with internal standards and (or) surrogates in a gas tight syringe. Purge and Trap operation is performed in general accordance with EPA method 5030. The sample is purged for eight minutes at a flow rate of 30mL per minute.

Soils and Solid Wastes. A solvent extraction is first performed using methanol. The methanolic extraction is achieved by placing ten grams of the soil sample into a 40mL VOA (volatile organic analysis) vial, adding 10uL of surrogate soil spike (1000ng/uL in methanol), and 10mL of reagent purge-and-trap grade methanol. The VOA is then hand shaken for two minutes and placed in a water-bath sonicator for ten minutes. Depending on anticipated concentration, 10 to 50uL of the extract is then added to 5mL of volatile free water in the purge and trap or 3ul of the extract is directly injected into the gas chromatograph.

Purge and Trap Conditions.

Instrument:	Tekmar LSC 2000
Purge flow:	20mL/min to 30mL/min
Purge time:	8 minutes
Dry purge time:	8 minutes
Desorb time:	3 minutes
Desorb temperature:	275 degrees C
Bake time:	10 minutes
Bake temperature:	290 degrees C

Gas Chromatography.

Instrument:	Gas Chromatograph
Column:	50 to 100 meter by 0.053mm, RT 502.2, megabore capillary.
Carrier flow:	Helium at 15mL/min.
Detector:	Electrolytic Conductivity detector.
Detector temperature:	225 degrees C
Injector temperatures:	175 degrees C
Column oven:	45 degrees C for 2 minutes 45 to 200 degrees C at 5/minute

Standard Preparations. Primary 8010 standards at 100mg/L (ppm)in methanol are purchased from a certified supplier.
Secondary Standards (1ng/uL): dilute primary standard by 100 times (100uL to 10mL).

Water Matrix Spikes. For 1ug/L (1 ppb) water concentration, add 5uL of 1ng/uL (ppm) secondary 601 standard to 5mL of water (1,000 times dilution).

Soil Matrix Spikes. For 1mg/kg (1 ppm) soil concentration, add 100uL of 100 ng/uL primary standard to ten grams of soil.

Typically, the following 10 compounds are quantified on matrix spikes covering early, middle, and late eluters: methylene chloride, 1,2-dichloroethane, 1,1-dichloroethane, chloroform, 1,1,1-trichloroethane, carbon tetrachloride, trichloroethylene, 1,1,2-trichloroethane, tetrachloroethylene, and tetrachloroethane. Other compounds are used depending upon the target compounds executed.

Calculations of Sample Concentrations.

173265

Water Samples

Concentration (ug/L) = [(Ax * A)/(As * Vs)] * D

Soil Samples

Concentration (ng/g) = [(Ax * A * Vt * D)/(As * Vi * W)]. Where:

Ax	is the area counts for the sample - method blank
A	is the amount of standard injected (ng)
As	is area counts for the standard
Vi	is the volume of extract injected (uL)
D	is the dilution factor on the sample
Vt	is the volume of total extract (uL)
Vs	is the volume of water extracted (mL)
W	is the weight of soil extracted (g)

For the standard procedures employed by TEG, these equations reduce to:

Water Samples: Conc (ug/L; ppb) = measured mass (ng)/5

Compound Identification. This method is used to identify and quantify the analytes listed in Table 5-1.

8.3 EPA METHODS 602 and 8020

Introduction. The purpose of this procedure is to describe the GC method for determination of volatile aromatic hydrocarbons in soils, solid wastes, and waters using a photoionization detector. Details of the method are found in EPA Document SW-846. Presented below is an overview of the method in terms of calibration, operating conditions, compound identification, and calculations. This method can be modified to include Methyl tert-Butyl Ether (MTBE) in accordance with the requirements of certain states.

Calibration. Calibration may be accomplished by either internal or external standard techniques. Standards are prepared at five concentrations spanning the linear range of the instrument. The standards are then analyzed and the response factor evaluated for linearity. If linearity is not achieved a second set of analyses is run. If linearity is still not achieved, a second set of standards is prepared and the process repeated. Linearity is acceptable when response factor values are within 15% standard deviation for internal standard calculations or if the mean residual from the linear regression is within 15%.

17336

Sample Preparation

Water Samples A 5mL aliquot of water is spiked with 5uL of 1 ng/uL surrogate standard (chlorobenzene) and extracted by purge and trap.

Soil Samples 10 grams of soil are weighed to the nearest 0.1 gram and placed into a clean VOA vial with 10mL of purge and trap grade methanol or freon-113. The VOA vial is shaken for 2 minutes, placed into a water bath and sonicated for 10 minutes. After sonication, the slurry is allowed to settle and 10 to 50uL of solvent are withdrawn, added to 5mL of water, and extracted by purge and trap or 3ul of the extract is directly injected into the gas chromatograph.

Purge and Trap Conditions.

Instrument:	Tekmar LSC 2000
Purge flow:	20mL/min to 30mL/min
Purge time:	8 minutes
Dry purge time:	8 minutes
Desorb time:	3 minutes
Desorb temperature:	275 degrees C
Bake time:	10 minutes
Bake temperature:	290 degrees C

Gas Chromatography.

Instrument:	Gas Chromatograph
Column:	30 meter by 0.053mm , DB-1 or DB-5, megabore capillary.
Carrier flow:	Helium at 15mL/min.
Detector:	Photoionization detector.
Detector temperature:	225 degrees C
Injector temperatures:	175 degrees C
Column oven:	45 degrees C for 4 minutes 45 to 175 degrees C at 10/minute

Standard Preparations. Primary 8020 standards at 100mg/L (ppm)in methanol are purchased from a certified supplier.
Secondary Standards (1ng/uL): dilute primary standard by 100 times (100uL to 10mL).

Water Matrix Spikes. For 1ug/L (1 ppb) water concentration, add 5uL of 1ng/uL (ppm) secondary 602 standard to 5mL of water (1,000 times dilution).

Soil Matrix Spikes. For 1mg/kg (1 ppm) soil concentration, add 100uL of 100 ng/uL primary standard to ten grams of soil.

Matrix spikes consist of the following compounds: benzene, toluene, chlorobenzene, ethylbenzene, m-xylene, o-xylene, and p-xylene.

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Calculations of Sample Concentrations.
Water Samples

Concentration (ug/L) = [(Ax * A)/(As * Vs)] * D

Soil Samples

Concentration (ng/g) = [(Ax * A * Vt * D)/(As * Vi * W)]. Where:

Ax	is the area counts for the sample - method blank
A	is the amount of standard injected (ng)
As	is area counts for the standard
Vi	is the volume of extract injected (uL)
D	is the dilution factor on the sample
Vt	is the volume of total extract (uL)
Vs	is the volume of water extracted (mL)
W	is the weight of soil extracted (g)

For the standard procedures employed by TEG, these equations reduce to:

Water Samples: Conc (ug/L; ppb) = measured mass (ng)/5

Soil Samples: Conc (mg/kg; ppm) = measured mass (ng)/Vi

Compound Identification. This method is used to identify and quantify the analytes listed in Table 5-1.

8.4 EPA METHOD 8015 TPH

Introduction. The purpose of this procedure is to describe the GC method for determination of Total Petroleum Hydrocarbons (TPH) in soils, solid wastes, and waters using a flame ionization detector. Details of the method are found in EPA Document SW-846 and the California LUFT Manual. The method is applicable to determination of gasoline, diesel, and other volatile and semi-volatile fuels in water, soils, and wastes. This method is approved by California Department of Health Services as a quantitative method for the determination of total fuels content.

Calibration. Calibration is accomplished by using external standard techniques. Standards are prepared at three concentrations spanning the linear range of the instrument. Standards composed of the anticipated fuel product to be analyzed are used for the calibration. The standards are then analyzed and the response factor evaluated for linearity. If linearity is not achieved a second set of analyses is run. If linearity is still not achieved, a second set of standards is prepared and the process repeated. Linearity is acceptable when response factor values are within 15% standard deviation for internal standard calculations or if the mean residual from the linear regression is within 15%.

Sample Preparation and Extraction 173263

Water Samples. A 33mL aliquot of water is extracted with 1mL of solvent by shaking vigorously for 5 minutes in a clean 40mL VOA vial. The mixture is allowed to settle and 3uL of solvent are withdrawn and injected into the gas chromatograph.

Soil Samples. 10 grams of soil are weighed to the nearest 0.1 gram and placed into a clean VOA vial with 10mL of solvent and NaSO4. The VOA vial is shaken for 2 minutes, and sonicated for 10 minutes. After sonification, the slurry is allowed to settle and 3uL of solvent are withdrawn and injected into the gas chromatograph.

Gas Chromatography.

Instrument:	Gas Chromatograph with FID
Column:	30 meter by 0.053, DB-1, megabore capillary.
Carrier flow:	Helium at 15mL/min.
Injector temperature:	175 degrees C
Detector temperatures:	225 degrees C
Column oven:	45 degrees C for 4 minutes, 45 to 205 degrees C at 10/min, Hold at 205 degrees C for 10 minutes.

Standard Preparation.

Substock Calibration Standards (in trichlorotrifluoroethane)

Low calibration standard (20 ng/uL): add 0.25uL gasoline to 10mL solvent.
Mid calibration standard (200 ng/uL): add 2.5uL gasoline to 10ml solvent.
High calibration standard (2000 ng/uL): add 25uL gasoline to 10mL solvent.

Low calibration standard (50 ng/uL): add 0.55uL diesel to 10mL solvent.
Mid calibration standard (500 ng/uL): add 5.5uL diesel to 10ml solvent.
High calibration standard (5000 ng/uL): add 55uL diesel to 10mL solvent.

Soil Matrix Spikes

Gasoline: add 2.5uL pure gasoline to 10 grams soil = 200mg/kg (ppm)
Diesel: add 5.5uL pure diesel to 10 grams soil = 500mg/kg (ppm)

Water Matrix Spikes. For 2mg/L (1 ppm) water concentration, dilute substock standards by 100 times.

Calibrations of Sample Concentrations

Water Samples

Conc (ug/L) = (Ax * A * Vt * D)/(As * Vi * Vs)

173269

Soil Samples

Conc (ng/g) = (Ax * A * Vt * D)/(As * Vi * W)

Where:

Ax	is the area counts for the sample - method blank
A	is the amount of standard injected (ng)
As	is area counts for the standard
Vi	is the volume of extract injected (uL)
D	is the dilution factor on the sample
Vt	is the volume of total extract (uL)
Vs	is the volume of water extracted (mL)
W	is the weight of soil extracted (g)

8.5 EPA METHOD 418.1

Introduction. The purpose of this procedure is to describe the method for determination of Total Recoverable Petroleum Hydrocarbons (TRPH) in soils, solid wastes, and waters using an infrared spectrometer. Details of the method are found in EPA Document SW-846. The method is applicable to determination of petroleum hydrocarbons in water, soils, and wastes. This method is approved by EPA as a quantitative method for the determination of total fuels content.

Calibration. Calibration for the method is accomplished by using external standard techniques. Standards are prepared at three concentrations spanning the linear range of the instrument. Standards composed of the anticipated fuel product to be analyzed are used for the calibration. The standards are then analyzed and the response factor evaluated for linearity. If linearity is not achieved a second set of analyses is run. If linearity is still not achieved, a second set of standards is prepared and the process repeated. Linearity is acceptable when response factor values are within 15% standard deviation for internal standard calculations or if the mean residual from the linear regression is within 15%.

Sample Preparation and Extraction

Water Samples. A 33mL aliquot of water is extracted with 3mL of solvent by shaking vigorously for 5 minutes in a clean 40mL VOA vial. The mixture is allowed to settle and 2ml of solvent are withdrawn and analyzed on the Infrared Spectrometer.

Soil Samples. 10 grams of soil are weighed to the nearest 0.1 gram and placed into a clean VOA vial with 10mL of solvent and NaSO4. The VOA vial is shaken for 2 minutes, and sonicated for 10 minutes. After sonification, the slurry is allowed to settle and 2ml of solvent are withdrawn and analyzed on the Infrared Spectrometer.

Equipment.

Instrument: Buck Scientific HC-404

Standard Preparation

Substock Calibration Standards (in trichlorotrifluoroethane)

Low calibration standard (50ng/uL): add .55uL diesel or oil to 10mL solvent.
Mid calibration standard (500ng/uL): add 5.5uL diesel or oil to 10ml solvent.
High calibration standard (5000ng/uL): add 55uL diesel or oil to 10mL solvent.

Soil Matrix Spikes Add 5.5uL pure diesel or oil to 10 grams soil = 500mg/kg (ppm)

Water Matrix Spikes For 5mg/L (5 ppm) water concentration, dilute 500 ppm substock standards by 100 times.

Calculations of Sample Concentrations

Water Samples

Conc (ug/L) = (Ax * A * Vt * D)/(As * Vi * Vs)

Soil Samples

Conc (ng/g) = (Ax * A * Vt * D)/(As * Vi * W)

Where:

Ax	is the area counts for the sample - method blank
A	is the amount of standard injected (ng)
As	is area counts for the standard
Vi	is the volume of extract injected (uL)
D	is the dilution factor on the sample
Vt	is the volume of total extract (uL)
Vs	is the volume of water extracted (mL)
W	is the weight of soil extracted (g)

8.6 EPA METHOD 610/8100

Introduction. This method can be used in determining the concentration of PAH's present in soil and water samples. This procedure involves extracting the PAH's from a 10 gram sample of soil or a 30 gram sample of water using freon. The extract is then analyzed by gas chromatography using an flame ionization detector. The detection limits for each PAH using this procedure are listed in Table 5-1.

Calibration. Calibration may be accomplished by either internal or external standard techniques. Standards are prepared at three or five concentrations spanning the linear range of the instrument. The standards are then analyzed and the response factor evaluated for linearity. If linearity is not achieved a second set of analyses is run. If linearity is still not achieved, a second set of standards is prepared and the process repeated. Linearity is acceptable when response factor values are within 15% standard deviation for internal standard calculations or if the mean residual from the linear regression is within 15%.

Apparatus and Reagents

- Freon - gas chromatographic grade
- Sodium sulfate - anhydrous
- 10 N Sodium hydroxide solution
- PAH stock solutions - 2000 ppm in methylene chloride.
- Surrogate spiking solution - 1000 ppm of 2-Fluorobiphenyl in 2-propanol.
- Silica gel cartridges prepared with activated 100/200 mesh silica gel.
- VOA vials - 40mL glass w/polyethylene screw caps.
- Shimadzu 14A GC with an flame ionization detector using a PTE-5 QTM, 15 meter, 0.53 mm diameter column, 0.5 μm film and Helium as carrier gas.

  Injection port temp - 250 degrees C
  Detector temp - 300 degrees C
  Column temp - 75 degrees C/2 min. to 300 degrees C at 12/min
  3 μl injection for analysis

Sample Preparation. Tare a 37.5ml VOA vial on a top loading balance and transfer 10 gram +/- .1 gram of soil sample in the vial. Add enough anhydrous sodium sulfate to vial until the soil becomes free flowing. Spike the soil sample by adding 10 μl of the surrogate spiking solution directly into the soil. Add 10ml of freon and cap vial. Shake sample well for 2 minutes and then sonicate for 10 minutes. Sample can now be analyzed by direct injection into the gas chromatograph.

For water samples, place 30.0 grams of water to be analyzed in a voa vial. Add enough base to water to bring pH to above 11. Spike the water sample by adding 3 μl of the surrogate spiking solution directly into the water. Transfer 2mls of freon to vial, cap and shake vigorously for 5 minutes. The freon layer (bottom) can now be analyzed directly. Results must be divided by 15 due to the concentration factor of the extraction procedure.

If any extract requires cleanup procedure, transfer 1-2ml of the extract through a silica gel column that has been prewashed with 2-3ml of freon. Discard the first 0.5mL of the extract that elutes from the cartridge, then collect the remaining fraction in a VOA vial. The extract is now ready for analysis by direct injection into the gas chromatograph.

QA/QC Analyses. At the beginning of every 12 hour shift a continuing calibration is to be run to verify that the calibration is still valid. The recommended concentration of this standard is 1 ppm of each component. The determined concentration of each PAH must be within 80% to 120% for the calibration to be considered valid. If these limits are not met a 4 point calibration is to be performed to reestablish calibration. The standard concentrations that are recommended are 0.5, 2.0, 5.0 and 10.0 ppm for both water and soil analysis.

For each set of sample analyses, a method blank is to be analyzed. A method blank consists of the anhydrous sodium sulfate shaken with 10ml of freon in a VOA vial. If sample cleanup was performed on any of the samples analyzed, a method blank must be analyzed in which the method blank was passed through a prepared silica gel column.

After each 10 samples are analyzed, a PAH matrix spike and matrix spike duplicate are to be extracted and analyzed. The recommended concentration to spike soil samples is 1 ppm. This is performed by spiking 10 +/- .1 gram of a soil sample with 15 μl of the 2000 ppm PAH stock solution. The recommended concentration to spike water samples is .2 ppm. This is performed by spiking 30 +/- .1 gram of a water sample with 3 μl of the 2000 ppm PAH stock solution. The spiked sample is then extracted according to the procedure outlined above. After analysis of the matrix spike and matrix spike duplicate, the percent recovery is to be determined as followed:

$$\% \text{ Recovery} = \frac{\text{Conc. determined}}{\text{Conc. Spiked}} \times 100$$

The acceptable % recovery limits are 65% to 125%. In addition to determining the percent recovery, the % RPD is to be determined and reported. To calculate the % RPD use the following calculation:

$$\% \text{ RPD} = \frac{\%\text{Rec}_{MS} - \%\text{Rec}_{MSD}}{(\%\text{Rec}_{MS} + \%\text{Rec}_{MSD})/2)}$$

This value is to be reported along with the % Recovery of the matrix spike and matrix spike duplicate.

8.7 EPA METHOD 608/8080

Introduction. This method can be used in determining the concentration of pesticides and PCB's present in soil and water samples. This procedure involves extracting the pesticides and PCB's from a 10 gram sample of soil or a 30 gram sample of water using hexane. The extract is then analyzed by gas chromatography using an electron capture detector. The detection limits for each pesticide and PCB using this procedure are listed below.

Calibration. Calibration may be accomplished by either internal or external standard techniques. Standards are prepared at three or five concentrations spanning the linear range of the instrument. The standards are then analyzed and the response factor evaluated for linearity. If linearity is not achieved a second set of analyses is run. If linearity is still not achieved, a second set of standards is prepared and the process repeated. Linearity is acceptable when response factor values are within 15% standard deviation for internal standard calculations or if the mean residual from the linear regression is within 15%.

Apparatus and Reagents.

- Hexane - pesticide grade
- Sodium sulfate - anhydrous
- PCB stock solutions - 200 ppm in methanol
- Pesticide stock solution 20 ppm and 2 ppm in methanol
- Surrogate spiking solution - 100 ppm Dibutylchlorendate in methanol.
- Florisil cartridges - Supelco LC-SI 6ml tubes
- VOA vials - 40mL glass w/polyethylene screw caps.
- Shimadzu 14A GC with an electron capture detector using a Rtx-5, 30 meter, 0.53 mm diameter column with 1.5 μm coating thickness. Confirmation column for pesticides is a DB-17, 30 meter, 0.53 mm diameter column with 0.5 μm coating thickness.

  Injection port temp - 300 degrees C
  Detector temp - 300 degrees C
  Column temp - 150 degrees C /3 min to 290 degrees C at 4/min
  3 μl injection for analysis
  Nitrogen for carrier gas

Sample Preparation. Tare a 40mL VOA vial on a top loading balance and transfer 10 gram +/- .1 gram of soil sample in the vial. Add enough anhydrous sodium sulfate to vial until the soil becomes free flowing. Spike soil with 10 μl of the surrogate spiking solution. Add 10ml of hexane and cap vial. Shake sample well for 2 minutes and then sonicate for 10 minutes. Sample can now analyzed by direct injection into the gas chromatograph.

For water samples, place 30.0 grams of water to be analyzed in a voa vial. Spike sample with 3 μl of surrogate spiking solution. Transfer 2mls of hexane to vial, cap and shake vigorously for 5 minutes. The hexane layer (top) can now be transferred to a vial for cleanup or analyzed directly. Results must be divided by 15 due to the concentration factor of the extraction procedure.

If sample requires cleanup procedure, transfer 1-3ml of extract to a Supelco cleanup cartridge that has been pre-rinsed with 2-ml hexane. Discard the first 0.5ml of extract that elutes from the cartridge and then collect the remaining fraction in a small vial. The extract is now ready for analysis by direct injection into the gas chromatograph.

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QA/QC Analyses. For each set of sample analyses, a method blank is to be analyzed. A method blank consists of the anhydrous sodium sulfate shaken with 10ml of hexane and spiked with 10 μl of surrogate spiking solution in a VOA vial. If sample cleanup was performed on any of the samples analyzed, a method blank must also be analyzed in which the method blank was passed through a Supelco Florisil cartridge prior to analysis.

For pesticide analysis a 25 ppb standard is to be analyzed to confirm the calibration curve at the beginning of each 12 hour shift. The measured concentration for each pesticide must be within 80% - 120% of the true value for the calibration to be considered still valid. If the calibration is determined not to be valid, a 4-point calibration is to be performed using the following pesticide concentrations, 5.0, 10.0, 25.0 and 50.0 ppb.

After each 10 samples are analyzed, a pesticide/PCB matrix spike and matrix spike duplicate are to be extracted and analyzed. If any samples were found with PCB's present, the PCB used in spiking should be the type that is in the samples. For soils the recommended spiking concentration is 1 ppm for PCB's and 20 ppb for pesticides. This is performed by spiking 10 +/- .1 gram of sample with 50ul of 200 ppm PCB stock in methanol, or with 10μl of the 20 ppm pesticide stock solution. The spiked sample is then mixed well with 10ml of hexane for 2 minutes and then sonicated for 10 minutes. For waters the recommended spiking concentration is .1 ppm for PCB's and 2 ppb for pesticides. This is performed by spiking 30 +/- .1 gram of sample with 15 ul of 200 ppm PCB stock or with 10 μl of the 2 ppm pesticide stock solution. The spiked sample is then mixed well with 2ml of hexane for 5 minutes. After analysis of the matrix spike and matrix spike duplicate, the percent recovery is to be determined as follows:

$$\% \text{ Recovery} = \frac{\text{Conc. determined}}{\text{Conc. Spiked}} \times 100$$

The acceptable % recovery limits are 65% to 125%. In addition to determining the percent recovery, the % RPD is to be determined and reported. To calculate the % RPD use the following calculation:

$$\% \text{ RPD} = \frac{\%\text{Rec}_{MS} - \%\text{Rec}_{MSD}}{(\%\text{Rec}_{MS} + \%\text{Rec}_{MSD})/2)}$$

This value is to be reported along with the % Recovery of the matrix spike and matrix spike duplicate.

Data Evaluation and Pesticide/PCB Quantitation. For pesticide analysis, dual columns are to be used, one for quantitation (Rtx-5) and the other (DB-17) for confirmation. Upon reviewing the data obtained from the quantitation column, any "hits" obtained on this column must be confirmed on the other column before the result is accepted as a true hit. The quantitation values must also be within 1 to 10 times of each other for the confirmation to be considered valid.

The first step in PCB analysis is to identify the type(s) of PCB present in the sample analyzed, if any. Each of the PCB's have a characteristic chromatogram fingerprint that can be used to identify them. Some of the PCB's have peaks appearing at the same retention time but the integrated area of these peaks relative to other peaks is different. The analyst must become experienced in using these relative peak ratios in the identification of the PCB. The use of transparent overlays prepared of each PCB type is used by TEG chemists and is very useful for identification purposes. Caution must still be used, however, when analyzing samples that have more than one type of PCB present.

Once the PCB type has been identified the 1 ppm standard of that specific PCB is to be analyzed to confirm the identification of the PCB. After the standard has been run, quantitation can then be performed. If the sample if free from other contaminants, the total area of the PCB may be used. A ratio of the total peak area of the PCB in the sample can then be made to that of the 1 ppm PCB standard to calculate the total PCB present in the sample. For example, if a sample has PCB 1254 present and the analysis resulted in a total area count of 5680, the concentration of this PCB can be calculated as follows:

Total area PCB 1254 1 ppm standard = 4850.63

$$\frac{1 \text{ ppm}}{4850.63} = \frac{X}{5680}$$

This ratio calculates "X" as the concentration of PCB 1254 in the sample to be 1.17 ppm.

If there are other contaminants present in the soil sample, which happens in most cases, the concentration of PCB present is to be calculated using the total area of a minimum of 3 peaks that have been used to identify the PCB. The total area of these peaks is then compared to the total area of these same peaks of the 1 ppm PCB standard and the concentration of the PCB calculated as indicated above.

The recommended peaks to use for each of the PCB's and their retention times are listed below. Most of the PCB's have only three peaks listed. For those PCB's which are more difficult to identify, there are more times listed.

173276

PCB TYPE	PEAK RETENTION TIMES (minutes)
1016	10.4, 11.1, 12.4
1221	5.02, 7.90, 8.58
1232	8.55, 10.33, 12.26
1242	10.4, 11.1, 12.4, 20.86, 22.11
1248	12.3, 16.7, 17.55
1254	20.88, 21.98, 23.25
1260	21.85, 23.10, 26.2

8.8 EPA METHOD 604/8040

Introduction. This method can be used in determining the concentration of Phenol's present in soil and water samples. This procedure involves extracting the Phenol's from a 10 gram sample of soil or a 30 gram sample of water using freon. The extract is then analyzed by gas chromatography using an flame ionization detector. The detection limits for each Phenol using this procedure are listed below.

Calibration. Calibration may be accomplished by either internal or external standard techniques. Standards are prepared at three or five concentrations spanning the linear range of the instrument. The standards are then analyzed and the response factor evaluated for linearity. If linearity is not achieved a second set of analyses is run. If linearity is still not achieved, a second set of standards is prepared and the process repeated. Linearity is acceptable when response factor values are within 15% standard deviation for internal standard calculations or if the mean residual from the linear regression is within 15%.

Apparatus and Reagents.

- Freon - gas chromatographic grade
- Sodium sulfate - anhydrous
- 5 N Sulfuric acid solution
- Phenol stock solutions - 2000 ppm in 2-propanol or other suitable solvent.
- Surrogate spiking solution - 1000 ppm of 2-Fluorophenol in 2-propanol.
- Silica gel cartridges prepared with activated 100/200 mesh silica gel.
- VOA vials - 40mL glass w/polyethylene screw caps.
- Shimadzu 14A GC with an flame ionization detector using a PTE-5 QTM, 15 meter, 0.53 mm diameter & 0.5 μm film column and Helium as carrier gas.

  Injection port temp - 175 degrees C
  Detector temp - 225 degrees C
  Column temp - 65 degrees C/3 min. to 185 degrees C at 10/min
  3 μl injection for analysis

Sample Preparation. Tare a 40mL VOA vial on a top loading balance and transfer 10 gram +/- .1 gram of soil sample in the vial. Add enough anhydrous sodium sulfate to vial until the soil becomes free flowing. Spike the soil sample by adding 10 μl of the surrogate spiking solution directly into the soil. Add 10ml of freon and cap vial. Shake sample well for 2 minutes and then sonicate for 10 minutes.

Sample can now analyzed by direct injection into the gas chromatograph.

