



**HOLLOMAN AFB
NEW MEXICO**

**ADMINISTRATIVE RECORD
COVER SHEET**

AR File Number 729

DRAFT

File: 19-8-24
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■■■■■■■ REMEDIAL
INVESTIGATION/
RCRA FACILITY
INVESTIGATION
QUALITY ASSURANCE
PROJECT ADDENDUM
FOR SITE SD-47

HOLLOMAN AIR
FORCE BASE,
NEW MEXICO

July 1993

W-C Project No. C3M11P

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1.1 PURPOSE AND SCOPE

The purpose of this Quality Assurance Project Plan (QAPP) is to provide specific guidance and quality assurance/quality control (QA/QC) requirements for the generation of environmental data of known quality for use in making site-specific decisions for the Remedial Investigation (RI) for Site SD-47 at Holloman Air Force Base (AFB), New Mexico.

This document provides discussion of project objectives, procedures, and specific measurements to be evaluated in the assessment of data generated for investigations at Holloman AFB. As an appendix to the QAPP, specific Standard Operating Procedures (SOPs) are also provided as a means of maintaining consistency with respect to procedures commonly used in conjunction with data collection activities.

This QAPP has been prepared by Woodward-Clyde (W-C) under Contract DACW45-93-D-0005 with the U.S. Army Corps of Engineers (USACE), Omaha District, in accordance with applicable elements of the USACE Engineering Regulation ER1110-1-263, Chemical Data Quality Management for Hazardous Waste Remedial Activities (USACE, October 1990), and Current EPA QA/QC guidance.

At the same time, this document contains essential elements of a "Chemical Data Acquisition Plan" as specified in CERCLA RI guidance (USEPA 1988d, 1989). This addendum is intended to complement and supplement the QAPP prepared for the RCRA Facility Investigation (RFI) at the T-38 Test Cell and Building 828 (W-C June 1993).

The work for the Holloman AFB RFI is directed by RCRA guidance, and areas of investigation are referred to as Solid Waste Management Units (SWMUs). Site SD-47 (not considered a SWMU) is under CERCLA guidance; thus, the area of investigation is referred to as a site. However, because of the similarities in QA/QC requirements between RCRA and CERCLA, for practical purposes, the term SWMU and site can be considered interchangeable.

Therefore, where sections of the QAPP have not been changed, the term SWMU will also be appropriately applied to Site SD-47.

1.2 QAPP ADDENDUM ORGANIZATION

The following provides information on the outline of this Addendum and how it should be used in conjunction with the original QAPP (June 1993).

- Section 1.0 Introduction - Addendum
- Section 2.0 Project Description - Addendum
- Section 3.0 Project Organization and Responsibility - See Original QAPP
- Section 4.0 Quality Assurance Objectives - Addendum
- Section 5.0 Sampling and Field Procedures - Addendum
- Section 6.0 Sample and Document Custody - Addendum
- Section 7.0 Calibration Procedures and Frequency - See Original QAPP
- Section 8.0 Analytical Procedures - Addendum
- Section 9.0 Analytical Data Reduction, Reporting, and Review Process - See Original QAPP
- Section 10.0 Performance and System Audits - See Original QAPP
- Section 11.0 Preventive Maintenance - See Original QAPP
- Section 12.0 Data Measurement Assessment Procedures - See Original QAPP
- Section 13.0 Corrective Action - See Original QAPP
- Section 14.0 Quality Assurance Reports to Management - See Original QAPP
- Section 15.0 References - Addendum

PROJECT DESCRIPTION

2.1 ENVIRONMENTAL SETTING

Holloman AFB is located within the Tularosa Basin in south-central New Mexico, approximately 5 miles southwest of Alamogordo in Otero County (see Figure 1-1). Las Cruces is the closest large town and is located about 70 miles to the southwest. El Paso, Texas is about 80 miles to the south-southwest and Albuquerque is about 200 miles to the north-northwest. The basin is bounded on the east by the Sacramento Mountains and on the west by the San Andres Mountains.

Holloman AFB lies on approximately 50,700 acres of land (see Figure 1-2). The main Base area is situated in the south, while testing facilities occupy most of the north. Off-base installations (not shown) include the Boles and San Andres well field about 14 miles southeast of the Base, the Bonita Lake water supply about 60 miles northeast, the El Paso radar site about 80 miles south-southwest, and the Silver City radar site approximately 165 miles west.

Land surrounding the Base includes privately-owned, public, and federally-owned land. The White Sands National Monument is directly southwest of the Base. The western edge of the Lincoln National Forest is about 10 miles east of the Base within the Sacramento Mountains. The major highway serving the Base is U.S. Highway 70 which runs in a northeasterly-southwesterly direction along the southern Base boundary. The city of Alamogordo has a population of near 30,000, and its economy is closely connected to Holloman AFB.

More details on site history, climatology, physiography, geology, surface water hydrology, hydrogeology, and ecology are provided in the FSP.

2.2 SITE HISTORY AND CURRENT USE

Site SD-47, the Petroleum, Oil, and Lubricant (POL) wash rack area, is located in the southeastern section of Holloman AFB, just east of the main runways, within the POL yard. The POL yard is completely covered by asphalt or gravel and is a fenced area bounded on the north by railroad tracks and on the west, south, and east by open fields. Desert vegetation is prevalent in the open fields surrounding the POL yard. The Holloman AFB property boundary is located to the east of the POL yard. The POL wash rack area is located south of Building 702 and west of the JP-4 storage tanks (Tanks 22, 15, and 14) within the POL yard.

Site SD-47 has been in operation since 1953 and has been used for vehicle and equipment washing (U.S. Air Force 1993). Wash water from the area flowed directly to the nearby drainage ditch until oil/water separators were installed in 1980. Water from the oil/water separators discharged to a drainage ditch, approximately 100 feet from the west fence line, via underground piping. The POL wash rack area is an active site, still used for vehicle and equipment washing.

2.3 SUMMARY OF PAST AND FUTURE WORK

Holloman AFB is the headquarters of the Air Combat Command 49th Fighter Wing whose primary mission is the training of tactical fighter air crews. Holloman AFB, formerly known as the Alamogordo Army Air Field, was initiated in 1942 as a wartime temporary facility. Following a brief period of inactivity after World War II, the Base was transferred in 1947 to the Air Material Command with the mission of providing facilities, development, and testing of pilotless aircraft, guided missiles, and allied equipment in support of the Air Material Command Research and Development Program (CH2M Hill 1983, A.T. Kearney 1988).

In 1951, the Base was placed under the guidance of the Air Force Missile Test Center located at Patrick AFB, Florida. In 1952, the Base was named one of the development centers of the Air Research and Training Development Command and became Holloman Air Development Center. In 1957, the center was designated as the Air Force Missile Development Center under the Air Force Systems Command (AFSC). The 49th Tactical Fighter Wing as assigned

to the Base in 1968. Prior to this addition, the flying mission was oriented principally toward research and development (CH2M Hill 1983, A.T. Kearney 1988).

The 833rd Air Division was activated in 1964, but deactivated in 1969 due to budgetary restrictions. In 1971, the Base was transferred from AFSC to the Tactical Air Command (TAC) with the 49th Tactical Training Wing assuming host responsibilities. In 1977, the 479th Tactical Training Wing was assigned to Holloman AFB. In 1980, the 833rd Air Division was reactivated and became operational, providing command supervision over all Base activities (CH2M Hill 1983, A.T. Kearney 1988).

Previous studies have included the Holloman AFB IRP Records Search performed by CH2M Hill with a report published August 1983 and the Holloman AFB RCRA Facilities Assessment performed by A.T. Kearney with a report published September 1988. Other RFI studies have been completed by Radian Corporation and Walk, Haydel and Associates. Woodward Clyde (W-C) has been selected by the USACE Omaha District to complete an RI for Site SD-47. Figure 2-1 presents the project schedule. Fieldwork is anticipated to begin on or about August 16, 1993 and is expected to be completed on or about September 10, 1993.

2.4 SUMMARY OF THE DATA QUALITY OBJECTIVES DEVELOPMENT PROCESS

Discussion of the Data Quality Objectives (DQOs) development process associated with the RI for Site SD-47 at Holloman AFB is provided in Section 3.0 of the FSP. Specific task objective details are given in FSP Section 5.0 and are summarized here.

DQOs are defined as quantitative and qualitative statements which specify the quality of the data and define the level of uncertainty that will be acceptable regarding decisions to be made for the various Holloman AFB sites. DQOs result from an iterative process of logical interaction between the decision-maker(s) and the technical team to develop statements which describe the level of uncertainty that the decision-maker(s) are willing to accept in the environmental data. This level of uncertainty is then used as the basis for designing the data collection program.

The data generated during the RI will be assessed for use in meeting the project objectives in accordance with criteria specified in this QAPP. The following paragraphs present a summary of the DQO process for the Holloman AFB RI.

2.4.1 Statement of the Problem

The problem associated with Site SD-47 is that due to a release of fuel-related constituents, soils and groundwater at the site may contain unacceptable levels of contaminants and corrective action may be required.

2.4.2 Decision/Logic Statements

The decision/logic statements developed for the RI at Holloman AFB are summarized below:

- If soil contamination is at or above New Mexico Environment Department's clean-up (action) levels, then corrective action will be recommended. If soil contamination is less than clean-up levels and the results of the Baseline Risk Assessment indicate that there is no unacceptable risk, then no further action will be recommended. Clean-up levels for soil are:
 - Total petroleum hydrocarbons (TPH) < 1,000 mg/kg and benzene < 25 mg/kg (Per USACE and Holloman AFB)
- If there is evidence of floating nonaqueous-phase liquid (NAPL) then corrective action will be recommended.
- If a release of fuel-related constituents of concern has occurred and a complete exposure pathway has been established resulting in an unacceptable risk to human health (i.e. excess cancer risk greater than 10^{-6} to 10^{-4} and noncarcinogenic hazard index greater than 1) or the environment, then the site will be recommended for further evaluation in a Feasibility Study (FS).
- If no chemicals of concern are detected or if constituents have been detected above project reporting limits, but below risk-based concentrations (RBCs),

then no further action will be recommended for the site. Also, if chemicals of concern are detected above RBCs, but no complete exposure pathway exists, then no further action will be recommended for the site.

2.4.3 Definition of the Domain for Decisions

The domain defined for decisions regarding the existence or extent of a release to soil will be limited to the respective site investigation boundaries laterally and to groundwater vertically. For groundwater, the domain is defined as the site investigation boundary.

The domain defined for decisions regarding soil exposure pathways will be limited to the respective site investigation boundaries. Groundwater at the site is nonpotable because of the high total dissolved solids; therefore, groundwater is not being considered an exposure pathway. If data indicate that sites other than SD-47 may be a source of contamination or if migration is occurring beyond the scope of this investigation, further studies may be necessary.

2.4.4 Data Inputs

The following is a summary of the data inputs identified as appropriate to support decisions for the respective sites:

- Published and unpublished reports, as well as other existing data and information regarding activities, existence, conditions or concentrations of contaminants at the respective sites
- Collection of subsurface samples for geotechnical and chemical analysis. Standard W-C operating procedures for sampling are presented in Appendix B of the original QAPP. Analysis will be performed off-site utilizing specific geotechnical tests or, for chemical analysis, EPA SW-846, 600 series or other appropriate methodologies. Laboratory SOPs and QC criteria are specified in the Laboratory Quality Management Plan (LQMP) in Appendix A of the original QAPP. QA/QC criteria to be used in evaluation of the data are provided in Section 4 of this QAPP.

