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INSTALLATION RESTORATION PROGRAM PHASE 2 CONFIRMATION AND
QUANTIFICATION STAGE 2 QUALITY ASSURANCE PLAN NAS FORT WORTH TX
1/1/1988
RADIAN CORPORATION



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

**ADMINISTRATIVE RECORD
COVER SHEET**

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INTEGRATED INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION
STAGE 2 - QUALITY ASSURANCE PROJECT PLAN

CARSWELL AIR FORCE BASE, TEXAS 76127

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document*

January 1988

Quality Assurance Project Plan

PREPARED FOR:
HEADQUARTERS, STRATEGIC AIR COMMAND
COMMAND SURGEON'S OFFICE (HQ SAC/SGPB)
OFFUTT AFB, NEBRASKA 68113

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



INSTALLATION RESTORATION PROGRAM
PHASE II - CONFIRMATION/QUANTIFICATION
STAGE 2

CARSWELL AIR FORCE BASE
QUALITY ASSURANCE PROJECT PLAN

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

JANUARY 1988

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1.0 QUALITY ASSURANCE/QUALITY CONTROL

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

1.1 Introduction

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

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

1.2 Project Description

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

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

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

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

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

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

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

- Site 3: Landfill 3
 - Install three upper zone monitor wells southeast, northwest, and northeast of site boundaries.
 - Install two upper zone monitor wells west of landfill near flight line drainageway.
 - Install one Paluxy Aquifer monitor well, west of the landfill (optional).

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TABLE 1.2-1. FIELD WORK SUMMARY (a)

SITES (b)	1	3	4	5	10	11	12	13	15	16	17	WSA	BSS BOUND	TOTAL
BORERHOLES	2	6	3	5	3	0	7	0	0	0	5	0	4	35
BORERHOLE DEPTH	60	403	105	173	69	0	184	0	0	0	173	0	138	1305
UZ WELLS (from boreholes above)	2	5	3	5	0	0	2	0	0	0	5	0	4	26
DEPTH UZ WELLS	60	173	105	173	0	0	69	0	0	0	173	0	138	891
PALUYI WELLS	0	1	0	0	0	0	0	0	0	0	0	0	0	1
DEPTH PALUYI WELLS	0	200	0	0	0	0	0	0	0	0	0	0	0	200
RAND AUGERS	0	0	0	0	0	0	0	0	3	0	0	0	0	11
DEPTH AUGERS	0	0	0	0	0	0	0	0	30	0	0	40	0	70
SOIL SANDS FROM AUGERS	0	0	0	0	0	0	0	0	15	0	0	16	0	31
SPLIT SPOON SAMPLES	6	15	9	15	18	0	28	0	0	0	15	0	12	118
SLUG TESTS	2	0	5	5	0	0	3	0	0	0	3	0	0	18
SOIL GAS DAYS	0	0	0	0	0	0	0	0	0	0	2	0	2	4
SOIL-SED SAMP BOUNDS	0	0	0	0	0	0	0	2	0	0	0	0	0	2
SOIL-SED SAMPLE POINTS	0	0	0	0	0	0	0	5	0	0	0	0	0	5
SOIL-SED SAMPLES	0	0	0	0	0	0	0	10	0	0	0	0	0	10
SUMP WATER SAMP BOUNDS	0	0	0	0	0	0	0	0	0	2	0	0	0	2
SUMP WATER SAMP POINTS	0	0	0	0	0	0	0	0	0	4	0	0	0	4
SUMP WATER SAMPLES	0	0	0	0	0	0	0	0	0	8	0	0	0	8
GW SAMPLING BOUNDS	2	2	2	2	0	2	2	0	0	0	2	0	2	2
GW SAMP POINTS	6	6	9	9	0	2	5	0	0	0	5	0	4	50
TOT GW SAMPLES	12	12	18	18	0	4	10	0	0	0	10	0	8	100

NOTES

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

b. Sites are as follows:

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

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

- Collect groundwater (two rounds) from the six newly installed monitor wells.
- Site 4: Landfill 4
 - Install three upper zone monitor wells east and north of the landfill.
 - Perform slug tests to determine hydraulic conductivity of upper zone.
 - Sample groundwater (two rounds) from all upper zone and Paluxy Aquifer wells at the site.
- Site 5: Landfill 5
 - Install three upper zone monitor wells east of landfill and two upper zone monitor wells west of the landfill.
 - Perform slug tests on newly installed upper zone wells to determine hydraulic conductivity.
 - Sample groundwater (two rounds) from existing and newly installed wells.
- Site 10: Waste Burial Area
 - Conduct magnetic survey to prevent drilling into buried container drums.
 - Perform three soil borings and analyze soil samples.

- Site 11: Fire Department Training Area 1
 - Continued sampling (two rounds) and analysis of two existing wells.

- Site 12: Fire Department Training Area 2
 - Install two upper zone monitor wells, sample groundwater (two rounds) from the newly installed wells and three existing wells.

 - Drill and sample five soil borings in Fire Training Area to test subsurface conditions.

 - Perform slug tests on three upper zone monitor wells to determine hydraulic conductivity.

- Site 13: Flightline Drainage Ditch
 - Collect surface soil and/or sediment samples (two rounds) at five locations along the bottom of the ditch to verify cleanup.

- Site 15: Entomology Dry Well
 - Determine location of Entomology Dry well. Hand auger and sample three soil borings in probable vicinity of the dry well.

 - Measure water levels in existing upper zone monitor wells.

- Site 16: Unnamed Stream
 - Collect surface water samples (two rounds) at four locations near oil/water separator.

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- Site 17: POL Tank Farm
 - Conduct a soil vapor survey of the entire area near the tank farm.
 - Install five upper zone groundwater monitor wells.
 - Sample groundwater (two rounds) from the newly installed upper zone wells.
 - Perform slug tests on three selected upper zone monitor wells to determine hydraulic conductivity.
- Site WSA: Weapons Storage Area (Off Base)
 - Hand auger and sample eight shallow soil borings.
- Site BSS: Base Service Station
 - Conduct a soil vapor survey.
 - Install four upper zone monitor wells.
 - Sample groundwater (two rounds) from the newly installed upper zone wells.

1.3 Project Organization and Responsibility

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

1.4 Quality Assurance Objectives

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

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

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

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

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

(Continued)

TABLE 1.4-1. (Continued)

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

^aPrecision - Relative Percent Difference (RPD) between duplicate matrix spike recoveries, or duplicate analyses.

^bAccuracy - Expected range of recovery for QC check samples and, as specified by the method, for matrix spike recoveries.

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

^dRange of relative error for species of interest, based on EPA method validation testing. See method for further explanation.

TABLE 1.4-2. QC ACCEPTANCE CRITERIA FOR METHOD 8240

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

D - Detected.

NA - Not Applicable.

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

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

(Continued)

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

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

D - Detected.

NA - Not Applicable.

GVA-SPN

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

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

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1.5.5 Soil and Sediment Sampling