For water samples, place 30.0 grams of water to be analyzed in a voa vial. Add enough acid to water to bring pH to below 2. Spike the water sample by adding 3 μl of the surrogate spiking solution directly into the water. Transfer 2mls of freon to vial, cap and shake vigorously for 5 minutes. The freon layer (bottom) can now be analyzed directly. Results must be divided by 15 due to the concentration factor of the extraction procedure.

If any extract requires cleanup procedure, transfer 1-2ml of the extract through a silica gel column that has been prewashed with 2-3ml of freon. Discard the first 0.5ml of the extract that elutes from the cartridge, then collect the remaining fraction in a VOA vial. The extract is now ready for analysis by direct injection into the gas chromatograph.

QA/QC Analyses. At the beginning of every 12 hour shift a continuing calibration is be run to verify that the calibration is still valid. The recommended concentration of this standard is 1 ppm of each component. The determined concentration of each phenol must be within 80% to 120% for the calibration to be considered valid. If these limits are not met a 4 point calibration is to be performed to reestablish calibration. The standard concentrations that are recommended are 0.1, 0.50, 1.00, and 10.0 ppm for both water and soil analysis.

For each set of sample analyses, a method blank is to be analyzed. A method blank consists of the anhydrous sodium sulfate shaken with 10ml of freon in a VOA vial. If sample cleanup was performed on any of the samples analyzed, a method blank must be analyzed in which the method blank was passed through a prepared silica gel column.

After each 10 samples are analyzed, a Phenol matrix spike and matrix spike duplicate are to be extracted and analyzed. The recommended concentration to spike soil samples is 1 ppm. This is performed by spiking 10 +/- .1 gram of a soil sample with 15 μl of the 2000 ppm phenol stock solution. The recommended concentration to spike water samples is .2 ppm. This is performed by spiking 30 +/- .1 gram of a water sample with 3 μl of the 2000 ppm phenol stock solution. The spiked sample is then extracted according to the procedure outlined above. After analysis of the matrix spike and matrix spike duplicate, the percent recovery is to be determined as follows:

173278

$$\% \text{ Recovery} = \frac{\text{Conc. determined}}{\text{Conc. Spiked}} \times 100$$

The acceptable % recovery limits are 65% to 125%. In addition to determining the percent recovery, the % RPD is to be determined and reported. To calculate the % RPD use the following calculation:

$$\% \text{ RPD} = \frac{\%Rec_{MS} - \%Rec_{MSD}}{(\%Rec_{MS} + \%Rec_{MSD})/2)}$$

This value is to be reported along with the % Recovery of the matrix spike and matrix spike duplicate.

8.9 REAGENT STORAGE

Reagents used in analysis are stored as described in Table 8-1.

TABLE 8-1.
REAGENT AND STANDARD STORAGE

Chemical	Method of Storage
Methanol:	In cabinet separate from other solvents
Freon-113:	In cabinet separate from other solvents
Neat Standards:	Refrigerator away from samples
Working Standards:	Methanol standards in refrigerator away from samples
Working Standards:	F113 standards in separate refrigerator

Reagent bottles are labeled with the date received, date opened, and recorded on a solvent and standard log sheet.

9.0 CALIBRATION PROCEDURES AND FREQUENCY

173273

9.1 INSTRUMENTATION LIST

A list of TEG's primary instrumentation and applicable methodology is summarized below in Table 9-1.

TABLE 9-1
INSTRUMENTATION LIST

INSTRUMENT	DETECTORS	METHODS
Gas Chromatograph	FID, PID, Hall, ECD	8010, 8020, 8015, 8100, 8080
Buck HC-404	IR	418.1
Tekmar LSC 2000	Purge and Trap	5030

9.2 STANDARD RECEIPT AND TRACEABILITY

Standards and solvents used in the preparation of substocks and analyses are recorded on receipt in the TEG Standard and Solvent Log-in Form, Figure 9-1. Bottles are labeled with the date received and opened. Each standard and solvent is "blank" tested for impurities prior to usage and periodically before each substock or working standard is prepared. Each type of solvent used by TEG is stored in a cabinet separate from the others. Each analytical group (and matrix) of standards is stored in refrigerators separate from other standards. Neat standards are similarly kept in separate, respective refrigerator compartments. Additional storage information is presented in Section 8.9.

9.3 STANDARD SOURCES AND PREPARATION

Preparation of standards and substocks is recorded on the Standard Preparation Log, Figure 9-2, according to procedures listed in the analytical methods, (Section 8).

Figure 9-1. Solvent and Standard Log-in Form

173280

TEG SOLVENT AND STANDARD LOG-IN FORM

TE	INITIALS	P.O. NUMBER	SOLVENT	GRADE	VENDOR	BATCH NUMBER	BLANK TEST	COMMENTS

173281

Figure 9-2. Standard Preparation Log

TEG STANDARD PREPARATION LOG

PREPARATION DATE	INITIALS	DESCRIPTION	ANALYTE	STARTING STANDARD OR SOLVENT	MEDIA	DILUTION FACTOR	FINAL CONC.

9.4 INSTRUMENTATION CALIBRATION

173282

9.4.1 Instrument Group Calibration

Table 9-2 has been prepared to summarize specific routine calibration procedures for each instrument group.

9.4.2 Initial Calibration and Linearity

Calibration standards are prepared for three to five concentration levels depending upon the method for use in determining the linearity of the system. The linearity of the response to concentration is assessed over the working range of the standards which are prepared for each analyte. A low level standard is prepared at or near the method detection limit. The medium and high level standards are prepared to correspond with the range of concentrations anticipated in the working samples and within the range of the detector. A solvent blank is run prior to the initial calibration runs in order to provide information regarding system cleanliness.

If the relative standard deviation of the linearity data is less than fifteen percent (15%), linearity is assumed and the average response factor, as defined by the slope of the response curve, is used in calculating concentration of unknown samples. If the relative standard deviation is greater than fifteen percent (15%), a calibration curve is prepared for each compound and the response factor for each sample is determined directly from the calibration curve. All calibration procedures and results are entered into the logbook for the instrument (see Instrument Initial Calibration Log, Figure 9-3, and Continuing Calibration Form, Figure 9-4).

TABLE 9-2
INSTRUMENT CALIBRATION

Instrument	Standard Source	# Standards Init. Cal.	Accept/Reject Criteria-Init.	Frequency	# Standards Cont. Cal.	Accept/Reject Criteria-Cont.	Freq.
Gas Chromatograph	Supelco Chemserve	3	Linear Reg. <15% RPD Response Factor	Cont. Cal Failure	1 + Dup.	<15%RPD	Daily + 10 Samp.
IR	In-House Chemserve	3	Linear Reg. <15% RPD Response Factor	Cont. Cal Failure	1 + Dup.	<15%RPD	Daily + 10 Samp

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Figure 9-3. Instrument Initial Calibration Log

CALIBRATION LOG

DATE:_____ ANALYST:_____ INSTRUMENT:_____

ANALYTE	FINAL CONC. PPM	ABSORB.	PEAK AREA	CONC. OF STK. USED	VOL.OF STK. USED	FINAL VOLUME	SOLVENT USED

CORRELATION:_____

X COEFFICIENT:_____

STD. ERROR:_____

Figure 9-4. Continuing Calibration Form

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TEG CONTINUING CALIBRATION FORM

DATE: _____

☐ Septum ☐ Column ☐ Inj, Col, Det Temp ☐ Gas Flow & Pressure Signature_____

TIME	PROJECT NUMBER	ANALYST	STANDARD NUMBER	CONCENTRATION	RESPONSE FACTOR	RELATIVE PERCENT DIFFERENCE

173285

9.4.3 QC Check Standards

On completion of the initial calibration, a QC check standard is run. The QC check standard is an independent check standard to validate the initial calibration.

9.4.4 Continuing Calibration

A continuing calibration check is run using either a standard prepared similarly to the curve standards or an EPA or certified commercial NBS-traceable check standard to validate the calibration. Following a solvent blank, a continuing calibration standard is run before starting each day and every ten samples, or every batch, if less than ten samples, to validate response factors and retention times. The percent difference of the check response factor to the initial calibration response should be less than 15%. Retention time calibration checks should fall within 5% of the Initial calibration. The results of the calibration checks are also entered on the Calibration Log for the instrument. If the check standards fail the continuing calibration criteria, initial calibration procedures must be implemented and continuing calibration rerun.

Surrogate standards and matrix spikes are used in analyses in order to monitor recovery of each sample through the extraction procedure. A separate log of extractions and recovery is maintained for each method. Absolute recovery varies with the method and the matrix. Recovery criteria are presented in Table 5-1.

9.4.5 Equipment Monitoring

Balances. Laboratory balances are to be calibrated prior to each group of weighings, or daily, according to the following protocol:

- check level of balance;
- zero the balance;
- weigh standard weight; and
- record true weight, measured weight, and error in Balance Calibration Log and sign.

Refrigerators. The purpose of monitoring refrigerator temperatures is to maintain a record of temperature variation which may affect sample integrity. Each working day, the refrigerator temperature will be monitored from the thermometer mounted in the unit and entered on the Refrigerator Temperature Log (Figure 9-6). Should the temperature be unacceptable, the QA Manager will be notified immediately.

Mobile Laboratory Temperature. The purpose of monitoring refrigerator temperatures is to maintain a record of temperature variation which may affect sample integrity. Each working day, the refrigerator temperature will be monitored from the thermometer mounted in the unit and entered on the Refrigerator Temperature Log (Figure 9-6). Should the temperature be unacceptable, the QA Manager will be notified immediately.

Figure 9-5. Balance Calibration Log

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TEG Mobile Lab

Balance Calibration Log

Date	Initial	Refernce Wt. 1	Reference Wt. 2

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Figure 9-6. Refrigerator Temperature Log

REFRIGERATOR TEMPERATURE LOG
TEG, Inc.

Refrigerator _____ Period _____ to _____

DATE	TIME	ANALYST	INIT	REFRIGERATOR TEMPERATURE Degrees Centigrade										ACTION
				0	1	2	3	4	5	6	7	8	9	10	

173289

10.0 PREVENTIVE MAINTENANCE PROCEDURES AND SCHEDULES

10.1 ROUTINE MAINTENANCE

The preventive maintenance program combines both in-house procedures and maintenance provided by the manufacturers and vendors of the equipment. Major equipment and components are periodically inspected and tested by manufacturers representatives, as appropriate. Routine parts replacement and system modifications are performed by qualified personnel. Listed in Table 10-1 are routine maintenance activities for the equipment listed in Section 9.

TABLE 10-1.
MAINTENANCE ACTIVITIES

Instrument	Activity	Frequency
Gas Chromatograph	Check Septum	Daily
	Change Septum	As required
	Check Carrier	Daily
	Clean PID lamp	As required
	Leak Check	Daily
IR Spectrophotometer	Clean Cell & Extractor	Each use
Balance	Clean, Calibrate	Daily
Refrigerator	Clean, Calibrate	Daily
Generators	Oil Change, Filters	100 Hours
Vehicle Engine	Oil Change, Filters	3000 miles

10.2 DOCUMENTATION

A maintenance logbook is kept to record problems, routine maintenance, and corrective service for each instrument (Figure 10-1). Items which require regular maintenance, such as filters, compressors, generators, and engines, are labeled with the date of last maintenance and due-dates (or criteria) for next regular maintenance.

10.3 CONTINGENCY PLAN

A stock of key replacement items is maintained so that down-time is reduced. Key personnel are trained in ares of routine maintenance, trouble shooting, and repair of electronic and mechanical failure. This is especially critical in the TEG mobile laboratory operation as backup equipment and factory maintenance may not be readily available.

In the event of total equipment failure, or the inability to repair equipment on-site, TEG will arrange either for back-up equipment and parts to be delivered or for service personnel to effect repairs as needed. If a substantial down-time is anticipated, judgement will be made whether to store samples until repairs are completed or to transfer samples to another TEG facility for analysis.

Figure 10-1. Repair Maintenance Log

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TEG REPAIR MAINTENANCE LOG

INSTRUMENT: _____

DATE	INITIALS	DESCRIPTION OF PROBLEM	DESCRIPTION OF REPAIR	DATE REPAIRED/WHOM

11.0 QC CHECKS, PRECISION AND ACCURACY AND DETECTION LIMITS

11.1 LABORATORY QC CHECKS

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11.1.1 Equipment QC Checks

Listed below in Table 11-1 are equipment monitoring activities with respect to QC checks. Monitoring of this equipment is documented on forms presented in Section 9.

TABLE 11-1.
EQUIPMENT MONITORING ACTIVITIES

Instrument	Activity	Frequency
Gas Chromatograph	Ongoing Calibration	Daily
IR Spectrophotometer	Calibration	Each use
Balance	Calibrate	Daily
Refrigerator	Monitor Temperature	Daily
Mobile Laboratory	Monitor Temperatures	Daily

11.1.2 Chemistry QC Checks

Several types of QC checks are standard to TEG analyses. The standard operating procedures for each analysis have specific types and frequency of QC checks which are followed at a minimum. In general, TEG QC checks include an evaluation of:

- blanks;
- precision;
- accuracy;
- recovery; and
- method detection limits.

If a method does not specify minimum QC checks or if the method QC requirements are less stringent than those listed in below in Table 11-2, the laboratory will use the QC guidelines presented in Table 11-2.

173293

TABLE 11-2
CHEMISTRY QC CHECKS

BLANKS	
Method Reagent Blanks	- prepared and analyzed at greater of one per sample set or 5%
MATRIX SPIKES	- prepared and analyzed at greater of one per sample set or 5% - minimum of one set per matrix
QC CHECK SAMPLES	- analyzed blind in duplicate semi-annually
QC CHECK STANDARDS	- analyzed at greater of one per sample set or 5%
DUPLICATE SAMPLES	- Duplicate samples or duplicate matrix spikes will be analyzed at greater of one per sample set or 5%; minimum of one per matrix
CONTINUING CALIBRATION STANDARDS	- Same as, or in lieu of QC check standards

11.1.3 Additional QC Checks

A calculated recovery of sample during analysis is accomplished by the addition and subsequent analysis of surrogate or matrix spiking compounds. Surrogate spiking compounds, which serve as substitute analytes, differ for each analysis and are usually not naturally occurring compounds. The surrogates are added to samples for analysis after aliquots of the sample have gone through the preparation process. Surrogates are chosen such that they are chemically similar to the analytes, with similar response, but do not interfere with determination of the analytes.

11.2 PRECISION AND ACCURACY

Precision is determined through evaluation of percent difference in duplicate analysis of samples, standards and surrogates. Precision may also be measured by evaluating the standard deviation of multi-point calibrations or the standard deviation of the high point in a span calibration.

Precision, as determined through percent difference in duplicate analysis of samples, standards and surrogates, is calculated as:

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$$\text{Precision} = \frac{A - B}{\frac{A + B}{2}} \times 100$$

where "A" is the larger value and "B" is the smaller value of two replicate analyses.

Accuracy, as percent recovery, is calculated from analysis of surrogate and matrix spike samples as follows:

$$\text{Accuracy} = \frac{A - B}{C} \times 100$$

where "A" is the analyte determined experimentally from the spike sample; "B" is the background level by separate analysis of the unspiked sample; and "C" is the amount of spike added.

11.3 METHOD DETECTION LIMITS AND PRACTICAL DETECTION LIMITS

Method detection limits (MDLs) are derived from in-house data according to the guidelines of 40CFR 136. Replicate samples or standards are analyzed, with the method detection limit being based on 3 times the standard deviation for the analyses.

Practical quantitation limits (PQLs) are defined as ten times the standard deviation resulting from the calculation used in determination of method detection limits.

MDLs and PQLs are re-evaluated every 12 months by in-house analyses or each time a modification is made to an analytical procedure.

173295

12.0 DATA REDUCTION, VALIDATION AND REPORTING

12.1 DATA REDUCTION

Each analysis is recorded by the field chemist on an Analysis Log (Figure 7.3) for the instrument being used. TEG uses microcomputers for data storage and reporting purposes. Initial chromatographic data gathering is performed either by integrators or computers which print a chromatogram and report integration. Each chromatogram is labeled during analysis to identify the project and sample number. It is the responsibility of the field chemist to evaluate each chromatogram with regard to correct integration, peak identification, and calibration. Verified numeric data from the chromatogram is then manually entered by the analyst into a spreadsheet on the microcomputer. A spreadsheet file, with a unique file name related to the project number and analysis, is created from a generic starter file for each project and analytical method. At the end of each day, the active file is transferred to a backup floppy. This backup floppy is stored in the final job file.

12.2 DATA VALIDATION

At the end of each day the field chemist (analyst) inspects the extraction logs, analysis logs, calibrations, raw data, and calculated data. The printed spreadsheet is placed in the project file and submitted to the QA officer for review. The quality assurance officer then reviews the data for errors and makes a determination as to whether each quality control parameter is within the limits set for the analysis. If the data are acceptable, they are approved for reporting. Both the analyst and QA officer are responsible for review of these measures. In the event that a QC parameter is unacceptable, corrective action will be taken. Corrective actions are discussed in Section 13.

12.3 DATA REPORTING

TEG uses computer automation where feasible to reduce potential for error between data reduction and reporting. Data reporting is performed following review of data and calculations by the analyst. The data generator prepares a preliminary report for review by the QA Manager. The QA Manager then reviews the report and prepares a QA summary. The generated report is then reviewed for typographical errors and forwarded to the laboratory director for review, signature and release to the client. A sample report is enclosed in an appendix.

12.4 DATA STORAGE

Hard copies of the final printout and report are maintained in the project file by job number along with printed chromatograms, logsheets, chain of custody records, floppy disk, and data tables. The purpose of this document control procedure is to provide guidelines to reduce the potential for document loss and mix-ups. Both electronic and printed media records are stored for a minimum of two years.

13.0 CORRECTIVE ACTION

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13.1 CRITERIA

Whenever the quality control goals set for precision or accuracy of data are not achieved, as summarized in Table 13.1, a program of corrective action is initiated.

13.2 RESPONSIBLE INDIVIDUALS

The first step in corrective action is identification of the source of the problem. Initial identification responsibility is with the analyst who will spot most problems. The quality assurance officer is responsible for identification of problems which the analyst may have overlooked. He must also initiate the corrective action and review the effectiveness of the action. The laboratory director is responsible for review of the QA Manager's reports.

13.3 CORRECTIVE ACTIONS

When a quality control problem is noted, the following steps are taken to identify and correct the problem:

- the hard copies of the data are re-examined;
- the analyst re-analyzes the sample(s), as appropriate;
- if the problem is not resolved by analysis, the QA Manager or the laboratory director is consulted to provide additional information about rectifying the problem; and
- if the problem cannot be solved in-house, equipment repair contractors, manufacturer's representatives, or outside consultants are contacted, as necessary to correct the problem.

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TABLE 13-1
SUMMARY OF CORRECTIVE ACTION PROCEDURES
(applicable to GC and IR analyses)

QC ACTIVITY	ACCEPTANCE CRITERIA	RECOMMENDED ACTION
System Blank	Response < MDL	Repeat, if same, identify source eliminate source
Reagent Water Blank	Response < MDL	Repeat, if same, identify source, correct problem
Reagent Blank	Response < MDL	Repeat, if same, identify source, Replace reagent
New Standard Validation	Relative % difference < 15%	Re-analyze; if still unacceptable, Reject Standard
Method Blank	Response < MDL	Repeat, if still unacceptable, identify cause, re-process, Re-analyze previous sample set
Initial Calibration	Relative % difference < 15%	Re-analyze; if still unacceptable, make fresh standards
QC Check Standards	Relative % Difference < 15%	Re-analyze; if still unacceptable, make fresh standard, use new standard
Cont. Cal. Standards	Relative % Difference < 15%	Re-analyze; if still unacceptable, make fresh standard, use new standard, Re-analyze previous sample set
Matrix Spikes	Method Control Limits	Re-analyze, if extremely low recoveries.

13.4 EXTERNAL SOURCES

Corrective actions are also initiated when other problems or irregularities are observed during external auditing procedures, client review, or by regulatory review. These externally initiated corrective actions may be a result of performance evaluations, audits, split samples or standards submitted by clients, or other certification procedures.

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13.5 NOTIFICATION OF PERSONNEL

The field chemist and QA Manager will initially discuss the identification of problems and implementation of corrective actions. If the problem is of a routine nature the QA Manager will make note of it in his QA report for the project to the laboratory director. If the problem is of a severe nature, the situation will be discussed immediately with the laboratory director so that he may be involved in the decision-making process regarding corrective action.

14.0 PERFORMANCE AND SYSTEM AUDITS

173299

14.1 GENERAL REQUIREMENTS

Performance and system audits are achieved through both external and internal processes. These audits are conducted with specified frequency to review and evaluate the individual components and the overall measurement system with regard to proper selection and usage. The following sections include descriptions and frequency of both internal and external audits.

14.2 SYSTEM AUDITS

14.2.1 System Audit Scope

The system audit is designed to evaluate the individual components of the operational system. A determination is made regarding the proper function, proper methodology, and relationship to the CompQAP. Resulting output from the system audit indicates deficiencies and areas which need improvement. Listed on the following page (Figure 14-1) are the system components which are evaluated through the system audit.

14.2.2 Internal System Audits

Internal system audits are conducted annually at each TEG facility. The audits are conducted by either the TEG corporate QA Manager or a laboratory director from another TEG facility. Each system component listed on the Internal Audit System Audit Form (Figure 14-1) is assessed and graded during the procedure.

14.2.3 External System Audits

TEG welcomes external system audits from regulatory agencies clients and peer groups. The external system audit provides an opportunity to improve the TEG system operation in ways that may be different from the internal audit and to evaluate the laboratory with respect to other laboratory operations.

14.3 PERFORMANCE AUDITS

14.3.1 Performance Audit Scope

Performance Audits are conducted for the purpose of evaluating the analytical capability of the laboratory. Both the accuracy of the overall analysis and the individual portions are evaluated. The performance audit consists of each of the following: blind samples, split samples, quality control samples, regulatory or commercial check samples, and blind spikes.

14.3.1 Internal Performance Audits

Internal performance audits are conducted semi-annually by the corporate QA Manager. Blind samples, QC samples and blind spikes are prepared at a different TEG facility. Sample splits are forwarded to another TEG laboratory for analysis. Commercial check samples may also be obtained. The report of analysis is prepared in the same manner as normal analytical report. The QA Manager reviews this report in comparison with known values and results of split analyses. The QA Manager then makes a formal report of the audit to the laboratory director.

14.3.2 External Performance Audits

External performance audits are requested by some regulatory agencies and clients. TEG conducts performance audits as required by regulatory agencies and clients.

173391

Figure 14-1. Internal System Audit Form

_____ SAMPLING PROCEDURES
_____ Sample Containers
_____ Cleaning
_____ Waste Disposal

_____ SAMPLE CUSTODY
_____ Field Custody
_____ Laboratory Custody

_____ ANALYTICAL PROCEDURES
_____ Method References
_____ Glassware Cleaning
_____ Reagent Storage
_____ Waste Disposal

_____ CALIBRATION
_____ Instrumentation List
_____ Standard Receipt and Traceability
_____ Standard Sources and Preparation
_____ Instrument Calibration

_____ PREVENTATIVE MAINTENANCE
_____ Routine Maintenance
_____ Documentation
_____ Contingency Plans

_____ QUALITY CONTROL CHECKS
_____ Laboratory QC Checks
_____ Equipment QC checks
_____ Chemistry QC checks
_____ Additional QC checks
_____ Precision and Accuracy
_____ Method and Practical Detection Limits

_____ DATA REDUCTION, VALIDATION AND REPORTING
_____ Data Reduction
_____ Data Validation
_____ Data Reporting
_____ Data Storage, Document Control

_____ CORRECTIVE ACTION
_____ Criteria
_____ Responsible Individuals
_____ Corrective Actions
_____ External Sources
_____ Notification of Personnel

_____ PERFORMANCE AND SYSTEM AUDITS
_____ General Provisions
_____ System Audits
_____ Performance Audits

_____ QUALITY ASSURANCE REPORTS

EXPLANATION

1. Passing
2. Needs Improvement
3. Unacceptable

15.0 QUALITY ASSURANCE REPORTS

173372

QA reports are prepared by the QA Manager on an annual basis. These reports contain:

- the results of performance audits;
- summary of individual project QA;
- periodic assessment of accuracy, precision and detection limits;
- significant QA/QC problems and recommended solutions; and
- the results of corrective actions implemented.

The QA Manager's report is prepared and delivered to the laboratory director and president of TEG. Overall laboratory performance and the results of system and performance audits are reviewed by the laboratory director and president of TEG. External QA reports are prepared, as required, by regulatory agencies and clients.

16.0 RESUMES

173393

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Education:

Masters Program, Geology/Geochemistry	- 1978-1980;	Tulsa University, Tulsa, Oklahoma
M.A., Creative Arts	- 1976;	Purdue University, West LaFayette, Indiana
B.A., Chemistry and Biology	- 1976;	Purdue University, West LaFayette, Indiana

Summation of Employment History:

1990 to Date:	*Transglobal Environmental Geochemistry, Inc.*, Solana Beach, California, Geochemist & QA Manager
1988 to Date:	*Transglobal Exploration & Geoscience, Inc.*, Solana Beach, California, President and Co-Founder
1980 to 1987:	*Unocal Science and Technology Division*, Brea, California, Research Geochemist
1976 to 1980:	*Dept of Energy, Energy Technology Center*, Bartlesville, Oklahoma Research Chemist

Professional Experience:

Ms. Hartman's professional career includes over thirteen years of varied experience in petroleum and environmental geochemical applications. In addition to extensive laboratory analytical work, she has been engaged in a variety of field data collection programs. Ms. Hartman has served as director of numerous oceanographic and land-based geochemical programs with Unocal Research and Transglobal Exploration. With TEG, Ms. hartman is responsible for field sample collection and analysis, reporting, and management of the Quality Assurance Program.

President and Co-Founder:

Transglobal Exploration & Geoscience
March 1988 to Present

Primary Duties:

As President and Co-founder of Transglobal & Geoscience in 1988, Ms. Hartman conducts all the duties of a president and is a senior geochemist experienced with gas chromatographic systems and data interpretation.

Research Geochemist:
Unocal Science and Technology
December 1980 to June 1987

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Primary Duties:
Direct all geochemical programs for Unocal Indonesia, Latin America, Dutch North Sea, and Egypt; provide technical interpretation and reports.

Participate in and provide technical support for marine geochemical exploration programs for petroleum in the Southern California Borderlands (1981), offshore California (1981), Behring Sea (1983) and North Sea (1985).

Direct surface-geochemical surveys for petroleum exploration in Nevada, Oregon, and Alberta, Canada.

Organize and conduct Basin Modeling Short Course for Unocal personnel.

Development of new HPLC methods for characterizing chemical-compound classes in petroleum.

Initial organization of geochemical database.

Research Chemist:
Department of Energy, Bartlesville
Energy Technology Center
September 1976 to December 1980

Primary Duties:
Organize geochemical studies to enhance on-going oil-to-oil correlation studies.

Development of new correlation methods using isotope ratio data.

Conduct petroleum studies using LC, HPLC, IR, AA and MS data.

Direct petroleum analysis lab.