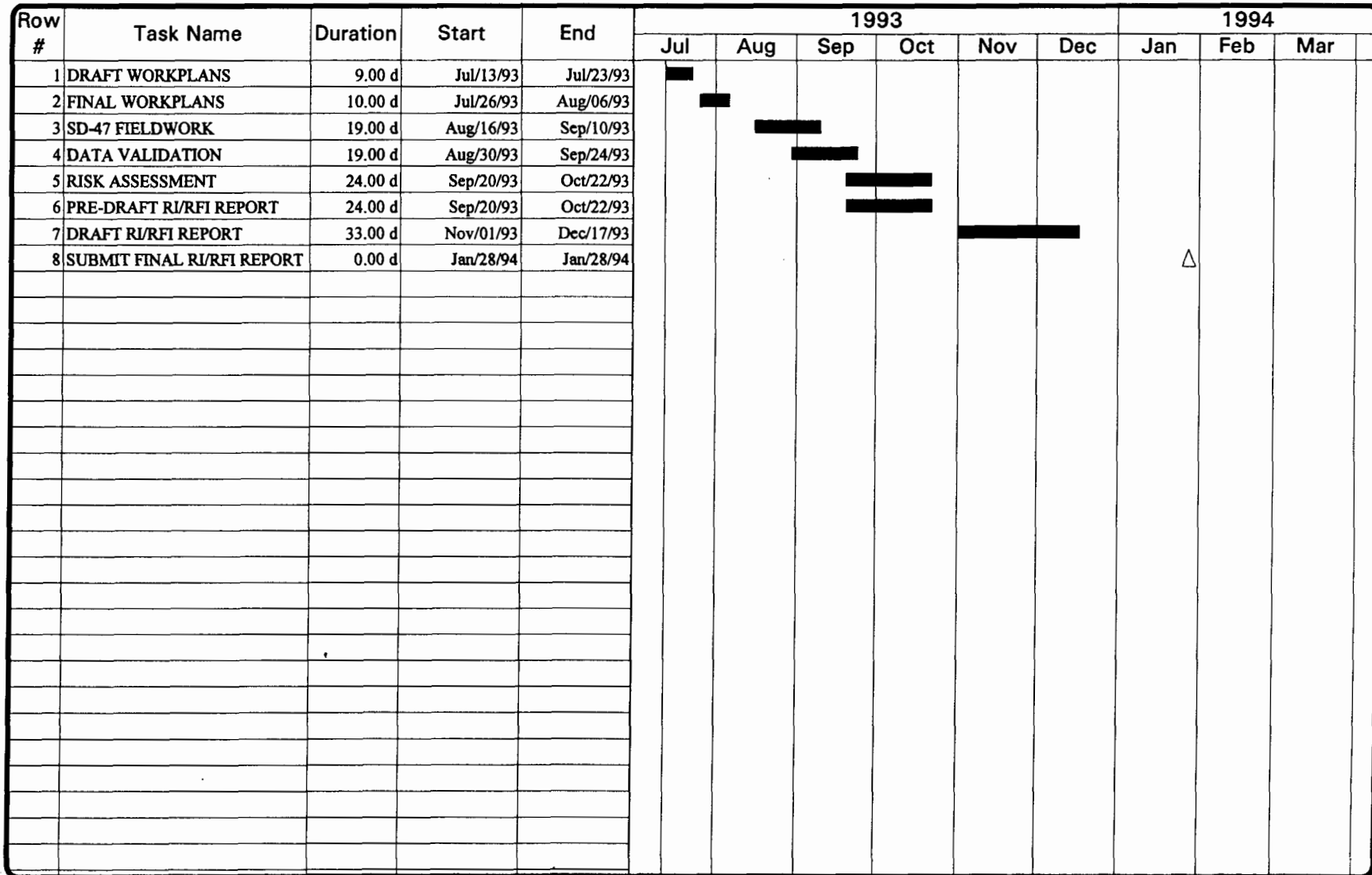
- Collection of groundwater samples for chemical analysis
- Observed presence or absence of floating nonaqueous-phase liquid (NAPL)
- Groundwater elevations at each monitoring well
- Aquifer permeabilities
- Complete geologic log for each soil boring and monitoring well
 - Estimation of thickness of near-surface stratigraphic units
 - Estimation of particle size and sorting
 - Soil characterization, classification, and descriptions
 - Estimation of soil permeability at each monitoring well location

2.4.5 Constraints on Uncertainty

The purpose of establishing constraints on uncertainty is to provide a means for evaluating the uncertainty associated with the data decision-makers are willing to accept. Consideration of false positives and false negatives is necessary in the evaluation of the consequences of making an incorrect decision. For the Holloman RI, risk-based data will be used in the qualitative analysis of the potential for false negatives; that is, recommending a site for no further action when a confirmed release may pose an unacceptable risk to human health or the environment.

Uncertainty in laboratory data arises from error in the measurement process. Measurement errors may be either systematic or random. Bias refers to the amount of systematic error in the measurement process; it is a measure of the average degree of agreement between measured values and the "true" value of the parameter measured. Precision is a measure of random error in the measurement process; it describes the degree to which data generated from repeated measurements differ from one another. Limits for uncertainty in measurements for laboratory data are specified in Section 4 of this QAPP.

FIGURE 2-1B RI/RFI SCHEDULE FOR SITE SD-47



QUALITY ASSURANCE OBJECTIVES

4.1 GENERAL

The overall QA philosophy for the RI at Holloman AFB is to provide measurement tools so that data collected will be defensible and of known quality. As such, the environmental data generated must meet quality assurance objectives designed to support decisions to be made concerning the respective sites. Quality assurance activities for field measurement systems are also an important aspect of this design. Activities for nonchemical data and data generated in the field will be discussed in the appropriate SOPs. The following paragraphs discuss laboratory analytical measurements.

All laboratory procedures are documented in writing as either laboratory Standard Operating Procedures (SOPs) or Method Procedures (MPs), which are edited and controlled. Internal quality control procedures for analytical services will be conducted by the laboratory in accordance with their LQMP and SOPs. These specifications include the types of QC samples required (sample spikes, surrogate spikes, reference samples, controls, blanks), the frequency of each, the compounds to be used for sample spikes and surrogate spikes, and the quality control acceptance criteria. The LQMP and SOPs are located in the original QAPP Appendix A and B, respectively.

The laboratory will document, in each data package provided, that analytical QC functions have been met. Any samples analyzed in nonconformance with the QC criteria will be reanalyzed by the laboratory if the laboratory procedures were not in control, as assessed by laboratory control samples and other data specific to the analysis, and if sufficient sample volume is available. If sufficient sample is not available or holding times would be compromised, it may be necessary to obtain replacement samples.

Quality assurance objectives for analytical data are usually expressed in terms of precision, accuracy, completeness, representativeness, comparability and sensitivity. Target ranges for these objectives are presented for analytical testing. Variances from the quality assurance objectives will result in the implementation of appropriate corrective measures and an

assessment of the impact of corrective measures on the usability of the data in the in the decision making process. The documentation acquired as a result of QC procedures will be included in the assessment of the usability of the analytical data.

The specific project objectives for the RI and the data needs and uses are described in detail in the FSP and summarized in Section 2.4 of this QAPP. In general, analytical data generated for the RI will be used in completing a Health and Environmental Assessment (HEA) in support of site-specific decisions. Data generated for the RI to be used in the HEA or to support other site decisions will involve the following elements:

- Soil and water samples, along with designated QC samples, will be sent to an off-site analytical laboratory and analyzed for site-specific analytes including: aromatic volatile organic compounds using EPA SW-846 Method 8020; petroleum hydrocarbons using EPA Method 418.1 and Modified Method 8015; Target Analyte List (TAL) metals (EPA-CLP SOW ILM02.0) will be analyzed using EPA SW-846 Method 6010 along with Methods 7060, 7421, 7470, and 7740 for arsenic, lead, mercury, and selenium, respectively. General water quality parameters will include alkalinity, chloride, fluoride, nitrate-nitrite, phosphate, sulfate and total dissolved solids using appropriate EPA methodologies.
- Quality control samples specified in the QAPP to be utilized by the laboratory for analysis are described in the LQMP (Appendix A of the original QAPP) for the respective methods.
- A data review of each sample delivery group shall be completed as described in Section 9.4 of the original QAPP. This review will be completed using EPA Functional Guidelines for Data Validation where appropriate.
- Data will be assessed for its usability to support site-specific decisions.

As part of the USACE quality assurance program, designated duplicate/split samples will be sent to the USACE MRD-L for analysis.

4.2 FIELD QA/QC SAMPLES

The following paragraphs describe the QA/QC samples anticipated for the Holloman AFB RFI.

4.2.1 Blanks

Field blanks and trip blanks will be collected during the RI and analyzed by the off-site laboratory. Field blanks, such as the ambient blank which is prepared by pouring distilled/deionized water into sample containers at certain sampling locations, may be used to determine if any transient contaminants have affected sample integrity. This information will be used to assess measurement error associated with the field contamination.

Rinsate blanks are prepared by pouring distilled/deionized water over or through the sample preparation/collection apparatus after it is cleaned. These data will be used to determine the potential for cross-contamination attributed to sampling equipment. Such information can be used to estimate measurement error associated with the field sample preparation, containers, field environment, cross-contamination, and laboratory analysis.

Trip blanks accompany only groundwater samples taken for volatile organic analysis and consist of volatile organic analysis (VOA) vials filled with ASTM Type II water at the laboratory. The samples will be shipped to the Base and sent back to the laboratory with routine samples; they will not be opened until they reach the laboratory. One trip blank will accompany each cooler containing samples requiring volatile organic analysis. All trip blanks will not necessarily be analyzed; the decision to analyze a trip blank will be based on several criteria. Trip blank analysis will be designated on the chain-of-custody for coolers used to ship VOA vials suspected of containing significant levels of VOCs based upon field observations (e.g. HNu readings). Also, trip blank analysis would be appropriate in the event of leakage or a broken VOA vial upon receipt by the laboratory. Trip blank information can be used to estimate error associated with shipment, containers, and laboratory analysis.

In general, field blanks will represent 10-15 percent of the samples collected. While the location and number of field blanks have been specified in the FSP, additional blanks may be collected depending upon conditions encountered during field activities. These additional

field blanks would be collected whenever such collection and analysis would be required in assessing the usability of the data.

4.2.2 Duplicates

Field duplicate samples for soil and groundwater will be collected and submitted for analysis in conjunction with the field samples. Field duplicates will be sampled such that collocated samples will be obtained from the sampling device in a manner which minimizes loss due to volatilization (i.e., VOA samples will be collected first for water and soil samples). Additionally, for soil, the material remaining in each half of the sampling device will be homogenized separately in stainless steel bowls before the materials are collected for additional analyses. Duplicate water samples for nonvolatile analysis will be necessarily collocated.

Field duplicate results will provide estimates of overall precision of sample collection, field sample preparation, and laboratory analysis (total within-batch measurement variability). Subdividing one or both of the collocated samples just prior to analysis provides for an estimate of laboratory precision. Soil duplicates homogenized for nonvolatile analysis provide information on sampling precision as well as providing an estimate of representativeness in addition to laboratory precision. Additionally, samples will be split and analyzed by two different laboratories (contracted analytical laboratory and MRD-L), which will help quantify the error associated with subsampling (i.e., split preparation) and laboratory bias or to estimate interlaboratory variability.

In general, field duplicates will represent about 5 percent of the soil samples collected and about 20 percent of the groundwater samples taken. While the location and number of duplicates has been specified in the FSP, additional duplicates may be collected depending upon conditions encountered during field activities. These additional duplicate samples would be collected whenever such collection and analysis would be required for assessing the usability of the data. Where groundwater has been determined to be continuous or exhibit similar qualities, the frequency of duplicate analysis may not be site-specific.