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

1.5.6 Air Monitoring and Soil Gas Sampling

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

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

1.6 Sample Custody

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

1.6.1 Chain of Custody

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

Sample Tags

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

RADIAN Field Number _____
Environmental & Industrial Services

6501 Mc-Pee Blvd./P.O. Box 30451/Austin, Texas 78768 (512)464-4757

Sample Type: _____

Client: _____

Location: _____

Preservative: _____

Sampler: _____

Date: _____

Comment: _____

Figure 1.6-1. Radian Sample Label

Chain of Custody Record

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

Transfer of Custody and Shipment

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

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

0110 0110

Laboratory Custody Procedures

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

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

1.6.2 Documentation

Sample Identification

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

Logs

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

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

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

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

Corrections to Documentation

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

1.6.3 Sample Packaging and Shipping

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

Water Samples

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

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

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

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

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

1.7 Calibration Procedures

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

Inductively-Coupled Plasma Emission Spectrophotometer Calibration

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

Atomic Absorption Spectrophotometer Calibration

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

Gas Chromatograph Calibration

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

Gas Chromatography/Mass Spectrophotometer Calibration

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

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

1.8 Analytical Procedures

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

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

1.8.1 Metals Analyses

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

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

TABLE 1.8-1. NUMBER OF WATER ANALYSES BY SITE

PARAMETER [Water Samples]	ANALYTICAL METHOD																	Base Surface MSA Wells Samples	Total
	1	2	3	4	5	10	11	12	13	15	16	17	18	19	20	21	22		
A403 Alkalinity - Carbonate, Bicarbonate, & Hydroxide (Field Test)	12	12	12	18	18	-	4	10	-	-	8	10	8	-	-	-	100		
A429 Common Anions (Chloride, Fluoride, Nitrate, Sulfate, Orthophosphate)	12	12	12	18	18	-	4	10	-	-	8	10	-	-	-	-	92		
A509B Chlorinated Phenoxy Acid Herbicides	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12		
E120.1 Specific Conductance (Field Test)	12	12	12	18	18	-	4	10	-	-	8	10	8	-	-	-	100		
E150.1 pH (Field Test)	12	12	12	18	18	-	4	10	-	-	8	10	8	-	-	-	100		
E160.1 Total Dissolved Solids	12	12	12	18	18	-	4	10	-	-	8	10	8	-	-	-	100		
E170.1 Temperature (Field Test)	12	12	12	18	18	-	4	10	-	-	8	10	8	-	-	-	100		
E200.7 Metal Screen (25 metals)	12	12	12	18	18	-	4	10	-	-	8	10	8	-	-	-	100		
E206.2 Arsenic	12	12	12	18	18	-	4	10	-	-	8	10	8	-	-	-	100		
E239.2 Lead	12	12	-	-	-	-	-	-	-	-	8	10	8	-	-	-	50		
E245.1 Mercury	12	12	12	18	18	-	4	10	-	-	8	10	8	-	-	-	100		
E270.2 Selenium	12	12	12	18	18	-	4	10	-	-	8	10	8	-	-	-	90		
E413.2 Oil and Grease	12	12	-	-	-	-	-	-	-	-	8	-	-	-	-	-	32		
E418.1 Petroleum Hydrocarbons	-	-	-	-	-	-	4	10	-	-	-	10	8	-	-	-	32		
E601 Purgeable Halocarbons	12	12	12	18	18	-	4	10	-	-	8	10	8	-	-	-	100		
E604 Phenols	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12		
E608 Organochlorine Pesticides	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12		
E625 Extractable Priority Pollutants	2	2	2	2	2	-	2	2	-	-	-	2	-	-	-	-	14		
SW5030/ SW8020 Purgeable Aromatics	12	12	12	18	18	-	4	10	-	-	8	10	8	-	-	-	100		

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

PARAMETER	ANALYTICAL METHOD (a)	DETECTION LIMIT (b)	REPORTING UNITS (c)	NUMBER OF ANALYSES	TRIP BLANKS	AMB COND BLANKS	DOUP BLANKS	DUP/REP	SECOND COLUMN	TOTAL ANALYSES
Alkalinity - Carbonate, Bicarbonate, & Hydroxide (Field Test)	A403	10	mg/L	100	-	-	10	10	-	120
Common Anions (Chloride, Fluoride, Nitrate, Sulfate, Orthophosphate)	A429	0.5	mg/L	92	-	-	10	10	-	112
Chlorinated Phenoxy Acid Herbicides	A509B	0.01	ug/L	12	-	-	2	2	0	24
Specific Conductance (Field Test)	E120.1	-	umhos/cm	100	-	-	-	-	-	100
pH (Field Test)	E150.1	-	pH Units	100	-	-	-	-	-	100
Total Dissolved Solids	E160.1	10	mg/L	100	-	-	-	10	-	110
Temperature (Field Test)	E170.1	-	deg C	100	-	-	-	-	-	100
Metal Screen (25 metals)	E200.7	0.2-90	mg/L	100	-	-	10	10	-	120
Arsenic	E206.2	0.005	mg/L	100	-	-	10	10	-	120
Lead	E239.2	0.005	mg/L	50	-	-	5	5	-	60
Mercury	E245.1	0.001	mg/L	100	-	-	10	10	-	120
Selenium	E270.2	0.005	mg/L	90	-	-	9	9	-	108
Oil and Grease	E413.2	0.2	mg/L	32	-	-	4	4	-	40
Petroleum Hydrocarbons	E418.1	1	mg/L	32	-	-	4	4	-	40
Purgeable Halocarbons	E601	0.02-5.10	ug/L	100	10	10	10	10	70	210
Phenols	E604	0.5-80	ug/L	12	-	-	2	2	0	24
Organochlorine Pesticides	E608	0.05-1.0	ug/L	12	-	-	2	2	0	24
Extractable Priority Pollutants	E625	1.0-50	ug/L	60	-	-	2	2	-	18
Purgeable Aromatics	SW5030/ SW8020	0.2-0.4	ug/L	100	10	10	10	10	70	210

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

PARAMETER	ANALYTICAL METHOD	DETECTION LIMIT	REPORTING UNITS	NUMBER OF ANALYSES	TRIP BLANKS	AIR COND BLANKS	EQUIP BLANKS	DUP/REP	SECOND COLUMN	TOTAL ANALYSES
Oil and Grease	SW3550/ E413.2	10	mg/kg	63	-	-	-	7	-	70
Petroleum Hydrocarbons	SW3550/ E418.1	50	mg/kg	83	-	-	-	9	-	92
Metal Screen (23 metals)	SW3050/ SW6010	0.2-90	mg/kg	117	-	-	-	12	-	129
Arsenic	SW3050/ SW7060	0.5	mg/kg	63	-	-	-	7	-	70
Lead	SW3050/ SW7420	0.5	mg/kg	27	-	-	-	3	-	30
Mercury	SW7471	0.5	mg/kg	73	-	-	-	7	-	80
Selenium	SW3050/ SW7740	1	mg/kg	63	-	-	-	7	-	70
Organochlorine Pesticides and PCB's	SW3550/ SW8080	0.01-0.2	mg/kg	33	-	-	-	4	19	56
Volatile Organic Compounds	SW5030/ SW8240	0.1	mg/kg	204	21	-	-	21	-	246
Semivolatile Organic Compounds	SW3550/ SW8270	1.0	mg/kg	177	-	-	-	18	-	195
Chlorinated Phenoxly Herbicides	SW8150	0.1-160	mg/kg	33	-	-	-	4	19	56
Organophosphorous Pesticides	SW8140		mg/kg	15	-	-	-	2	9	26
Extraction Procedure Toxicity	40 CFR 261.24	0.002-0.5	mg/L	50	-	-	-	5	-	55
Soil Moisture Content	ASTM D2216	-	per cent (%)	149	-	-	-	15	-	164

EPA Method 3050 Acid Digestion

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

EPA Method 6010/200.7 - ICP Procedures

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

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

EPA Method 7000 - Atomic Absorption

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

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

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

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

1.8.2 Organic Analyses

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

EPA Method 413.2 - Oil and Grease (Infrared)

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

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

EPA Method 418.1 - Petroleum Hydrocarbons (Infrared)

Oil and grease is a measure of biodegradable animal greases and vegetable oils whereas petroleum hydrocarbons are considered mineral oils. A sample of 1 liter volume is collected in a wide mouth glass bottle. The sample is acidified to <2 pH with H₂SO₄ as a means of preventing microbial activity. Serial extraction with fluorocarbon-113 is accomplished in a separatory funnel, with interferences removed in silica gel adsorbant. Analysis is performed by infrared spectrophotometry.