173395

BLAYNE HARTMAN, Ph.D.
Vice President, Transglobal Environmental Geochemistry
Principle Geochemist and Co-Founder, Solana Beach, California

Education:

Ph.D., Geological Sciences (Geochemistry)	- 1983; University of Southern California, Los Angeles, California
M.S., Geological Sciences (Geochemistry)	- 1978; University of Southern California, Los Angeles, California
B.S., Chemical Engineering	- 1975; Clarkson University, Potsdam, New York

Summation of Employment History:

1990 to Date:	*Transglobal Environmental Geochemistry, Inc.*, Solana Beach, California, Laboratory Director
1988 to Date:	*Transglobal Exploration and Geoscience, Inc.*, Solana Beach, California, Vice President and Co-founder
1986 to 1988:	*InterOcean Systems, Inc.*, San Diego, California, Chief Geochemist
1982 to 1986:	*Unocal Science and Technology Division*, Brea, California Research Geochemist
1977 to 1981:	*L.A. Pierce College*, Los Angeles, California Instructor
1977 to 1978:	*California State University Northridge*, Northridge, California Instructor

Professional Experience:

Dr. Hartman's daily responsibilities, with respect to TEG, include direction of laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review and method development, and direction of corporate development.

Dr. Hartman's academic research included a variety of chemical oceanography projects including: petroleum tracing using stable and radiogenic compounds as tracers; process controls across the airwater interface; and gas chromatography of dissolved gases in water and sediments.

Prior to co-founding Transglobal Exploration, Dr. Hartman was chief marine geochemist with InterOcean Systems, where his responsibilities included direction of marine sediment and bottom-water geochemical exploration programs. As a research chemist with Unocal Research, Dr. Hartman was responsible for development of geochemical prospecting techniques in onshore and offshore applications. These research operations included extensive method development and use of a variety of gas chromatography methods. Other research included use of stable metal isotopes as correlation parameters for organic materials.

Vice President and Co-Founder:
Transglobal Exploration & Geoscience
March 1988 to Present

173395

Primary Duties:
As Co-founder and Vice President of Transglobal & Geoscience in 1988, Dr. Hartman has been personally responsible for directing geochemical technical development, equipment design and maintenance, applications development, and implementation of exploration programs, analyses, and reporting.

Marine Geochemist:
InterOcean Systems, Inc.
March 1986 to March 1988

Primary Duties:
Director of marine sediment and marine bottom-water geochemical exploration programs for petroleum.

Technical interpretation and report presentation of marine sediment and marine bottom-water (sniffing) hydrocarbon data fo. petroleum exploration.

Development of new analytical methods for marine sediment and marine bottom-water exploration for petroleum.

Research Geochemist:
Unocal Science and Technology Division
September 1982 to March 1986

Primary Duties:
Director of two marine geochemical exploration programs for petroleum in the North Sea (1985) and the Bering Sea (1983).

Surface geochemical prospecting for precious metal deposits, petroleum, and geothermal resources.

Applications of radioisotopes for age dating petroleum and dating ground water residence times.

Investigations on the use of gaseous halocarbons as gas tracers for assessing the characteristics of petroleum reservoirs.

Pioneer studies on the applications of stable metal isotopes as correlation parameters for organic materials.

TEACHING

173397

Instructor:
Introductory Oceanography Laboratory, Physical Geology and
Introductory Oceanography, L.A. Pierce College
September 1977 to June 1981 (8 semesters)

Instructor:
Introductory Oceanography California State University Northridge
September 1977 to May 1978

PUBLICATIONS

Publications in various geochemistry and marine chemistry fields. List available on request.

RESEARCH CRUISES

Over 40 oceanic geochemical research cruises.

DERHSING LUU, Ph.D.
President, Transglobal Environmental Geochemistry/Texas

173393

Education:

Ph.D., Analytical Chemistry	- 1986; Southern Illinois University, Carbondale, Illinois
B.S., Chemistry	- 1977; National Chung Hsing University, Taiwan

Summation of Employment History:

1992 to Date:	*Transglobal Environmental Geochemistry/ Texas,* Austin, Texas President / Laboratory Director
1990 to 1991:	*Texas Research Institute*, Austin, Texas Laboratory Manager, GC/MS Operator, Corporate QA Officer
1989 to 1990:	*ENSR Corporation*, Camarillo, California, Air Toxics Monitoring Tech. Supervisor & Reg. QA Officer
1985 to 1989:	*Global Geochemistry,* Canoga Park, California Project Manager

Professional Experience:
Dr. Luu's daily responsibilities with respect to TEG/Texas include direction of laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review and method development.

Dr. Luu's academic research included a variety of novel automated analytical instruments development including: methanol analyzer and hydrocarbon analyzer.

Prior to founding TEG/Texas, Dr. Luu was R&D senior scientist with Global Geochemistry Corp. where his responsibility included development of methanol analyzer for CARB (California Air Resource Board) and hydrocarbon analyzer for Schlumberger. As a senior chemist for Air Toxic Lab with ENSR, Dr. Luu was responsible for daily laboratory operations and method development for air toxic laboratory. As an environmental laboratory manager and corporate QA officer with TRI (Texas Research Institute), Dr. Luu was responsible for supervising, performing GC/MS analysis, training, method developing for indoor air monitoring, and devising corporate QA/QC policy.

President and Director:
Transglobal Exploration & Geochemistry
1992 to Present

Primary Duties:
As President of TEG /Texas, Dr. Luu is in charge of direction of laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review and method development.

Laboratory Manager, GC/MS Operator, Corporate QA Officer:
Texas Research Institute
1990 to 1991

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Primary Duties:
As Laboratory Manager, managed both EPA and IH work, method implementations, provided technical support for clients.

As GC/MS Operator, handled all GC/MS work including standard EPA methods (8240's, 624, 625, TO-14) and other non routine types of analyses such as material characterizations, indoor air analysis, etc.

As Corporate QA Officer, rewrote the corporate QA manual and laboratory QC handbook. Executed QA policy including internal audits, problem solving and provided QA knowledge for corrective actions.

Air Toxics Monitoring Technical Supervisor & Regional QA Officer:
ENSR Corporation
1989 to 1990

Primary Duties:
Created the method development for air monitoring. Implemented the QA policy.

Project Manager:
Global Geochemistry
1985 to 1989

Primary Duties:
Project Manager for project entitled "Preconcentration and Determination of Reduced Sulfur Compounds in Ambient Air by Purge and Trap / GC-FPD Detection", project sponsored by Southern California Edison. Performed EPA analyses (EPA 8015, EPA 8020, and EPA 418.1). Designed a computer program for data calculations to improve EPA lab productivity and for instrument hardware control. R&D Project Manager for CARB research project to developed the methanol analyzer for exhaust emission studies.

173310

MICHAEL A. KOROSEC, M.S.

President, Transglobal Environmental Geosciences Northwest, Inc.
Principle Geochemist, Environmental Chemist, Geologist Program Manager

Education:

MBA, Finance and Management	- 1987; City University and Pacific Lutheran Univ.
M.S., Geological Sciences	- 1978; University of Southern California
B.S., Biology	- 1975; Case Western Reserve University

Summation of Employment History:

1989 to Date:	*Transglobal Environmental Geosciences Northwest, Inc.*, Laboratory Director and Analytical Chemist
1978 to 1989:	*Washington Department of Natural Resources*, Geologist
1978 to 1980:	*L.A. Pierce College* Instructor
1975 to 1978:	*University of Southern California* Teaching Assistant and Instructor
1973 to 1975:	*Chi Corporation* Technical Writer

Professional Experience:

Mr. Korosec's daily responsibilities with respect to TEG Northwest include direction of all laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review, marketing, and contract negotiations.

While with TEG, Korosec has developed unique preparation methods and analytical techniques for on-site analysis of PAH's, PCB's and chlorinated pesticides in soils, and PAH's and BTEX in tars.

Korosec's academic research included studies of the chemical and physical controls on the transport of dissolved nutrients across the sediment-water interface, using UV spectrophotometry and gas chromatography.

Prior to founding TEG/Northwest, Korosec was in charge of the state of Washington, Division of Geology and Earth Resources' Geothermal Exploration Program. The work included the development of a water analysis laboratory for the determination of dissolved cat ions, an ions and trace metals in thermal and mineral waters. Instrumentation included AA spectrophotometer, UV spectrophotometer, mercury analyzer and specific ion meters. Additional work included drilling programs for temperature gradient and heat-flow studies, whole rock geochemistry, age dating, and geologic mapping. As program manager, Korosec was responsible for all contracting, subcontracting and reporting to the U.S. Department of Energy.

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Laboratory Director and Analytical Chemist:
Transglobal Exploration & Geoscience
1989 to Present

Primary Duties:
Formed the Northwest branch of the TEG network through a contractual agreement with TEG, Solana Beach, CA. Own and operate a fleet of Mobile Environmental Laboratories.

Geologist:
Washington Department of Natural Resources:
1978 to 1989

Primary Duties:
State Geologic Map Program; production of 1:100,000 and 1:250,000 maps through compilation and new mapping. Program and Project Manager for U.S. Dept. of Energy-funded state-wide geothermal program. Geothermal exploration, construction of a complete water analysis laboratory, geochemical analysis of thermal and mineral waters, geothermal drilling.

Instructor:
L.A. Pierce College
1977 to 1978

Primary Duties:
Instructed course on Oceanography.

Teaching Assistant and Instructor:
University of Southern California
1975 to 1978

Primary Duties:
Instructed and assisted course on Oceanography.

Technical Writer:
Chi Corporation
1973 to 1975

Primary Duties:
Worked on newsletter, advertisements and user manual production.

MARK JERPBAK, M.S., R.G.
President, TEG Sacramento
Director and Registered Geologist

173612

Education:

M.S., Geology and Geophysics	- 1988;	University of Iowa Iowa City, Iowa
B.A., Geology	- 1981;	Cal State University Chico Chico, California

Summation of Employment History:

1992 to Date:	*TEG Sacramento* Laboratory Director
1991 to Date:	*Yolo County Environmental Health Services* Consultant
1990 to 1992:	*EnLab Mobile Services* Marketing Director/Principal Analyst
1987 to 1990:	*EnergyLog Corporation* Geologist/Geochemist
1984 to 1987:	*University of Iowa* Graduate Student (Research with Iowa Geological Survey)
1981 to 1984:	*EnergyLog Corporation* Geologist/Geochemist

Professional Experience:
Mr. Jerpbak's daily responsibilities with respect to TEG/Sacramento includes direction of all laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review, marketing, and contract negotiations.

Since 1981, Mr. Jerpbak has worked with several companies and agencies in geology and geochemistry in the United States and overseas, including: Ascension Island, Papau New Guinea and Japan. His work has included gas chromatography in the petroleum industry, gas and vapor analyses and wet chemical titration in the geothermal industry, injection tests in active geothermal areas, and gas chromatography by EPA methods in the environmental industry. He has worked extensively in the field and in the mobile lab environment.

Mr. Jerpbak holds a M.S. degree from the University of Iowa in geology and geophysics. He is a California State Registered Geologist and also consults for the Yolo County Department of Public Health, and Environmental Health Services in California.

Laboratory Director:
TEG, Sacramento
1992 to Present

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Primary Duties:
Mr. Jerpbak's daily responsibilities with respect to TEG/Sacramento includes direction of all laboratory operations, supervision of laboratory personnel, analysis, report preparation, technical review, marketing, and contract negotiations.

Consultant:
Yolo County Environmental Health Services
1991 to Present

Primary Duties:
Oversee continuing implementation of county ordinances regarding Class 2 injection wells. Geologic advisor to the Environmental Health Services Director.

Marketing Director / Principal Analyst:
EnLab Mobile Services
1990 to 1992

Primary Duties:
Directed Marketing and worked as principal analyst performing gas chromatography using EPA methods for organic analysis. A ..isted the building of a mobile laboratory.

Geologist:
EnergyLog Corporation
1981 to 1990 (Time off for University of Iowa 1984 to 1987)

Primary Duties:
Performed mobile lab work in the petroleum and geothermal industries located in California and overseas.

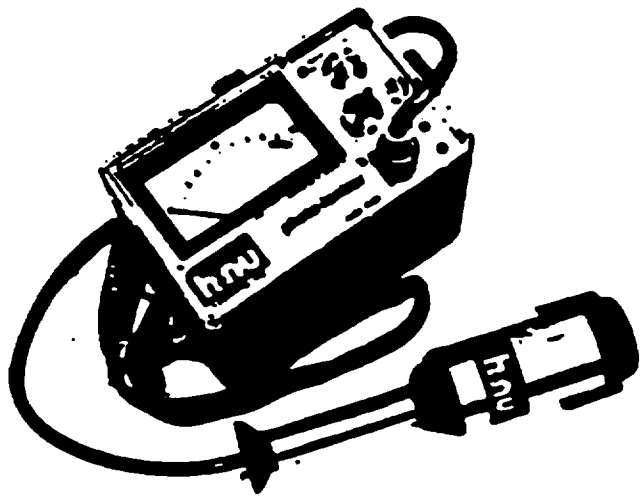
173315

INSTRUCTION MANUAL

FOR

MODEL PI 101

PHOTOIONIZATION ANALYZER



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SECTION 1

INTRODUCTION

The model PI 101 has been designed to measure the concentration of trace gases in many industrial or plant atmospheres. The analyzer employs the principle of photoionization for detection. This process is termed photoionization since the absorption of ultraviolet light (a photon) by a molecule leads to ionization via:

$$RH + h\nu \rightarrow RH^{+} + e^{-}$$

where RH = trace gas

$h\nu$ = a photon with an energy ≥ Ionization Potential of RH

The sensor consists of a sealed ultraviolet light source that emits photon which are energetic enough to ionize many trace species (particularly organics but do not ionize the major components of air such as O_2, N_2, CO, CO_2, or H_2O. A chamber adjacent to the ultraviolet source contains a pair of electrodes. Wh a positive potential is applied to one electrode, the field created drives any ions, formed by absorption of UV light, to the collector electrode where the current (proportional to concentration) is measured.

To minimize adsorption of various sample gases, the ion chamber is made of an inert fluorocarbon material, is located at the sampling point, and a rapid flow of sample gas is maintained through the small ion chamber volume.

The analyzer will operate either from a rechargeable battery for more than 10 hours or continuously from the AC battery charger. A solid state amplifier board in the probe and a removable power supply board in the readout module ena rapid servicing of the unit in the field.

The useful range of the instrument is from a fraction of a ppm to about 2,000 ppm. For measurement at levels above 2,000 ppm, dilution of the sample stream with clean air is recommended. Some typical specifications for the model PI 101 Photoionization Analyzer are given in Table 1.

TABLE 1

SPECIFICATIONS FOR MODEL PI 101
PHOTOIONIZATION ANALYZER

performance (benzene referred)

range 0.1 to 2000 ppm
detection limit 0.1 ppm
sensitivity (max) 0-2 ppm FSD over 100 division meter scale
repeatability ± 1% of FSD
linear range 0.1 to 600 ppm
useful range 0.1 to 2000 ppm
response time < 3 sec to 90% of full scale
ambient humidity to 95% RH
operating temperature ambient to 40°C*

physical

size:	probe 6.3 DIA x 28.5L (cm)	(2-1/2 x 11-1/4")
	readout 21W x 13D x 16.5H (cm)	(8-1/4 x 5-3/16 x 6-1/2
	stowed 21W x 13D x 24H (cm)	(8-1/4 x 5-3/16 x 9-1/2
	cable 80 cm long (32")	

weight: probe .55 kg (20 ounces)
readout 3.2 kg (7 pounds)
total (shipping) 5.4 kg (12 pounds)

controls and functions

mode switch Off, Battery Check, Standby (zero), 0-2000, 0-200, 0-20 ppm
low battery indicator light
zero (10 turn ± 300% FSD max)
span (10 turn counting dial 1.0 to 10 times nominal sensitivity)
readout 4-1/2" (11.3 cm) meter Taut Band movement graduated 0-5-10-15-20, divisions
signal output for recorder 0-(-5V) FSD
power output for recorder 12 VDC - jack on side of instrument

power requirements of operating times

continuous use, battery > 10 hours
continuous use with HNU recorder reduces instrument battery operating time to 1/2 normal time
recharge time, max < 14 hours, 3 hours to 90% of full charge
recharge current, max .4 Amps @ 15 VDC

TABLE 1 (Continued)

construction

Designed to withstand the shock and abuse to which portable instruments are often subjected. The readout is housed in a two piece aluminum case, and finished with a solvent resistant baked acrylic textured paint.

The probe is fabricated from extruded aluminum sections and machined plastic.

serviceability

The probe and readout are of a modular design allowing rapid servicing and/or replacement of mechanical and electrical components. All module interwiring includes quick disconnects.

maintenance

The instrument contains only one moving part, and consumes no gases or reagents. The only routine maintenance procedure is cleaning the light source window every several weeks.

calibration check

Check instrument calibration at least once per week with HNU calibration standard to ensure that the high sensitivity of the instrument is maintained.

* Instrument is temperature compensated so that a 20°C change in temperature corresponds to a change in reading of < ± 2% full scale at maximum sensitivity.

SECTION 2

OPERATION

2.1 Unpacking

Unpack the instrument carefully and remove the housing, the probe and any spare parts from the shipping carton. Place the instrument on a table or bench with the label upright. Remove the top section of the instrument by opening the two fasteners on the cover (see figure 1). The inner panel of the top section can be removed by pulling up on the fasteners. The top section of the instrument contains the battery charger and a waist strap. The waist strap clips on to the strap brackets of the instrument when needed.

Before attaching the probe, check the function switch on the control panel to make sure it is in the off position. The 12 pin interface connector for the probe is located just below the span adjustment on the face of the instrument (see figure 2). Carefully match the Alignment Key in the probe connector to the 12 pin connector on the control panel, and then twist the probe connector until a distinct snap and lock is felt.

Attached to the instrument is a warranty card which should be filled out completely and returned to HNU Systems.

2.2 Operation

Turn the function switch to the battery check position. The needle on the meter should read within or above the green battery arc on the scaleplate. If the needle is in the lower portion of the battery arc, the instrument should be recharged prior to making any measurements. If red LED comes on, the battery should be recharged.

Next, turn the function switch to the on position. In this position the UV light source should be on. Look into the end of the probe to see the purple glow of the lamp.

A brief description of the instrument controls and functions is shown in Figure 2.

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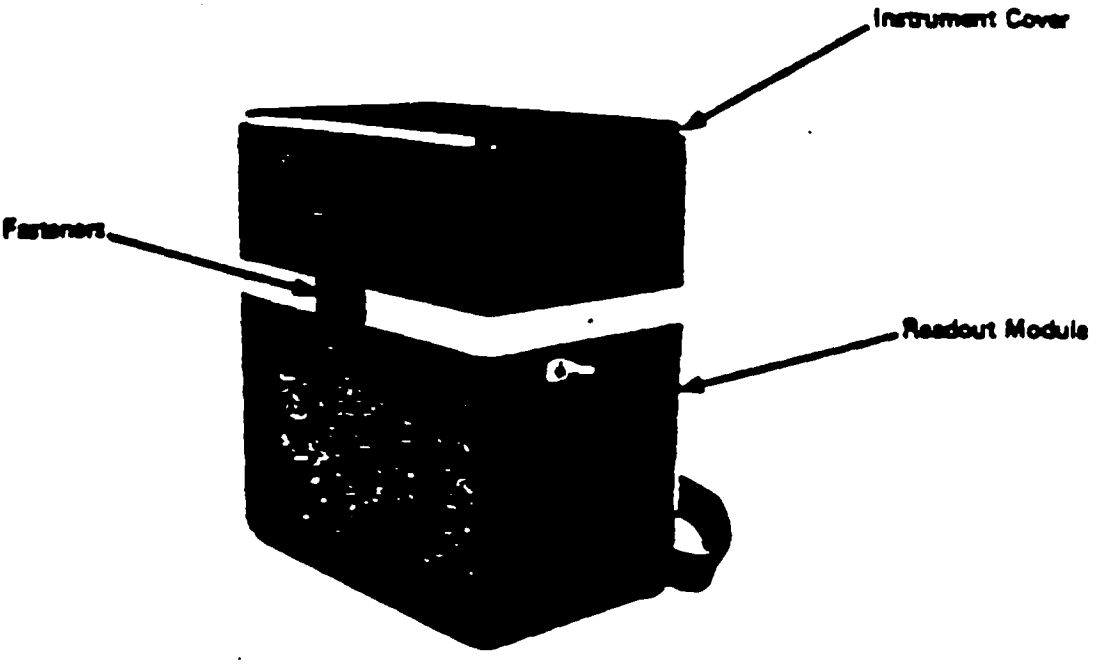


Figure 1. Unpacking the Photoionizer.

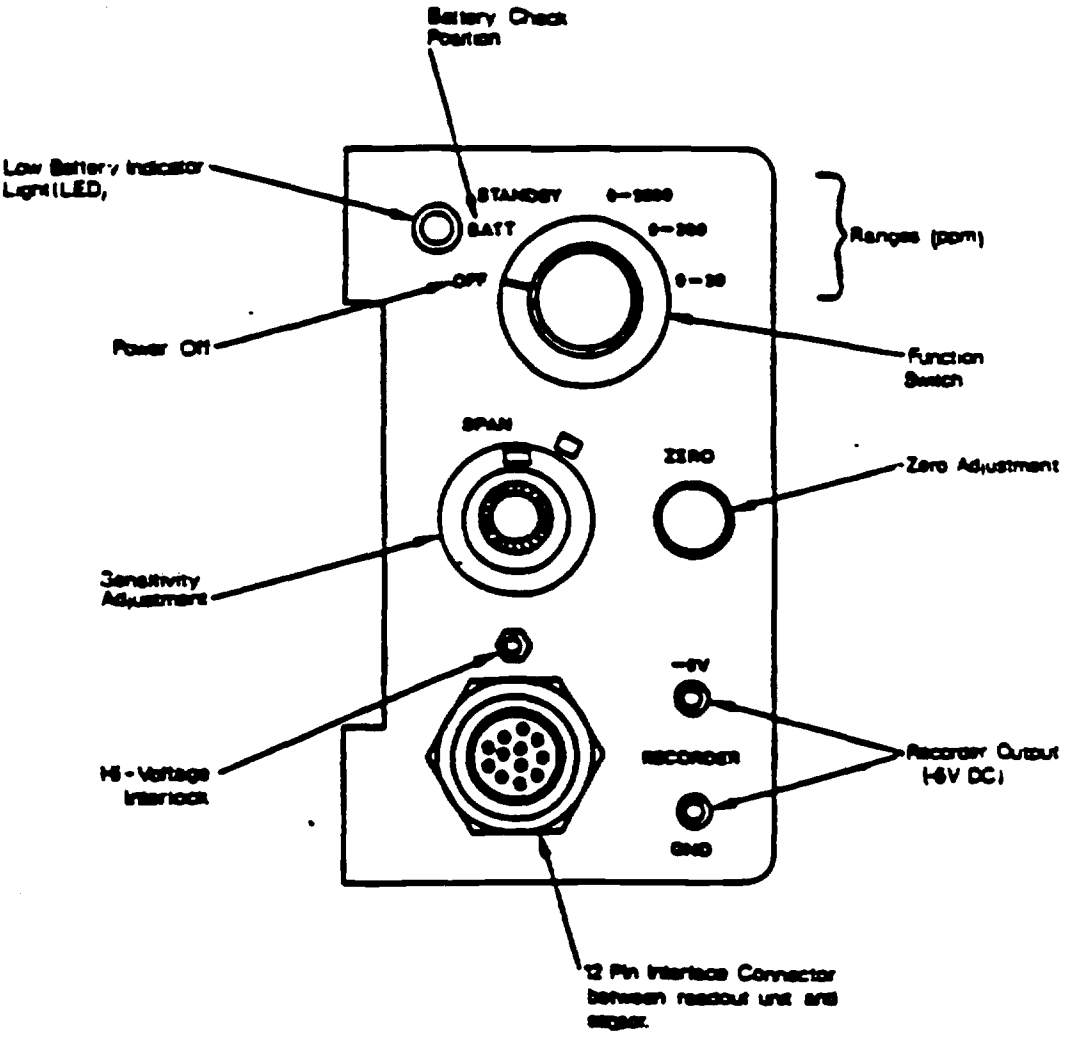
TABLE II

BRIEF DESCRIPTION OF INSTRUMENT
CONTROLS AND FUNCTIONS*

Control	Function
Six Position Switch	OFF - Shuts off all power and removes DC vo
	ON - In any other function position or mode, the electronics are on.
	BATTERY CHECK - Indicates the condition battery. If needle position is in portion of green battery arc, the inst ment should be recharged.
	STANDBY - UV lamp is off but electronics a This position will conserve power and the useful operating time between r of the battery. This position is lized to adjust the electronic zero.
	RANGES - 0-20, 0-200, 0-2000 direct rea available at minimum p in for benz sensitivity is availa by adjusting span potentiometer.
Zero Potentiometer	A ten turn potentiometer is employed to the zero electronically when the instrument placed in the standby position with the pro attached. This eliminates the need for carbon free gas.
Span Potentiometer	A ten turn counting potentiometer is uti lis upscale setting of the meter on calibra Counter-clockwise rotation increases th vity (~10 times). This pot can increase th sitivity to make the instrument direct rea nearly any gas which the instrument res

*For position of layout controls see Figure 2.

Figure 2 Control Panel Functions



To zero the instrument, turn the function switch to the standby position and rotate the zero potentiometer until the meter reads zero. Clockwise rotation of the zero potentiometer produces an upscale deflection while counterclockwise rotation yields a downscale deflection. Note: no zero gas is needed, since this is an electronic zero adjustment (see below). If the span adjustment setting is changed after the zero is set, the zero should be rechecked and adjusted, if necessary. Wait 15 or 20 seconds to ensure that the zero reading is stable. If necessary, readjust the zero.

The instrument is now ready for calibration or measurement by switching the function switch to the proper measurement range. The instrument is supplied calibrated to read directly in ppm (v/v) 0-20, 0-200, 0-2000 of benzene with the span position set at 9.8. For additional sensitivity, the span potentiometer is turned counterclockwise (smaller numbers) to increase the gain. By changing the span setting from 10.0 to [illegible] 0 the sensitivity is increased approximately [illegible] fold. Then, the 0-20, 0-200, and 0-2000 ppm scales become 0-2, 0-20, and 0-200 ppm full scale, respectively. This span control is also utilized to make the instrument scale read directly in ppm of the compound being measured. E.g., it is adjusted to match the value of a calibration gas to that same reading on the instrument scale. The span control can be utilized to calibrate nearly any compound, measured by photoionization, to be direct reading on the 0-20 ppm range. For example, gain settings of 4.5 or 8.9, respectively, will provide direct reading capability (0-20, 0-200 ppm) for vinyl chloride and trichloroethylene, respectively. For a listing of approximate gain setting values see Table IV.

A small DC operated fan is used to pull air through the photoionization sensor at a flow rate of three to seven hundred centimeters per minute (ca. 0.5 lpm). The fan provides nearly instantaneous response times (Figure 3) while consuming little power. The characteristics of a fan are such that it cannot tolerate a significant pressure drop without affecting the flow rate and therefore either the instrument reading or response time. Since photoionization is essentially a nondestructive technique, changes in flow rate do not affect the signal but if a large pressure drop is imposed at the inlet of the probe, the sample may not reach the sensor.