4.2.3 Matrix Spike/Matrix Spike Duplicate Samples

Samples specific to Holloman AFB site matrices will be submitted for Matrix Spike and Matrix Spike Duplicate (MS/MSD) analysis in addition to the analysis of the field samples for organics. Also, MS and duplicate (MS/D) analysis will be done for samples submitted for metals analysis. Results will be used to assess the potential for sample matrix interferences.

In general, MS/MSD or MS/D analysis associated with field samples will be about 5 to 10 percent of the samples collected. While the location and number of duplicates have been specified in the FSP, samples may be collected for additional MS/MSD analysis depending upon conditions encountered during field activities. Additional MS/MSD analysis would be run whenever such collection and analysis would be required for assessing the usability of the data.

4.3 LABORATORY QA/QC SAMPLES

4.3.1 Method or Preparation Blank

A method blank consists of analyte-free deionized water or washed sea sand for organic analysis of solids. The method blank is carried through each step of the analytical method. The method blank data will be used to evaluate contamination attributed to laboratory operations during analysis.

4.3.2 Surrogate Spikes

Surrogate spikes are compounds added to every blank, sample, matrix spike, matrix spike duplicate, and standard when specified in the analytical methodology. The results are utilized to evaluate the accuracy of analytical measurement on a sample-specific basis. Surrogates are generally brominated, fluorinated, or isotopically labeled compounds not expected to be detected in environmental media. Results are expressed as percent recovery (% R) of the surrogate spike. Low recoveries may indicate matrix interference.

4.3.3 Laboratory Control Samples (LCS)

Laboratory control samples (LCS) are well-characterized, laboratory-generated samples and will be used to monitor the laboratory's day-to-day performance of analytical methods. Certain LCS will be used to monitor the precision and accuracy of the analytical process independent of matrix effects. Other LCS will be used to identify any background interference or contamination of the analytical system which may lead to the reporting of elevated concentration levels or false positive results.

The results of the LCS will be compared to well-defined evaluation criteria (see Tables in Section 4.0) to determine whether the laboratory system is "in control". Controlling lab operations with LCS (rather than surrogates or MS/MSD) offers the advantage of being able to differentiate low recoveries due to procedural errors from those due to matrix effects.

4.3.4 Analytical Spike

Although not routinely performed, an analytical spike will be performed and utilized in the graphite furnace atomic absorption analyses for lead. Analytical spikes are post-digestion spikes to be prepared prior to analysis by adding a known quantity of the analyte to an aliquot of the digested sample. The unspiked sample aliquot must be compensated for any volume change in the spike samples by addition of deionized water to the unspiked sample aliquot. The volume of the spiking solution added must not exceed 10 percent of the analytical sample volume. Both the unspiked and spiked samples are analyzed in identical fashion. Analytical spike recoveries on each sample are utilized to determine whether or not the sample analytical result must be quantified through the method of standard additions. The sample selected for a post-digestion spike will be based on a determination by the laboratory on which groundwater sample has the highest TDS for each site.

4.4 QUANTITATIVE QA/QC MEASUREMENTS

4.4.1 Precision

Precision is the measure of variability between individual sample measurements under prescribed conditions. Precision can be assessed by replicate measurements of known

laboratory standards and analysis of duplicate environmental samples. Replicate samples can be compared by calculating the sample standard deviation; however, precision will more typically be determined as relative percent difference (RPD) between duplicate sample results.

Replicate measurements of known standards (laboratory control samples) are routinely monitored by the laboratory by comparing the RPD with control limits established at plus three standard deviations from the mean RPD of historical data. Duplicate environmental samples submitted from the field at a rate of one duplicate for every 10 environmental samples or per set collected. Precision criteria for duplicate laboratory control samples to be achieved by the analytical laboratory for the parameters to be analyzed are provided in Tables 4-2 through 4-4.

4.4.2 Accuracy

Accuracy is the degree of agreement of a measurement to an accepted reference or true value. An evaluation of the accuracy of a measurement system provides an estimate of bias. The accuracy of an analytical method is evaluated by analyzing known reference standards. The percent recovery achieved by analysis of known reference standards or spiking compounds will be used to define the accuracy for the compounds of interest. One known reference standard is also analyzed for every batch of 20 samples. The percent recovery of an analyte is calculated by dividing the "true" value, T, into the observed value, X, and multiplying by 100.

The specific criteria ranges of accuracy for each measurement parameter are defined within the analytical test methods. Acceptable accuracy measures are also dependent on the sample matrix. Accuracy criteria (percent recovery) for the parameters to be analyzed are provided in Tables 4-2a through 4-2c. The measurement of these data quality objectives are assessed for the laboratory control samples. Criteria for matrix spikes will be used to assess the potential for matrix interference. Tables 4-3 and 4-4 provide accuracy and precision criteria for surrogate and matrix spikes.

The accuracy of field measurements of pH will be assessed through premeasurement calibrations and postmeasurement verifications, using at least two standard buffer solutions. The two measurements must each be within 0.1 standard unit of buffer solution values. Precision

will be assessed through replicate measurements. The electrode will be withdrawn, rinsed with deionized water, and reimmersed between each replicate. The instrument used will be capable of providing measurement to 0.1 standard unit. See Section 7.0 for a discussion of the SOPs for measuring pH, conductivity, and temperature in the field.

4.4.3 Method/Project-Required Detection Limits

Reporting limits are defined as the lowest level of measurement that can be reliably achieved within specified limits of precision and accuracy under routine laboratory operating conditions. In Section 8 of this QAPP, Tables 8-2 through 8-4 list the project-specific goals for reporting limits for analyses to be conducted under this QAPP. These are the reporting limits that the laboratory should be able to meet on pure water using the analytical methods specified in Table 8-1. The reporting limits for samples may be considerably higher depending upon the sample matrix. The reporting limits desired for analyses at Holloman AFB would be as low as necessary to achieve the data quality objectives. However, when using SW-846 methodologies that cover a broad range of compounds, it is not always possible to achieve reporting limits this low. Itemization of method-specific reporting limits will be presented in Section 8.0.

4.4.4 Analytical Completeness

Analytical completeness is defined as the percentage of valid analytical results obtained from measurement systems compared with the total number of analytical results requested (USACE 1990). Based on an extensive EPA database for the CLP, laboratories generally achieve 80 percent completeness (USEPA 1987).

An overall completeness goal for data essential to making decisions is 100 percent. Although this goal may not be achieved, it may still be possible to make site-specific decisions. The impact of rejected or missing data on project decisions will be evaluated on a case-by-case basis. Furthermore, the auditing procedures that are in place with both the USACE and W-C help in the selection of subcontract laboratories which demonstrate good quality practices, and due to good communication with the laboratory, analytical completeness is generally not less than 90 percent. During the assessment of the data, an evaluation of samples needed to make decisions with respect to project objectives will be made.

4.5 QUALITATIVE QA/QC MEASUREMENTS

4.5.1 Representativeness

Representativeness is the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition. Although representativeness is a qualitative measurement, it is evaluated through a multi-step process beginning with a quantitative check of accuracy and precision data as described in Sections 4.4.1 and 4.4.2.

In the case of collocated duplicate samples, which will be collected and utilized as a means to assess field representativeness, satisfactory representativeness will first be assessed by the agreement between analytical results for collocated field duplicate samples against the precision criteria listed in Table 4-4. In the event that RPD exceed those values listed in Table 4-4, the data will be evaluated for appropriateness for use in RPD comparison by the following criteria. For analytes with both sample concentrations greater than 5x the reporting limit, the duplicate sample results should agree within 50% relative percent difference (RPD) for soil samples and 25% RPD for aqueous samples. For analytes with either or both sample concentrations less than 5x the reporting limit, duplicate sample results should agree within $\pm 2x$ the reporting limit for soil and aqueous samples. Results for analytes not meeting these criteria will be evaluated in light of project objectives and, if professional judgement warrants, qualified as estimated in all associated samples during the review process. A summary of the collocated duplicate samples to be collected is provided in the FSP.

Whether or not the sampling effort is completed in compliance with the procedures described in Section 5.0 of this document and in respective sections in the Field Sampling Plan is another factor utilized in the evaluation of representativeness. When recommendations are made concerning the representativeness of the data, available information in terms of project objectives will be considered.

4.5.2 Comparability

Comparability expresses the confidence with which one data set can be compared to another. Comparability also involves a multi-step evaluation and can be related to accuracy and precision as these quantities are measures of data reliability. Data are comparable if siting considerations, collection techniques, and measurement procedures, methods, and reporting are equivalent for the samples within a sample set. A qualitative assessment of data comparability will be made of applicable data sets.

TABLE 4-2a

QC EVALUATION CRITERIA FOR AROMATIC VOLATILES¹ (GC)
AND PETROLEUM HYDROCARBONS² (IR)

Parameter	Accuracy (Percent Recovery)		Precision (RPD) (%)	
	Water	Soil/Sediment	Water	Soil Sediment
Benzene	85-115	80-125	15	15
Ethylbenzene	90-115	70-125	20	15
MTBE	80-120	75-125	20	15
Toluene	80-120	75-125	20	15
Xylenes (total)	80-120	75-125	20	15
TRPH	90-100	90-105	5	5

¹ SW846 3rd Ed. Method 8020; based on laboratory control samples

² EPA Method 418.1 and Modified 8015

GC = Gas Chromatography

IR = Infrared Spectroscopy

MTBE = methyl-*tert*-butyl ether

SAMPLING AND FIELD PROCEDURES

5.1 OVERALL PHILOSOPHY

The attainment of good quality data from which sound remedial decisions can be made involves many critical steps, not the least of which is sampling. Sampling and related activities provide the representative media upon which all subsequent steps, such as analysis, evaluation, and remedial design, will be based. Therefore, the proper performance of sampling procedures, along with good quality control, are critical for the collection of representative samples necessary for the generation of usable environmental data.

The following paragraphs identify general procedures which will be used during site investigations at Holloman AFB. Site-specific applications of these procedures and further details are provided in SOPs published in Appendix B of the June 1993 QAPP.

5.2 QUALIFICATIONS OF SAMPLING PERSONNEL

The Field Manager will be a project professional having experience in coordinating the fieldwork. The personnel responsible for sampling and other field activities will have experience sampling the respective matrices. They will have read, and become familiar with, the FSP and appropriate QAPP sections including the SOPs to be used at the site. They will be cognizant of the importance and level of quality control that must be maintained in order to produce the most representative samples. Loss of volatiles is always of major concern; and where these are indicated, particular care shall be executed. The quality and use of the data depends upon the proper taking of samples; therefore, sampling activities may be monitored throughout the RI at Holloman AFB by QA/QC personnel.

5.3 METHODS OF COLLECTION

The following paragraphs discuss, in general, activities to be undertaken at the site.

5.3.1 Field Analytical Services

Field analytical services will provide screening analysis of soil vapor and headspace of soil samples collected as part of the investigations at SD-47. Additionally, headspace analysis will be performed on groundwater samples collected at the respective sites. The soil and groundwater sampling and analysis will be performed by a designated subcontractor as described in the FSP. This sampling and analysis will be conducted on site using gas chromatography (GC) with either a photoionization detector (PID) or flame-ionization detector (FID) system mounted in a specially equipped van. This system will be set up to analyze for benzene, toluene, ethylbenzene, and xylenes (BTEX), and total volatile hydrocarbon fraction which may be present in the soil, soil vapor and/or groundwater, utilizing methods as specified in the subcontractor's QA Plan and SOPs in Appendix C of this Addendum.

This field screening procedure will be designed to aid in the location of releases of contamination which may have occurred at Holloman AFB sites and will be used to locate potential sources of fuel and solvent contamination. The locations of the sampling points are specified in the FSP and are dependent on site-specific hydrogeology and available data.