1.8.3 Extraction Procedures

EPA Method 1310 - Extraction Procedure (EP) Toxicity Test

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

EPA Method 3550 - Sonication Extraction

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

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

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

EPA Method 5030 - Purge and Trap

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

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

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

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

1.8.4 Organic Analyses by GC/MS

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

EPA Method 8240 - GC/MS for Volatile Organics

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

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

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

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

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

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

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

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

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

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

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

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

1.8.5 Organic Analyses by GC

EPA Method 601 - Halogenated Volatile Organics

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

EPA Method 8020 - Purgeable Aromatics

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

EPA Method 8080/608 - Organochlorine Pesticides and PCBs

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

100-100

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

EPA Method 604 - Phenols

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

EPA Method 8150/SM 509B - Chlorinated Phenoxy Herbicides

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

1.8.6 Other Water Parameters

EPA Method 150.1 - pH

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

EPA Method 120.1 - Specific Conductance

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

EPA Method 170.1 - Temperature

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

Standard Method 403 - Alkalinity

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

Standard Method 429 - Common Anions

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

EPA Method 160.1 - Total Dissolved Solids

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

1.9 Data Reduction, Validation, and Reporting

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

1.9.1 Data Reduction

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

1.9.2 Data Validation

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

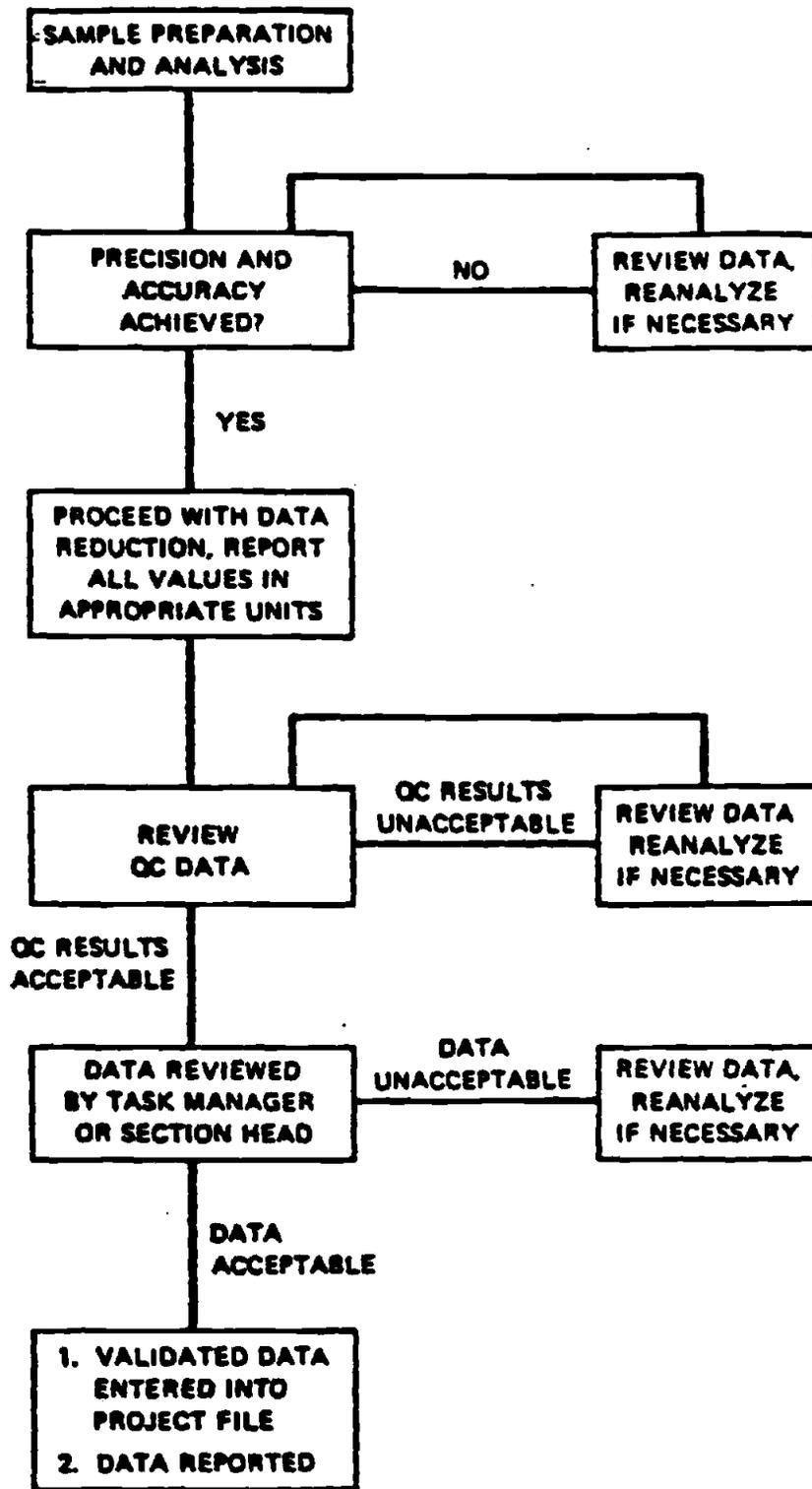


Figure 1.9-1. Data Reporting Scheme

10/27/04

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

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

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

1.9.3 Data Quality Review

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

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

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

Instrument Response Linearity

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

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

where, x = calibration concentrations

y = instrument response (peak area)

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

Precision

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

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

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

where, x = individual measurement

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

n = number of measurements

The CV is then calculated as:

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

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

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

where, df = degrees of freedom.

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

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

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

Accuracy

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

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

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

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

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

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

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

1.9.4 Reporting

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

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

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1.10 Internal Quality Control

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

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

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

TABLE 1.10-1. SUMMARY OF INTERNAL QUALITY CONTROL PROCEDURES

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

(Continued)

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TABLE 1.10-1. (Continued)

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

(Continued)

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TABLE 1.10.1 (Continued)

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

(Continued)

TABLE 1.10-1. (Continued)

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

(Continued)

TABLE 1.10-1. (Continued)

Parameter	Analytical Method	Quality Control Check	Frequency	Acceptance Criteria	Purpose/Corrective Action	
Volatiles CLP Modified	8240 (GC/MS)	<u>Laboratory</u>				
		Check of mass spectral ion intensities using BFB	Daily prior to sample analyses	Refer to method (Table 3)	Retune instrument Repeat BFB analysis	
		System performance check compounds	Every 12 hours	RF >0.300 (0.250 for bromoform)	1) Evaluate system 2) Repeat calibration	
		Calibration check compounds	Every 12 hours	% Difference <30%	1) Evaluate system 2) Repeat calibration	
		Surrogate spikes	Every sample	Based on CLP (See Table IV)	1) Evaluate system 2) Recalculate data and/or reanalyze extract 3) Reextract and reanalyze sample or flag data	
		Internal standard	Every sample	Refer to method (Table 5)	Flag data	
		Extraction blank	Daily prior to analyses	<CLP CRDL except for common laboratory contaminants which may be 5% CRDL	1) Reanalyze blank 2) Reextract blanks/samples for analytes that are > than CRDL 3) Reanalyze samples/blank	
		Matrix spike	5%	Refer to method (Table 6)	1) Run check standard 2) Correct problem 3) Flag data	
		Matrix spike duplicate	5%	Refer to method (Table 6)	Flag data	
		<u>Field</u>				
Trip blanks	10%; minimum one per program	None	Used to determine sources of contamination			
Duplicate field samples	10%; minimum one per program	None	Used to determine sampling/analytical variability			

(Continued)

TABLE 1.10-1. (Continued)

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

(Continued)

TABLE 1.10-1. (Continued)

Parameter	Analytical Method	Quality Control Check	Frequency	Acceptance Criteria	Purpose/Corrective Action
Organochlorine Pesticides and PCBs	8080 or 608 GC	Multipoint calibration, 4 points	Initial calibration	$r > 0.990$ or use single point if response factor $< 20\%$	Repeat calibration
CLP Modified		Single point calibration	Daily prior to sample analyses	RPD $\pm 15\%$	Repeat test Repeat calibration
		Reagent blank	Daily	Less than minimum detection limit	1) Clean instrument 2) Rerun blank 3) See lab manager
		Surrogate standards	Every sample	Dibutylchloroendate 24-154% water 20-150% soil	1) Check calculations 2) Reanalyze extract 3) Reextract or flag data
		Matrix spike	10%; minimum one per set	Refer to method	1) Check calculations 2) Reanalyze extract 3) Reextract or flag data
		Matrix spike duplicate	10%; minimum one per set	Refer to method	Flag data
		Extraction blank	Daily prior to sample analysis	Refer to method	1) Clean system 2) Repeat test
		Breakdown check (Endrin & DDT)	Daily	$< 20\%$	1) Clean injection port 2) Replace front 2 inches of column packing 3) Refer to method
		<u>Field</u>			
		Duplicate field sample	10%; minimum one per program	None	Used to assess sampling/analytical variability
		Equipment blanks	10%; minimum one per program	None	Used to assess sources of contamination

(Continued)

TABLE 1.10-1. (Continued)