TABLE III

VERIFICATION OF ELECTRONIC ZERO FOR PHOTOIONIZATION ANALYZER*

Sample	Instrument Reading (ppm)	% of F.S.
Room Air	0.7	35
Room Air Passed Through 6" x 3/4" OD Charcoal Scrubber	0.1	5
Zero Air	0.25	12.5
Zero Air Passed Through 6" x 3/4" OD Charcoal Scrubber	0.04	2

*Maximum Gain = 2 ppm full scale.

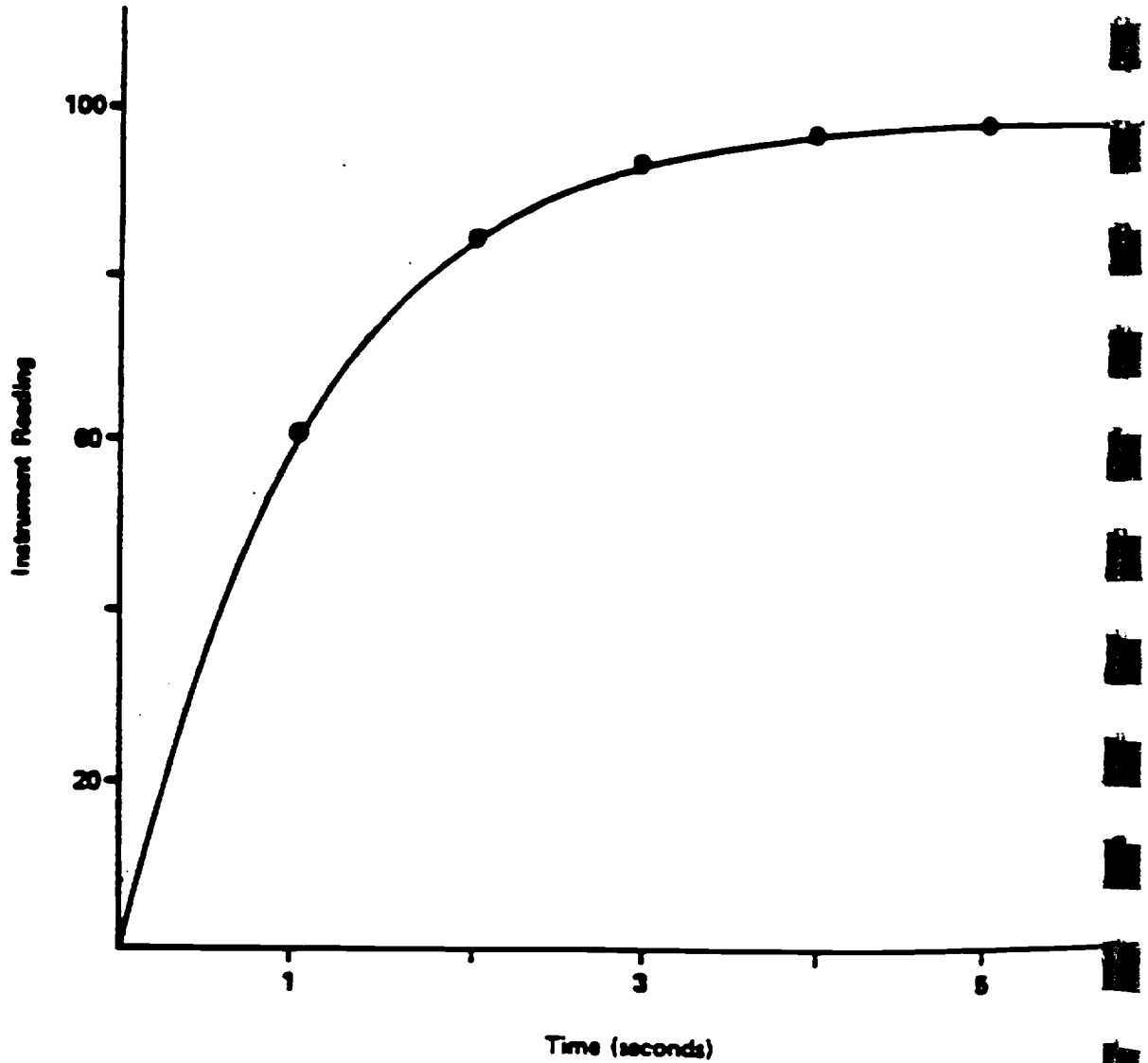
TABLE IV

RELATIVE PHOTOIONIZATION SENSITIVITIES* FOR VARIOUS GASES

Chemical Grouping	Relative Sensitivity	Examples
Aromatic	10.0	Benzene, Toluene, Styrene
Aliphatic Amine	10.0	Diethylamine
Chlorinated Unsaturated	5-9	Vinyl Chloride, Vinylidene Chloride, Trichloroethylene
Carbonyl	5-7	MEK, MIBK, Acetone, Cyclohexene
Unsaturated	3-5	Acrolein, Propylene, Cyclohexene, Allyl Alcohol
Sulfide	3-5	Hydrogen Sulfide, Methyl Mercaptan
Paraffin (C_5-C_7)	1-3	Pentane, Hexane, Heptane
Ammonia	0.3	—
Paraffin (C_1-C_4)	0	Methane, Ethane . . .

*Sensitivities in ppm (v/v).

Figure 3. Time Response for the Photoionization Analyzer.



The instrument was designed to measure trace gases over a concentration range from less than 1 ppm to 2000 ppm. Higher levels of various gases (to percentage range) can be measured but the recommended procedure is to dilute the sample with clean air to a concentration of less than 500 ppm. This is generally within the linear range of the instrument and if the measured concentration is multiplied by the dilution ratio the correct concentration in the stream can be determined. A typical calibration curve is shown in Figure 4. Note that the calibration curve for benzene (the photoionization standard) is linear (over more than three decades) up to about 600 ppm (v/v).

If the probe is held close to AC power lines or power transformers, an error may be observed. For measurements made in close proximity to such items, their effect on measurements can be determined by the following procedure. Zero the instrument in an electrically quiet area, in the standby position, then move the instrument to the questionable area involved. If AC pickup is going to be a problem, the meter (in the standby position) will indicate the magnitude of the error.

The instrument is equipped with an automatic solid state battery protection circuit. When the battery voltage drops below ~ 11 volts, this circuit will automatically turn off the power to the instrument. This prevents deep discharging of the battery and considerably extends the battery life. If the instrument is unintentionally left on overnight, the battery will be unharmed because of the battery protection circuit. If the instrument battery check reads low and the lamp doesn't fire, plug the charger into the instrument. The power to the analyzer should then be returned.

To charge the battery, place the mini phone plug into the jack on left side of the bezel prior to plugging charger into 120 VAC. When disconnecting charger, remove from 120 VAC before removing mini phone plug. The battery is completely recharged overnight (ca. 14 hours). To ensure that the charger is functioning, turn the function switch to the battery check position, place phone plug into jack and plug charger into AC outlet. The meter should go upscale if charger is working and is correctly inserted into the jack.

The instrument can be operated during the recharge cycle. This will lengthen the time required to completely recharge the instrument battery.

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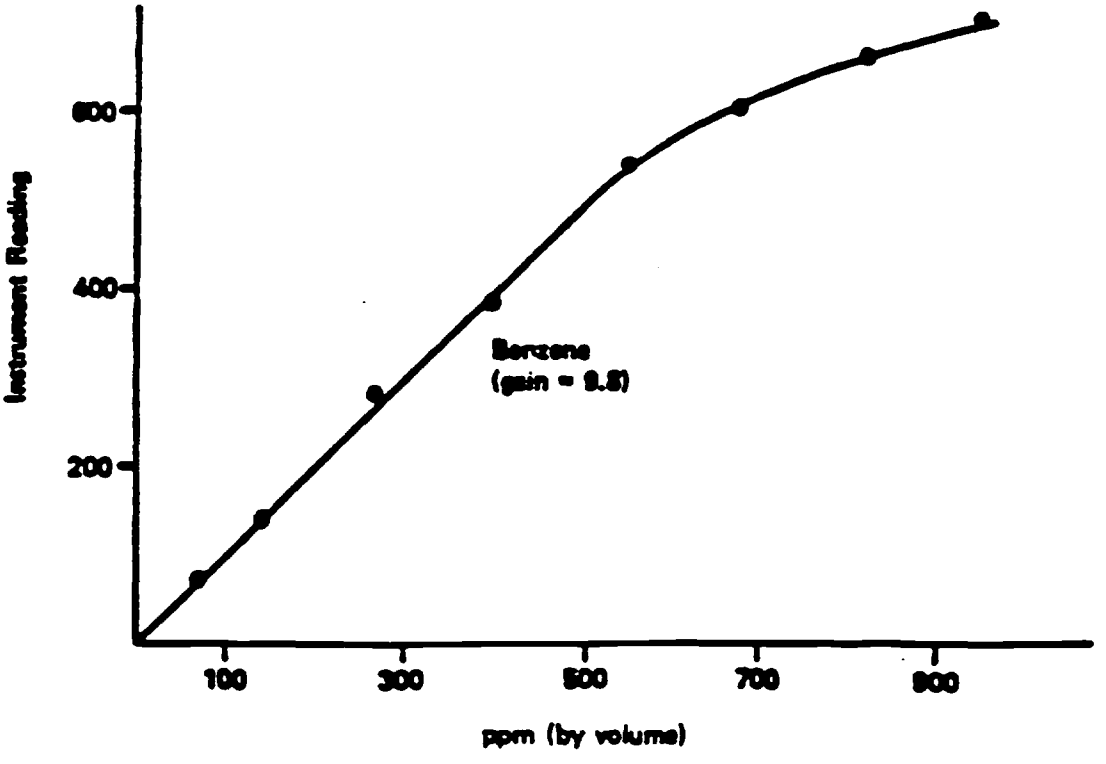
Figure 4. Typical Calibration Curve for Photoionization Analyzer.



SECTION 3

CALIBRATION

Static or dynamic gas generation systems can be utilized for calibratio of the instrument. A number of such systems for generating test atmospheres for various gases have been described by G. O. Nelson in "Controlled Test Atmospheres," Ann Arbor Science Publishers, Ann Arbor, Michigan (1971).

The most convenient packages for calibration are the non-toxic analyzed gas mixtures available from HNU Systems in pressurized containers (Catalogue #101-350).

A rapid procedure for calibration involves bringing the probe and readou in close proximity to the calibration gas, cracking the valve on the tank and checking the instrument reading. This provides a useful spot check for the instrument.

The recommended and most accurate procedure for calibration of the instru ment from a pressurized container is to connect one side of a 'T' to the pressur container of calibration gas, another side of the 'T' to a rotameter and th side of the 'T' directly to the 8" extension to the photoionization probe (see Figure 5). Crack the valve of the pressurized container until a slight flow indicated on the rotameter. The instrument draws in the volume of sample requir for detection, and the flow in the rotameter indicates an excess of sample. adjust the span pot so that the instrument is reading the exact value of the cal bration gas. (If the instrument span setting is changed, the instrument sho be turned back to the standby position and the electronic zero should be readjus if necessary.)

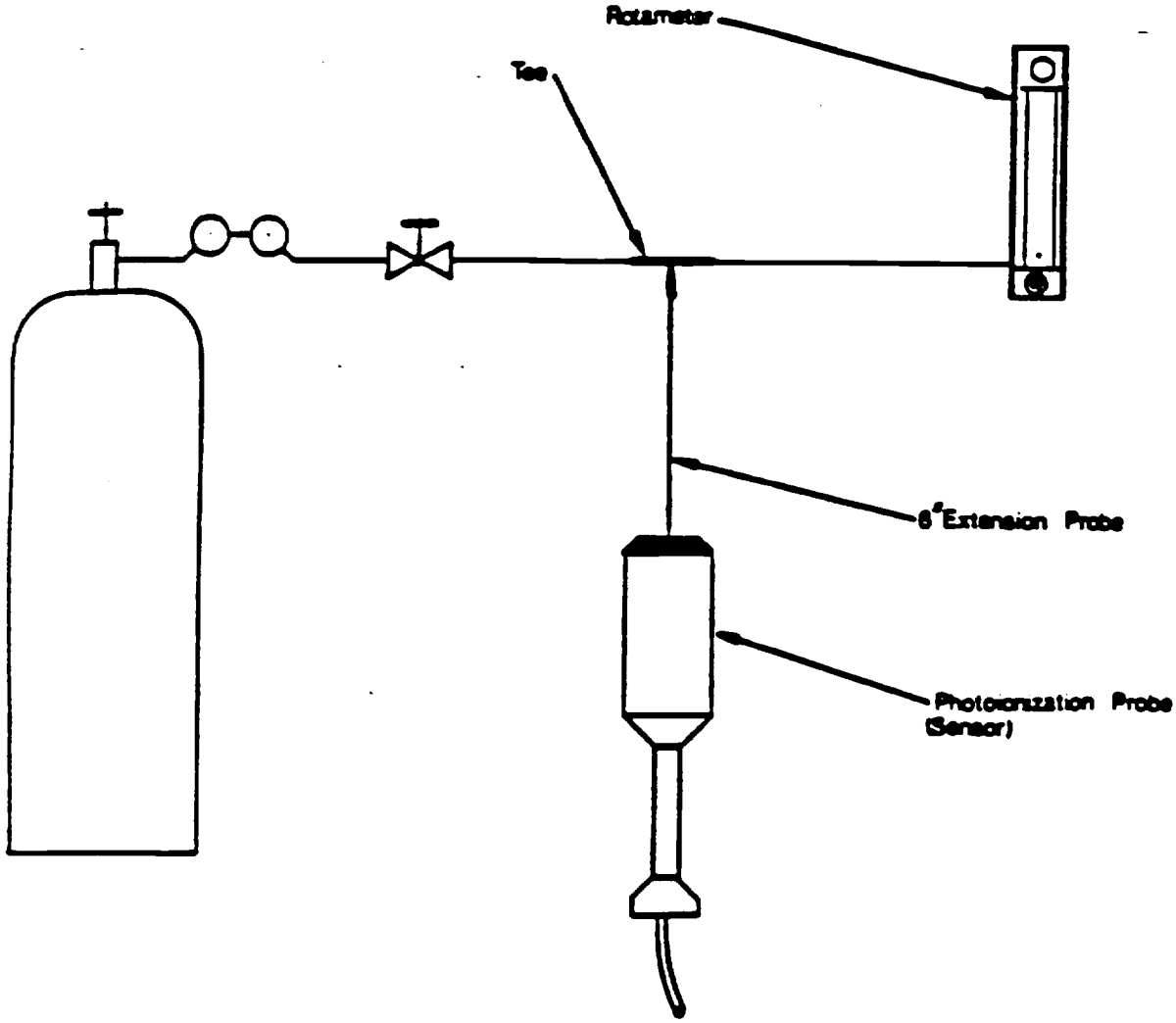


Figure 5. Recommended Calibration Procedure for Photoionization Analyzer

The calibration gas* should be prepared in the same matrix (air, nit hydrogen, etc.) in which it is to be measured, otherwise an inaccurate rea may be obtained. The increased response which is seen in oxygen free gases c be attributed to a reduction in the quenching of ions by oxygen (actually O and is typical of any ionization detector. The quenching effect of oxygen is constant from about ten percent O_2 to very high levels.

If a gas standard prepared in nitrogen is to be used for measurements in air, fill a 0.5 or 1 liter bag with the standard then add 50 or 100 cc of p oxygen to bring the level to 10-12%.

Any error between this value and 20% oxygen is quite small.

If the sample to be measured is in nitrogen, standards should be prepared in nitrogen. This will result in an increase in sensitivity of approximately 4.

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* Calibration with toxic gases should be performed in a hood since the 101 is a non-destructive analyzer.

SECTION 4

DETECTION PRINCIPLE AND THEORY

The detection principle of this portable instrument is photoionization. A wide variety of organic compounds and some inorganic compounds can be measured with this technique. Photoionization (with ~ 10 eV photons) applied to the analysis of trace gases in air can eliminate fragment ion formation (signals) from the major components of air yet still allow the ionization of many impurities of interest in industrial atmospheres. This is demonstrated by the listing of ionization potentials* in Tables V-XVII. Note the high (12 eV) ionization potentials for the major components of air. In addition, the choice of a sufficiently low ionization energy often permits the selective ionization of one or two components in a complex gas mixture.

While the ionization potential serves as a rough guide to whether or not a response is obtained, it does not predict what the quantitive response actually is. In some cases, a species with an ionization potential 10.3 or 10.4 eV will give a response. In these cases, however, the response is usually low because of its low ionization efficiency at 10 eV. A partial list of actual relative sensitivities obtained with a photoionization analyzer is given in Table XVIII. The use of the tables should allow a determination of the specificity of the instrument in a given application on many industrial processes; this instrument may not respond to the starting materials or by-products but will respond to a product. An example of this is seen in the vinyl chloride monomer plants where neither ethylene or dichloroethane is detected but vinyl chloride is detected.

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* Ionization potential is defined as the energy required to move an electron an infinite distance from the nucleus or more simply, the energy required to produce a positive ion and an electron.

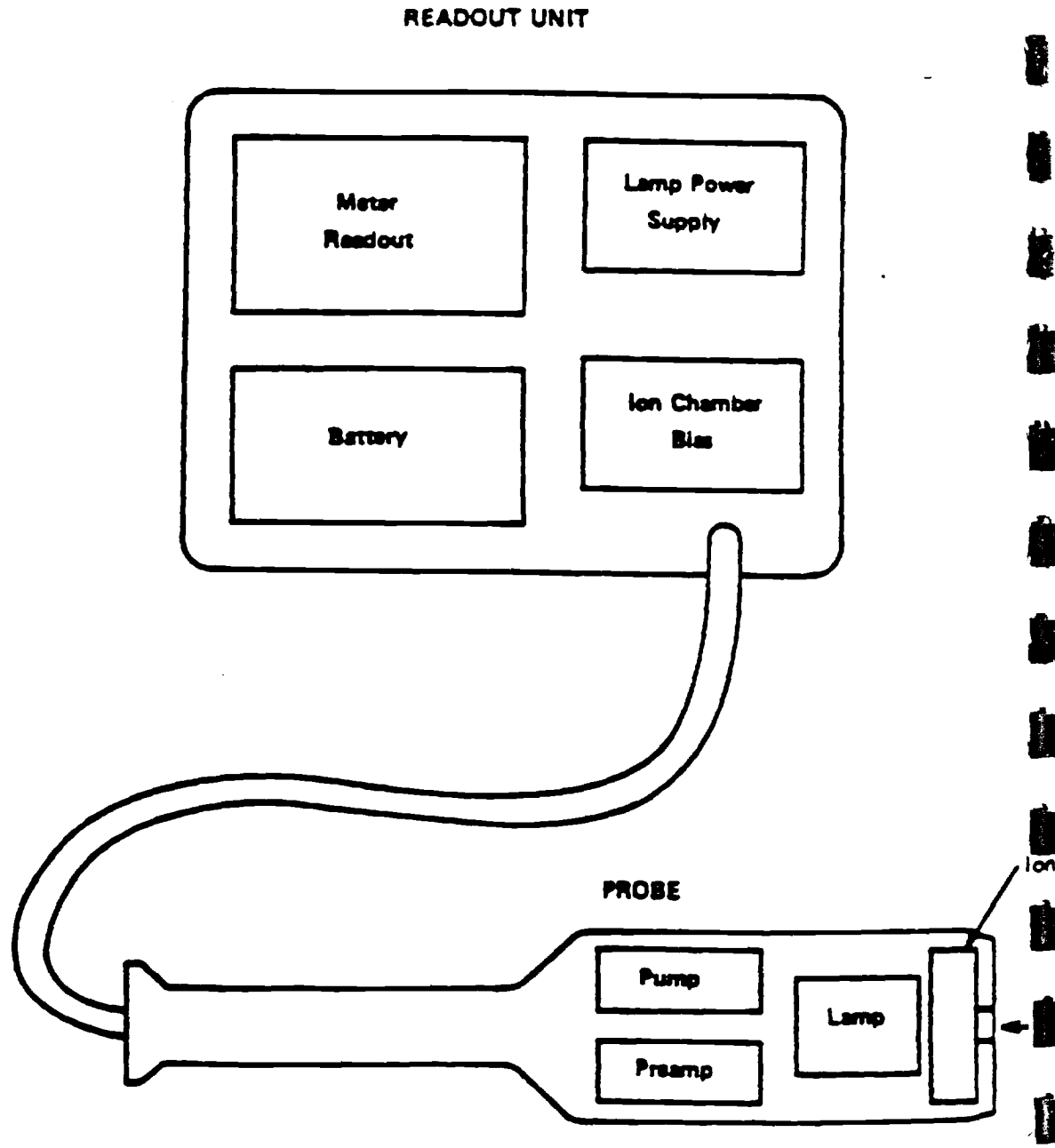

Figure 8. Block Diagram of Portable Photoionization Analyzer.

A block diagram of the major components of the photoionization analyzer is shown in Figure 6. The instrument is separated into two units interconnected by multiconductor electrical cable. The probe contains a fan for moving the air into the sensor, the ultraviolet lamp which is ignited by applying a DC voltage between the anode and cathode, the ionization chamber which contains a pair of electrodes and is adjacent to the lamp, and a signal amplifier. The photons (~ 10 eV) which are emitted from the lamp pass through a UV transmitting window and into the ionization chamber where absorption of the UV radiation by a molecule which has an ionization potential of 10 eV or less will lead to ion formation via

$$Rh + h\nu \rightarrow Rh^{+} + e^{-}$$

A positively biased high voltage electrode is used to push any ions formed by absorption of UV to the collector electrode where the current (proportional to concentration) is measured. This current is then converted to a proportional voltage by the amplifier in the probe. An electrical diagram of the instrument is depicted in Figure 7. The amplifier is gain stabilized by negative feedback and provides a voltage source output to drive the analog meter readout as well as the gain control network. The sensitivity of the instrument is controlled by changing the loop gain of the amplifier. A 12 volt battery provides the primary power for a high efficiency DC-DC converter which supplies the various potentials required for instrument operation.

Figure 7. Electrical Block Diagram of Photoionization Analyzer

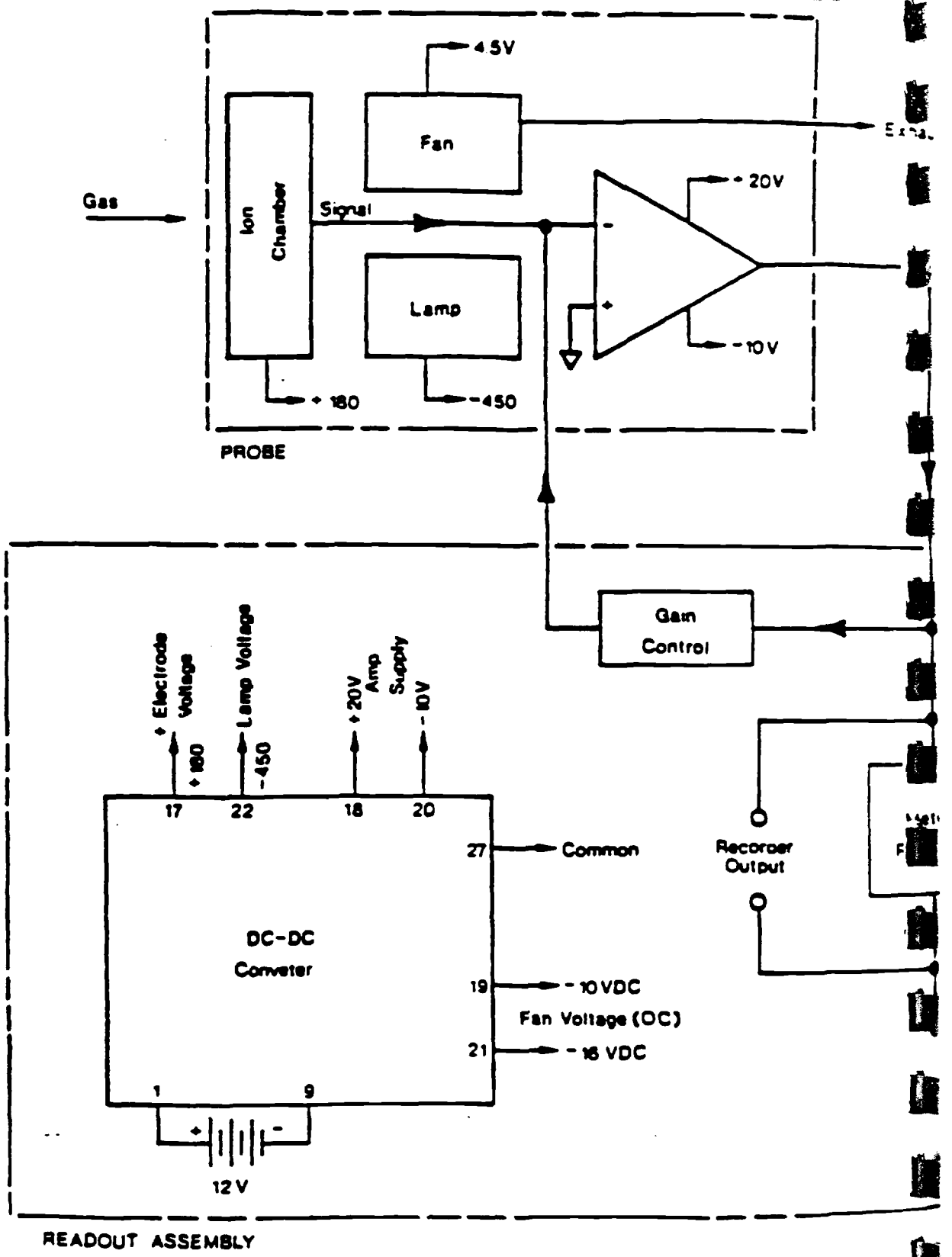

TABLE V

SOME ATOMS AND SIMPLE MOLECULES

	IP (eV)		IP (eV)
H	13.595	I_2	9.28
C	11.264	HF	15.77
N	14.54	HCl	12.74
O	13.614	HBr	11.62
Si	8.149	HI	10.38
S	10.357	SO_2	12.34
F	17.42	CO_2	13.79
Cl	13.01	COS	11.18
Br	11.84	CS_2	10.08
I	10.48	N_2O	12.90
H_2	15.426	NO_2	9.78
N_2	15.580	O_3	12.80
O_2	12.075	H_2O	12.59
CO	14.01	H_2S	10.46
CN	15.13	H_2Se	9.88
NO	9.25	H_2Te	9.14
CH	11.1	HCN	13.91
OH	13.18	C_2N_2	13.8
F_2	15.7	NH_3	10.15
Cl_2	11.48	CH_3	9.840
Br_2	10.55	CH_4	12.98

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TABLE VI

PARAFFINS AND CYCLOPARAFFINS

Molecule	IP (eV)
methane	12.98
ethane	11.65
propane	11.07
n-butane	10.63
i-butane	10.57
n-pentane	10.35
i-pentane	10.32
2,2-dimethylpropane	10.35
n-hexane	10.18
2-methylpentane	10.12
3-methylpentane	10.08
2,2-dimethylbutane	10.06
2,3-dimethylbutane	10.02
n-heptane	10.08
2,2,4-trimethylpentane	9.86
cyclopropane	10.06
cyclopentane	10.53
cyclohexane	9.88
methylcyclohexane	9.85

