Site: Richards Gebaur
ID # MA9571824292
Break: 1.2 wkpl
Other: Dames & Moore
3-15-96

— FINAL —

WORK PLAN
Richards-Gebaur Air Force Base

F41624-94-D-8102
Delivery Order 0003

UEBL 95-6004
Close ST007
&
UEBL 95-7001
Phase 2 Site Inspection at SS008

PREPARED FOR:
Air Force Center for Environmental Excellence
Brooks AFB, Texas

This final plan provides for sampling, closure activities and report preparation of Site ST007 and sampling, excavation and report preparation for Site SS008. Contaminated soil will be bioremediated in a landfarm constructed by Delivery Order 0004, if available, or disposed of off base.

Questions regarding this plan may be directed to the Delivery Order Manager, Wayne Mizer, (913) 677-0023, ext. 118.

March 15, 1996

PREPARED BY:

DAMES & MOORE, INC.

FINAL

WORK PLAN

RICHARDS-GEBAUR AIR FORCE BASE
F41624-94-D-8102
DELIVERY ORDER 0003

UEBL 95-6004
CLOSE ST007
&
UEBL 95-7001
PHASE 2 SITE INSPECTION AT SS008

PREPARED FOR:
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS

March 15, 1996

PREPARED BY:
DAMES & MOORE, INC.

LIST OF ACRONYMS

AFB	Air Force Base
AFBCA	Air Force Base Conversion Agency
AFCEE	Air Force Center for Environmental Excellence
AGST	Aboveground Storage Tank
ASTM	American Society of Testing and Materials
BCP	Base Realignment and Closure Cleanup Plan
CDRL	Construction Data Requirements List
CMP	Corrugated Metal Piping
COR	Contracting Officer Representative
CQP	Construction Quality Plan
DOM	Delivery Order Manager
DOT	Department of Transportation
DRMO	Defense Reutilization and Marketing Office
EPA	Environmental Protection Agency
FSP	Field Sampling Plan
HSP	Environmental Health and Safety Plan
IRP	Installation Restoration Program
JRS	Job Reporting System
MDNR	Missouri Department of Natural Resources
MSDS	Material Safety Data Sheets
NFRAP	No Further Response Action Plan
OWS	Oil Water Separator
PA/SI	Preliminary Assessment/Site Inspection
PA	Preliminary Assessment
PM	Project Manager
POL	Petroleum, Oil and Lubricants
QAPP	Quality Assurance Project Plan
QC Tool	Quality Control Tool
QPP	Quality Program Plan
RCRA	Resource Conservation and Recovery Act
RD/RA	Remediation Design/Remedial Action
RI/FS	Remedial Investigation/Feasibility Study
SAP	Environmental Sampling and Analysis Plan
SI	Site Investigation
SOW	Scope of Work

LIST OF ACRONYMS (Cont'd)

TCLP	Toxicity Characteristic Leaching Procedure
TPH	Total Petroleum Hydrocarbons
TRPH	Total Recoverable Petroleum Hydrocarbons
TVH	Total Volatile Hydrocarbons
USDA	United States Department of Agriculture
UST	Underground Storage Tank
WPCP	Water Pollution Control Program

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TABLES

APPENDICES

1.0 INTRODUCTION

This Work Plan documents the field investigations and remedial action program for the closure and restoration of former underground storage tank (UST) site ST007 and former test cell area SS008 at the former Richards-Gebaur Air Force Base (AFB), Missouri. This program also includes the excavation of an estimated 20 cubic yards of fuel contaminated soils.

This work is being performed as part of the Base Realignment and Closure Cleanup Plan (BCP) for Richards-Gebaur AFB. The work will be in accordance with the procedures necessary to close the subject sites in compliance with Missouri Department of Natural Resources (MDNR) and federal regulations.

This Work Plan was developed in accordance with the Statement of Work provided by the U.S. Air Force Center for Environmental Excellence (AFCEE) dated July 26, 1995. Site specific plans prepared to augment this work plan include the Health and Safety Plan (HSP), Field Sampling Plan (FSP), Quality Assurance Project Plan (QAPP), and Construction Quality Plan (CQP). These plans have been incorporated into a Quality Program Plan (QPP).

2.0 SITE BACKGROUND

Richards-Gebaur AFB, under the control of the Air Force Base Conversion Agency (AFBCA), is located in western Missouri, approximately 18 miles south of downtown Kansas City and about 3 miles east of the Kansas state line.

Richards-Gebaur AFB is located within the Osage Plains region of the Central Lowland physiographic. The region is characterized by low relief, wide, maturely dissected uplands, and relatively steep valley slopes. The topography of Richards-Gebaur AFB is gently rolling with an elevation range between 960 and 1,060 feet above mean sea level. Most of the storm water from the base drains into the Little Blue River, with the exception of the Belton Training Complex which drains into the West Fork of East Creek. Both of these watersheds ultimately flow into the Missouri River.

2.1 FORMER UNDERGROUND STORAGE TANK SITE ST007

Four steel 25,000-gallon underground storage tanks (USTs) located at the ST007 site were removed in November 1988. These USTs supplied JP-4 fuel for the aircraft hydrant refueling system from 1954, when they were installed, through 1971. In 1977, the tanks were abandoned in place and filled with water to remove fuel vapors. During the first quarter of 1988 the tanks, pumps, and associated piping were removed. Fuel-contaminated soil was observed when the tanks were removed. Soil borings were completed at the excavation site and analyses confirmed fuel contamination (General Testing Laboratories, Inc., 1989). A passive venting system was installed in 1989 as an initial remediation effort.