5.3.2 Drilling

Drilling of soil borings shall be performed during the RI at Holloman AFB. Site-specific procedures and drilling techniques to be used, along with the appropriate QA/QC activities, are provided in the respective FSP sections. As many of the drilling activities will be common to all sites, SOPs are provided in the original QAPP for these activities and are listed below:

Activity	SOP
Soil Borings	1
Soil Sampling	1
Headspace Analysis	15
Monitoring Well Installation	3
Monitoring Well Development	3
Sample Handling	6
Decontamination	7
Boring Abandonment	8

5.3.3 Soil Sampling and Geotechnical Analysis

Soil samples will be obtained for chemical analysis from soil borings and surface samples at the site as described in the FSP. Soil samples from borings will be collected at specified intervals. The samples will be collected using a nominal 3-inch-diameter split spoon, using the standard penetration test (SPT) in accordance with SOP No. 1. The SPT consists of driving the split spoon 18 inches with a 140-pound hammer having a freefall of 30 inches. Blow counts per 6-inch interval will be recorded on the boring log for split-spoon sampling. These samples will be screened using headspace analysis by HNu according to protocols specified in SOP No. 15. The two samples exhibiting the highest headspace readings from each boring will be shipped to a laboratory for chemical analyses. Sampling locations for the respective sites are detailed in the FSP. Specific procedures for soil sampling will be followed and are in SOP No. 1 of the original QAPP.

Selected geotechnical tests, such as moisture content (ASTM D 2216), visual classification (ASTM D 2488), grain size (ASTM D 421 and D 422), and Atterberg limits (ASTM D 4318), will be performed by a qualified laboratory.

5.3.4 Groundwater Sampling

Based on analytical results from Geoprobe analysis, monitoring wells will be installed as specified in the FSP according to guidelines established in SOP No. 3. The samples will be collected using either Teflon or stainless steel bailers. The specific procedures for decontamination of equipment and sample collection, including QA/QC activities, are provided in SOP No. 4.

5.3.5 Slug Testing

Slug tests will be conducted on each monitoring well (unless it contains floating NAPL) to obtain estimates of hydraulic conductivity. Data will be analyzed using the methods of Bouwer and Rice (1976), updated by Bouwer (1989). Standard procedures for slug testing, water level measurement, decontamination, handling of investigation-derived waste, and documentation will be followed and are included in SOP Nos. 12, 9, 7, 17, and 6.

5.3.6 Water Level Measurement

Groundwater levels in each of the monitoring wells will be measured during well development, purging and groundwater sampling, and slug testing. Water levels will be used to develop groundwater table contours and evaluate the horizontal hydraulic gradients at each site. A logbook will be prepared for the purpose of maintaining a record of access to the wells. The logbook will contain well keys and specific instructions for maintaining the integrity of the wells during activities requiring access. This logbook will remain with Holloman AFB Environmental Flight after fieldwork is completed. Standard procedures will be followed and are included in SOP No. 9.

5.3.7 Location Survey

The elevations and horizontal coordinates of each new sampling location will be surveyed by a professional land surveyor registered in the State of New Mexico. The measured elevations at monitoring wells will include the ground surface (to nearest 0.1 foot) and the top of the PVC casing (to nearest 0.01 foot). All of the planned soil borings will be marked and labelled for future reference (horizontal coordinates to nearest 0.1 foot). Standard procedures for identification and description of field sampling points are described in SOP No. 14.

5.4 RATIONALE FOR SAMPLE SITE SELECTION

The rationale and numbers for sampling of the various media are described in the DQO development sections of the FSP for the RI. A summary of the DQO development process is provided in Section 2.3 of this QAPP.

5.5 PREPARATION OF SAMPLING EQUIPMENT AND CONTAINERS

Sampling equipment and appropriate containers will be specified in the respective sections of the FSP. The preparation of equipment shall be described in the appropriate SOPs designated for the RI activities. It is anticipated that only certified and precleaned sample containers will be used. Where this is not the case, appropriate cleaning procedures will be detailed in the FSP.

5.6 SAMPLING CONTAINERS, PRESERVATION, AND HOLDING TIMES

The general requirements for sampling containers, preservation, and holding times are provided in Table 5-1a and Table 5-1b. Site-specific requirements will be detailed in the FSP.

5.7 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Appropriate procedures shall be used for all sample handling activities as described in the SOPs contained in Appendix B of the original QAPP in accordance with the USACE sample handling protocol (Appendix F, ER 1110-1-263, 10/1/90). These procedures shall be followed to ensure the integrity of all samples shipped for laboratory analysis.

5.8 DECONTAMINATION

Decontamination of sampling equipment will be an important aspect of the RI. Cross-contamination may compromise the assessment of data for use in making site-related decisions.

Thorough decontamination of all sampling and intrusive equipment will be performed to prevent cross-contamination of samples. Decontamination will be performed when equipment enters the area of investigation initially, between intrusive activities, and before the equipment is removed. All decontaminated equipment will be inspected prior to use. Rinsate blank samples will be taken on the decontaminated sampling equipment used for water sampling at a frequency specified in the FSP or where field conditions warrant additional rinsate samples. Rinsate blank samples will be sent to the analytical laboratory to be analyzed for

the same parameters as the samples. Decontamination of personnel and equipment will take place at specified decontamination stations. Specific procedures are provided in SOP No. 7. Refer to the original Health and Safety Plan for additional personnel decontamination procedures. Personnel decontamination will take place to comply with the Health and Safety Plan and to prevent cross-contamination of samples.

TABLE 5-1a

SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR SOIL SAMPLES

Method	Parameter	Number of Containers/Sample	Minimum Sample Size	Preservation	Holding Time
8020	Aromatic volatile organics	2-4 oz. glass VOA vials with Teflon-lined septa	10g	4°C	14 days
418.1	Petroleum hydrocarbons	1-16 oz. wide-mouth glass jar with Teflon-lined lid	30g	4°C	28 days
8015 ¹	Petroleum hydrocarbons	1-16 oz. wide-mouth glass jar with Teflon-lined lid	30g	4°C	28 days
6010 ²	Total metals	1-16 oz. wide-mouth glass jar with Teflon-lined lid	10g	4°C	28 days ³

¹ Modified Method 8015

² In addition to Method 6010, includes 7060 (arsenic), 7421 (lead), 7470 (mercury), and 7740 (selenium)

³ Holding time based on mercury, all other metals have a 6-month holding time

TABLE 5-1b

SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES FOR WATER SAMPLES

Method	Parameter	Number of Containers/Sample	Minimum Sample Size	Preservation	Holding Time
8020	Aromatic volatile organics	2-40 mL glass VOA vials with Teflon-lined septa	40 mL	4°C and 4 drops HCL to pH <2	14 days
418.1	Petroleum hydrocarbons	1-1 L amber glass bottle with Teflon-lined lid	1L	4°C and HCl to pH <2	28 days
6010 ¹	Total metals	1-500 mL polyethylene bottle	500 mL	4°C and HNO ₃ to pH <2	28 days ²
310.0	Alkalinity	1-1 L polyethylene bottle	100 mL	4°C	14 days
325.3	Chloride	1-1 L polyethylene bottle	100 mL	4°C	28 days
340.2	Fluoride	1-1 L polyethylene bottle	200 mL	4°C	28 days
353.3	Nitrate/Nitrite	1-500 mL glass bottle	100 mL	4°C and H ₂ SO ₄ to pH <2	28 days
365.3	Phosphate	1-1 L polyethylene bottle	100 mL	4°C and H ₂ SO ₄ to pH <2	28 days
375.4	Sulfate	1-1 L polyethylene bottle	100 mL	4°C	28 days
160.1	Total dissolved solids	1-1 L polyethylene bottle	200 mL	4°C	7 days

¹ In addition to Method 6010, includes 7060 (arsenic), 7421 (lead), 7470 (mercury), and 7740 (selenium)

² Holding time based on mercury, all other metals have a 6 month holding time

SAMPLE AND DOCUMENT CUSTODY PROCEDURES

Verifiable sample custody will be an integral part of all field and laboratory operations associated with Holloman AFB site investigations. Traceable steps will be taken in the field and laboratory to document that all samples have been properly acquired, preserved, and identified. The following sections provide the detail related to carrying out verifiable field and laboratory documentation.

6.1 SAMPLE LABELING

A sample numbering system will provide a tracking mechanism to allow retrieval of the sample and sample information and identification of the sampling locations. A unique sample number will be assigned to each sample. Procedures for this system are provided in SOP No. 6. All COE samples and Chain-of-Custody (COC) records being shipped to the MRD laboratory will additionally be labeled with the project I.D. "MRD #2058". Notification will be made to the QA laboratory one (1) week prior to the first delivery of samples and at least 24 hours notice given for Saturday sample delivery.

6.2 FIELD DOCUMENTATION

6.2.1 Field Logbooks

Bound field logbooks with sequentially numbered pages will be used to record all pertinent field data collection activities performed or observations made. Documentation in the field logbook will be sufficient to reconstruct the sampling activities without relying on the memories of the field team members. Entries into the field logbook for sampling events will include, but are not necessarily limited to, the following information:

- Project name
- Date and time
- Sample location
- Sample number

- Sample depth
- Number of aliquots
- Media type
- HNU/OVA readings
- Sampling personnel present
- Type of health and safety clothing/equipment used
- Analyses requested
- Time of sample collection
- Sample preservation
- Field observations, to include soil description (if relevant)
- Weather conditions
- Other project-specific information

In addition, field sketches will be made in the field logbooks when appropriate, with reference points tied to existing permanent structures in the area (i.e., trees, fence posts, buildings). Details are provided in SOP No. 6.

All entries will be made in blue or black ink and no erasures will be allowed. If an incorrect entry is made, the information will be crossed out with a single strike mark and the change initialed and dated by the team member initiating the change.

Each page in the field logbook will be signed and dated at the bottom by all persons making entries on that page.

Field logbooks will be identified by a project-specific number (i.e., Logbook #1 for Project Number C3M11P, etc.) and stored in the field project files when not in use. At the completion of the field activities, the logbooks will be maintained in the permanent project file.

6.2.2 Field Collection Sheets

To supplement the information recorded in the field logbook, sample collection field sheets (SCFSs) will also be maintained for every sampling location. An example of the SCFS to be used is provided in SOP No. 6.

6.2.3 Daily Quality Control Report

Daily Quality Control Reports (DQCRs) will be completed whenever sampling is done and will contain QA/QC information pertaining to field activities. An example of the DQCR to be used is provided in SOP No. 6. DQCRs will be maintained by members of the field sampling team and cross-checked for completeness at the end of each day by the Field Manager. They will be signed and dated by individuals making entries and initialed by the Field Manager. DQCRs will be compiled and sent to the USACE Project Manager once every week in the event no problems or deviations from the schedule arise.

6.2.4 Photographic Documentation

Representative photographs of monitoring well locations, with respect to surrounding areas and relative to objects used to locate the well, will be taken. The picture number and roll number will be logged in the field logbook to identify the area depicted in the photograph. A separate photographic documentation logbook will be maintained by the Field Manager during the field activities associated with Holloman AFB RI. The film roll number will be identified by taking a photograph of an information sign as the first frame of the roll. The project and film roll numbers and date will be shown on this sign. The picture number, roll number, and a description of the picture will be logged in the photographic documentation logbook (as well as on the SCFSs, if appropriate).

6.3 CHAIN-OF-CUSTODY PROTOCOL

6.3.1 Field

Each cooler containing samples sent to the analytical laboratory will be accompanied by a COC record. An example form is provided in SOP No. 6. This section describes the procedures for sample documentation utilizing COC protocol. Detailed procedures are provided in SOP No. 6 and in accordance with ER-1110-1-263 (USACE).

The primary purpose of the COC procedures is to provide documentation of sample tracking from collection through storage and analysis. COC forms will become the permanent records

of all sample handling and shipment. The Field Manager will be responsible to the Project QA/QC Officer for monitoring compliance with COC procedures.