TABLE VII

ALKYL HALIDES

Molecule	IP (eV)
HCl	12.74
Cl_2	11.48
CH_4	12.98
methyl chloride	11.28
dichloromethane	11.35
trichloromethane	11.42
tetrachloromethane	11.47
ethyl chloride	10.98
1,2-dichloroethane	11.12
1-chloropropane	10.82
2-chloropropane	10.78
1,2-dichloropropane	10.87
1,3-dichloropropane	10.85
1-chlorobutane	10.67
2-chlorobutane	10.65
1-chloro-2-methylpropane	10.66
2-chloro-2-methylpropane	10.61
HBr	11.62
Br_2	10.55
methyl bromide	10.53
dibromomethane	10.49
tribromomethane	10.51
CH_2BrCl	10.77
$CHBr_2Cl$	10.59
ethyl bromide	10.29
1,1-dibromoethane	10.19
1-bromo-2-chloroethane	10.63

TABLE VII (Continued)

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Molecule	IP (eV)
1-bromopropane	10.18
2-bromopropane	10.075
1,3-dibromopropane	10.07
1-bromobutane	10.13
2-bromobutane	9.98
1-bromo-2-methylpropane	10.09
2-bromo-2-methylpropane	9.89
1-bromopentane	10.10
HI	10.38
I_2	9.28
methyl iodide	9.54
diiodomethane	9.34
ethyl iodide	9.33
1-iodopropane	9.26
2-iodopropane	9.17
1-iodobutane	9.21
2-iodobutane	9.09
1-iodo-2-methylpropane	9.18
2-iodo-2-methylpropane	9.02
1-iodopentane	9.19
F_2	15.7
HF	15.77
$CFCl_3$ (Freon 11)	11.77
CF_2Cl_2 (Freon 12)	12.31
CF_3Cl (Freon 13)	12.91
$CHClF_2$ (Freon 22)	12.45
$CFBr_3$	10.67

TABLE VII (Continued)

Molecule	IP (eV)
CF_2Br_2	11.07
CH_3CF_2Cl (Genetron 101)	11.98
$CFCl_2CF_2Cl$	11.93
CF_3CCl_3 (Freon 113)	11.73
$CFHBrCH_2Br$	10.75
CF_2BrCH_2Br	10.83
CF_3CH_2I	10.00
$n\text{-}C_3F_7I$	10.36
$n\text{-}C_3F_7CH_2Cl$	11.84
$n\text{-}C_3F_7CH_2I$	9.96

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TABLE VIII

ALIPHATIC ALCOHOL, ETHER, THIOL, AND SULFIDES

Molecule	IP (eV)
H_2O	12.59
methyl alcohol	10.85
ethyl alcohol	10.48
n-propyl alcohol	10.20
i-propyl alcohol	10.18
n-butyl alcohol	10.04
dimethyl ether	10.00
diethyl ether	9.53
n-propyl ether	9.27
i-propyl ether	9.20
H_2S	10.46
methanethiol	9.440
ethanethiol	9.285
1-propanethiol	9.195
1-butanethiol	9.14
dimethyl sulfide	8.685
ethyl methyl sulfide	8.55
diethyl sulfide	8.430
di-n-propyl sulfide	8.30

TABLE IX

ALIPHATIC ALDEHYDES AND KETONES

Molecule	IP (eV)
CO_2	13.79
formaldehyde	10.87
acetaldehyde	10.21
propionaldehyde	9.98
n-butyraldehyde	9.86
isobutyraldehyde	9.74
n-valeraldehyde	9.82
isovaleraldehyde	9.71
acrolein	10.10
crotonaldehyde	9.73
benzaldehyde	9.53
acetone	9.69
methyl ethyl ketone	9.53
methyl n-propyl ketone	9.39
methyl i-propyl ketone	9.32
diethyl ketone	9.32
methyl n-butyl ketone	9.34
methyl i-butyl ketone	9.30
3,3-dimethyl butanone	9.17
2-heptanone	9.33
cyclopentanone	9.26
cyclohexanone	9.14
2,3-butanedione	9.23
2,4-pentanedione	8.87

TABLE X

ALIPHATIC ACIDS AND ESTERS

Molecule	IP (eV)
CO_2	13.79
formic acid	11.05
acetic acid	10.37
propionic acid	10.24
n-butyric acid	10.16
isobutyric acid	10.02
n-valeric acid	10.12
methyl formate	10.815
ethyl formate	10.61
n-propyl formate	10.54
n-butyl formate	10.50
isobutyl formate	10.46
methyl acetate	10.27
ethyl acetate	10.11
n-propyl acetate	10.04
isopropyl acetate	9.99
n-butyl acetate	10.01
isobutyl acetate	9.97
sec-butyl acetate	9.91
methyl propionate	10.15
ethyl propionate	10.00
methyl n-butyrate	10.07
methyl isobutyrate	9.98

TABLE XI

ALIPHATIC AMINES AND AMIDES

Molecule	IP (eV)
NH_3	10.15
methyl amine	8.97
ethyl amine	8.86
n-propyl amine	8.78
i-propyl amine	8.72
n-butyl amine	8.71
i-butyl amine	8.70
s-butyl amine	8.70
t-butyl amine	8.64
dimethyl amine	8.24
diethyl amine	8.01
di-n-propyl amine	7.84
di-i-prop., amine	7.73
di-n-butyl amine	7.69
trimethyl amine	7.82
triethyl amine	7.50
tri-n-propyl amine	7.23
formamide	10.25
acetamide	8.77
N-methyl acetamide	8.90
N,N-dimethyl formamide	9.12
N,N-dimethyl acetamide	8.81
N,N-diethyl formamide	8.89
N,N-diethyl acetamide	8.60

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TABLE XII

OTHER ALIPHATIC MOLECULES WITH N ATOM

Molecule	IP (eV)
nitromethane	11.08
nitroethane	10.88
1-nitropropane	10.81
2-nitropropane	10.71
HCN	13.91
acetonitrile	12.22
propionitrile	11.84
n-butyronitrile	11.67
acrylonitrile	10.91
3-butene-nitrile	10.39
ethyl nitrate	11.22
n-propyl nitrate	
methyl thiocyanate	10.065
ethyl thiocyanate	9.89
methyl isothiocyanate	9.25
ethyl isothiocyanate	9.14

TABLE XIII

OLEFINS, CYCLO-OLEFINS, POLENES, ACETYLENES

Molecule	IP (eV)
ethylene	10.515
propylene	9.73
1-butene	9.58
2-methylpropene	9.23
trans-2-butene	9.13
cis-2-butene	9.13
1-pentene	9.50
2-methyl-1-butene	9.12
3-methyl-1-butene	9.51
3-methyl-2-butene	8.67
1-hexene	9.46
1,3-butadiene	9.07
isoprene	8.845
cyclopentene	9.01
cyclohexene	8.945
4-methylcyclohexene	8.91
4-vinylcyclohexene	8.93
cyclo-octatetraene	7.99
acetylene	11.41
propyne	10.36
1-butyne	10.18

TABLE XIV 173352

SOME DERIVATIVES OF OLEFINS

Molecule	IP (eV)
vinyl chloride	9.995
cis-dichloroethylene	9.65
trans-dichloroethylene	9.66
trichloroethylene	9.45
tetrachloroethylene	9.32
vinyl bromide	9.80
1,2-dibromoethylene	9.45
tribromoethylene	9.27
3-chloropropene	10.04
2,3-dichloropropene	9.82
1-bromopropene	9.30
3-bromopropene	9.7
$CF_3CCl{=}CClCF_3$	10.36
$n\text{-}C_5F_{11}CF{=}CF_2$	10.48
acrolein	10.10
crotonaldehyde	9.73
mesityl oxide	9.08
vinyl methyl ether	8.93
allyl alcohol	9.67
vinyl acetate	9.19

173353

TABLE XV

HETEROCYCLIC MOLECULES

Molecule	IP (eV)
furan	8.89
2-methyl furan	8.39
2-furaldehyde	9.21
tetrahydrofuran	9.54
dihydropyran	8.34
tetrahydropyran	9.26
thiophene	8.860
2-chlorothiophene	8.68
2-bromothiophene	8.63
pyrrole	8.20
pyridine	9.32
2-picoline	9.02
3-picoline	9.04
4-picoline	9.04
2,3-lutidine	8.85
2,4-lutidine	8.85
2,6-lutidine	8.85

TABLE XVI

AROMATIC COMPOUNDS

Molecule	IP (eV)
benzene	9.245
toluene	8.82
ethyl benzene	8.76
n-propyl benzene	8.72
i-propyl benzene	8.69
n-butyl benzene	8.69
s-butyl benzene	8.68
t-butyl benzene	8.68
o-xylene	8.56
m-xylene	8.56
p-xylene	8.445
mesitylene	8.40
durene	8.025
styrene	8.47
α-methyl styrene	8.35
ethynylbenzene	8.815
napthalene	8.12
1-methylnapthalene	7.96
2-methylnapthalene	7.955
biphenyl	8.27
phenol	8.50
anisole	8.22
phenetole	8.13
benzaldehyde	9.53
acetophenone	9.27
benzenethiol	8.33
phenyl isocyanate	8.77

TABLE XVI (Continued)

Molecule	IP (eV)
phenyl isothiocyanate	8.520
benzonitrile	9.705
nitrobenzene	9.92
aniline	7.70
fluoro-benzene	9.195
chloro-benzene	9.07
bromo-benzene	8.98
iodo-benzene	8.73
o-dichlorobenzene	9.07
m-dichlorobenzene	9.12
p-dichlorobenzene	8.94
1-chloro-2-fluorobenzene	9.155
1-chloro-3-fluorobenzene	9.21
1-bromo-4-fluorobenzene	8.99
o-fluorotoluene	8.915
m-fluorotoluene	8.915
p-fluorotoluene	8.785
o-chlorotoluene	8.83
m-chlorotoluene	8.83
p-chlorotoluene	8.70
o-bromotoluene	8.79
m-bromotoluene	8.81
p-bromotoluene	8.67
o-iodotoluene	8.62
m-iodotoluene	8.61
p-iodotoluene	8.50
benzotrifluoride	9.68
o-fluorophenol	8.66

TABLE XVII

MISCELLANEOUS MOLECULES

Molecule	IP (eV)
ethylene oxide	10.565
propylene oxide	10.22
p-dioxane	9.13
dimethoxymethane	10.00
diethoxymethane	9.70
1,1-dimethoxyethane	9.65
propiolactone	9.70
methyl disulfide	8.46
ethyl disulfide	8.27
diethyl sulfite	9.68
thiolacetic acid	10.00
acetyl chloride	11.02
acetyl bromide	10.55
cyclo-$C_6H_{11}CF_3$	10.46
(n-C_3F_7)(CH_3)C=O	10.58
trichlorovinylsilane	10.79
$(C_2F_5)_3N$	11.7
isoprene	9.08
phosgene	11.77

TABLE XVIII

RELATIVE SENSITIVITIES FOR VARIOUS GASES
(10.2 eV Lamp)

173357

Species	Photoionization Sensitivity*
p-xylene	11.4
m-xylene	11.2
benzene	10.0 (reference standard)
toluene	10.0
diethyl sulfide	10.0
diethyl amine	9.9
styrene	9.7
trichloroethylene	8.9
carbon disulfide	7.1
isobutylene	7.0
acetone	6.3
tetrahydrofuran	6.0
methyl ethyl ketone	5.7
methyl isobutyl ketone	5.7
cyclohexanone	5.1
naptha (86% aromatics)	5.0
vinyl chloride	5.0
methyl isocyanate	4.5
iodine	4.5
methyl mercaptan	4.3
dimethyl sulfide	4.3
allyl alcohol	4.2

TABLE XVIII (continued) 173353

Species	Photoionization Sensitivity*
propylene	4.0
mineral spirits	4.0
2,3-dichloropropene	4.0
cyclohexene	3.4
crotonaldehyde	3.1
acrolein	3.1
pyridine	3.0
hydrogen sulfide	2.8
ethylene dibromide	2.7
n-octane	2.5
acetaldehyde oxime	2.3
hexane	2.2
phosphine	2.0
heptane	1.7
allyl chloride (3-chloropropene)	1.5
ethylene	1.0
ethylene oxide	1.0
acetic anhydride	1.0
α pinene	0.7
dibromochloropropane	0.7
epichlorohydrin	0.7
nitric oxide	0.6
β pinene	0.5
citral	0.5
ammonia	0.3

TABLE XVIII (continued)

Species	Photoionization Sensitivity*
acetic acid	0.1
nitrogen dioxide	0.02
methane	0.0
acetylene	0.0
ethylene	0.0

*Expressed in ppm (v/v).

SECTION 5

TROUBLESHOOTING

If problems occur while using the photoionization analyzer, it is recommended that the following troubleshooting guide be followed before consulting the factory.

5.1 General Aid to Fault Determination

Check battery condition. Recharge if necessary (Section 2). Turn the instrument on. Look into the Sample Inlet of the probe unit. A violet colored glow from the UV light source should be observed in all positions of the mode switch except the standby position. If unstable readings are obtained a faulty probe cable or electrical connection could be the problem. To check, hold the probe normally and flex the cable firmly. Watch the meter for fluctuations as the cable is stressed. Individual wires in the readout can be checked in a similar way. Check the coaxial connector on the amplifier board in the probe.

In the more sensitive ranges, a fluctuation in the reading may be noted if a hand or other large object is placed in very close proximity to the probe. This is normal for the instrument and will not result in an error in the measurement as long as the probe is held stationary while the measurement is being taken.

If the probe is held close to AC power lines or power transformers an error may be observed. If measurements are to be made in close proximity to such items, their effect on measurements can be determined by the following procedure. Zero the instrument in an electrically quiet area in the standby position, then move the instrument to the questionable area involved. If AC pickup is going to be a problem, the meter (in the standby position) will indicate the magnitude of the error.

5.2 Disassembly of Instrument

PROBE - Turn the function switch to the OFF position and disconnect the probe connector from the readout unit. Remove the exhaust screw found near the base of the probe (see Figure 8.) Grasp the end cap in one hand and the probe shell in the other, and gently pull to separate the end cap and lamp housing from the shell. Loosen the screws on the top of the end cap and separate the end cap and ion chamber from the lamp and lamp housing. Care must be taken so that the ion chamber doesn't fall out of the end cap and the lamp doesn't slide out of the lamp housing. Turn the end cap over in your hand and tap on the top of it; the ion chamber should fall out in your hand. Place one hand over the top of the lamp housing and tilt slightly; the light source will slide out of the housing. The amplifier board can be removed from the lamp housing assembly by unsnapping the coaxial connection and then removing the retaining screw.

To reassemble this unit, first slide the lamp back into the lamp housing. Place the ion chamber on top of the lamp housing, checking to make sure that the contacts are properly aligned. Place the end cap on top of the ion chamber and replace the two screws. The screws should be tightened only enough to seal the "O" ring. DO NOT OVERTIGHTEN. Line up the pins on the base of the lamp housing with the pins inside the probe shell. Gently slide the housing assembly into the probe shell. DO NOT FORCE the assembly into the shell as it only fits one way.

READOUT UNIT - Turn the function switch to the OFF position and disconnect the probe from the readout unit before disassembly is conducted (see Figure 10). Remove the accessory power jack plug. Loosen the screw on the bottom of the case and, holding the instrument by the bezel, remove the case. The power supply board and control panel can be removed by unscrewing two screws and two nuts. The entire panel, including the function switch, zero and span pots is removed in this operatio Electrically disconnecting this module is simple, since all connections are made with Molex connectors.

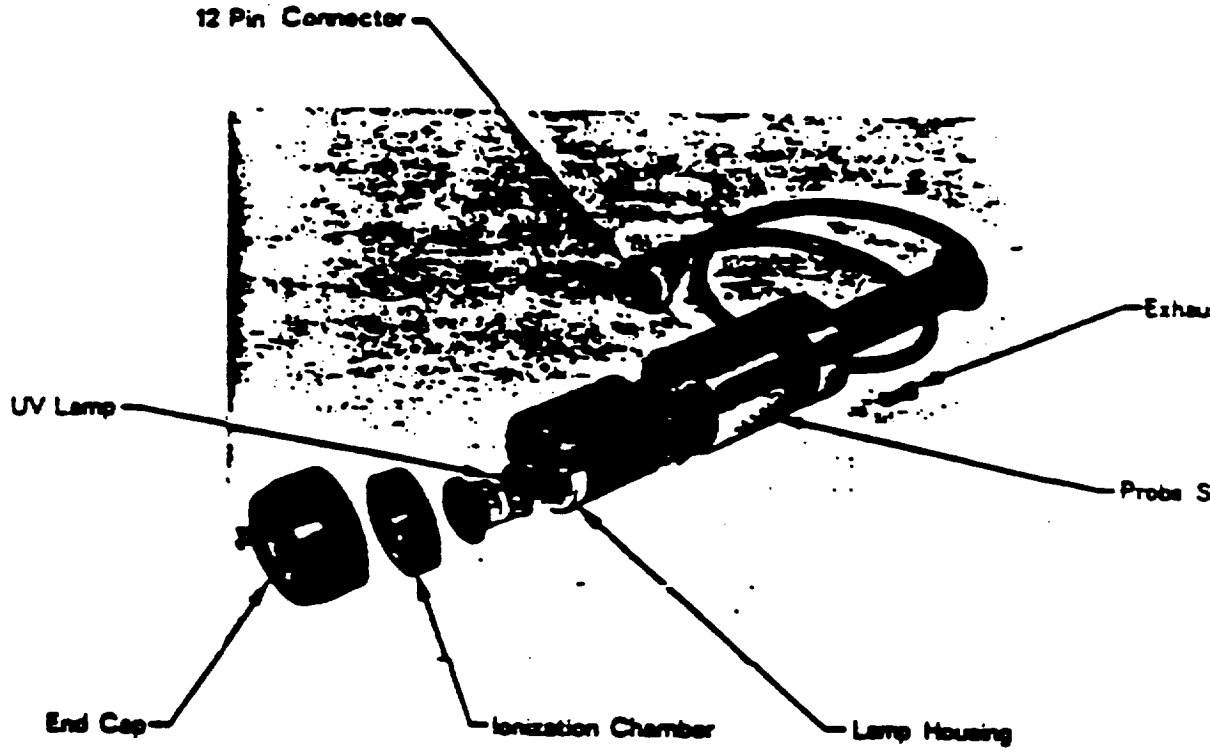
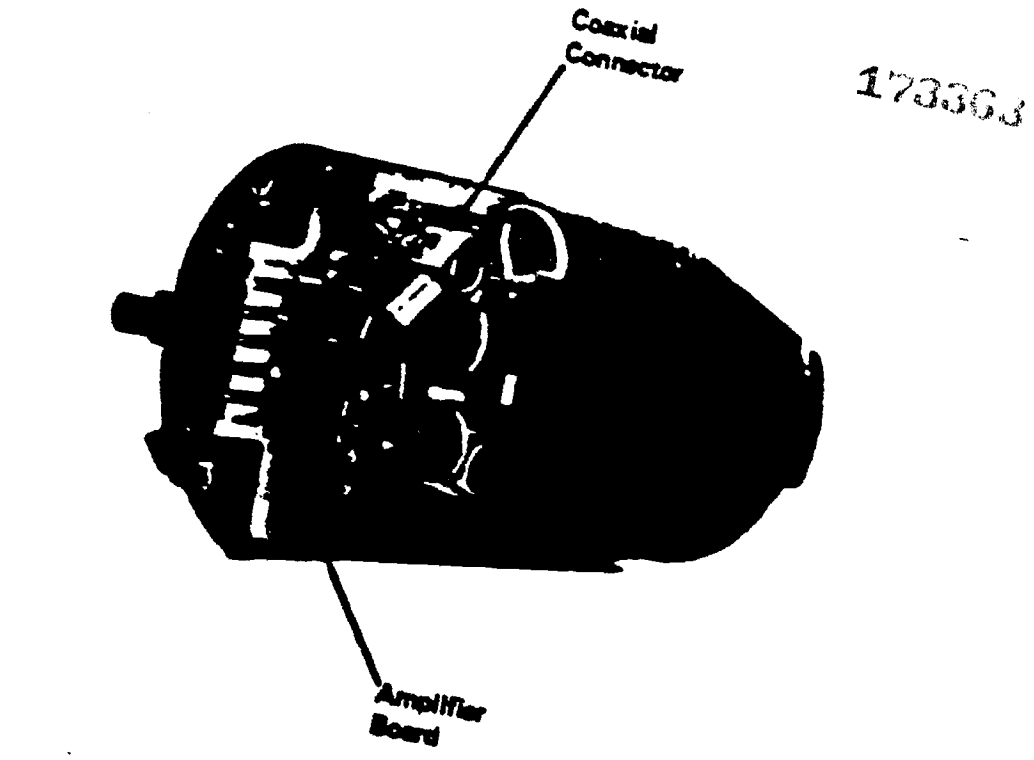


Figure 8. Component Parts of Probe

173363



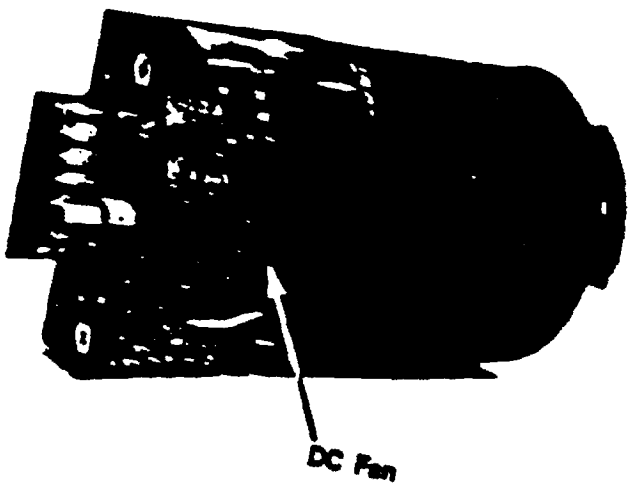


Figure 8. Component Parts of Lamp Housing

5.3 Specific Faults

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1. No meter response in any switch position (including BATT CHK)

   A. Broken meter movement

      (1) Tip instrument rapidly from side to side. Meter needle should move freely, and return to zero.

   B. Electrical connection to meter is broken

      (1) Check all wires leading to meter and clean the contacts of quick-disconnects.

   C. Battery is completely dead

      (1) Disconnect battery and check voltage with a volt-ohm meter.

   D. Check 2 amp fuse

   E. If none of the above solves the problem, consult the factory.

2. Meter responds in BATT CHK position, but reads zero or near zero for all others

   A. Power supply defective

      (1) Check power supply voltages per Figure 11. If any voltage is out of specification, consult the factory.

   B. Input transistor or amplifier has failed

      (1) Rotate zero control; meter should deflect up/down as control is

      (2) Open probe. Both transistors should be fully seated in sockets

   C. Input signal connection broken in probe or readout

      (1) Check input connector on printed circuit board. Should be firmly pressed down.

      (2) Check components on back side of printed circuit board. All connecti should be solid, and no wires should touch any other object.

      (3) Check all wires in readout for solid connections.

3. Instrument responds correctly in BATT CHK, AND STBY, but not in measuring

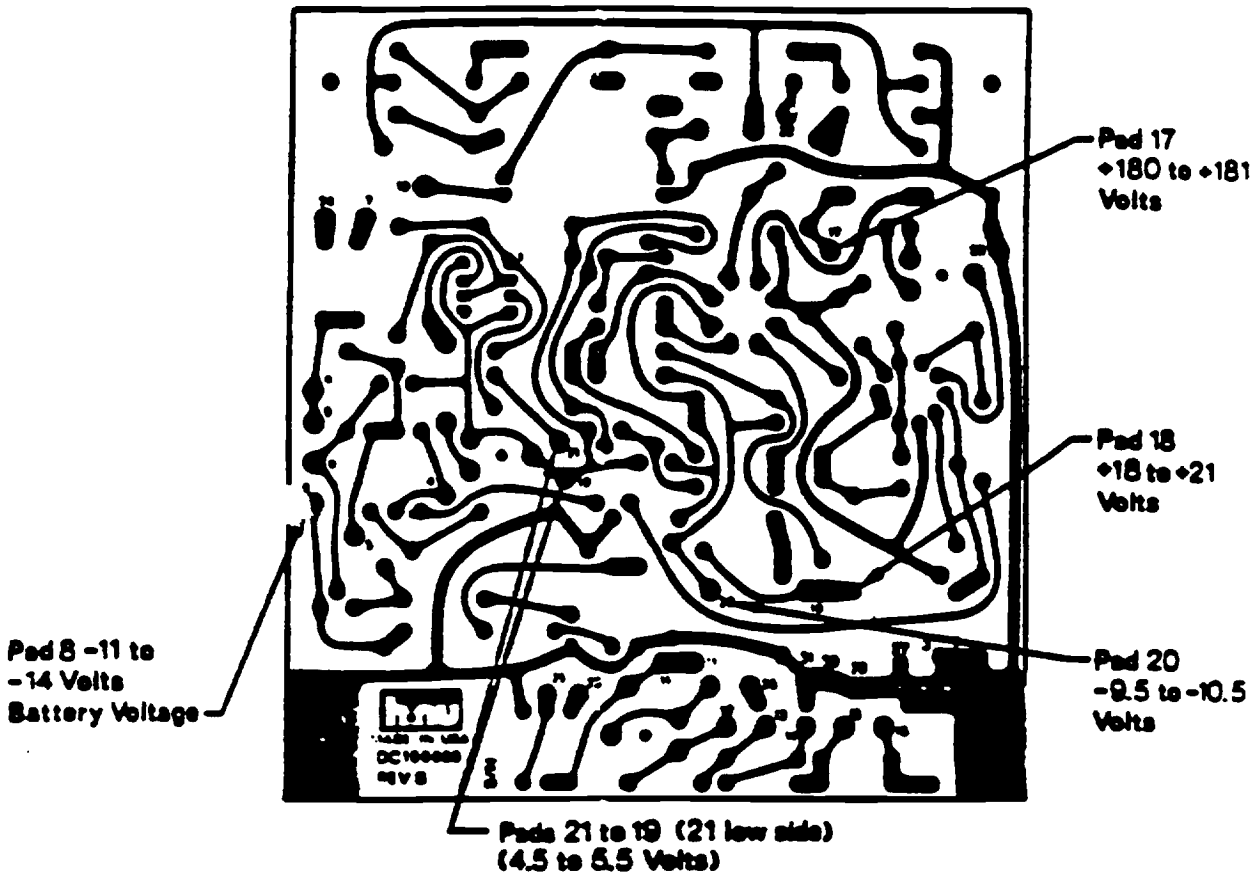
   A. Check to see that light source is on (See General Faults section.)

      (1) Check high voltage power supply (see Figure 11).

      (2) Open end of probe, remove lamp and check high voltage on lamp contact ring.

      (3) If high voltage is present at all above points, light source has m likely failed. Consult the factory.

1. All voltages measured with probe connected and instrument mode switch in BATT CHK position.
2. All measurements referred to ground (pads 2,3 and 27) except pad 21 measured to pad 19 and pad 8 to pad 11.