Parameter	Analytical Method	Quality Control Check	Frequency	Acceptance Criteria	Purpose/Corrective Action
<u>Laboratory</u>					
Halogenated Volatile Organics	601/8010 (GC/RSD)	Multipoint calibration (minimum five points)	Initially and as required	RSD <20% for RPs	Recalibrate
		Daily calibration (single-point)	Daily, before sample analysis	Refer to Method 8010	1) Rerun 2) Recalibrate
		QC/Cs (analytes of interest)	Daily, before sample analysis	Measured value within 95% CI	1) Repeat QC/Cs analysis for analytes that failed; if problem persists; 2) Evaluate system; correct problem.
		Reagent blank	Daily	≤ 5 X IDL	Used to assess sources of contamination
		System blank	Daily	< IDL	Run until system is clean
		Matrix spike	10%; minimum one per set	Established criteria in Method 8010 Table 3	1) Analyze QC/Cs for analytes that failed spike test; if passes: 2) Flag data for matrix effects; if QC/Cs fails; 3) Evaluate system; recalibrate; and reanalyze any samples affected by out-of-control condition.
		Matrix spike duplicate	10%; minimum one per set	RPD <50%	Flag data
		Surrogate spikes	Every sample, reagent blank, and standard.	±50%; lab must set own criteria (p.38) after 30 samples	1) Check for errors in calculations or standards; 2) Recalculate data and/or reanalyze extract; 3) Reextract and reanalyze or flag data.
<u>Field</u>					
		Equipment blanks	10%; minimum one per program	None	Used to assess sources of contamination
		Trip blanks	10%; minimum one per program	None	Used to assess sources of contamination
		Duplicate field samples	10%; minimum one per program	None	Used to determine sampling/analytical variability
		Ambient Condition blanks	10%; minimum one per program	None	Used to assess sources of contamination

(Continued)

TABLE 1.10-1. (Continued)

Parameter	Analytical Method	Quality Control Check	Frequency	Acceptance Criteria	Purpose/Corrective Action
<u>Laboratory</u>					
Volatile Aromatics	602/8020 (GC/PID)	Multipoint calibration (minimum five points)	Initially and as required	RSD <20% for RPs	Recalibrate
		Daily calibration (single-point)	Daily, before sample analysis	Refer to Method 8020	1) Rerun 2) Recalibrate
		QCCS (analytes of interest)	Daily, before sample analysis	Measured value within 95% CI	1) Repeat QCCS analysis for analytes that failed; if problem persists; 2) Evaluate system; correct problem.
		Reagent blank	Daily	<5 X IDL	Used to assess sources of contamination
		System blank	Daily	< IDL	Run until system is clean
		Matrix spike	10%; minimum one per set	Established criteria in Method 8020 Table 3	1) Analyze QCCS for analytes that failed spike test; if passes; 2) Flag data for matrix effects; if QCCS fails; 3) Evaluate system; recalibrate; and reanalyze any samples affected by out-of-control condition.
		Matrix spike duplicate	10%; minimum one per set	RPD <50%	Flag data
		Surrogate spikes	Every sample, reagent blank, and standard.	+50%; lab must set own criteria (pt3a) after 30 samples	1) Check for errors in calculations or standards; 2) Recalculate data and/or reanalyze extract; 3) Reextract and reanalyze or flag data.
<u>Field</u>					
		Equipment blanks	10%; minimum one per program	None	Used to assess sources of contamination
		Trip blank	10%; minimum one per program	None	Used to assess sources of contamination
		Duplicate Field Sample	10%; minimum one per program	None	Used to assess sampling/analytical variability
		Ambient Condition Blank	10%; minimum one per program	None	Used to assess sources of contamination

(Continued)

TABLE 1.10-1. (Continued)

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

(Continued)

TABLE 1.10-1. (Continued)

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

(Continued)

TABLE 1.10-1. (Continued)

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

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

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

10/11/83

1.10.1 Laboratory QC

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

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

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

These procedures are described below.

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

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

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

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

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

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

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

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

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

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

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

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

Each of these is described below.

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

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

100-0000

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

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

Surrogate Standard Spike Samples--All samples will be spiked with a surrogate standards as described in SW-846. The spiking level used should be that which will give an amount in the purge apparatus that is equal to 50 ug/kg of the sample. If the recovery for any surrogate standard does not fall within the control limits for method performance, the sample will be reanalyzed. If the surrogate recovery fails twice, the results reported for that sample must be qualified as being outside of control limits. The laboratory must monitor the frequency of data so qualified to ensure that it remains at or below 5%. Three surrogate standards, 4-bromofluorobenzene, 1,2-dichloroethane d₄, and toluene d₈, are used to monitor recovery of volatile compounds varying in volatility and polarity. Three base/neutral--nitrobenzene-d₅, 2-fluorobiphenyl, and p-terphenyl-d₁₄--and three acid--phenol-d₅, 2-fluorophenol, and 2,4,6-tribromophenol--extractable surrogate compounds are used to monitor recovery of semivolatile organics.

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

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

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

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

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

Metals Analyses by ICPES and Atomic Absorption

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

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

These procedures are described below.

Calibration--Calibration procedures are described in Section 1.7.

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

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

Calibration Blank (ICPES)--At a frequency of 10 percent, a calibration blank will be analyzed during sample analyses. As specified in Method 6010, this standard is prepared by diluting 2 mL of (1+1)HNO₃ and 10 mL of (1+1)HCl to 100 mL DI H₂O. If response to this standard is verified to be outside three standard deviations of the mean calibration blank value, then correct the problem, recalibrate, and reanalyze the previous ten samples.

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

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

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

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

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

Fluoride Analyses

Fluoride analyses will be performed according to EPA Method 340.2. Quality control procedures include:

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

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

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

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

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

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

Titrimetric Determination of Chloride

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

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

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

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

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

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

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

Turbidimetric Determination of Sulfate

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

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

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

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

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

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

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

1.11 Performance and Systems Audits

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

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

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

1.11.1 Audit Approach

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

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

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

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

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

1.11.2 Systems Audit

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

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

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

Site: _____ Date: _____

Contract: _____ Auditor: _____

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

Figure 1.11-1. Example Systems Audit Checklist

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

1.11.3 Performance Audit

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

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

1.12. Preventative Maintenance

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

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

Each of these efforts are discussed in the following sections.

1.12.1 Maintenance Responsibilities

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

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

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

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

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

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

**RADIAN
PHYSICAL CHEMISTRY**

INSTRUMENT

MODEL	S/N
DATE	TECHNICIAN

CONDITION

OPERATIONAL **LAST CAL DATE**
 UNKNOWN _____
 BROKEN **BY** _____

COMMENTS

Figure 1.12-1. Equipment Status Tag

RAD-573

1000 00000-1
 THE UNIVERSITY OF CHICAGO LIBRARY
 520 EAST 58TH STREET, CHICAGO, ILL. 60637
 TEL: 773-936-3000 FAX: 773-936-3000
 WWW.CHICAGO.LIBRARY.ORG

Designation Source

Instrument SO₂ Analyzer
 Model Thermo-Electron Series 40
 S/N SDM-10269-115

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

Figure 1.12-2. Equipment Inventory Control Form

1.12.2 Maintenance Schedules

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

1.12.3 Spare Parts

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

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

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

1.13 Assessment Of Precision, Accuracy, and Completeness

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

1.13.1 Precision

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

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

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

TABLE 1.13-1. MEASURES OF PRECISION

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

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

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

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

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

1.13.2 Accuracy

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

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

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

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

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

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

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

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

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

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

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

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

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

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

1.13.3 Completeness

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

1.14 Corrective Action

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

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

MALFUNCTION REPORT

Malfunction Type _____

- 1 - QC Limits Exceeded
- 2 - Documentation
- 3 - Other (explain)

Urgency Level _____

- 1 - Requires immediate attention
- 2 - Should be addressed within 7 days
- 3 - Requires written explanation within 14 days.