The field team members are responsible for the care and custody of the samples collected until the samples are transferred to another authorized party such as an overnight carrier or the laboratory representative. The field team, under the direction of the field manager, is responsible for enforcing COC procedures during fieldwork.

General COC procedures are provided below.

- The COC form is completed for each shipping container of samples collected. The sample identification number, sample date, type and size of sample container, analysis requested, preservative, and other pertinent information is recorded on the form.
- When the form is completed or when all samples have been collected that will fit in a single shipping container (such as a metal or plastic ice chest), the field team members will cross-check the form for possible errors and sign the chain-of-custody record. Corrections are made to the record with a single strike mark and dated and initialed. All entries will be made in blue or black ink. Each cooler will be accompanied by a separate chain-of-custody, sealed in a Ziploc-type bag, and taped to the inside of the cooler lid.
- A shipping bill is then completed and the shipping bill number recorded on the COC.

When transferring custody of the samples, the individual relinquishing custody of the samples will verify sample numbers and condition and will document the sample acquisition and transfer by signing and dating the COC. This process documents sample custody transfer from the sampler, usually through an express courier, to the analyst in the contracted analytical laboratory. Samples are packaged for shipment and dispatched to the analytical laboratory with a separate COC form accompanying each cooler.

A copy of each COC form is retained by the sampling team for the project file and the original is sent with the samples. Bills of lading will also be retained as part of the documentation for the chain-of-custody records.

In conjunction with data reporting, the analytical laboratory will return the original or a photocopy of the original COC to the Project Manager for inclusion into the central project file. Where errors are made on the COC with respect to samples, these changes will be duly noted on the COC and the DQCR.

6.3.2 Laboratory

Laboratory COC, sample storage, and dispersment for analysis and associated documentation are found in the Laboratory Quality Management Plan (LQMP) in Appendix A of the original QAPP.

6.4 PROJECT FILE

A project file containing complete project documentation of all aspects of the activities associated with Holloman AFB site investigations will be maintained by the Project Manager. This file, after completion of field and analytical work, will include:

- Project plans and specifications
- Field logbooks and data records;
- Photographs, maps, and drawings
- Sample identification document;
- Chain-of-Custody records (copies)
- The entire analytical data package provided by the laboratory, including QC documentation
- Data review notes
- References and literature
- Report notes and calculations
- Progress and technical reports
- Correspondence and other pertinent information

Project documentation will be checked for completeness to include peer reviews, checking of calculations, PE signatures on drawings where appropriate, etc., before being included to the file.

8.1 FIELD PROCEDURES

Field analytical services will be performed as described in Section 5.3.1 of this QAPP.

8.2 LABORATORY PROCEDURES

The general laboratory procedures anticipated for the RI at Holloman AFB are summarized in Table 8-1 and include EPA SW-846 and other appropriate EPA methodologies. The specific analyses planned for each site are defined in the FSP. Included in the procedures below are general method-specific DQOs and would be applicable whenever a particular method is specified in the respective sections of the FSP. Specific laboratory practices for the methods listed below, including sample preparation, sample tracking, and documentation controls, are provided in the LQMP in Appendix A of the June 1993 QAPP.

8.2.1 Aromatic Volatile Organic Compounds (VOCs)

Aromatic volatile organic compounds (VOCs) include compounds among the class of compounds associated with fuels (e.g. JP-4 jet fuel) such as benzene, toluene, ethylbenzene, and xylenes (BTEX). The SW-846 Method 8020 is appropriate for the determination of aromatics and nonhalogenated organics where the volatile contaminants of interest are reasonably defined. This method is a purge-and-trap gas chromatographic (GC) separation method that employs a photoionization detector (PID). This method requires second-column confirmation of detected peaks, unless expertise and familiarization with the contaminants has been established and documented. Compounds and associated reporting limits are provided in Table 8-2a.

8.2.2 Petroleum Hydrocarbons

Total petroleum hydrocarbons (TPH) analysis is indicated where suspected or known releases or disposal of fuels, waste petroleum, oil, and lubricants (POL) have occurred. The methodology to be used for the Holloman AFB RI is either Method 418.1 which employs infrared (IR) spectroscopy or Modified Method 8015 which employs gas chromatography (GC). Soil samples will be prepared by soxhlet extraction Method 9071 prior to analysis as indicated in Table 8-1 for Method 418.1.

TPH analysis gives information concerning total petroleum hydrocarbon levels and is useful as an indicator tool, in conjunction with BTEX, for fuel contamination of soil and groundwater. The reporting limits for TPH are provided in Table 8-2b.

8.2.3 Metals

The metals analyses for the RI at Holloman AFB consist of metals on the target analyte list (TAL). Interpretation of metals data can be complex, particularly when background and/or naturally occurring levels complicate the analysis. Groundwater at Holloman AFB sites will be analyzed for total recoverable metals to assess the extent and potential for transport and exposures of contaminant metals.

The methodology for metals analyses is provided in Table 8-1. The following are various factors which influence the use of particular methods:

- Detection limits
- Interference
- Stability
- Project-specific DQOs

Most metals, with a few exceptions (see Table 8-1), are detected at levels appropriate for Holloman AFB DQOs by inductively coupled plasma emission spectroscopy (ICP). Method 6010 is indicated for water and soil for ICP analysis. Atomic absorption (AA) methods for arsenic, lead, mercury, and selenium are indicated to achieve the levels necessary

for human health risk evaluations. Table 8-3 provides reporting limits for the various ICP and AA methods.

8.2.4 Groundwater Quality and Other Parameters

Various parameters will be analyzed for purpose of assessing groundwater quality at Holloman AFB. Table 8-1 lists methods appropriate for nitrate/nitrite, chloride, sulfate, fluoride, phosphate, total dissolved solids, and alkalinity. The use of these parameters can aid in the evaluation of contaminant chemistry and transport in groundwater.

Other parameters may be analyzed for purpose of assessing bioremediation potential. Table 8-1 lists methods appropriate for nitrate/nitrite, orthophosphate, total phosphorous, pH, total Kjeldahl nitrogen, total organic carbon, chemical oxygen demand, and biological oxygen demand.

Reporting limits for water quality and other parameters are provided in Tables 8-4a and 8-4b.

TABLE 8-1

ANALYTICAL PROCEDURES FOR HOLLOMAN AFB RFI

Parameter	Technique ¹	Extraction and Analysis Method ²	
		Water	Soil/Sediment
Aromatic Volatile Organics	GC	5030/8020	5030/8020
BTEX	GC	8020	8020
TPH - L, H ³	GC	NA	8015 ⁴
TRPH	IR	418.1	9071/418.1
Metals ⁵	ICP	3010/6010	3050/6010
Arsenic	GFAA	7060	3050/7060
Lead	GFAA	3020/7421	3050/6010
Mercury	CV	7470	7471
Selenium	GFAA	7740	3050/7740
Alkalinity	Titrametric	310.1	NA ⁶
Chloride	Colorimetric	325.3	NA
Fluoride	Potentiometric	340.2	NA
Nitrate/Nitrite	Spectrophotometric Cd Reduction	353.3	NA
Phosphate	Colorimetric	365.3	NA
Sulfate	Turbidimetric	375.4	NA
Total Dissolved Solids (TDS)	Gravimetric	160.1	NA

¹ GC = gas chromatography; ICP = inductively coupled plasma emission spectroscopy; GFAA = graphite furnace atomic absorption spectroscopy; CV = cold vapor atomic absorption spectroscopy; IR = infrared; Cd = cadmium

² The 3000 - 9000 methods are from the Third Edition SW-846. The 300 and 400 methods are from EPA 600/4-79-020 (1983)

³ Both light and heavy fractions analyzed

⁴ Modified Method 8015

⁵ With the exceptions of As, Pb, Hg, and Se, all metals are analyzed using the same technique and extraction/analysis method

⁶ Not applicable

TABLE 8-2a

REPORTING LIMITS FOR AROMATIC VOLATILE ORGANICS¹ (8020)²

Compound	Water (µg/L)	Soil (µg/kg)
Benzene	2	2
Chlorobenzene	2	2
1,4-Dichlorobenzene	3	3
1,3-Dichlorobenzene	4	4
1,2-Dichlorobenzene	4	4
MTBE	8	8
Ethylbenzene	2	2
Toluene	2	2
Xylenes (total)	2	2

¹ Using purge-and-trap method (Method 5030).

² SW846, 3rd Edition

MTBE = Methyl *tert*-butylether

TABLE 8-2b

REPORTING LIMITS FOR PETROLEUM HYDROCARBONS (418.1)¹

Compound	Water (mg/L)	Soil (mg/kg)	Method
Total recoverable petroleum hydrocarbons (TPH)	0.5	10	418.1 ¹
	.05	.05	8015 ²

¹ EPA Method 418.1 using Soxhlet Extraction Method 9071 for soils

² Modified EPA Method 8015

TABLE 8-3
REPORTING LIMITS FOR TOTAL METALS¹

Analyte	Soil (mg/kg)	Water (mg/L)
Aluminum, Al	1.0	0.05
Antimony, Sb	1.0	0.1
Arsenic, As ²	0.1	0.010
Barium, Ba	1.0	0.1
Beryllium, Be	1.0	0.01
Cadmium, Cd	1.0	0.005
Calcium, Ca	1.0	0.05
Chromium, Cr	1.0	0.007
Cobalt, Co	1.0	0.05
Copper, Cu	1.0	0.01
Iron, Fe	1.0	0.05
Lead, Pb ²	0.1	0.001
Magnesium, Mg	1.0	0.05
Manganese, Mn	1.0	0.01
Mercury, Hg ³	0.01	0.001
Nickel, Ni	1.0	0.01
Potassium, K	1.0	0.1
Selenium, Se ²	0.1	0.001
Silver, Ag	1.0	0.002
Sodium, Na	1.0	0.05
Thallium, Tl	1.0	0.1
Vanadium, V	1.0	0.01
Zinc, Zn	1.0	0.01

¹ Target Analyte List metals as listed in CLP SOW ILM02.0 (analyzed by ICP except where noted)

² GFAA = Graphite Furnace Atomic Absorption Spectroscopy

³ CVAA = Cold Vapor Atomic Absorption Spectroscopy

TABLE 8-4a

REPORTING LIMITS FOR WATER QUALITY AND OTHER PARAMETERS¹

Parameter	Water (mg/L)
Alkalinity	1.0
Chloride ²	0.1
Fluoride	0.1
Nitrate/Nitrite	0.1
Orthophosphate	0.01
Total Phosphorous	0.01
TOC ²	1.0
COD	5.0
BOD	3.0
TKN	0.05
Sulfate ²	1.0
TDS	1.0

¹ EPA Methods 600/4-79-020 (1983), except where noted

TDS = Total Dissolved Solids
 TKN = Total Kjeldahl Nitrogen
 TOC = Total Organic Carbon
 COD = Chemical Oxygen Demand
 BOD = Biological Oxygen Demand

² EPA Methods SW-846, 3rd edition

TABLE 8-4b

REPORTING LIMITS FOR OTHER SOIL PARAMETERS¹

Parameter	Soil (mg/kg)
Nitrate/Nitrite	0.1
Orthophosphate	0.1
Total Phosphorous	0.1
TKN	1.0

¹ EPA Methods 600/4-79-020 (1983)

REFERENCES

-
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- U.S. Army Corps of Engineers. 1990. Chemical Data Quality Management for Hazardous Waste Remedial Activities. ER 1110-1-263. October 1, 1990.
- U.S. Environmental Protection Agency. 1983. Methods for Chemical Analysis of Water and Wastes. EPA 600/ 4-79/020.
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- U.S. Environmental Protection Agency. 1987. Data Quality Objectives for Remedial Response Activities. EPA/ 540/G-87/003.