All Voltages Respect to Ground							
pads	voltage	pads	voltage	pads	voltage	pads	voltage
1	− 5.7V	9	− 12.2V	17	180V	25	0
2	GRD	10	− 12.1V	18	− 19.4V	26	0
3	GRD	11	0	19	− 10.6V	27	GRD
4	−10.7V	12	0	20	− 9.7V	28	0
5	− 11.3V	13	0	21	−14.5V	29	GRD
6	− 12.1V	14	0	22	−400V	30	GRD
7	0	15	0	23	0	31	GRD
8	− 12.2V	16	0	24	0		

Figure 11 Power Supply PC Board

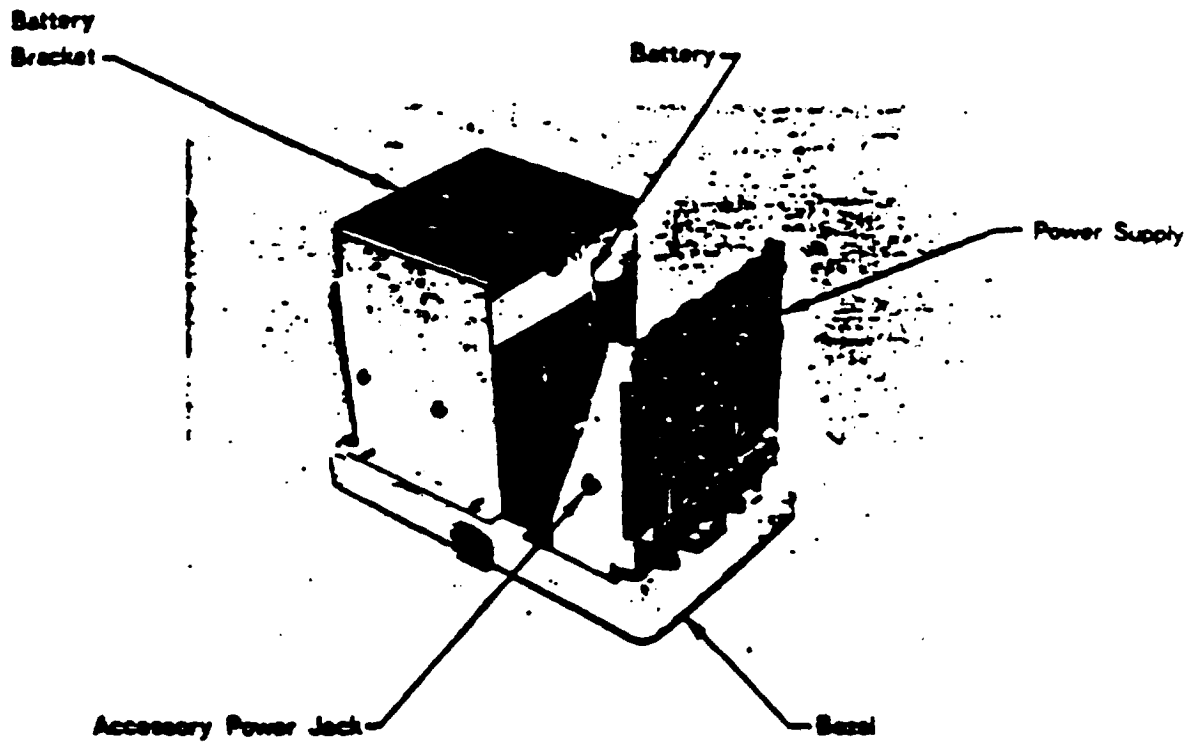


Figure 10. Component Parts Of Readout Unit.

hnu chemical instrumentation

17336

To: Sales
From: QC
Date: 12-21-84
Subject: Spare Probe(s) Calibration of PI-101 for

LAW ENGINEERING AND TESTING WO# 116

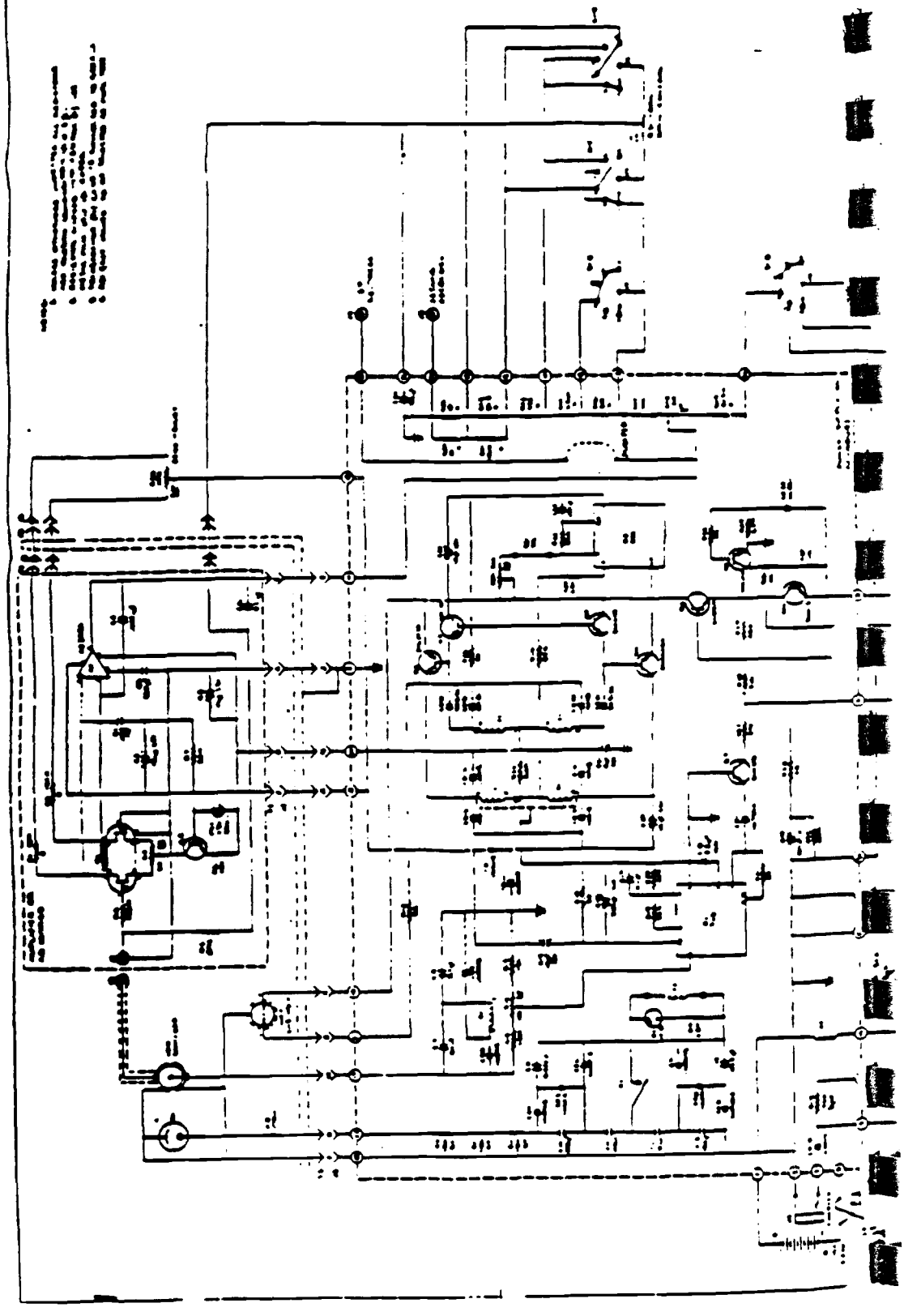
A PI-101, S/N 41653, was calibrated to be direct reading on Benzene with two probe assemblies, consisting of a 10.2 eV lamp (12696) probe (S/N 41653) and a 11.7 eV lamp (13387) probe (04507) respectively. Calibration was performed as follows:
The 10.2 eV lamp probe assembly was connected to the unit and calibrated to be direct reading on benzene. The 11.7 eV lamp probe assembly was then connected and calibrated by rezeroing the unit and adjusting the span to 4.0 to read benzene directly. Rezeroing must be performed with every probe assembly interchange.

The pertinent data is shown in Table 1. The unit is now calibrated to read benzene directly for both probe assemblies, with the same power supply module. It is important to emphasize that the lamps cannot be interchanged between the two probes, since the individual amplifiers are calibrated to lamp output.

Table 1

Power Supply S/N	Probe Amp S/N	Lamp (eV)	Lamp (S/N)	Span Pot	100 ppm Benzene	HNU
41653	4051	10.2	12696	9.8	100.0	[illegible]
41653	4160	11.7	13387	4.0	100.0	[illegible]

173363



SECTION 6

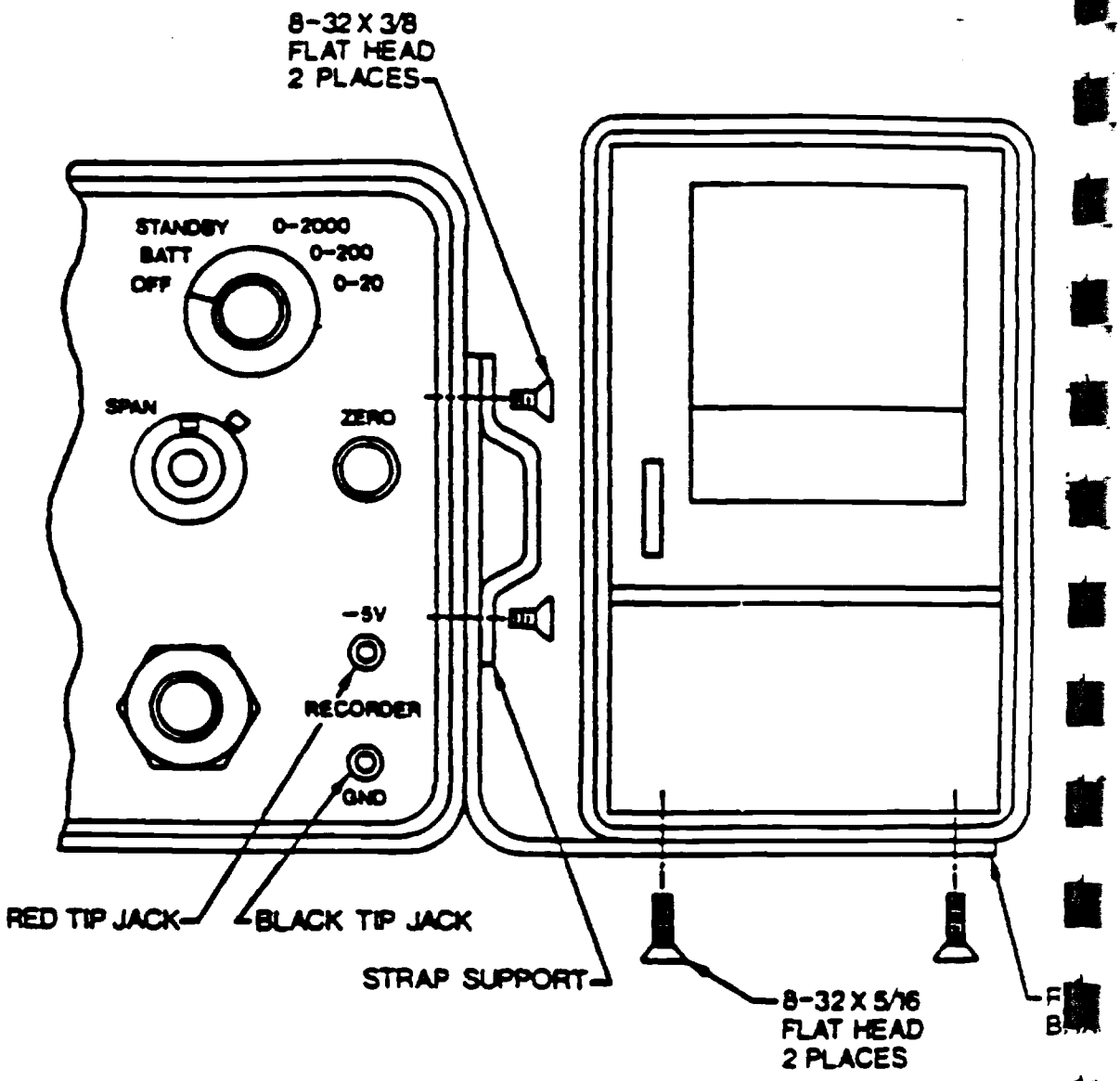
173369

REPLACEMENT PARTS LIST

Part No.	Assembly
100004A	Probe Shell Assembly
100005A	Ion Chamber
100006A	Fan/Light Source Housing
100007A	Amplifier Board
100008A	Fan
100009A	Light Source (10.2 eV)
100010A	"O" Ring Kit
100011A	Battery
100012A	Meter
100013A	Charger
100014A	Power Supply Unit
100015A & 100016A	Case (both halves)
100017A & 100018A	Straps
100019A	Switch
100020A	Pot (span)
4750-0001A	Pot (zero)
100074	Probe Extension

173370

SECTION 8
PI-101 RECORDER ASS'Y
INSTRUCTIONS



NOTES:

1. Remove strap support on right side of PI-101 case.
2. Mount recorder bracket between case & strap support using 8-32 X 3/8 long screws su
3. Mount recorder to bracket using 8-32 X 5/16 screws supplied.
4. Connect harness to plug on rear of recorder. Insert power plug into receptacle on side of case. Insert red pin plug into red tip jack and black pin plug into black tip jack on PI-101 front panel.

173371

Publications on Photoionization Available from HNU Systems

(1) Driscoll, J. N. and P. Warneck, "The Analysis of ppm Levels of Gases in Air by Photoionization Mass Spectrometry," J. Air Poll. Cont. Assoc. 23, 858 (1973).

(2) Driscoll, J. N. and F. F. Spaziani, "A New Instrument for Continuous Monitoring of Odorous Sulfur Compounds," presented at the ISA National Meeting, N.Y. (Oct. 1974).

(3) Driscoll, J. N. and F. F. Spaziani, "Trace Gas Analysis by Photoionization" presented at the ISA Analysis Instrumentation Div. Meeting, King of Prussia, Pa. (May 1975).

(4) Photoionization Detector for Gas Chromatography," presented at the Pittsburgh Conf. on Anal. Chem. and Spectroscopy, Cleveland (March 1976).

Requests for these papers should be sent to:

Publications Department

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Local Representative:

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(404) 991-7170

173572

ADDENDUM A

to

Instruction Manual

for

Model PI 101

PHOTOIONIZATION ANALYZER

ION CHAMBER CLEANING PROCEDURE

Although the technique of photoionization is not sensitive to moisture, some electronic instability can be seen in the 101 portable analyzer as the result of excessive moisture. The following chart lists the symptoms expected, the possible causes, and solutions:

Symptom	Possible Cause	Solution
Loss in sensitivity	Condensation on instrument window	Avoid extreme temperature changes
		Acclimatize instrument to environment
Zero drift	Condensation on polarizing electrode	
	Ion chamber is dirty	Clean ion chamber

To clean the ion chamber: (See Section 5.2)

Remove the ion chamber. Remove all four screws, swing screen aside, and pull out the mesh. Using a Q-tip, gently clean the chamber with methanol to remove deposit . Dry in a vacuum oven at 90°C for 2 hours. Reassemble.

173373

HNU MODEL 101 SPECIFICATION SHEET

Serial # 41653

Calibration BENZENE By SD

Range: 0-20, 0-200, 0-2000 PPM

Span Pot Setting: 9,8 (10,2EV), 4,0 (11,7EV)

Light Source Energy: 9.5 eV _____ 10.2 eV 12696 11.7 eV 13387

Sensitivity: _____

Detection Limit: _____

Accessories: _____

GAS	CONC. (PPM)	RESPONSE
PROBE SN 41653 (10.2EV)		
BENZENE	100.0	100.0
HNU REF	97.0	56.0
PROBE SN 04507 (11.7EV)		
BENZENE	100.0	100.0
HNU REF	97.0	79.0

Instructions

Accumet®
Model 956
Portable Analog
pH/mV Meter

Catalog No. 13-636-956

Fisher Scientific

173376

173377

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Range:	
pH	0 - 14 pH
Millivolts	±700 mV
Resolution:	
pH	0.05 pH
Millivolts	5 mV
Precision:	
pH	±0.05 pH
Millivolts	±5 mV
Relative Accuracy:	±0.05 pH[1]

SPECIFICATIONS

Input Impedance	>2.5 x 10^{10} ohms
Tolerable Source Resistance	0-2000 megohms
Amplifier Drift	0.5 pH in 24 hrs.
Manual Temp. Compensation	0 to 100°C
Battery	9 volt alkaline[2]
Panel Meter	4½" taut band with mirror-back
Environmental Rating:	
Humidity Range	0 - 90%
Operating Temp. Range	15 to 45°C
Storage Temp. Range	0° to 80°C
Physical Data:	
Dimensions	34.3cm W x 25.4 D x 10.2 H (13.5"W x 10 D x 4 H)
Carrying Weight	1.8 kg (4 lb.)
Shipping Weight	2.3 kg (5 lb.)

INTRODUCTION

The Fisher Model 956 Accumet pH meter is a portable, battery-powered instrument intended for field us where rough handling can be expected and where electric power is not available. Mounted on the front panel are three simple operating controls used to select measuring function (pH or mV), to standar instrument with a buffer solution, and to compensate for sample temperature. The meter is equipped BNC and pin input jacks. A threaded socket accepts the electrode support rod. The meter movement a associated electronics are mounted on the rear of the panel, and can be completely removed from the c for service (and battery replacement) by simply removing four screws.

The Model 956 is powered by a supplied 9-volt alkaline battery with an operating life of approximately hours. The instrument employs advanced operational amplifier input circuitry, thus using to advantage th latest in solid-state technology for optimum reliability and trouble-free service in the most demanding environments.

[1]*Within 2 pH units of standardization.*

[2]*Approximately 100 hrs. operating time.*

UNPACKING

The Accumet Model 956 is shipped in a single carton containing the items listed below. While unpacking, check each item against the packing list. If a shortage exists, notify your representative, giving the name and number of the missing item. Also be sure to complete and return the warranty card located at the rear of this manual.

NOTE: In the event that shipping damage has been observed, retain the carton and packing material intact with the unit and file a claim with the final carrier. Usually, the firm will send an inspector to ascertain liability.

Quantity	Item	Cat. No. or Part No.
1	Accumet Portable pH Meter Assembly	69368
	Containing:	
1	Accumet pH Meter	13-620-956
1	Beaker, 100mL	41951
1	pH-9 Bottle	31222
1	pH-4 Bottle	31223
1	Thermometer	31142
1	Support Rod	41831
1	Electrode Holder	19941
1	Battery	40367
1	Combination Electrode	13-620-108
1	Instruction Manual	69369

OPERATING CONTROLS

Prior to using the Model 956, become familiar with the location and function of each control and connector. All are located inside the case (see figure 1) and are described in detail below:

Readout Meter. An analog meter with a pH scale covering 0-14 pH units, and a millivolt scale covering ± 700 millivolts. The scales are graduated in 0.1 pH and 10 millivolt increments, respectively, and are mirrored to minimize parallax errors.

Mechanical Meter Zero. A screwdriver adjustment that mechanically zeros the meter pointer. With the instrument sitting on a flat, level surface, the adjustment must be made with the FUNCTION selector in the OFF position to avoid electrical deflection of the pointer.

FUNCTION Selector. A three-position rotary switch used to disconnect battery power (OFF position) when measurements are not being taken, and to select the operating mode: pH for pH determinations and MV for millivolt measurements.

TEMPERATURE Control. A potentiometer that functions only in the pH mode to compensate for the effects of solution temperature on the electrode. The control is continuously variable from 0° to 100°C with a scale graduated in 2° increments.

STANDARDIZE Control. A multi-turn potentiometer that is used in pH determinations to set the meter to the pH value of a buffer solution, thereby compensating for the differences in the zero potential of electrode systems. In millivolt and redox measurements, the control establishes the millivolt zero reference point on the meter.

INPUT Jack. A jack that receives the BNC lead from the combination electrode, or any lead from an indicator electrode with a BNC connector.

NOTE: If an indicator electrode with a pin jack is to be used, the pin jack adapter Cat. No. 13-620-490 should be connected to the meter.

REF Jack. A jack that receives any single-lead from a reference electrode with a pin connector.

Support Mounting Socket. A threaded socket (immediately to right of TEMPERATURE control) which accepts the electrode support rod when instrument is in operation.

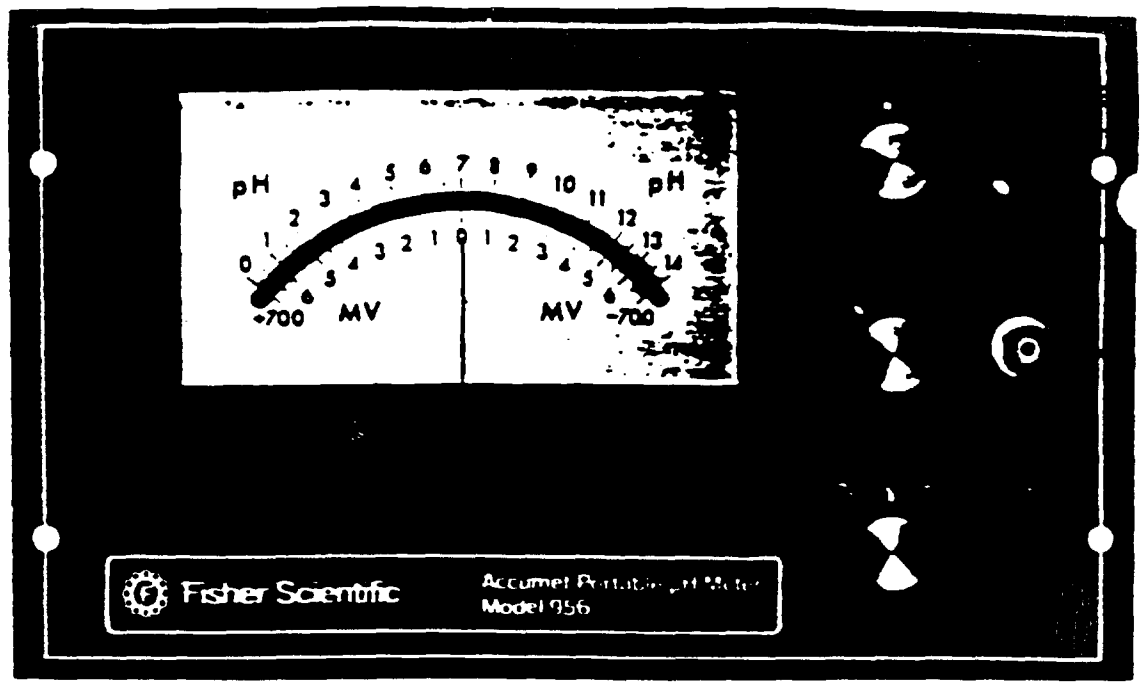

Figure 1. Controls

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BATTERY REPLACEMENT

The life expectancy of the supplied alkaline power cell (Eveready No. 522) is approximately 100 hours of total operation, if instrument usage does not exceed 4 hours/day. Low battery power is indicated by a loss of accuracy, erratic indications or no meter deflection when the FUNCTION selector is set to the pH or MV positions. A more accurate check can be made using a battery checker. When so doing, a reading of 50% (4.5V or less on a 9V battery) indicates that the battery should be replaced.

Ideally, the battery should be replaced with an Eveready No. 522 alkaline power cell such as that supplied with the instrument. However, in an emergency, a standard 9-volt transistor radio battery (No. 216 or 2C may be used — but with a considerably shorter life expectancy. Additionally, if a transistor radio battery is allowed to remain in the instrument beyond its useful life, battery leakage could cause damage to sensitive meter circuitry.

When replacement is required or when it is desired to check the battery with a checker, perform the following:

1. Set FUNCTION selector to OFF.
2. Unplug electrode leads.
3. Remove electrode support rod.
4. Remove the four screws (2 along each side) securing front control panel to carrying case, then lift panel up and out of case.
5. Unsnap connector, then remove battery from holding clips.
6. Check or replace battery, then reassemble instrument by generally reversing steps 1 through 5.

PRELIMINARY PROCEDURES

Prior to making a pH or millivolt measurement, the mechanical zero of the meter must be checked and the electrode system must be properly installed.

Checking and Adjusting Meter Zero

17339

Before initial use, the mechanical zero of the meter movement must be checked and, if necessary, adjusted. The meter pointer should indicate precisely 7 pH (or zero millivolts) with the FUNCTION selector set to OFF. If the above conditions are not met, adjust the MECHANICAL ZERO, using a small screwdriver, until specified indication is obtained.

Installing pH Electrode System

The Model 956 is supplied with a plastic-body combination electrode that is especially suited to the rugged conditions associated with field work. The INPUT and REF jacks will accommodate all other indicator and reference electrodes that employ BNC and pin cable connectors, respectively. The supplied electrode holder contains openings for one or two standard size electrode caps.

NOTE: At this point, the electrode(s) should be properly conditioned according to the manufacturer's instructions.

To install the supplied combination electrode, perform the following:

1. Unsnap the support rod from its molded case compartment and screw (clockwise) the threaded end into the socket in the meter panel.
2. Install electrode holder (see Figure 2) on support rod by depressing plate on underside of holder, sliding holder onto support rod, and releasing plate.
3. Remove the plastic cot from the tip of the electrode.
4. Slip electrode body into slot on either side of holder and lower it until cap is firmly seated.
5. Observe that FUNCTION selector is set to OFF, then remove shorting cap from the BNC jack.
6. Insert the round BNC connector jack onto the INPUT jack.
7. Check electrode system efficiency by standardizing in a buffer of known value and measuring in a second buffer by generally following the **Standardizing Instrument** and **Performing pH Determinations** procedures in the **OPERATION** section.
8. The electrode is now installed and ready for use (see **OPERATION** section). When not in use store the electrode as directed by the following procedure.

OPERATION

Separate procedures are provided below for standardizing the instrument, for performing pH measurements, and for performing millivolt measurements. Note that in all the procedures that follow, the FUNCTION selector should always be in the OFF position when immersing or removing the electrode system from solution. This practice avoids meter fluctuations that may damage the movement. Also the FUNCTION selector must always be set to OFF when the instrument is not in use to avoid unnecessary battery drain.

Standardizing Instrument

173382

The Model 956 is calibrated at the factory to indicate the exact pH of solutions measured at 25°C, using a signal representing the theoretical potential of a 100% efficient electrode system. However, the actual potential of each electrode system varies slightly from the theoretical and shifts the calibration point. For this reason, the instrument must be standardized prior to performing one or a series of pH determinations.

The Model 956 is standardized as follows:

1. Set up electrode system as described under **Installing pH Electrode System.**
2. Place a buffer container directly under the electrode system, then lower electrode system into buffer solution.

   NOTE: Always situate buffer and sample containers in case compartment provided to avoid damage from spillage.
3. Immerse the supplied thermometer into the buffer solution.
4. Allow at least 2 minutes for the electrode and buffer systems to reach thermal equilibrium, then set the TEMPERATURE control to match the thermometer indication.
5. Turn the FUNCTION selector to pH.
6. Adjust the STANDARDIZE control until the meter indicates the exact pH of the buffer as determined from a buffer pH-versus-temperature table (usually supplied by the buffer manufacturer).