Laboratory: _____ Reported to: _____

Location: _____ Position: _____

Contract: _____

Date/Time of Malfunction: _____ Date Reported: _____

Malfunction Reported by: _____

Matrix: Solid Liquid Hydrocarbon Groundwater Air

Description of Problem: _____

Action: _____

Date/Time Resolved: _____ By Whom: _____

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

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

Distribution: _____

Figure 1.14.1. Malfunction Reporting Form

100-4000

U.S. GOVERNMENT PRINTING OFFICE: 1980 O-280-000

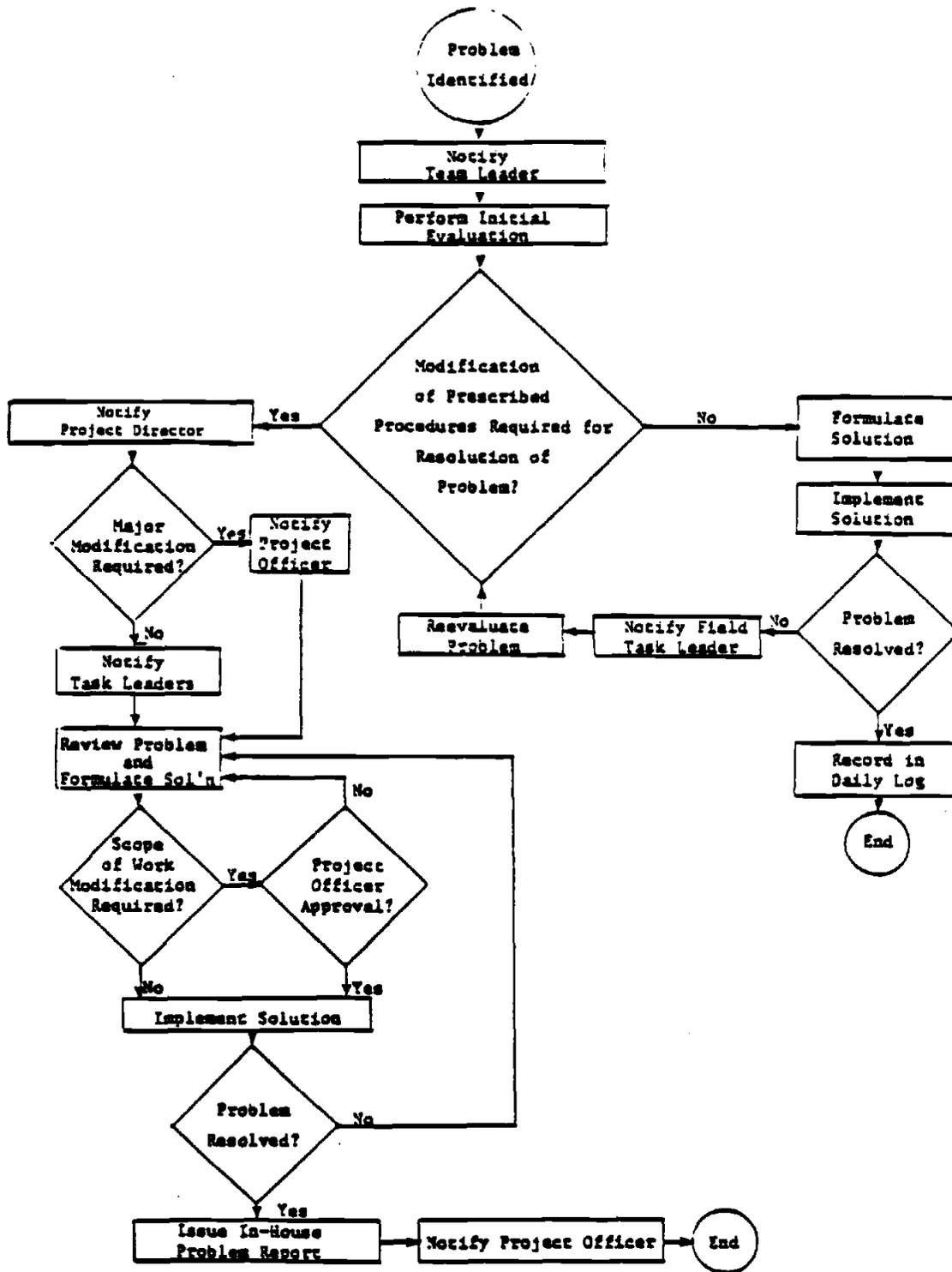


Figure 1.14-2. Corrective Action Flow Scheme



RESEARCH & ENGINEERING

RECOMMENDATION FOR CORRECTIVE ACTION

RCA NO.:	DATE:	URGENCY LEVEL <input type="checkbox"/> 1. Potential for major loss of investment. 2. Potential for failure to achieve cost quality objectives. 3. Suggested improvement.
ORIGINATOR:		
ORGANIZATION/INDIVIDUAL RESPONSIBLE FOR ACTION:		

A. Problem Identification

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

B. Recommended Corrective Action

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

C. Problem Resolution

PLANNED CORRECTIVE ACTION:	PROPOSED BY:	DATE PROPOSED:	SCHEDULED IMPLEMENTATION:
IMPLEMENTED CORRECTIVE ACTION:			
			DATE IMPLEMENTED:

D. QA Verification

VERIFIED BY:	DATE:
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White: Original

Yellow: Laboratory supervisor/engineer's copy

Pink: Engineer's copy

3 of 2010

Figure 1.14-3. Recommendation for Corrective Action Form

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

UFCOM # 570

1.15 Quality Assurance Reporting

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

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

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

1.15.1 Quality Assurance Reporting

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

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

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

1.15.2 Quality Control Data Reporting

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

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

DUPLICATE AND BLANK SAMPLE SUMMARY

PERIOD _____ PREPARED BY _____ DATE _____

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

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

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

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1.15.2.3 Monthly QC Progress Reports

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

- Section 1.0 - Introduction and Summary

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

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

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

- Section 2.0 - Sampling QC Activities

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

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

- Section 3.0 - Analytical QC Activities

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

- Section 4.0 - Summary of QC Data

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

- Section 5.0 - Malfunctions Reported and Completed

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

2.0 METHODS PROTOCOLS

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

2.1. Magnetometer Surveys

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

2.2 Drilling Techniques

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

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

2.2.1 Hollow-Stem Augering

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

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

2.2.2 Mud/Air Rotary Drilling (Optional)

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

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

2.3 Monitor Well Installation

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

2.3.1 Hollow-Stem Auger Method

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

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

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

- Following casing and screen placement, a gravel pack (washed and bagged silica sand or gravel) having a grain size distribution compatible with the screen slot size is slowly placed between the well screen and the auger before the augers are pulled. As the augers are pulled, the gravel pack settles around the screen. The top of the gravel pack is placed approximately three feet above the top of the screen. After the gravel pack height is measured, a three foot bentonite seal (granulated or pellets) is emplaced through the augers directly on top of the gravel pack. After the bentonite has formed a complete seal, the remainder of the annulus is grouted to land surface with a Type I Portland cement and bentonite slurry.

- If well stick-up is of concern in an area, the well will be completed flush with the land surface. The specifications for a below surface well completion are as follows. Cut the casing two to three inches below land surface, and install a protective locking lid with a cast iron valve box assembly. Center the lid assembly in a three foot diameter concrete pad sloped away from the valve box. Ensure that free drainage is available within the valve box. Also, provide a screw-type casing cap to prevent infiltration of surface water. Maintain a minimum of one foot clearance between the casing top and the bottom of the valve box. Clearly mark the well number on the valve box lid and well casing. Securely lock the valve box lid.

- For above ground well completions, the well casing will extend two to three feet above land surface. The specifications for an above land surface well completion are as follows. Provide

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

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

2.3.2 Mud/Air Rotary Method (Optional)

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

2.3.3 Aquifer Testing

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

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

r_c - radius of well (feet)

R_e - effective radius over which y is dissipated

r_w - radius of borehole

\ln - natural log

L - length of screen (feet)

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

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

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

2.4 Sample Collection

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

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

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

2.4.1 Water Samples

Groundwater Samples

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

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

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

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

TABLE 2-1. (CONTINUED)

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

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

TABLE 2-1. (CONTINUED)

(3) Chlorinated phenoxy acid herbicides in water and soil/sediment samples. Limits of Detection must be at or below the values specified. (A509B, SW6150)

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

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

(4) Organochlorine pesticides in water and soil/sediment samples. Limits of detection must be at or below the values specified. (E608, SW6080)

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

TABLE 2-2. WATER SAMPLE/ANALYTICAL SUMMARY

Reference Method	Parameter	Method Detection Limit	Method Type	Container Type, No. and Volume	Preservation and Storage Requirements	Sample Preparation Procedures	Maximum Holding Time (Preparation)	Maximum Holding Time (Analysis)
SM403	Alkalinity-Carbonate Bicar., & Hydroxide (Field Test)	10 mg/L	Titration	Polyethylene or borosilicate glass bottle 1-liter	Refrigerated at 4°C	none	N/S	14 Days
SM69b	Chlorinated Phenoxy Acid Herbicides	0.01 ug/L	GC	1-L glass bottles w/TPE lined caps	4°C	Hydrolyze, Esterify, GC	7 days	40 days
EPA 120.1	Specific Conductance (Field Test)	N/S	Wheatstone Bridge-type conductivity meter	None	None	Determine temperature measure conductivity	-	2.8 days
EPA 150.1	pH (Field Test)	N/S	Electrometric pH meter	None	None	Measure directly in field medium	-	Analyze Immediately
EPA 625	Priority Pollutants (2)	1-50 ug/L	GC/MS	(2) 1000 mL glass; TFE-lined cap	Refrigerated at 4°C	Continuous extraction with methylene chloride	7 days	40 days
EPA 200.7	Metals (3)	0.002-0.9 mg/L	ICP	(1) 500 mL polyethylene bottle	pH <2 w/HNO ₃	HNO ₃ HCl digestion	N/S	6 months
EPA 206.3	As	4 ug/L	AA (furnace)	(1) 500 ml polyethylene	pH<2 w/HNO ₃	HNO ₃ digestion	N/S	6 months
EPA 270.3	Se	2 ug/L	AA (furnace)	(1) 500 ml polyethylene	pH<2 w/HNO ₃	HNO ₃ digestion	N/S	6 months
EPA 245.1	Hg	0.2 ug/L	AA (vapor)	(1) 500 ml polyethylene bottle	pH<2 w/HNO ₃	KMnO ₄ , HNO ₃ , H ₂ SO ₄ digestion	N/S	6 months 28 days
EPA 413.2	Oil & Grease	0.2 mg/L	IR	(1) 1000 mL glass bottle	pH<2, w/HCl, refrigerated at 4°C	Freon Extraction	N/S	28 days