- U.S. Environmental Protection Agency. 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA. Interim Final EPA/540/G-89/004.
- U.S. Environmental Protection Agency. 1988. Laboratory Data Validation, Functional Guidelines for Evaluating Inorganic Analyses. EPA Data Review Work Group.
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- U.S. Environmental Protection Agency. 1990. Draft National Functional Guidelines for Organic Data Review. Multi-Media, Multi-Concentration (OLM01./0) and Low Concentration Water (OLCO1.0). December 1990 Rev. June 1991.
- U.S. Environmental Protection Agency. 1990. Guidance for Data Usability in Risk Assessment. Interim Final. EPA/540/G-90/008. Directive 9285.7-05. October 1990.
- U.S. Environmental Protection Agency. 1990. National Oil and Hazardous Substances Pollution Contingency Plan; Final Rule. Federal Register Vol. 55(46):8666-8865.
- U.S. Environmental Protection Agency. 1991. Contract Laboratory Program Statement of Work for Inorganic Analysis Document Number ILM02.1. September 1991.

APPENDIX A

SEE APPENDIX A OF ORIGINAL QAPP, JUNE 1993

APPENDIX B

SEE APPENDIX B OF ORIGINAL QAPP, JUNE 1993

APPENDIX C

SOPs FOR PLAINS ENVIRONMENTAL SERVICES

MOBILE LABORATORY SERVICES

STANDARD OPERATING AND QUALITY ASSURANCE PROCEDURES

FOR

SOIL VAPOR INVESTIGATIONS

SHALLOW GROUNDWATER SAMPLING AND ANALYSIS

AND SOIL SAMPLING AND ANALYSIS

PLAINS ENVIRONMENTAL SERVICES
SALINA, KANSAS

SEPTEMBER 1990

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SECTION II. EQUIPMENT AND SAMPLING METHODS

EQUIPMENT. All sampling and analytical equipment is installed in a Ford E-250 Super-Van for ease of mobility and efficient sample handling from sample collection to sample analysis. A floor plan of the sampling equipment and laboratory area is presented in Plate 1.

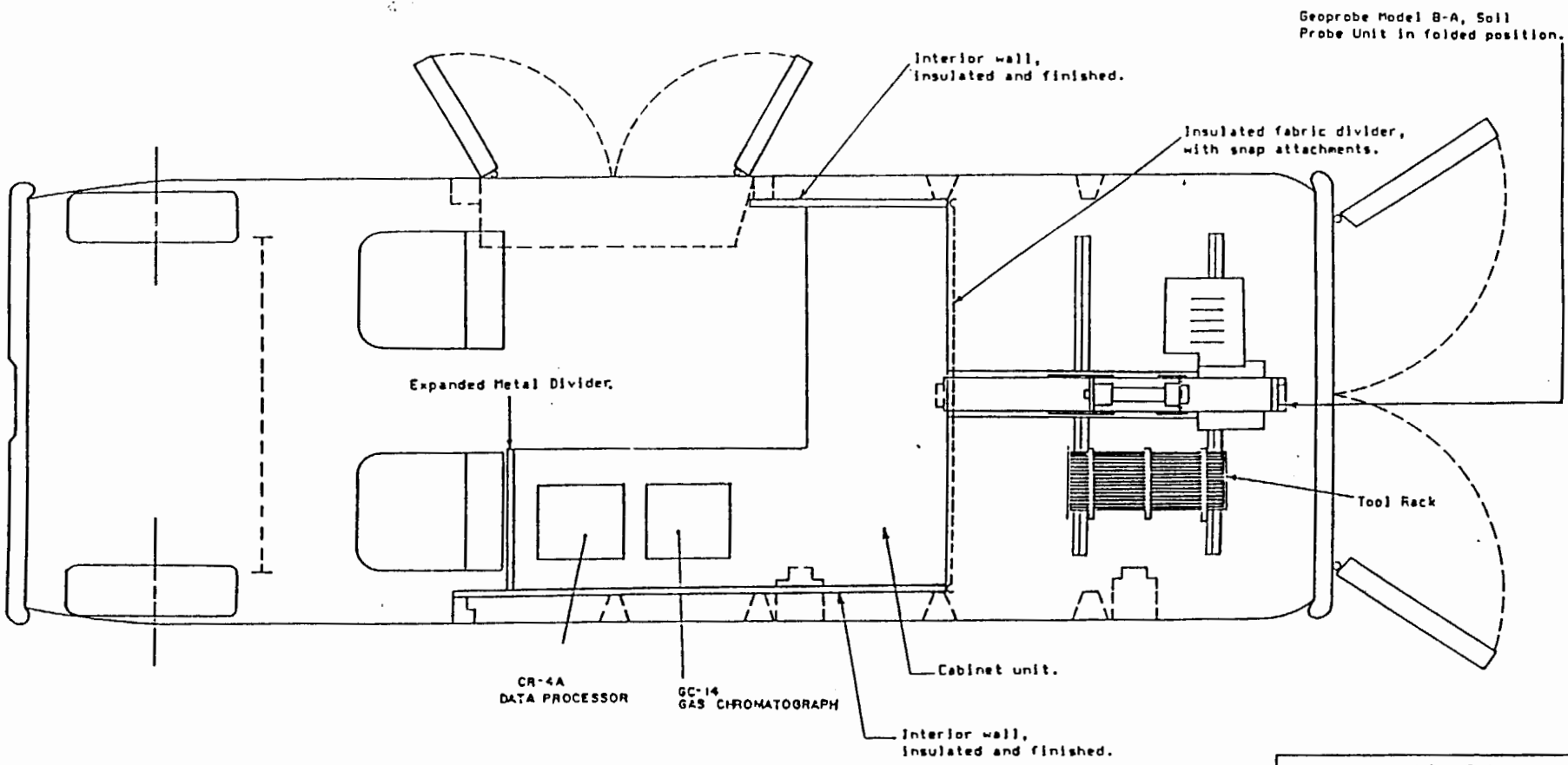
PROBE UNIT. The probe unit consists of a Geoprobe Model 8-M which includes a hydraulically driven percussion hammer used for probe penetration. Steel probe rods are three feet in length and one inch o.d. Rod ends are threaded for easy connection and tight seals to provide a continuous probe and to prevent air leakage. The rods are hydraulically driven to depths of sampling interest. The steel rods with disposable driving points can withstand forces required to penetrate subsurface materials to depths of 60 feet. In addition to soil gas sampling, Plains Environmental Services is equipped to perform groundwater and soil sampling with the probe unit.

SOIL GAS SAMPLING. The probe unit is equipped with a retraction device which allows removal of the rods from the soil. Soil gas samples are collected by retracting the rods 1-2 inches to remove the driving point and to create a space for soil gas removal. Vacuum is applied to the head of the rods for soil gas extraction. Rods are purged with 3 - 5 rod volumes of air to remove extraneous air before sampling. Soil gas samples are collected by use of disposable syringes and transferred to the gas chromatograph for analysis.

GROUNDWATER SAMPLING. Shallow groundwater samples are collected by probing to groundwater depths with the probe rods and then removing the probe rods. One-half inch PVC pipe is screened by cutting slots in the pipe and inserted into the one inch hole. After the "well" has charged with groundwater, polyethylene (3/8" o.d.) tubing is inserted through the opening of the PVC well casing for water sampling. A peristaltic pump is connected to the top of the polyethylene tubing for sample collection. Forty milliliter vials are filled with 20 mL of sample, capped, and heated to approximately 60 C. This effectively removes volatile organic compounds from the aqueous phase to the headspace which is then sampled and injected into the gas chromatograph.

Alternately, a small bailer can be used to sample water at depths of greater than 30 feet or when the concern for volatility may preclude the use of a peristaltic pump.

SOIL SAMPLING. Soil samples can be collected at discrete levels by the use of a special sampling tube attached to the end of the probe rod. Soil samples can be added to a 40-mL vial for headspace analysis or collected and sent to an off-site laboratory for analysis.



Plan View
 Geoprobe Model B-A and Mobil
 Laboratory Unit
 In Ford E-250 Super-Van.

PLATE 1	
SCALE: 1/16" = 1"	CRWN EY: DWG
Date: Jan. 89	APPR EY:

PLAINS ENVIRONMENTAL SERVICES

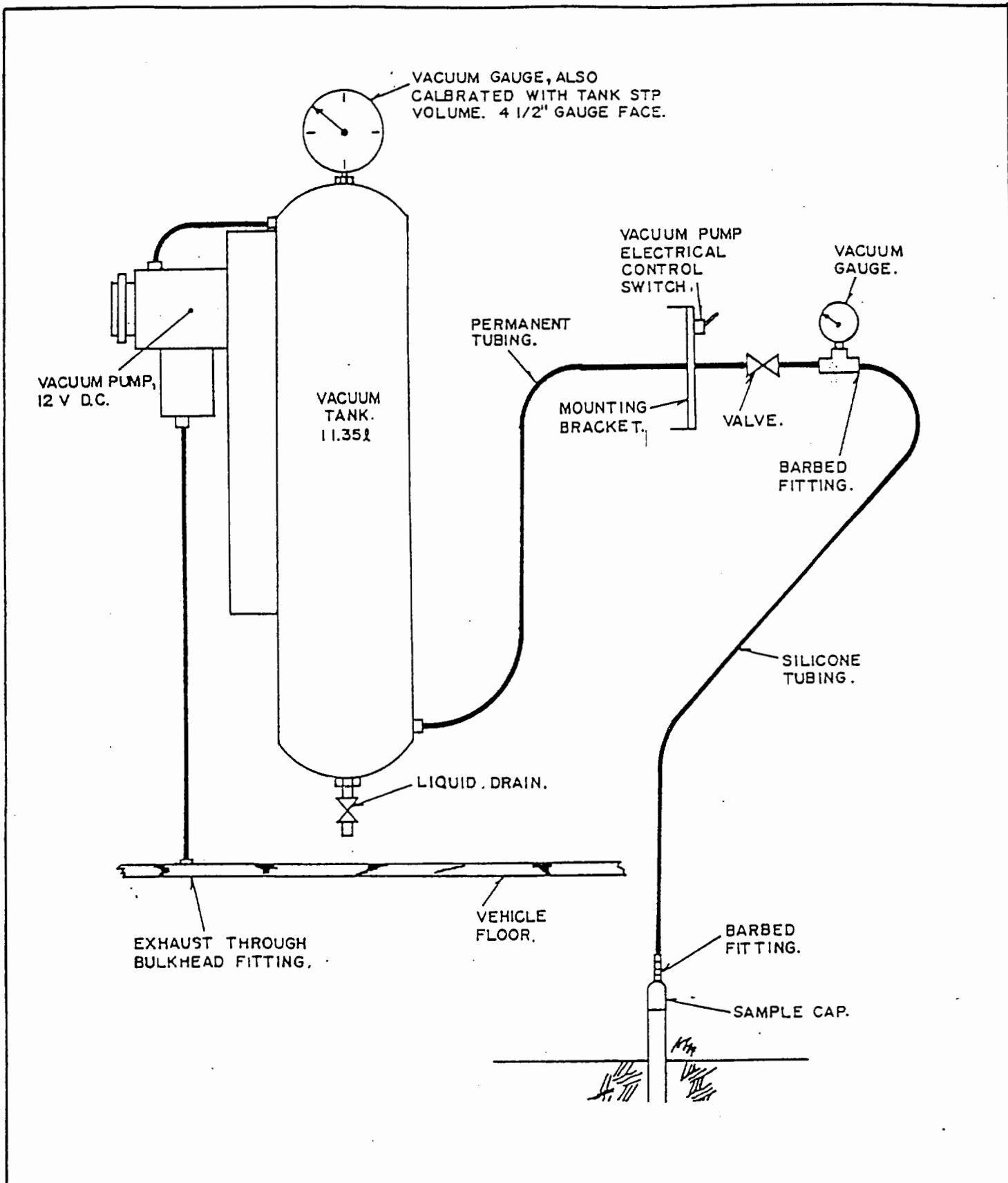
VACUUM/VOLUME SYSTEM. A vacuum/volume system consisting of a vacuum pump (capable of applying 24 inches of mercury), a storage tank, two vacuum gauges, and a line valve allows for a controlled purge and sampling rate which minimizes soil gas disturbance. The line gauge and valve provide an accurate measurement of purge volumes which reduces the disruption of soil gas equilibrium. Silicon tubing is used to connect the vacuum system to the probe head. Silicon has been shown to be inert to organics and does not readily adsorb organic compounds within a short contact time. The vacuum/volume system is depicted in Plate 2. After rod purging the rods are permitted to return to atmospheric pressure (line gauge reading of zero), an indication that the rods have been filled with soil gas.