   NOTE: Due to the high impedance characteristics of the glass membrane, the connecting cable of the electrode should not be moved or touched while measurements are being performed; otherwise, unstable meter indications may result.
7. Turn the FUNCTION selector to OFF.
8. Remove electrode system and thermometer from the buffer, and rinse them with distilled water.

Performing pH Determinations

Proper use and care of electrodes are fundamental to achieving reliable pH determinations. Therefore, all instructions supplied by the electrode manufacturer should be carefully followed.

Assuming that the instrument has been properly standardized, a pH determination is made as follows:

1. Be certain that FUNCTION selector is set to OFF.
2. Place sample container in case compartment directly beneath electrode system, then lower electrode system into sample solution.

   NOTE: Always situate sample containers in compartment provided to avoid damage from spillage.
3. Place the supplied thermometer into the sample, and allow at least 2 minutes for electrode system and sample solution to reach thermal equilibrium.
4. Set the TEMPERATURE control to match thermometer indication.
5. Turn the FUNCTION selector to pH, and read the pH value of the sample directly from the meter.
6. Turn the FUNCTION selector to OFF.
7. Remove electrode system and thermometer from the sample, and rinse them with distilled water.
8. Repeat steps 2 through 7 for remaining samples.
9. Upon completing final determination each day, be certain that FUNCTION selector is in OFF position.

Performing Millivolt Determinations

The Model 956 is a convenient tool for measuring electrode potential and indicating results over a −700 to +700 millivolt range. There is no need to standardize the instrument with a buffer or compensate for solution temperature. Readings can be taken as soon as the millivolt zero reference point is established, with no further standardization necessary.

Assuming that the electrodes are conditioned and installed according to instructions from manufacturer, a millivolt measurement is made as follows:

1. Be certain that FUNCTION selector is set to OFF.
2. Connect the shorting cap to the INPUT jack.
3. Turn FUNCTION selector to MV position and adjust STANDARDIZE control until meter indicates zero millivolts (or any other desired value).
4. Turn FUNCTION selector to OFF, remove jumper, and connect electrode leads to INPUT and REF jacks.
5. Place sample container in case compartment directly beneath electrode system, then lower electrode system into sample solution.

   NOTE: Always locate sample container in compartment provided to avoid damage from spillage.
6. Turn FUNCTION selector to MV and read electrical potential of solution directly from meter.
7. Turn FUNCTION selector to OFF.
8. Remove electrodes from sample and rinse them with distilled water.
9. Repeat steps 7 through 10 for remaining samples.
10. Upon completing final determination each day, be certain that FUNCTION selector is in OFF position.

SERVICE

Solid-state components and easily accessible assemblies simplify servicing of the Model 956. The following information is given to aid qualified service personnel and help minimize downtime. The information includes a brief circuit description, a troubleshooting guide, procedures to check instrument performance, buffer accuracy, electrode system efficiency, a procedure to remove the meter panel, and calibration and checking procedures. Also included at the end of the manual are replacement parts and a schematic. In addition, Fisher Scientific Company maintains a company wide Instrument Service Division with fully staffed service centers to assist with any service problems.

Understanding the Circuit

A single, operational amplifier in the Model 956 circuitry provides the necessary high-impedance input as well as the amplification required to drive the analog meter. This and the use of three diodes in the reference circuit facilitates meter indication of either polarity as well as excellent battery voltage stability over the entire instrument range.

173384

Troubleshooting Chart

If the instrument is not operating properly, select the SYMPTOM category (below) that best describes the operating malfunction, and proceed to check the PROBABLE CAUSE areas given under the category — taking proper CORRECTION action as directed.

NOTE: The Model 956 is a precision, electronic instrument and should only be serviced by compet trained personnel.

Symptom	Probable Cause	Corrective Action
1. Meter pointer does not respond to any FUNCTION switch position.	1. Battery defective.	1. Replace battery.
	2. Open circuit in meter.	2. Replace meter.
	3. Defective FUNCTION switch.	3. Replace FUNCTION switch
	4. Defective STANDARDIZE control.	4. Replace STANDARDIZE control
	5. Defective Op Amp.	5. Replace Op Amp.
2. Cannot adjust meter to indicate pH of buffer for standardization.	1. Electrode	1. Replace electrode.
	2. Buffer defective.	2. Replace buffer.
	3. Defective input circuit.	3. Perform all steps under Checking Instrument Performance. If test fails, check circuit continuity with low voltage ohmmeter.
	4. Electrode not properly immersed in solution.	4. Make sure tip of electrode immersed at least one inch.
	5. No solution in reference cavity of electrode.	5. Add fill solution to reference cavity (nongel-filled only).
	6. Amplifier defective.	6. Replace Op Amp.
3. Meter pointer drifts.	1. Electrode defective.	1. Replace electrode.
	2. Defective input circuit.	2. (Same as 2 and 3 above).
	3. Defective FUNCTION selector.	3. Replace selector switch.
	4. Solution being measured is unbuffered and exposed to air.	4. Use proper technique for measuring unbuffered solutions.
4. Meter indicates the same pH in any solution.	1. pH-sensitive section of electrode cracked.	1. Replace electrode.
5. Results incorrect.	1. Electrode defective.	1. Replace electrode.
	2. Buffer defective.	2. Replace buffer. Also see Checking Buffer Accuracy.
	3. Amplifier not operating properly.	3. Replace Op Amp.
	4. Meter defective.	4. Replace meter.
	5. Electrostatic charge on meter glass face.	5. Apply anti-static solution to meter face.
	6. TEMPERATURE Control knob misaligned.	6. Realign knob as directed under Calibrating pH Scale and Temperature Control.
	7. Instrument out of calibration.	7. Recalibrate as directed under Calibration Procedures.

Checking Instrument Performance

While performing the following procedure, there should be little, if any, drift and fluctuation in the meter needle in either the pH or mV mode. The presence of drift and/or fluctuation indicates an instrument defect

Instrument performance is checked as follows:

1. Connect shorting cap to the INPUT jack. (This shorts instrument input.)
2. Set FUNCTION Selector to pH position.
3. Set TEMPERATURE Control to 25°C.
4. Adjust STANDARDIZE Control until meter indicates 7.0 pH.
5. Turn STANDARDIZE Control to full clockwise and full counterclockwise positions; meter should indicate at least 4.0 and 10.0 pH respectively.

   NOTE: This demonstrates that STANDARDIZE Control has sufficient range to compensate for the zero potential of electrode systems.
6. Set FUNCTION Selector to MV.
7. It should be possible to adjust STANDARDIZE Control until meter indicates 0.0 millivolts (center scale).

Checking Buffer Accuracy

The most practical way to check buffer accuracy is to substitute a questionable bottle of buffer with a fresh, unused bottle. Some buffers deteriorate with age, but contamination is the principal cause of inaccuracy. A common practice is to regularly use two buffers — one as a working buffer and one as a check buffer.

Checking Electrode System Efficiency

Once instrument performance and buffer accuracy are found to be satisfactory, check efficiency of electrode system as follows:

1. Install combination electrode.
2. Obtain two buffer solutions that are several pH units apart in the 3 to 10 pH range.
3. Standardize the instrument with one of the buffers (as directed by **Standardizing Instrument** procedure given in the **OPERATION** section).
4. Determine the pH value of the other buffer (as directed by **Performing pH Determinations** procedure in the **OPERATION** section).

   NOTE: The result of this determination should be within 0.1 pH units of the known buffer value. If it is not, repair or replace the electrode system.

Removing Meter Panel

Most service procedures, such as battery and component replacement, require that the meter panel be removed from the case. This can be accomplished quickly and easily as follows:

1. Set FUNCTION Selector to OFF.
2. Disconnect electrode system from meter.
3. Remove electrode and electrode holder from support rod, then unscrew rod from meter panel.
4. Remove the four screws (two along each side) securing meter panel to carrying case, then lift panel up and out of case.
5. All components are mounted to rear of panel and are now easily accessible for service.

Calibration

The Model 956 is factory calibrated to perform within the stated pH and MV specifications. Under normal conditions, this calibration will yield satisfactory results over a long time period. However, it is recommended that the instrument be recalibrated annually or after any circuit component (except battery) has been replaced. An internal component view of the meter is shown in figure 2.

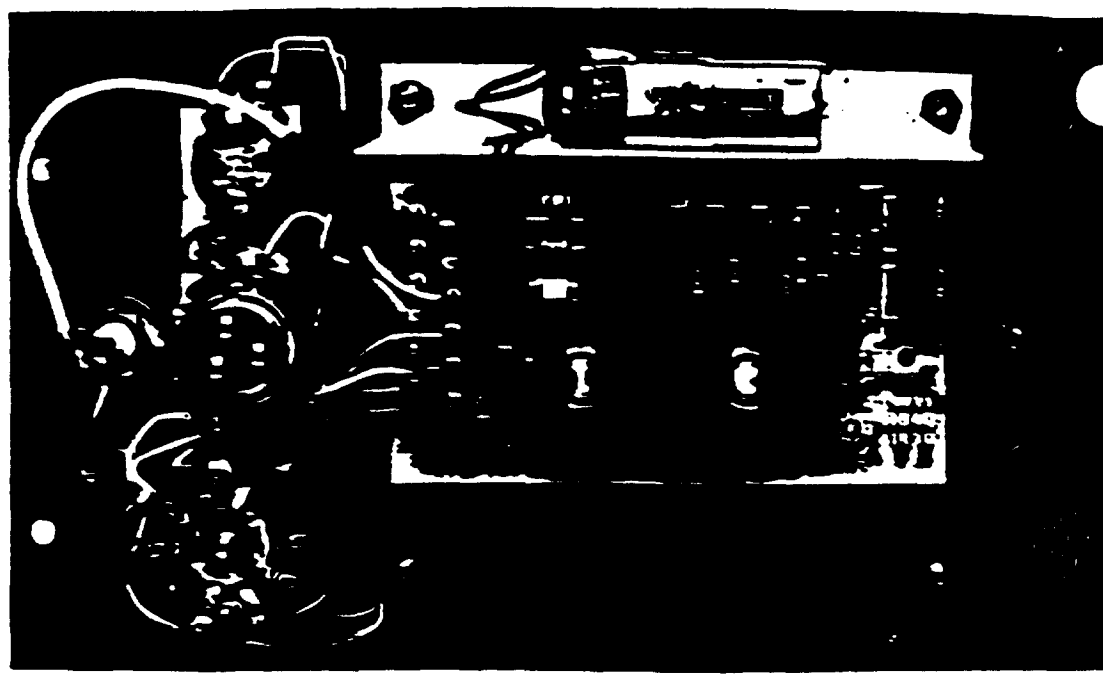


Figure 2. Internal Components

Calibrating Millivolt Scale

The millivolt scale is calibrated as follows:

1. Perform steps 1 through 3 under **Removing Meter Panel.**
2. Remove the four screws (two along each side) securing meter panel to case.

   NOTE: For calibration purposes, it is not necessary to remove panel from case since calibrating potentiometers are accessible by lifting panel up from left side.
3. Check and, if necessary, adjust the meter mechanical zero as directed under **Checking and Adjusting Meter Zero.**
4. Connect the supplied shorting cap to the INPUT jack.
5. Turn FUNCTION Selector to MV position.
6. Adjust STANDARDIZE Control until meter indicates exactly 0.0 mV, then return FUNCTION Selector to OFF.
7. Remove cap from INPUT jack and in its place, connect a millivolt source (with accuracy of 0.1% or better).
8. Adjust millivolt source to produce an output of +500 mV.
9. Model 956 should indicate +500 mV. If not, readjust R2 on circuit board until +500 millivolt indication is obtained.

   NOTE: Positive deflection of meter is to the left of the 0.0 center position.
10. Reverse polarity of millivolt source.
11. Model 956 should indicate −500 mV. If not, readjust R2 until the meter indicates midway between −500 mV and the incorrect negative reading.

Calibrating pH Scale and Temperature Control

The pH value of a solution is generally dependent upon temperature; hence, the accuracy of a pH scale is dependent upon the accuracy of the TEMPERATURE Control. Consequently, both these components are calibrated in conjunction with each other as follows:

NOTE: It is recommended that the mV calibration procedure be completed before calibrating the pH scale. Therefore, the procedure given below assumes that meter panel is not secured to the case and that the millivolt source is still connected to the INPUT jack.

1. Set millivolt source to 00.00 or disconnect source and connect shorting cap to the INPUT jack.
2. Turn FUNCTION Selector to pH and, if necessary, readjust STANDARDIZE Control until meter indicates exactly 7.00 pH.
3. Rotate TEMPERATURE Control to full clockwise and full counterclockwise positions. Knob pointer should approximately align with the 0 to 100°C scale markings. If not, loosen the two knob setscrews and realign knob until above specifications are met.
4. Set TEMPERATURE Control to 25°C.
5. Connect millivolt source to INPUT jack (if disconnected in step 1) and adjust millivolt source to supply an output of +295.785 millivolts.
6. The meter should indicate 2.0 ±0.3 pH. If not, adjust R10 on circuit board until correct indication is obtained.
7. Reverse polarity of millivolt source.
8. Meter should indicate 12.0 ±0.3 pH. If not, readjust R10 until meter indicates midway between noted reading and correct reading.

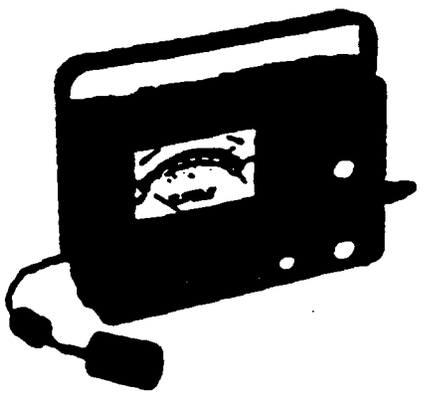
   NOTE: If desired, Model 956 pH scale can be calibrated using buffers. In this case, instrument should be first standardized with a pH 7.00 buffer and then calibrated using a pH 4.00 and adjusting R10.
9. Reassemble instrument by generally reversing steps 1 through 3 under Removing Meter Panel.

Replacement Parts

The replacement parts, along with their location drawings, are provided in this section. The section is arranged in assembly to subassembly breakdown. That is, the highest order assembly appears first, followed by its subassembly make up. Non-field repairable assemblies or subassemblies are not broken down into their component parts. Note that parts information is only valid at the publication date (see back cover) of this manual, and subsequent revisions may have occurred after publication.

173389

YSI MODELS 33 AND 33M S-C-T METEF INSTRUCTION



GENERAL DESCRIPTION

The YSI Model 33 and 33M S-C-T Meters are portable, battery powered, transistorized instruments designed to accurately measure salinity, conductivity and temperature. They use a probe consisting of a rugged, plastic conductivity cell and a precision YSI thermistor temperature sensor combined in a single unit.

Conductivity with the Model 33 is expressed as micromhos/centimeter; with the 33M, it is millisiemens/meter (mS/m). These are measurements of the electrical conductance the sample would show if measured between opposite faces of a 1 cm cube. (Conversion information: 1 micromho/cm = 0.1 mS/m.) Salinity is the number of grams of salt/kilogram of sample (ppt = parts per thousand). This measurement assumes the sample contains a "standard" sea water salt mixture. The sample temperature is measured in degrees Celsius.

Salinity measurements are manually temperature compensated by direct dial. Conductivity measurements are not temperature compensated; however, a temperature function is provided on the instrument to aid with calculation of corrections. When temperature and conductivity are known, it is possible to calculate salinity; and when only temperature and salinity are known, it is possible to calculate conductivity. This is discussed in the section on Recalibration.

SPECIFICATIONS

Model 33 Conductivity

Ranges: 0 to 500 (x1), 0 to 5,000 (x10), and 0 to 50,000 micromhos/cm (x100) with YSI 3100 Series Probes. (Note: The "micromho" designations on the meter are a shorthand form for "micromho/cm".)

Accuracy: (See Error Section)
±2.5% max. error at 500, 5,000 and 50,000 plus probe.
±3.0% max. error at 250, 2,500 and 25,000 plus probe.

Readability:
2.5 micromhos/cm on 500 micromho/cm range.
25 micromhos/cm on 5,000 micromho/cm range.
250 micromhos/cm on 50,000 micromho/cm range.

Temperature Compensation: None.

Model 33M Conductivity

Ranges:
0 to 50 (x1), 0 to 500 (x10), and 0 to 5,000 mS/m with YSI 3100 Series Probes.

Accuracy: (See Error Section)
±2.5% max. error at 50, 500, and 5,000 plus probe.
±3.0% max. error at 25, 250, and 2,500 plus probe.

Readability:
0.25 mS/m on 50 mS/m range.
2.5 mS/m on 500 mS/m range.
25.0 mS/m on 5,000 mS/m range.

Temperature Compensation: None.

Salinity

Range: 0-40 ppt in temperature range of -2 to +45 within specified conductivity range of 0 to 50 micromho/cm (0 to 5,000 mS/m). See chart in section Recalibration.

Accuracy (See Error Section)
Above 6°C: ±0.9 ppt at 40 ppt and ±0.7 ppt at 20 ppt plus conductivity probe.

Below 6°C: ±1.1 ppt at 40 ppt and ±0.9 ppt at 20 ppt plus conductivity probe.

Readability: 0.2 ppt on 0-40 ppt range.

Temperature Compensation: Manual by direct dial -2 to +45°C.

Temperature Range: -2 to +50°C.

Accuracy: ±0.1°C at -2°C, ±0.6°C at 45°C plus (See Error Section)

Readability: ±0.15°C at -2°C to ±0.37°C at 45°C.

Power Supply: Two D-size alkaline batteries. Eve 295 or equivalent, provide approximately 200 hour operation.

Instrument Ambient Range: -5 to +45°C. A maximum of ±0.1% of the reading per °C change in instr temperature can occur. This error is negligible i instrument is readjusted to redline for each readi

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173391

Salinity Error

The salinity readings are a function of temperature and conductivity, therefore the accuracy is a function of both.

The temperature scale and temperature control have been designed to minimize the temperature error contribution to the salinity error. The error shown in Figure 3 is the total of the temperature and conductivity probe, the temperature scale and the salinity scale error.

FIGURE 3

Example
Meter Reading: 10 ppt. @ 10°C
% of Reading Error: 6.5%
Accuracy: 10 ppt ±0.65 ppt for all errors, combined worst case.

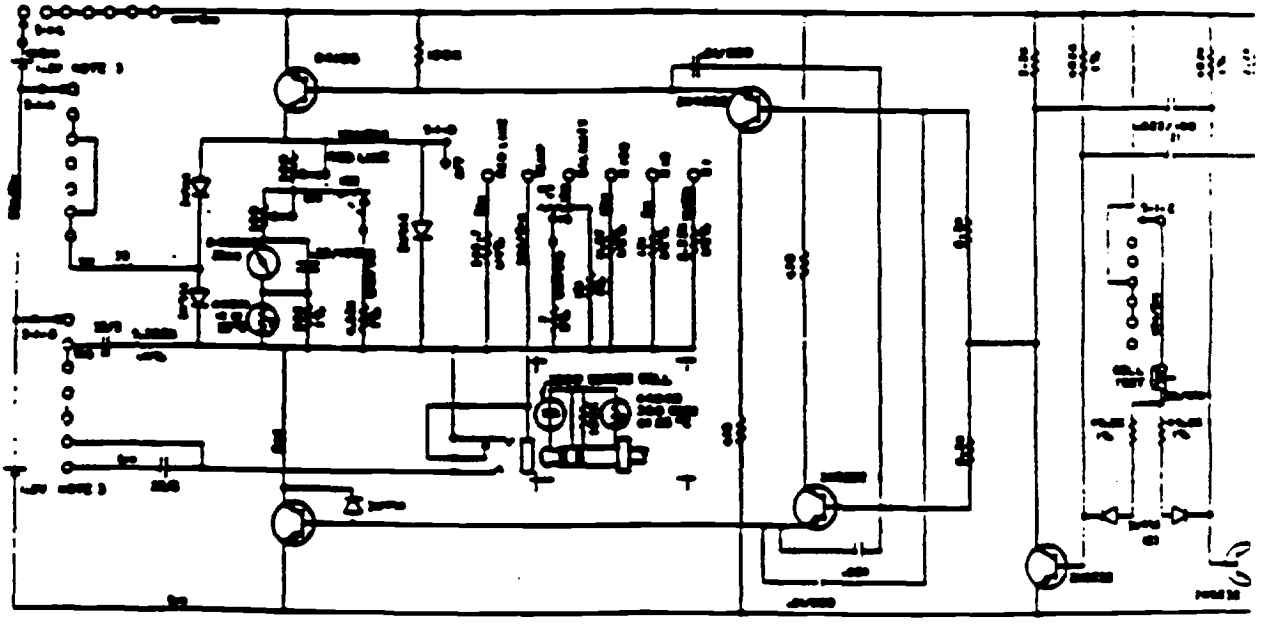
CIRCUIT DESCRIPTION

The circuit is composed of two parts: a multivibrat and switching transistors. The multivibrator produc a square waveform voltage. The square wave is appli to two switching transistors. They alternately appl two batteries of opposite polarity to the probe th providing AC power which minimizes polarization of facts. The meter is in series with one battery a measures the current from it. The current from th battery is proportional to the conductance of the cell Salinity is measured in a special range conductivit circuit which includes a user-adjusted temperatur compensator. In the temperature, reading and X1 posi tions, the multivibrator operates at 1000Hz. In th salinity, X100 and X10 positions the multivibrato operates at 400Hz; in these ranges, pushing the CEL TEST button drops the frequency to 100Hz, allowing th operator to test for probe polarization.

INSTRUMENT MAINTENANCE

The only maintenance required is battery replacement Two "D" size alkaline flashlight cells, such as Ever eady E95 or equivalent, will provide 200 hrs. of opera tion. Accuracy will not be maintained if zinc-carbo "D" cells are used. Battery replacement is indicate when the reading adjustment cannot be accomplished.

Replace batteries every six months to reduce the dange of corrosion due to leaky batteries. To replace bat teries, remove the screws from the rear cover. Th battery holders are color coded. The positive end mus go on red.



NOTES:
Resistance values in ohms. K = 1,000. Resistors are 1/2 W, 10%, unless otherwise specified.

Battery is D size, alkaline only. Eveready E-95 or equivalent.

This schematic is representative an may be slightly different from the circuit in your instrument.

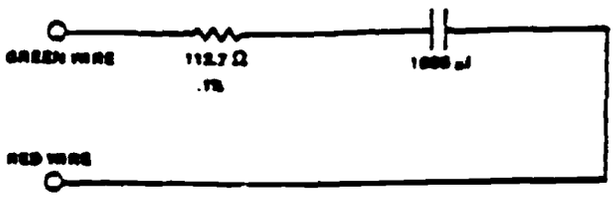
TSI MODEL 33 AND 33K SCHEMATIC

2. You may use the resistor and capacitor hookup shown in the sketch to substitute for the probe in the following recalibration procedure.

a. Set the instrument for a salinity measurement as normal.

b. Substitute a 1000 microfarad capacitor and 112.7 ohm 0.1% tolerance resistor for the probe.

Connect the resistor and capacitor between the green wire and red wire on the jack connections inside the instrument.



c. Turn the temperature dial until the meter reads redline.

d. Reinstall the temperature knob with the arrow at 25°C.

This is a temporary calibration only. Return the instrument to the factory for proper recalibration.

YSI 3300 SERIES CONDUCTIVITY/TEMPERATURE PROBES

Description

These probes are designed and constructed for rug[illegible] accurate service in field use. The conductivity cell constant is 5.0/cm (500.0/m) ±2%. Each probe contains a precision YSI thermistor temperature sensor of ±0.1°C accuracy at 0°C and ±0.3°C at 40°C. The low capacitance cable assembly terminates in a three terminal 0.25" dia. phone plug.

The 3318 has a 18 foot cable and the 3311 a 50 foot cable. Other lengths are available on special order.

The probe has a rigid P.V.C. body, platinized pure nickel electrodes, and a rugged cable.

Cleaning and Storage

Cleaning

When the cell test indicates low readings the probable cause is dirty electrodes. Hard water deposits, oils and organic matter are the most likely contaminants.

For convenient normal cleaning soak the electrodes for 5 minutes with a locally available bathroom tile cleaning preparation such as Dow Chemical "Bathroom and Chrome Cleaner," Johnson Wax "Envy, Instant Cleaner," or Lysol Brand "Basin, Tub, Tile Cleaner."

For stronger cleaning a 5 minute soak in a solution made of 10 parts distilled water, 10 parts isopropyl alcohol and 1 part HCl can be used.

Always rinse the probe thoroughly in tap water, then in distilled or deionized water after cleaning and before storage.

CAUTION: Do not touch the electrodes inside the probe. Platinum black is soft and can be scraped off.

If cleaning does not restore the probe performance replatinizing is required.

Storage

It is best to store conductivity cells in deio[illegible] water. Cells stored in water require less fre[illegible] platinization. Any cell that has been store[illegible] should be soaked in deionized water for 24 hours [illegible] use.

Replatinization

1. Clean the probe.

2. Place the cell in a 50 ml (approximate) [illegible] beaker and add enough YSI 3140 Platinizing Solution [illegible] cover the electrodes. Do not cover the top of [illegible] probe.

3. Plug the probe into the Model 33 or 33M, swit[illegible] the X100 scale to platinize the electrodes. Move [illegible] probe slightly to obtain the highest meter reading [illegible] continue platinizing for the approximate time [illegible] below:

Meter Reading microhmhos/cm	mS/m	Time [illegible] minute
30.000	3.000	5
25.000	2.500	6
20.000	2.000	8
15.000	1.500	11
10.000	1.000	16

4. After the elapsed time, remove the probe and r[illegible] in tap water, then in distilled or deionized water.

5. Return the solution to its container. 2 oz [illegible] solution should be sufficient for 50 treatments.

Probe Use and Precautions

1. Obstructions near the probe can disturb read[illegible] At least two inches of clearance must be allowed [illegible] non-metallic underwater objects. Metallic obj[illegible] such as piers or weights should be kept at lea[illegible] inches from the probe.

2. Weights are attached to the cable of the YSI [illegible] and 3311 Probes. The YSI 3127 Weights are supplie[illegible] pairs with a total weight of 4 ounces per pair. [illegible] it becomes necessary to add more weight to over[illegible] water currents, we suggest limiting the total we[illegible] to two pounds (8 pairs). For weights in ounces of [illegible] pounds use an independent suspension cable. In e[illegible] case, weights must be kept at least 6 inches away [illegible] the probe.

3. Gentle agitation by raising and lowering the p[illegible] several times during a measurement insures flow [illegible] specimen solution through the probe and improves [illegible] time response of the temperature sensor.

Conductivity and Salinity Corrections for Long Cabl[illegible]

The additional length of wire in long cables [illegible] capacitance and resistance which will effect read[illegible] The recommended way to correct for these influence[illegible] by use of YSI Conductivity Calibrator Solutions [illegible] below), which will permit an estimate of corre[illegible] factors. If these solutions are not available, [illegible] following tables can be used for the correctio[illegible] errors caused by cable resistance and capacitanc[illegible] special length versions of the 3318, 3311, S-17913 [illegible] S-16130 probes.