(Cont. In next)

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TABLE 2-2. (Continued)

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

(Continued)

TABLE 2-2

TABLE 2-2. (Continued)

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

(1) Chlorinated phenoxy acid herbicides in water and soil/sediment samples. Limits of Detection must be at or below the values specified. (A509B, SW8150)

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

TABLE 2-2. (Continued)

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

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

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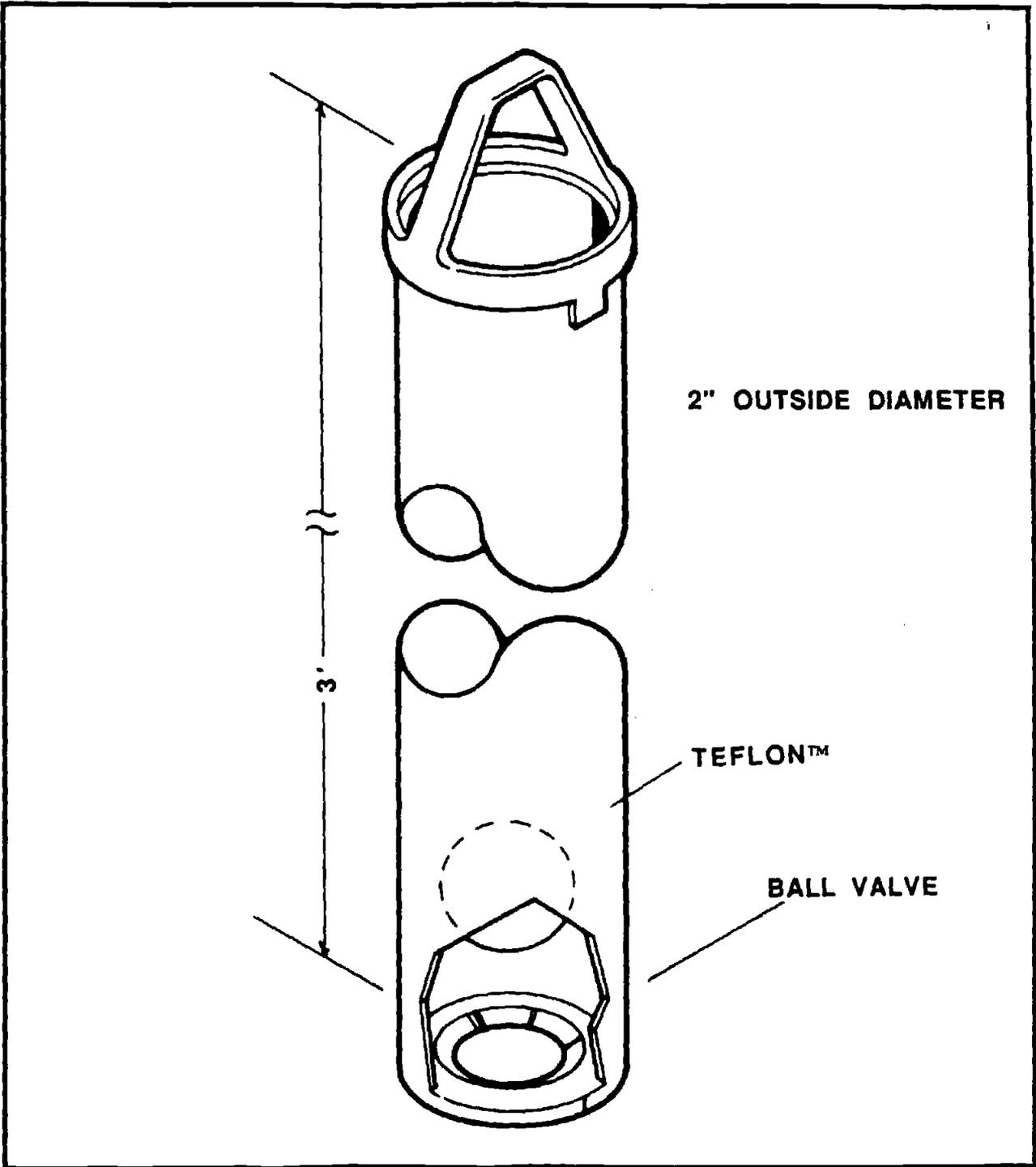