SAMPLE COLLECTION AND TRANSFER. Soil gas samples are collected by inserting a 1-cc disposable syringe through the silicon tubing at the rod head (see Plate 3). The syringe is immediately taken to the gas chromatograph for direct injection of the sample. Alternately, 10-cc evacuated vials are used with double ended transfer needles to collect samples when duplicates are required, when samples are needed for off-site analysis, or when the gas chromatograph can not process samples fast enough to keep up with the sampling equipment. Stored samples have been shown to be stable for several days.

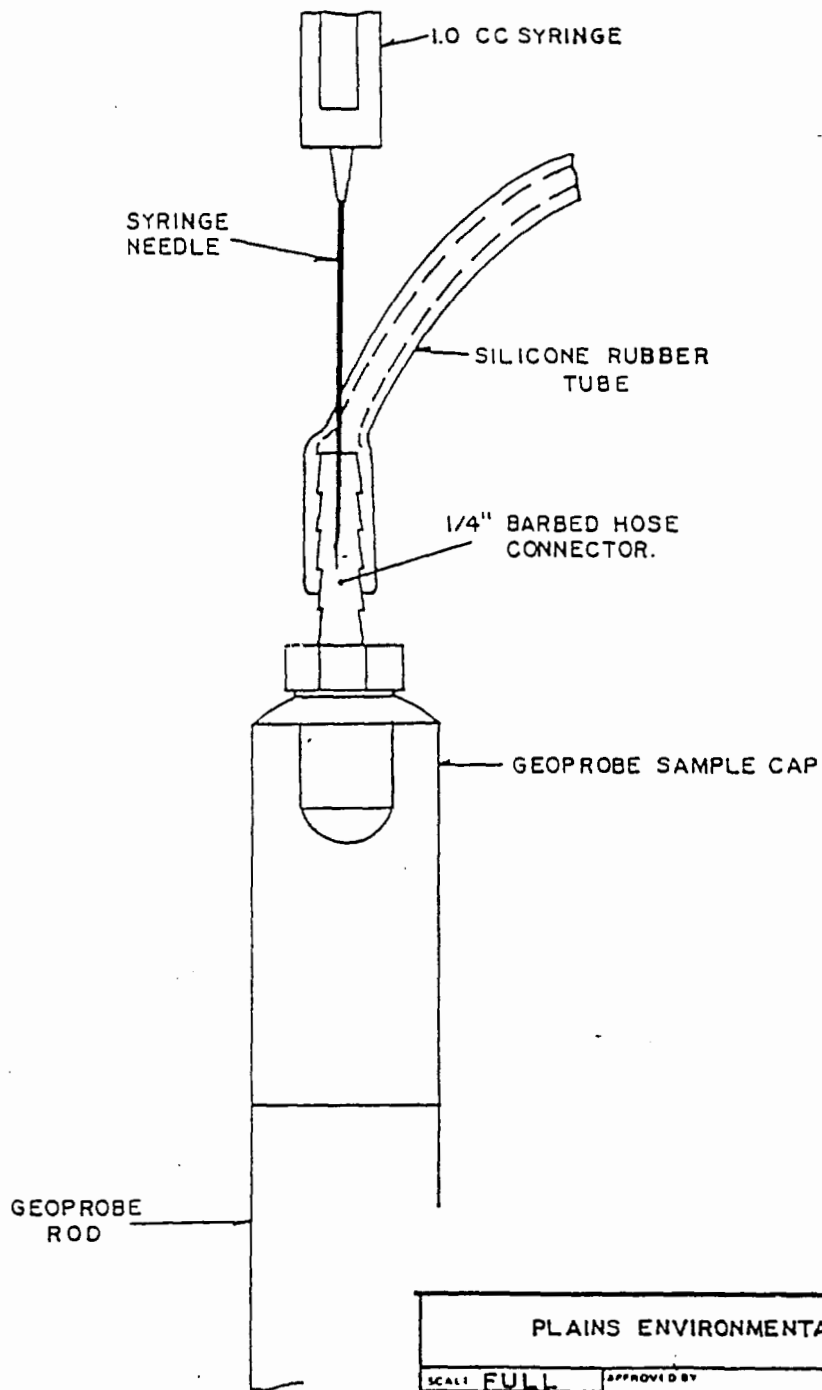
DECONTAMINATION. Probe rods are decontaminated by scrubbing the inside and outside with soapy water followed by rinsing the rods with deionized water. If contamination persists, a propane torch is used to apply heat which effectively removes volatile organics from the rods for reuse. A new section of silicon tubing is used for each sample point and a new disposable syringe is used for each sample which essentially eliminates cross contamination of sample points.

Decontaminated rods are used at each sample point. Vertical profile samples are collected by inserting cleaned rods to each profile depth. This procedure reduces the potential of transferring contaminants vertically during rod penetration and removal.

ANALYTICAL SYSTEM. The analytical system includes a laboratory grade gas chromatograph (GC) and computerized data processing station for data acquisition, storage, and retrieval. A Shimadzu GC Model GC-14 equipped with FID, PID, and ECD detectors provides a wide range of sensitivity for detecting petroleum hydrocarbons (especially aliphatics), aromatic compounds, and chlorinated organic solvents. PID/FID and PID/ECD detectors can be connected in series for additional verification of analytes. The data station consists of a Shimadzu Data Processor Model C-R4A dual channel, dual disk processor which acquires, stores, calculates, and prints chromatogram results. Up to 10 chromatograms can be recalled on the CRT screen for



PLAINS ENVIRONMENTAL SERVICES		
SCALE NTS	APPROVED BY	DRAWN BY DWG
DATE 6-20-89		
VACUUM SAMPLING SYSTEM		
		DRAWING NUMBER
		PLATE 2

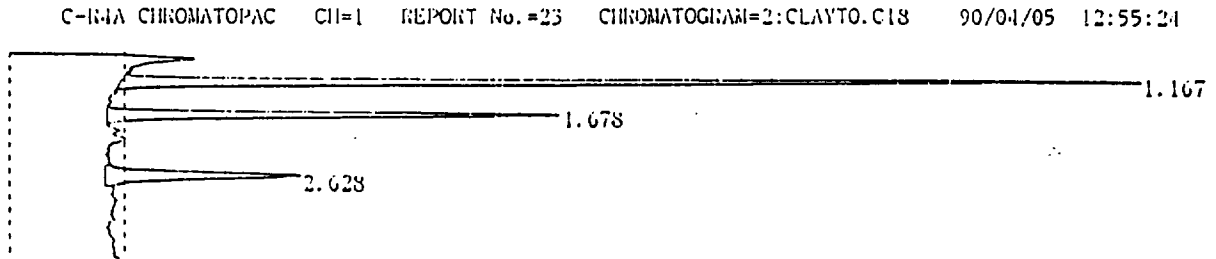


PLAINS ENVIRONMENTAL SERVICES		
SCALE FULL	APPROVED BY	DRAWN BY DWG
DATE 6-20-89		
SOIL GAS REMOVED SYSTEM		
	DRAWING NUMBER	PLATE 3

fingerprinting which is extremely useful in determining sources of site contamination. All data are stored on 3.5 inch disks and hard copied from the printer.

A detector configuration of the PID/ECD will provide results in the parts per billion by volume range. The FID configuration provides results in the parts per million by volume range. Copies of chromatograms for some of the compounds of interest are presented in Figures 1 and 2.

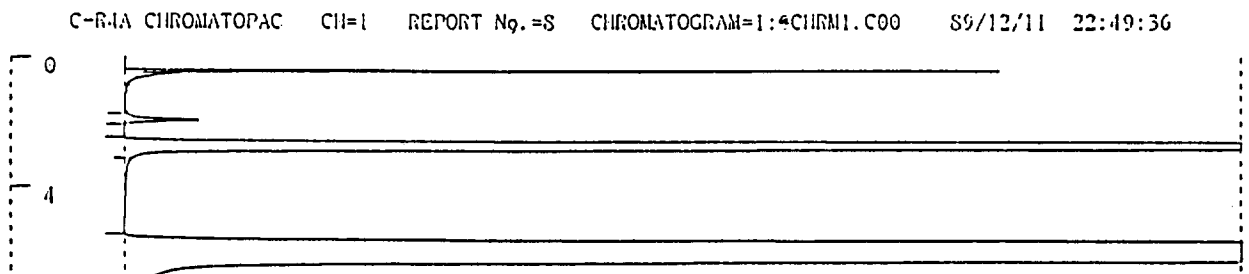
Figure 1. PID



** CALCULATION REPORT **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	6	1.167	17204	3661	V	1	1.944	BENZENE
	9	1.678	8725	1602	V	2	1.4483	TOLUENE
	17	2.628	5084	688	V	3	1.3167	M,P-XYLENE
TOTAL			31012	5951			4.709	

Figure 2. ECD



** CALCULATION REPORT **

CH	PKNO	TIME	AREA	HEIGHT	MK	IDNO	CONC	NAME
1	1	0.433	27976	12550				
	2	0.543	4298	645	V			
	3	2.001	6633	1046		1	0.0018	CCL4
	4	2.768	1215099	156318		3	9.2469	TCE
	5	6.036	15846955	970825		4	9.0423	PENC
TOTAL			17100960	1141384			18.2909	

SECTION III. QUALITY ASSURANCE/QUALITY CONTROL

QA/QC. Quality assurance procedures included in this proposal are intended to assure the quality and integrity of sample collection and sample analysis. Strict adherence to QC procedures and qualified field personnel who understand potential sources of sample contamination and analytical systems are crucial to successful on-site, turn-key operations. Laboratory quality data can be generated in the field providing that experienced personnel and state-of-the-art analytical equipment are available. PES conducts all field analysis under the direction of an experienced senior chemist using state-of-the-art equipment and technology. All sampling equipment and analytical equipment represents vendor top-of-the-line instrumentation. Operators have been factory trained in the operation of the equipment.

FIELD LOG SHEET. A field log will be maintained to assist in sample tracking and identification. An example of the Field Log Sheet is included in Figure 3.

SAMPLE INTEGRITY. Sample integrity is maintained by the prevention of equipment contamination and by using disposable supplies when practical. Probe rods are decontaminated before use for sampling. Materials such as tubing and sample transfer or storage containers are disposable and not reused. Under normal operating conditions, samples are injected into the gas chromatograph within 30 seconds of sample collection which minimizes sample loss and potential for degradation or contamination. New syringes and new tubing are used at the rod head where samples are withdrawn. Plate 3 illustrates the sample collection technique.

FIELD BLANKS. The sample system is checked at least three times daily by analyzing field blanks on the complete system. Rods, tubing, syringes and vials are assured of being contaminant free by performing the field blanks. A syringe blank is analyzed daily to provide background information of ambient air conditions for possible sample contamination and also for health and safety purposes.