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DRT-15C (9/88)

I. SPECIFICATIONS FOR DRT-15 C

173398

Ranges NTU	2 Ranges: 0-20, 0-200 NTU
Linearity	(+ or -) 1% of Full Scale on either range
Repeatability	(+ or -) 1% of Full Scale on either range
Sensitivity	0.01 NTU change on "20" range
Response	Virtually immediate in all ranges
Power Supply	6 Volt battery. 2.6 amp hours 115/230 VAC, 50/6 Battery Charger
Controls	Combination Range Switch for: ON/OFF Range Selec Reference Adjust
Recorder Output	0-1mA adjustable, 100 maximum resistance
Reference Standard	0.1 NTU (Nominal)
Dimensions	11" x 9 1/4" x 5 1/2" (27 cm) x (22.7 cm) x (13.5 cm)
Weight	4.5 lbs.(2.05 kilograms)

II. LIST OF STANDARD ACCESSORIES

QUANTITY	CAT.#	DESCRIPTION
1	50083	Instruction Manual
1	60002	Reference Standard 0.1 NTU (Nomin
1	70048	Battery Charger 115 V 60 Hz
		OR
	70020	Battery Charger 230 V 60 Hz
2	50050	Cuvettes complete with screw top
1	50009	Light Shield
1	70825	Recorder Plug

DRT-15C (9/88)

IV. OPERATION AND DESCRIPTION

173499

The EPA recommends that cuvettes used for instrument cali
or sample measurement be matched or indexed.

For accurate measurements in the low range rotate the cuve
the well to obtain the minimum reading. Mark the cuvette c
the adhesive dots provided and the instrument so that orie
of the cuvette will be identical each time it is placed i
instrument.

To operate the turbidimeter, switch to the "20" range and
the Reference Standard (0.1 NTU) in the optical well.

With the light shield in place over the well, adjust the
ence Adjust knob to cause the meter to read the reference
dard value on the scale. The unit is now ready for use in
range.

To make a measurement of a sample, clean one of the cuvette
fill to within approximately 1/2" of top with the sample.
the top on the cuvette and carefully clean the outside surf
the cuvette with a lint free wiper such as Kimwipes. Plac
sample in the well and place the light shield over the
Select the appropriate range for best readability.

If the instrument has been subjected to cold (below 10 d
Celsius) and then brought indoors, it should be allowed to
up before use, since condensation may form on the various l
This can be aided by leaving the case open and the instrume
for approximately a half hour.

V. RECORDER OUTPUT

The DRT-15C is shipped complete with a 0-1 mA Recorder O
The jack is located on right side of the chassis (refer to
figure 2). To use, connect the 1/8" miniplug provided to
recorder. Adjust R11 to obtain a full scale output compatib
a full scale reading on the DRT-15C. Once this adjustmer
made, the DRT-15C will always be set up for this recorder.

VII. CALIBRATION PROCEDURES

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A. STANDARD FORMAZIN SOLUTIONS

Calibration of this instrument is based on Form material which can be made by synthesis and re repeatedly within one percent. When properly mixed uniform in the number, size and shape of its particl making it an ideal turbidity standard. The unit of and thus the calibration of this instrument Nephelometric Turbidity Units (NTU) based on Formazi

Calibration samples may be obtained by diluting stock suspension using "Turbidity-Free" water. stock suspension may be prepared by the user (R A.W.W.A. "Standard Methods", 14th Edition) or it purchased in kit form, HF scientific part number 500

Each kit contains:

- -- 1 liter of 4000 NTU Stock Suspension
- -- 1 Gallon (3.79 liters) turbidity-free water
- -- 7 Sample cuvettes (28mm), with screw caps
- -- Instructions for dilution
- -- 1 200 µl Pipette

The following table gives the recommended dilutions stock suspension. Be sure to adequately mix the suspension prior to removing a portion for dilution.

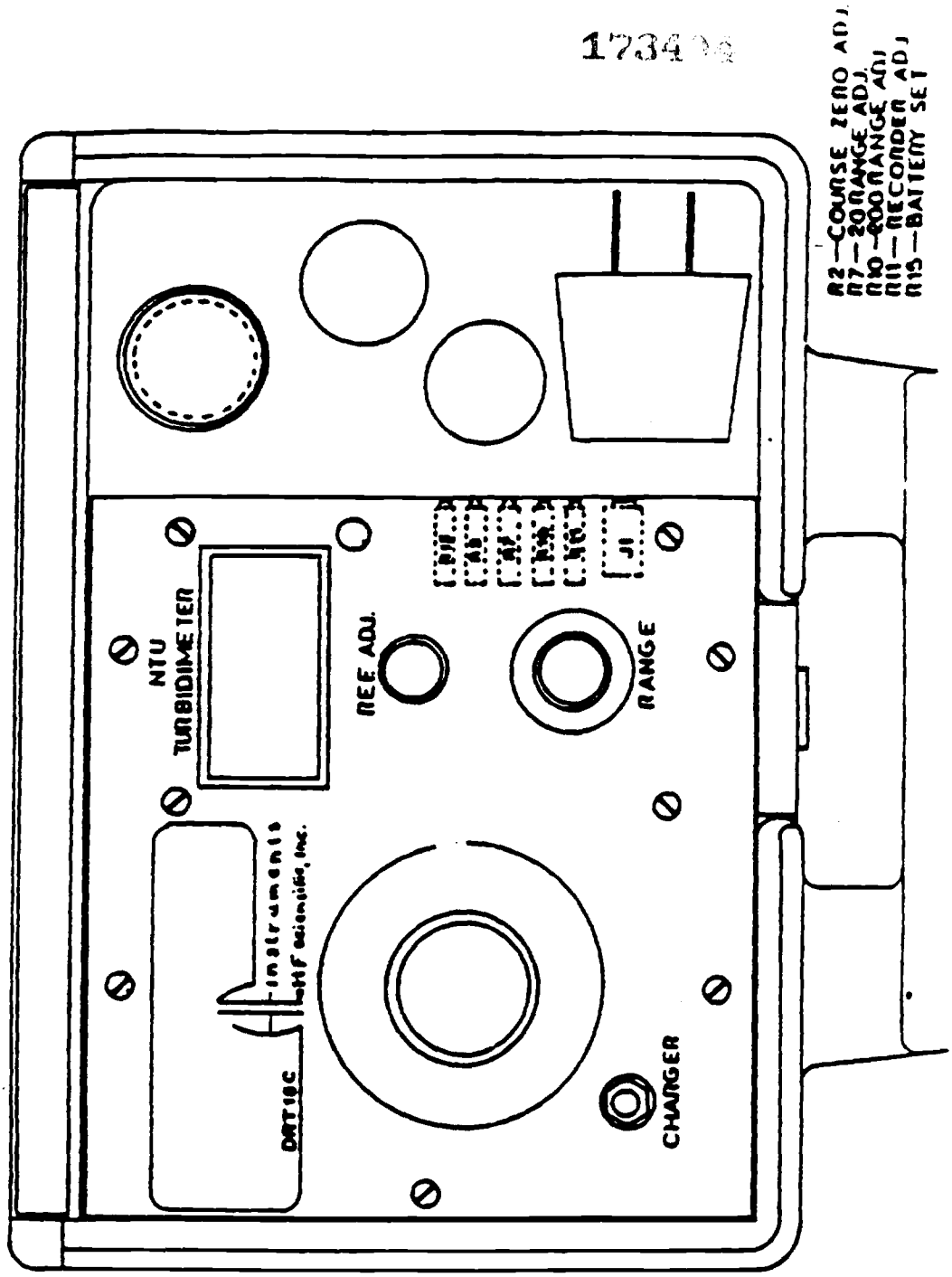
Pipettes Required	Formazin Standard in NTU's	Pipette amount below in ml 200 ml flask and dilute with "Turbidity-free water"
9ml & 1ml in 1/100	198	9.9ml of 4000 NTU stock suspe
9ml & 1ml in 1/100	19.8	9.9ml of 400 NTU formazin dil
1ml in 1/100	20	0.95ml of 400 NTU formazin dil

The equipment recommended for the above are:
1-1ml in 1/100 TD pipette, 1-9ml TD pipette, 3-200ml volumetric
The 400 NTU formazin dilution can be made from 1 10:1 dilution 4000 NTU stock suspension and should be made prior to making dards.

NOTE: 1. When the prepared samples start to flocculate, they ar unreliable and fresh ones must be made. This will occur rapidly for the lower value diluted suspensions.

2. The value of "Turbidity-Free" water is approximately 0 This value has been added to low value dilution, i.e., 2. includes 0.1 NTU for water.

DRT-15C (9/88)


R2—COURSE ZERO ADJ.
R7—20 RANGE ADJ.
R10—200 RANGE ADJ.
R11—RECORDER ADJ.
R15—BATTERY SET
NTU
TURBIDIMETER
REF. ADJ.
RANGE
J1
instruments
HF scientific, inc.
DRT15C
CHARGER

DRT-15C (9/88)

IX. MAINTENANCE

173499

The DRT-15 is not designed for field servicing. It sh returned to your local distributor or to H.F. scientific service requirements. The exceptions are Battery a Assembly replacement. This can be done in the field prov new battery is hooked up in the same manner as the Batter replaced.

A. BATTERY REPLACEMENT

Should the battery (HF catalog #70006) fail, it can b replaced. Make certain the instrument is turned off. all the accessories in the foam holder. Next, remo foam holder by placing fingers in the cuvette hol pulling the rear of the foam forward, then up. Th phillips head chassis screws should be be removed. the chassis from the case by sliding the chassis all to the right then pulling up. The two screws on the side of the chassis need to be removed now. This will for the removal of the battery clamp and the old b Replace the battery by reversing the procedures de above. When connecting the battery, be certain th connect the red wire to the terminal marked (+) a black wire to the terminal marked (-).

B. LAMP REPLACEMENT

The lamp source (HF catalog #21084) used in the DRT-1 an extremely long life. Before replacing the lamp certain that the battery is not in need of a charge not defective. To replace lamp remove the chas described in battery replacement. Remove the lamp wi TB1 terminals numbers 9 and 10. To remove the lamp, the two set screws on the outermost barrel with a 5/6 wrench and pull the lamp straight out. Replace the l the reverse order. Make sure the lamp is pushed all t in. The set screws should be snugged up; excess p could damage the lamp. Replace the chassis in the cas recalibrate as described in calibration procedures.

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APPENDIX G

MILLIPORE

OPERATION AND MAINTENANCE INSTRUCTIONS

Operation and Maintenance Instructions OM100

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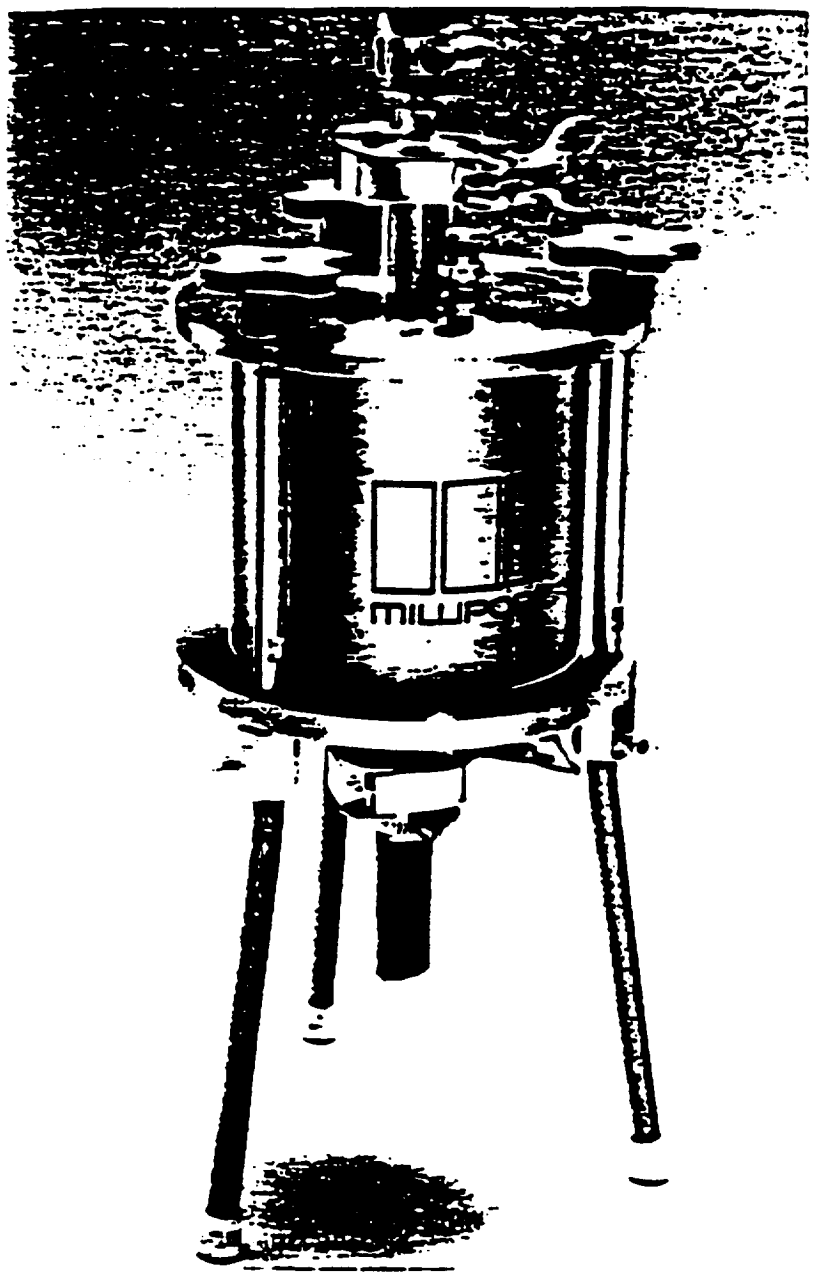
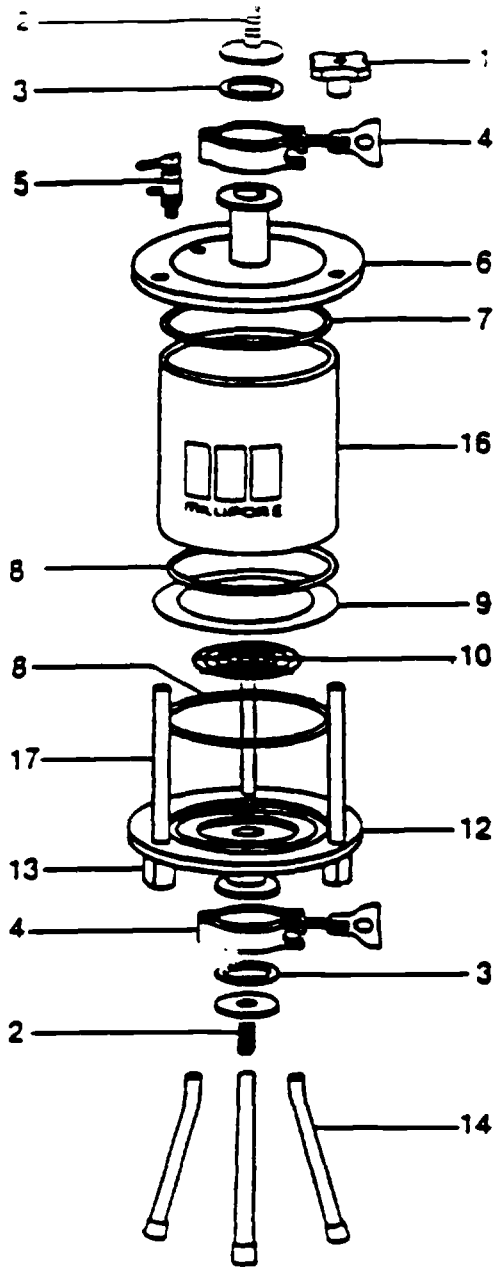


Hazardous Waste Filtration System
Cat. No. YT30 142 HW

MILLIPORE

INTRODUCTION

The Millipore® Hazardous Waste Filtration System (YT30142HW) is used in the toxicity determination of a solid waste in compliance with the Resource Conservation and Recovery Act (RCRA). This system has been designed to allow for absolute filtration and separation of solids from liquids by pressure filtration. The 1.5 L extension barrel; top and bottom plates; underdrain support; filter support system; relief valve; and connectors are all construc of stainless steel. To avoid extraneous contamination from the holder assemb itself, all surfaces of the components (exposed to the test sample) are Teflon® coated. The TC connections of the inlet/outlet of the system allow for ease in removal, cleaning, and maintenance.



173411

COMPONENTS		CATALO
1. Handwheel Knob (3)		YY22
2. T.C. Hose Connector (2)*		34(
3. T.C. Silicone Gasket (2)	10/pk	YY20
4. Tri-Clamp®, 1 1/2" (2)		YY20(
5. Vent Valve*		33
6. Assembly Top Plate*		-
7. Silicone O-Ring	4/pk	YY22
8. Teflon O-Ring (2)		YY22
9. Screen Support, 142mm.*		YT40
10. Underdrain Support*		YT30
11. Allen Hex Key, 3/16 (not shown)		--
12. Assembly Bottom Plate*		--
13. Leg Bushing/Socket Screw (3)	3/pk	YY22
14. Handwheel Wrench (not shown)		--
15. Literature, O&M (not shown)		YT30
16. Cylinder, 142mm.*		11-
17. Cylinder Extension Post (3)	3/pk	XX42(

*Teflon-coated

Hazardous Waste Filtration System
Cat. No. YT30142HW

AVAILABLE FILTERS

HAWP14250	0.45um MF-Membrane, 142mm (pk/50)
DAWP14250	0.65um MF-Membrane, 142mm (pk/50)
AAWP14250	0.80um MF-Membrane, 142mm (pk/50)
AP1512450	Glass Fiber Prefilter, 124mm, "Fine" (pk/50)
AP2512450	Glass Fiber Prefilter, 124mm, "Coarse" (pk/50)

ACCESSORIES

T.C.Gasket, 1 1/2"	10/pk	YY20
Leg Cap, Rubber	3/pk	YY22
O-Ring, Viton®	4/pk	YY22
O-Ring, LCR-treated Buna-N	5/pk	YY40
PVC Tubing with Clamp, 1/2" X 10'		XX67(

ASSEMBLY OF EQUIPMENT

1. Remove handwheel bolts from top of unit and remove top-plates of holder assembly. Install Teflon O-ring in the groove at the base of the stainless steel cylinder. Examine under-drain screen to ensure that the radial spokes are down. Then replace support screen.

2. Weigh filters and prefilters to be used or use average weights of 142 Mill filters listed below:

Filter	Prefilter
AA - 0.73g	AP25 - 2.64g
DA - 0.79g	AP15 - 1.04g
HA - 0.88g	

   Wet filter(s) by floating in pan of deionized water.

3. Place required filter(s) on base support screen. If more than one filter required, place HA filter on screen first, followed by the other filter(s) increasing pore size (i.e. DA, AA).

4. Center the stainless steel cylinder (grooved end down) onto the membrane(s) assure that an even seal is obtained.

5. Install the AP15 prefilter (if needed) followed by the AP25 prefilter (ro sides up) by lowering through the cylinder top onto the membrane(s). The prefilter may appear oversized, however, it will abut the sides of the cylinder.

6. Place top plate of the filter holder on top cylinder rim. The red silicone O-ring fitted into groove of plate should seal evenly onto rim. Replace handwheel bolts to top of unit and screw down evenly and snugly until wrist tight. Additional tightening must be accomplished by means of plastic wr provided.

7. Fit the PVC tubing over the Tri-Clover® hose adaptor and secure with hose Attach other end of PVC tubing to a nitrogen tank regulator outlet and secu with a hose clamp. Put aside until you are ready for step (2) under "Sam Preparation and Filtration Procedure".

SAMPLE PREPARATION AND FILTRATION PROCEDURE

1. Take a representative sample (minimum size 100g) of the waste to be teste

2. Using a funnel, pour test material to be filtered into the unit through t Tri-Clamp opening . Attach the TC hose adaptor (fitted with 1 1/2" gaske the TC connection of top plate, using the stainless steel TC clamp provid

3. Place appropriate receiving vessel below TC sanitary outlet or attach PVC to TC adaptor and run hose to appropriate container.

4. Slowly increase pressure on nitrgen tank. When liquid flow begins from o of assembled holder, immediately turn regulator valve handle a few turns lower pressure. Bleed air from top-plate vent valve slowly until pressur gauge reads between 10-15 psi. Close vent valve and (if necessary) readj regulator valve to set pressure between 10-15 psig. Continue filtration flow ceases.

5. Increase inlet pressure stepwise in 10 psi increments to 75 psi and conti filtration until flow ceases. No leaks should be apparent.

6. Shut off pressure from nitrogen tank regulator outlet valve, then open ve valve gradually to release pressure from cylinder.

7. Remove inlet TC hose connector and handwheel bolts, then remove top plate extension cylinder of holder.

8. Keep the liquid fraction under refrigeration at 1-5°C (34-41°F) for futur analysis. The liquid should be clear of particulate material.

9. Remove filters, prefilters, and solid cake material. Prepare the solid material for extraction by either grinding it (including filters and prefilters) to pass through a 9.5 mm (3.8") standard seive or by subject to the structural integrity procedure outlined in the Federal Register.*

*Federal Register, Dec. 18, 1978. Vol. 43, No. 243.

10. Weigh the ground solid material and subtract from this the weight of the filters and prefilters that were used. (Step No. 2 under Assembly of Equipment). Measure a volume of water at 4°C that is equal in weight t material previously collected. The figure obtained is to be applied to t procedure in Step (15) below.

11. Place the solid material in an extractor. Information on a suitable extra can be found in the Federal Register.*

12. Add to the extractor a weight of deionized water equal to 16 times the we of the solid material added to the extractor. This includes any water us transferring the solid material to the extractor.

13. Begin agitation and adjust the pH of the solution to 5.0 ± 0.2 using 0.5 N acetic acid according to the methodology stated in the Federal Register.*

14. At the end of the 24 (± 0.5) hours extraction period, separate the extracte material into solid and liquid phases by repeating above procedures.

15. Adjust the volume of the resulting liquid phase with deionized water so tha its volume is twenty times that occupied by a quantity of water at 4°C eq weight to the initial quantity of solid material in step (10) above. Combi this solution with the original liquid phase in step (8).

16. The analysis conducted to determine conformance with the toxicity criterion must be made with the methods (or equivalent) outlined in the Federal Register.*

*Federal Register, Dec. 18, 1978. Vol. 43, No. 243.

DISCUSSION

Experience has shown that many waste samples (after extraction) can be filtere within 20 minutes using only an AP25 prefilter superimposed on an HA (0.45um) Some examples include: paper mill effluents, slime muds, secondary sludge, and ash.

Primary effluents, such as fibers, may require a combination of an AP15 prefil and a DA (0.65um) or AA (0.8um) filter in addition to an HA filter to accomplis adequate filtration. In setting up such combinations the filter with the smal pore size is placed onto the support screen, followed by other filters from fi coarse with the prefilter always on top.

Difficult-to-filter samples, such as acidified extractions of wood bark, may re a full complement of filters.

If samples appear cloudy after filtration through an HA filter, they should be filtered through a GS (0.22um pore size) filter.

CAUTION

- Pressure introduced into the system should not exceed 100 psi.
- All flexible tubing used with the system should be able to withstand pre exceeding 100 psi.

FOR TECHNICAL ASSISTANCE

Write: Millipore Corporation
Ashby Road
Bedford, Massachusetts, 01730
C/O Technical Service

Call: Millipore Corporation
Technical Service
1-800-225-1380

In Massachusetts:
(617) 275-9200

To Place an Order:

Call 800-225-1380 (Toll Free)
And ask for "Order Services".

Millipore is a registered trademark of
Millipore Corporation, Bedford, MA. 01730

REV. 4/86

Tri-Clamp and Tri-Clover are trademarks of Ladish Co.

Teflon, and Viton are trademarks of E.I.Dupont de Nemours & Co. Inc.

d. Collect Sample - Groundwater sampling will be conducted by using dedicated bladder pumps or bailers. Both collection procedures are described below.

d.a. Bladder Pump - After purging, the air hose will be fitted to the air line nipple on the bladder pump and the compressor will be turned on. The discharge rate for the bladder pump should be set around 100 mls/minute for successful volatile sampling. This rate will be measured by using a 100 ml graduated cylinder and timing the flow. The flow rate will be adjusted with the controller until 100 mls/minute is achieved. Volatile samples will be collected first. Vials for volatile analysis will be completely filled leaving no air space. Semi-volatile samples will be filled next followed by the pesticide/PCBs, herbicides, ions, total metals, pH, specific conductance, temperature, and total dissolved solids. Dissolved metal samples will be collected last by placing a 0.45 micron filter in-line. The sample will be collected into a preserved container.

d.b. Bailer - After purging the well and sufficient recharge has been allowed, samples for volatile organics should be collected using the first bailer volume. Lower the bailer slowly until it contacts the water surface, and allow the bailer to sink to the desired depth and fill, with a minimum of surface disturbance. Slowly withdraw the bailer, taking care to prevent contact of the bailer line with the ground. Slowly discharge the contents into the appropriate sample containers. Repeat the process as necessary to fill each

container to the required volume. Vials for volatile analysis will be completely filled, leaving no air space above the liquid portion (to minimize volatilization). Check that the Teflon on the Teflon-lined silicone septum is toward the sample in the caps and secure the cap tightly. If semi-volatile compounds are to be sampled for, collect these samples next. Proceed to the collection of samples for the remaining analyses. Be careful of all pre-preserved bottles. If acids are present, open the bottle upwind and away from the body. All samples for dissolved metals should be collected last and filtered through a 0.45 um filter within 15 minutes after collection. A Millipore filtration system will be utilized for this procedure. The procedure for Millipore filtering is as follows:

1. Assemble the Millipore filtration unit. Assembly procedures can be found in Appendix C.

2. Using a funnel, pour test material to be filtered into the unit through the Tri-Clamp opening. Attach the TC hose adaptor (fitted with 1-1/2" gasket) to the TC connection of top plate, using the stainless steel TC clamp provided.

3. Place appropriate receiving vessel below TC sanitary outlet or attach PVC hose to TC adaptor and run hose to appropriate container.

4. Slowly increase pressure on nitrogen tank. When liquid flow begins from outlet of assembled holder, immediately turn regulatory valve handle a few turns to lower pressure. Bleed air from top-plate vent valve slowly

until pressure gauge reads between 10-15 psi. Close vent valve and (if necessary) readjust regulator valve to set pressure between 10-15 psi. Continue filtration until flow ceases.

5. Increase inlet pressure stepwise in 10 psi increments to 75 psi and continue filtration until flow ceases. No leaks should be apparent.

6. Shut off pressure from nitrogen tank regulator outlet valve, then open vent valve gradually to release pressure from cylinder.

7. Remove inlet TC hose connector and handwheel bolts, then remove top plate and extension cylinder of holder.

8. Acidify e sample with nitric acid to a pH of ≤ 2. Test with pH paper.

9. Decontaminate the filtration apparatus as outlined in Section 2.3.4.

e. Measure Water Level - After samples have been collected, the well cap should be replaced. Static water level will be measured again after sufficient recharge has been allowed (24 hours).

f. Measure pH, Temperature and Specific Conductance - Follow procedure as outlined in Section 2.3.

g. Custody, Handling and Shipping - Complete the procedures as outlined in Sections 2.2.2 and 2.2.3.

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