Figure 2-1. Bottom Entry Teflon™ Bailer

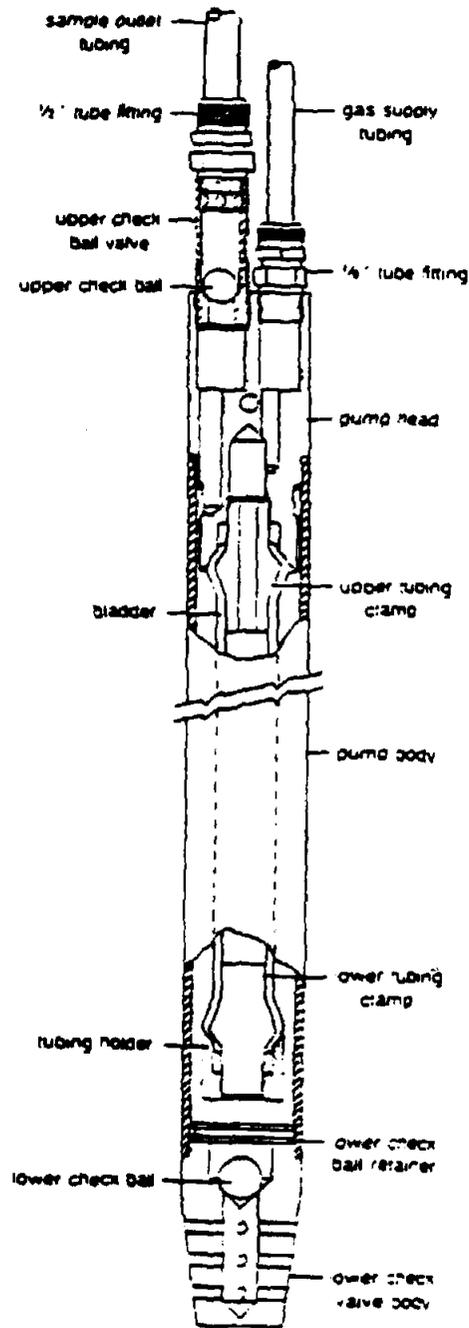


Figure 2-2. Bladder Pump

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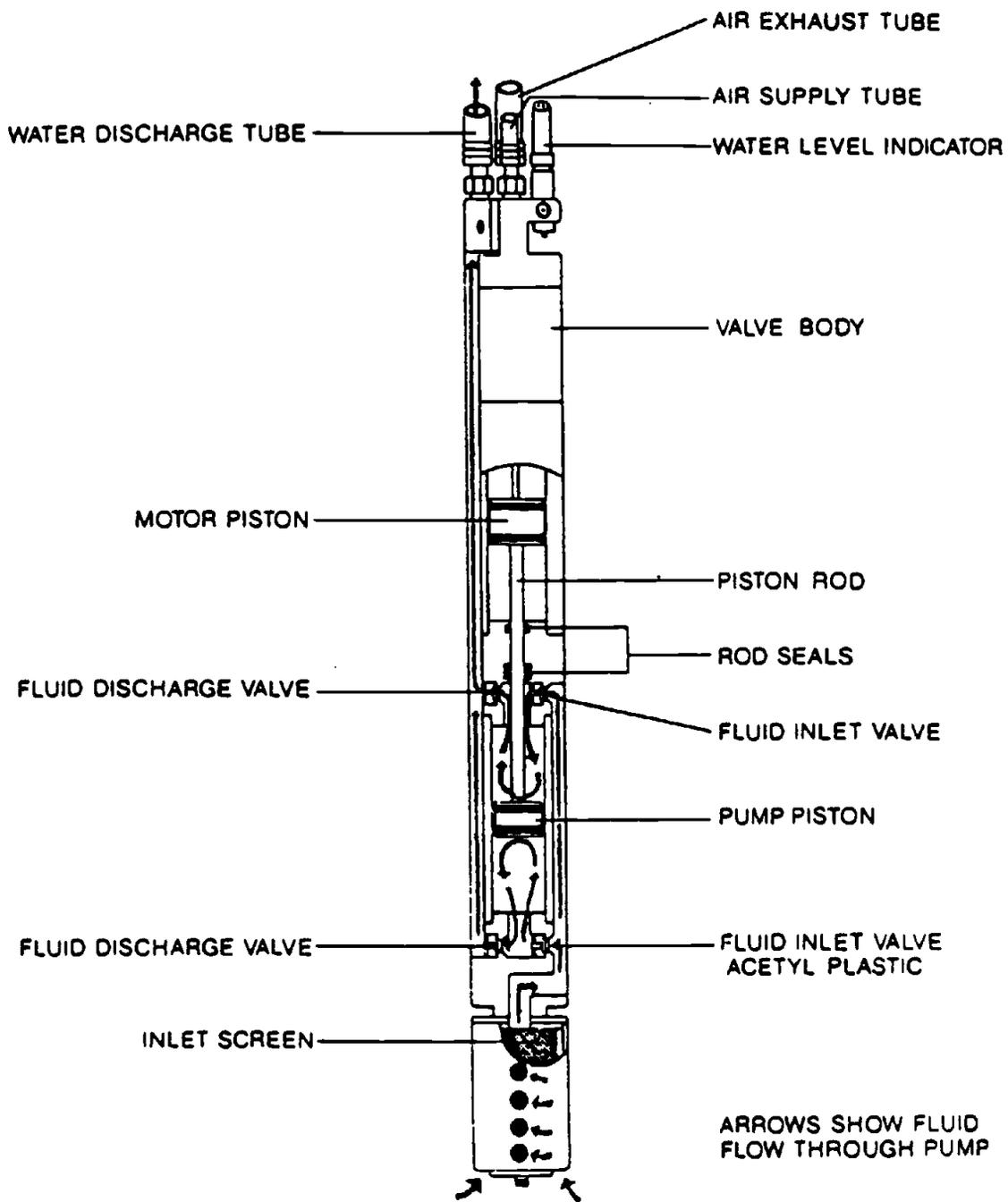