INSTRUMENT CALIBRATION. The GC is calibrated with standards for each analyte of interest. Commercially available gas standards such as carbon tetrachloride for the electron capture detector (ECD) or benzene, toluene, and xylene for the flame ionization (FID) and photoionization detectors (PID) are also analyzed daily; at the beginning of each run, after every 10 field samples, and at the end of each day. PES prepares and analyzes gas standards for each compound of interest within several days of project startup. Commercially available standards are used to monitor retention time and response factor variability.

Figure 3. Field Log Sheet

Site ID:			Sampler:		
Date:			Analyst:		
Sample ID	Time	Depth (ft)	PES No.	Purge Vol. (L)	Comments

Due to the expense and difficulty of purchasing gas standards, it is not always possible to use commercially prepared gas standards for the analytes being investigated. The use of a commercially available standard for monitoring detector sensitivity and response factor stability has shown to be satisfactory in monitoring the GC's performance.

In case gross contamination is detected and samples can not be diluted sufficiently for field analysis, a greater than result is reported.

DUPLICATES. In addition to field blanks, sample duplicates will be analyzed for every 20 field samples analyzed. Total peak areas of all peaks greater than 500 counts should have a relative percent difference (RPD) of not greater than 25%¹ where:

$$RPD = \frac{|X_1 - X_2|}{(X_1 + X_2)/2} \times 100\%$$

X₁ = sample result
X₂ = duplicate sample result

CONTINGENCIES. The analytical equipment is protected from the sampling equipment area by an insulated enclosure between the laboratory mid-section of the van and the back Geoprobe area. Contingencies in the case of analytical equipment failure include the use of evacuated vials which have been shown to retain vapor samples for several days without significant sample deterioration.

¹ This is an expected range. The actual range is determined from data generated from each project site.

SECTION IV. PERSONNEL QUALIFICATIONS/EXPERIENCE

PES is committed to providing high quality, technical expertise in soil gas applications. The commitment to responsive, accurate, and efficient surveys is exemplified by the professional staff assigned to all projects. The mobile laboratory is always staffed by at least one experienced chemist with experience in soil gas sampling and in operating the gas chromatograph system. All PES field personnel participate in an annual medical monitoring program and are current in the 40-Hour Basic Health and Safety Training as required under OSHA 1910.120. Resumes of key professional staff are included in the Appendix.

PES offers the following references for projects involving soil gas investigations.

1. Mr. Gregory W. Wallace, Woodward-Clyde Consultants, 5055 Antioch Road, Overland Park, Kansas 66203. Projects: Various projects in Kansas using soil gas and headspace analysis of water samples for plume delineation of hydrocarbon and chlorinated solvent contaminants for grain elevators and chemical manufacturing facilities. (913) 423-4242.
2. Ms. Zohreh Yousefi, Woodward-Clyde Consultants, 904 Wind River Lane, Gaithersburg, Maryland 20878. Project: Plume definition of groundwater contamination from diesel fuel in the Washington, DC area. (301) 258-9780.
3. Mr. Thomas M. Christy, Kejr Engineering, Inc., 607 Barney Street, Salina, Kansas 67401. Project: Grain Elevator Soil Gas Investigation. Scope of Work: Soil gas investigation of a carbon tetrachloride spill. (913) 825-1851.
4. Mr. Oren Gottlieb, Geraghty & Miller, Inc., 101 W. Ohio Street, Indianapolis, Indiana 46204. Project: Chemical Company, Soil Gas Survey. Scope of Work: Horizontal and vertical delineation and source determination of VOC contamination. (317) 684-3480.
5. Mr. Karl E. Ruhmann, SCI Environmental, Inc., 245 Chesterfield Industrial Boulevard, Chesterfield, Missouri 63005. Project: Groundwater plume delineation in Springfield, Illinois and St. Louis, Missouri. Scope of Work: Headspace analysis of water samples and soil gas analysis for hydrocarbon contamination in groundwater. (314) 537-9901.

6. Mr. Kenneth E. Hunter, Deuel & Associates, Inc.,
7208 Jefferson St. N.E., Albuquerque, NM 87109.
Project: Commerce City, Colorado solvent recovery
facility. Scope of Work: Soil gas investigation to
delineate vertical and horizontal migration of
solvents. (505) 345-8732.
7. Mr. Ronald B. Haddock, ATC Environmental Inc.,
920 S. 107th, Suite 103, Omaha, Nebraska 68114.
Project: Service Station Underground Storage Tanks
Assessment. Scope of Work: Soil gas investigation
of gasoline USTs. (402) 390-2603.
8. Mr. Royce J. Face, Geraghty & Miller Hydrocarbon
Services; 5100 E. Skelly Drive, Suite 1000, Tulsa,
Oklahoma 74135. Project: Petroleum Company, Soil
Gas Survey. Scope of Work: Horizontal and vertical
delineation of petroleum hydrocarbons.
(918) 664-9900.
9. Mr. Gregory J. Brennan, Howard R. Green Company,
4250 Glass Rd. N.E., Cedar Rapids, Iowa 52409-9009.
Project: Soil Gas Survey in Iowa. Scope of Work:
Hydrocarbon delineation at a manufacturing facility
near Cedar Rapids, Iowa. (319) 395-7805.
10. Mr. Matthew D. Kramer, McLaren, 901 St. Louis
Street, Springfield, Missouri 65806. Project:
Hydrocarbon plume investigation near Springfield,
Missouri. Scope of Work: Soil gas survey for
hydrocarbon contamination. (417) 864-8811.
11. Mr. Michael G. Felix, Nebraska Department of
Environmental Control, 301 Centennial Mall South,
Lincoln, Nebraska 68509. Project: Soil gas
sampling in several cities in Nebraska. Scope of
Work: Determination of potential sources for
contamination of municipal water systems.
(402) 471-4217.
12. Mr. Bruce A. Reed, TerraTech, 1330 East First, Suite
104, Wichita, Kansas 67214. Project: Various site
investigations for property assessments in Wichita
and surrounding towns. Scope of Work: Soil gas
survey and groundwater analyses for hydrocarbon
contamination. (316) 262-0735.
13. Mr. Allen Hains, Law Engineering, 7616 LBJ Freeway,
Dallas, Texas 75251. Project: Soil gas sampling
in the Dallas/Fort Worth metropolitan area. Scope
of Work: Plume delineation from UST leaks.
14. Mr. Thomas G. Correll, Terracon Environmental, 2211
South 156th Circle, Omaha, Nebraska 68130.
Project: Soil gas, groundwater, and soil sampling
in the Council Bluffs, Iowa area. Scope of Work:
Site assessments for facilities with underground
storage tanks.

SECTION V. SITE SAFETY PLAN

Plains Environmental Services provides a safe working environment during all field operations. Ambient air samples are analyzed daily during field operations to assure minimum worker exposure to toxic volatile organic chemicals. Levels 50 times lower than OSHA's published threshold level values (TLVs) are considered acceptable for normal field activities. Levels exceeding TLV/50 will be brought to the attention of the Safety Officer and the client's site manager. Appropriate measures to ensure worker safety will be discussed, implemented and documented before additional on-site activity is resumed.

All gas standards used in the mobile laboratory are stored in break resistant air bags or in pressurized steel cylinders at parts per million levels. A minimal inventory of gas standards is routinely maintained, thereby reducing the potential of exposure due to leaks or container rupture. Material Safety Data Sheets (MSDSs) are located in the mobile van and have been read by all on-site, PES personnel

The Safety Officer is on-site during all field operations and has been trained in First Aid and CPR. All field personnel have been instructed in the safe operation of the field equipment. The following emergency information is read by all on-site, PES personnel and is posted in the mobile van for easy access.

Hospital number: _____

Ambulance number: _____

Location of nearest telephone: _____

Location of Hospital: _____

Site location: _____

Contact (family physician, spouse, friend, etc.):

APPENDIX
RESUMES

RESUME

Lynn R. Newcomer
President

EDUCATION

- Goshen College - B.A. in Biology - 1968
- University of Iowa - M.S. in Chemistry - 1979
- Dallas, Texas - Characterizing and Identifying Hazardous Wastes - 1985
- Cincinnati, Ohio - Environmental Protection Agency Symposium on Municipal Sludges and Dredging - 1986, 1987
- Washington, D.C. - Environmental Protection Agency Symposium on Solid Waste and Quality Assurance - 1986-1988
- OSHA 40-Hour Training CFR Part 1910.120 - Dec. 1989

PROFESSIONAL AFFILIATIONS

- American Chemical Society
- American Industrial Hygiene Association

TECHNICAL PAPER

- Author of "Performance of the Toxicity Characteristic Leaching Procedure," presented at the Hazardous Materials Control Research Institute Conference Proceedings in Washington, D.C., March 1987; at the U.S. Environmental Protection Agency Symposium on Solid Waste Testing and Quality Assurance in Washington, D.C., July 1987; and at the Workshop on Leaching Tests sponsored by Oak Ridge National Laboratory in Oak Ridge, Tennessee, July 1987
- Author of "The Determination of Volatile Organic Compounds by Gas Chromatography Using an Automated Heated Headspace Technique. Submitted to the U.S. EPA Region IV, Atlanta, Georgia, December 1988

EXPERIENCE

Mr. Newcomer started Plains Environmental Services in May 1988 after spending seven years as Technical Director at Wilson Laboratories, Salina, Kansas. His experience also includes 13 years as a high school and college chemistry instructor. He was presented the Outstanding Young Educator Award in 1974, and was awarded a National Science Foundation grant in 1978.

As Technical Director, Mr. Newcomer provided expertise in all areas of analytical chemistry including method development and validation, technical writing, sampling and analysis plans, data review, and quality control procedures. His regulatory expertise includes RCRA, CERCLA, SARA, and SDWA requirements. Mr. Newcomer has served as an expert witness for litigations involving claims of negligence and interpretation of laboratory results.

Most recently, Mr. Newcomer has been involved in developing, training, and operating mobile laboratory equipment for the sampling and analysis of volatile organic compounds by gas chromatography. He has trained several engineering firms in the operation of mobile laboratory equipment similar to the equipment owned and operated by Plains Environmental Services. Both soil gas and automated heated headspace methods using multiple detectors have been used to delineate contamination boundaries of subsurface materials. His work has been directly related to meeting USEPA consent order and state regulatory requirements. He has been actively involved in providing mobile laboratory services for approximately 50 sites within a nine state area.

RESUME

Michelle Hartwig
Chemist

EDUCATION

- Northwestern State College - B.S. in Natural Science - 1985
- OSHA 40-Hour Training CFR Part 1910.120 - Apr. 1990

EXPERIENCE

Ms. Hartwig taught high school science and mathematics for three years before working as a chemist in a commercial laboratory for one year. She has had extensive training and experience in the operation of the Geoprobe soil gas sampling equipment. She has also received training in the operation of the mobile laboratory equipment including the Shimadzu Gas Chromatograph. Her experience includes the training of an engineering firm in the operation of GC equipment and in chromatogram evaluation of soil gas data. She has been actively involved in performing on-site sampling and laboratory services for soil gas investigations at approximately 100 sites within a nine state area.

RESUME

Daniel G. Beisner
Geologist

EDUCATION

- Fort Hays State University - B.S. in Geology - 1990
- OSHA 40-Hour Training CFR Part 1910.120 - Jun. 1990

EXPERIENCE

Mr. Beisner, a recent graduate, has been involved with the operation of the Geoprobe sampling equipment for the past three months. He has participated in a three day training session with Geoprobe in the operation of the sampling and analytical system used for mobile laboratory services. He has been involved in approximately 25 sites within a four state area.

FINAL PAGE

ADMINISTRATIVE RECORD

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