Figure 2-3. Piston Pump

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

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

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

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

Surface Water Samples

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

Water Blanks and Duplicates

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

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

2.4.2 Soil And Sediment Samples

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

Hand Auger Sampling

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

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

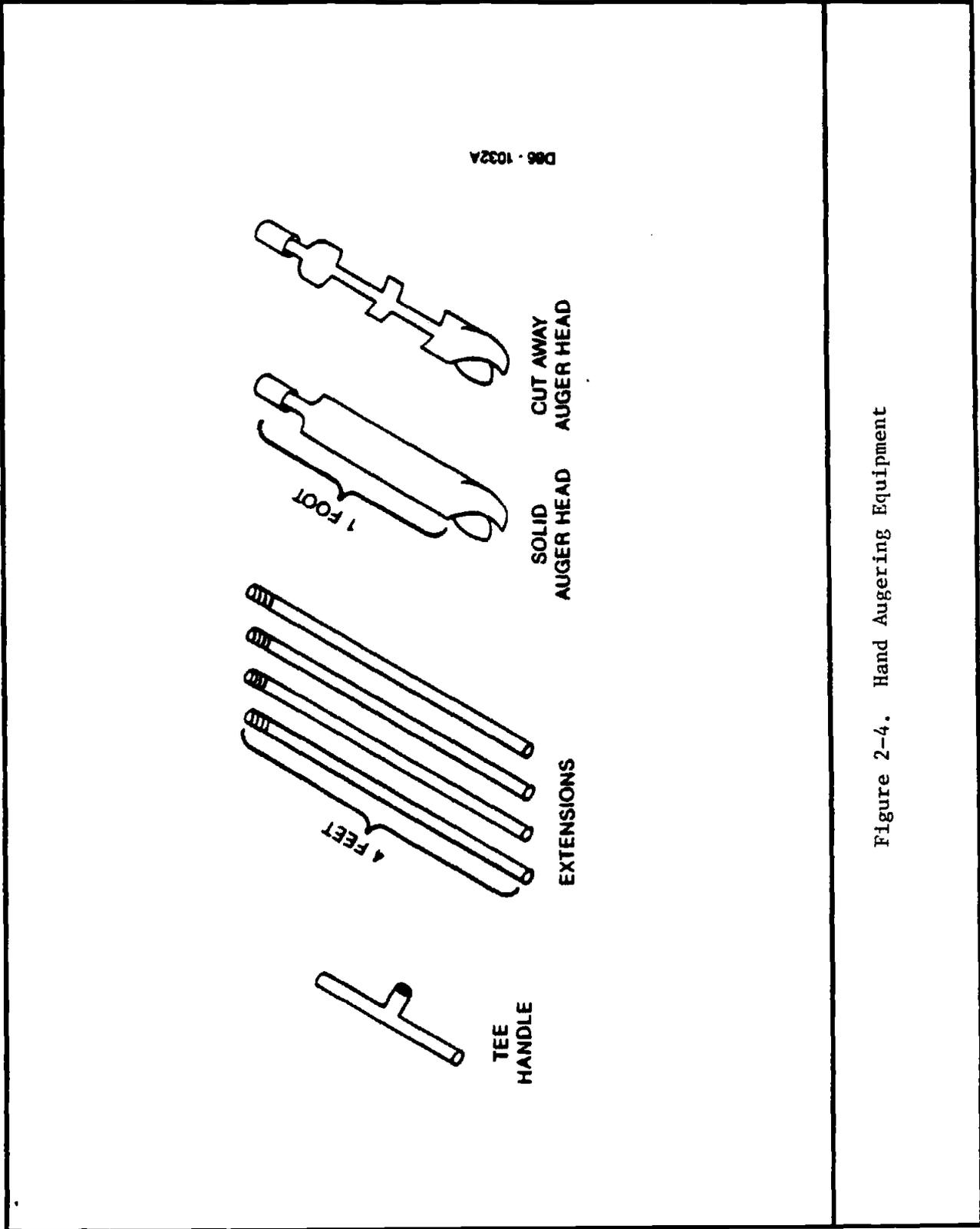


Figure 2-4. Hand Augering Equipment

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

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

Split-Spoon Samples

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

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

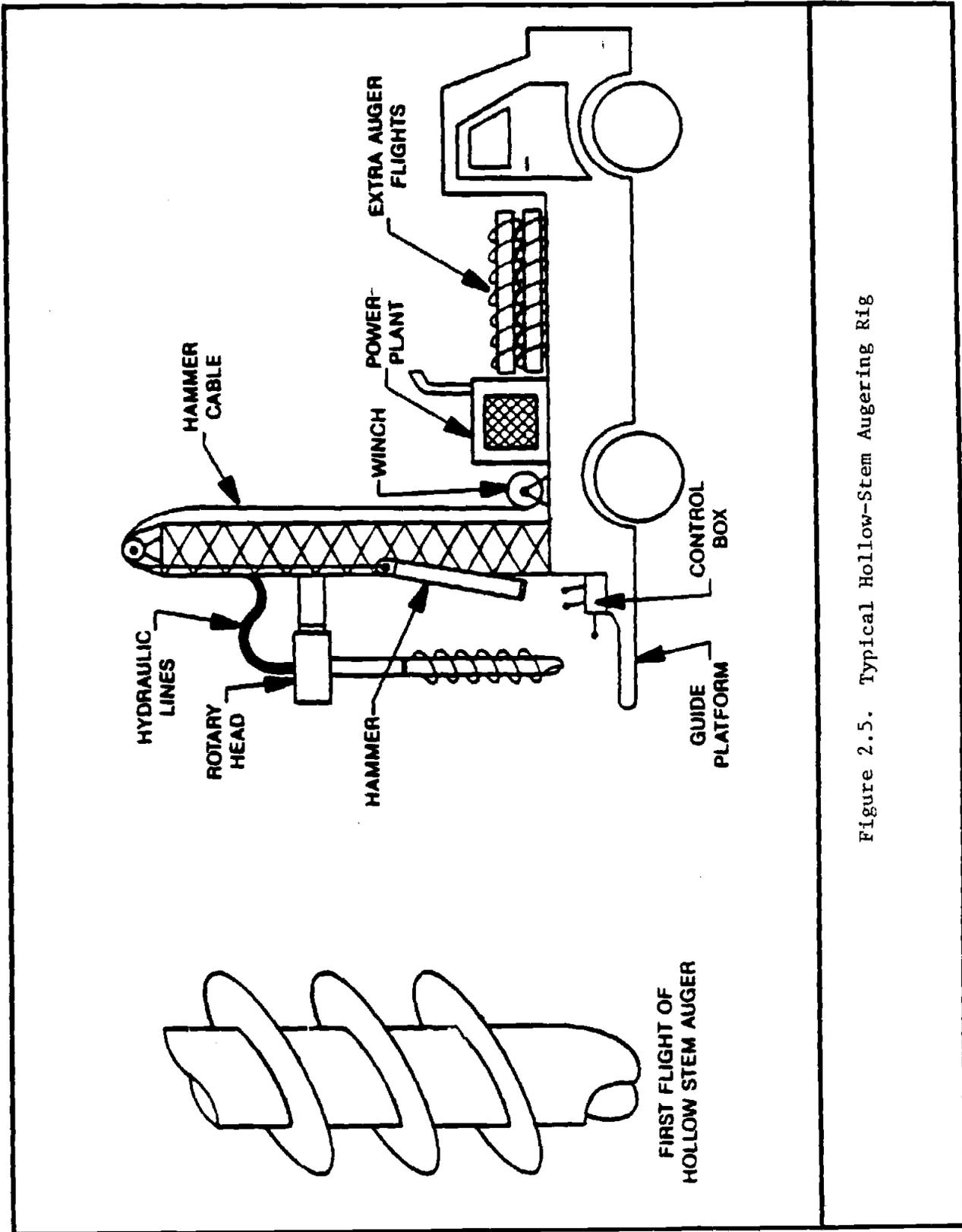


Figure 2.5. Typical Hollow-Stem Augering Rig

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

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

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

Soil Toxicity Sampling

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

Solid Sample Duplicates

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

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

2.4.3 Gas Sampling

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

Gas Sampling Approaches

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

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

Air Monitoring - Drilling and Hand Augering Activities

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

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

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

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

Mobile GC Laboratory Soil Gas Sampling

Shallow soil gas will be collected by pumping a small amount of the soil gas out of the ground through a hollow probe driven a few feet into the ground and analyzing the gas for the presence of volatile contaminants. The soil gas analysis is performed in the field so that samples do not have to be packed or shipped. The analytical results are available immediately and can be used to help direct an investigation.

Soil gas samples are collected by driving a probe into the ground by a hydraulic pusher/puller mechanism, then the probes are purged. After

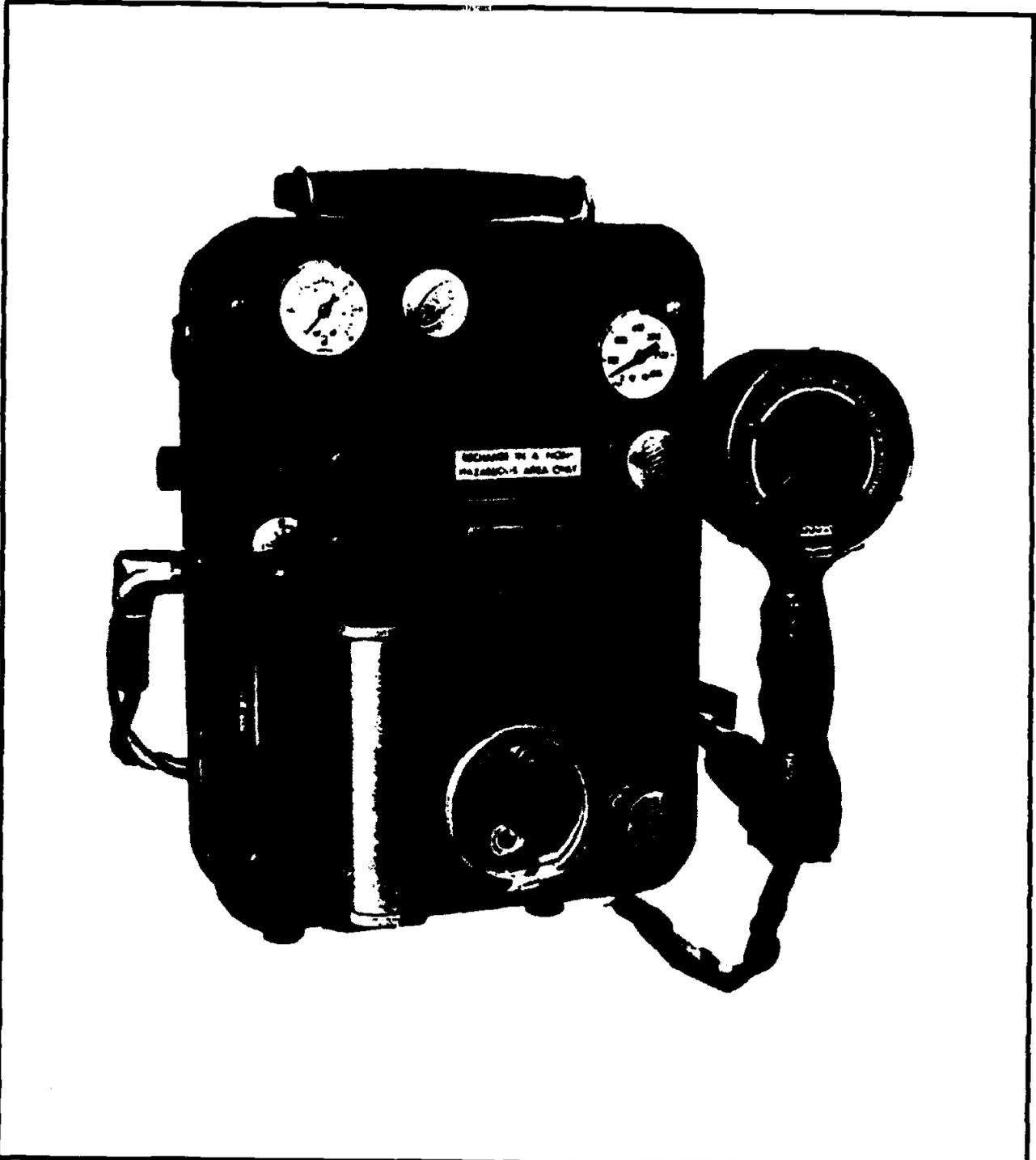


Figure-2-6. Foxboro Century Systems Portable Organic Vapor Analyzer Model OVA-108

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purging and while the soil gas is being drawn through the probe, a gas sample is taken by a glass syringe which is inserted through a section of silicone tubing (leading to the pump) and into the stainless steel tubing into the adaptor. Gas samples only contact steel surfaces and are never in contact with potentially sorbing materials (i.e., tubing, hose, pump diaphragm). A vacuum gauge monitors the negative pressure in the evacuation line to assure that there is no impedance to gas flow through clay or water-saturated soils.

One or two 10 ml air samples are collected from each sampling probe after one to four minutes of pumping. These 10 ml samples are subsampled according to analytical requirements and replicates are injected into the gas chromatograph for documentation of reproducibility. More than two injections may be necessary where there are multiple contaminants which require different sample sizes for chromatographic analysis. The reproducibility of soil gas samples from the same probe is typically within 20 percent and is always within a factor of two.

After the analysis is completed the probe is removed and the probe hole is backfilled with native materials.

2.4.4 Sample Requirements

Samples will be collected in the containers specified for the particular analysis. The container types, preservation techniques, holding times and sample volumes for each analysis are presented in detail in Tables 2-1 and 2-2.

2.5 Site Management

After completion of each borehole or well the soil cuttings will be placed in drums and removed per direction of the base civil engineer. The

site will then be cleaned of any remaining cuttings. The drums will be transported to a location within the installation boundary. The base is responsible for ultimate disposal of the contaminated soils using base resources.

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