2.2 FORMER TEST CELL AREA SS008

Site SS008 was used from 1956 to 1977 as an aircraft maintenance area with operations such as wash rack, refueling, painting and oil changing. A number of soaps, solvents, oils, and lubricants were stored at Site SS008 for use, and waste materials were stored at the site for disposal after use. During a water line trench excavation on March 13, 1991, a petroleum odor was noted in the excavated soil by Richards-Gebaur AFB personnel. Additionally, approximately one inch of free product was observed on groundwater that had accumulated in some areas of the trench.

2.3 PREVIOUS INVESTIGATIONS

The previous investigations and reports concerning this site include:

- Geoenvironmental Exploration, Building 902, Richards-Gebaur AFB, MO, General Testing Laboratories, Inc., October 1989
- Site Inspection, ST007 Leaking Underground Storage Tank (LUST), Building 902, Geraghty and Miller, Inc. Environmental Services, November 1991.
- IRP Site Inspection, Site SS008, Test Cell Area, Richards-Gebaur AFB, MO, Burns & McDonnell, December 1993.

3.0 REMEDIATION MANAGEMENT

3.1 CLEANUP GOALS AND OBJECTIVES

The cleanup goal is the reduction of contaminants in soils to action levels acceptable to MDNR and the Air Force. Since ST007 is a former UST site, the MDNR Leaking UST Soil Cleanup Guidelines for Undisturbed Soil (matrix) was used to determine cleanup objectives. A score of 80 was calculated for the site from this matrix which establishes benzene, toluene, ethylbenzene, and xylene (BTEX) at 1, 5, 10, and 10 ppm, respectively, and total petroleum hydrocarbons (TPH) at 200 ppm. The MDNR Leaking UST Soil Cleanup Guidelines for Undisturbed Soil matrix is presented as Table 1.

Since there are no established cleanup criteria for soil removals and closures such as SS008, the levels of allowable residual contamination following closure of this site are the "airport/industrial use" levels calculated for Richards-Gebaur AFB by Missouri Department of Health (MDOH). These cleanup levels support continuing use of the site as an airport. In addition to the MDOH "airport/industrial use" levels, the Air Force has decided to cleanup the site to 500 total recoverable petroleum hydrocarbons (TRPH). The MDOH cleanup goals are presented in Table 2.

If groundwater has been impacted by petroleum contamination, the following criteria established by MDNR must be achieved prior to declaring a site clean. The action levels include 50 parts per billion (ppb) for benzene, 150 ppb for toluene, 320 ppb for ethylbenzene, 320 ppb for xylenes, 750 ppb for total BTEX, and 10,000 ppb for TRPH.

3.2 RESOURCE MANAGEMENT

Dames & Moore will be responsible for resource management. Methods employed to adjust resources will include increased manpower assigned to the project, additional equipment, and a continual review of work requirements with a focus towards completion of the project on schedule and within budget. The lines of authority and communication for the Delivery Order are shown in Appendix A, Organization Chart.

3.3 SCHEDULE

The schedule will be updated monthly as required by the contract and provided to AFCEE and the Contracting Officer. The schedule will be available for discussion at the pre-performance conference.

3.4 CONTRACTOR/SUBCONTRACTOR RESPONSIBILITIES

3.4.1 Dames & Moore, Inc.

Dames & Moore will provide project management, environmental services, and oversight of removal measures. The review of the environmental and hydrologic data will be conducted by the Dames & Moore Quality Control Manager, Delivery Order Manager, and/or the Project Manager.

3.4.2 W. R. King Contracting, Inc.

W. R. King Contracting, Inc. will serve as the remediation subcontractor. The tasks assigned to the remediation subcontractor will consist of excavating an estimated 20 cubic yards of contaminated soil at the former test cell site, SS008; moving contaminated soil from the site to the landfarm (if applicable); backfilling and restoring the sites to its original condition; and mobilizing and demobilizing all equipment necessary to preform the above mentioned tasks. No subcontracting will be authorized by W. R. King Contracting as part of this project.

3.4.3 Ross Analytical Services, Inc.

Ross Analytical Services, Inc. (Ross) will conduct laboratory analysis of soil and groundwater samples consistent with the site specific QAPP. Ross will not subcontract any portion of this work to a third party.

3.4.4 Max's Enterprises, Inc.

Max's Enterprises, Inc. will perform the abandonment of the biovents at Site ST007. Max's Enterprises is a permitted State of Missouri well driller and will not subcontract any portion of this work to a third party.

3.4.5 PSA Environmental

PSA Environmental (PSA) will perform soil and groundwater sampling as part of the field investigation at sites ST007 and SS008. PSA will not subcontract any portion of their work to a third party.

3.5 REGULATORY AGENCY INVOLVEMENT

The regulatory agency involvement will be coordinated through the AFBCA, with participation from the Environmental Protection Agency (EPA), and MDNR. The MDNR participation will involve providing comments on the project plans, issuing necessary permits, and approving closure criteria.

3.6 MEASURES OF PERFORMANCE

3.6.1 Milestones

Maintenance of project milestones is paramount to performance. Dames & Moore will adjust resources to achieve the milestones described in the schedule.

3.6.2 Quality

The quality execution of this delivery order began in the planning stage and will continue through completion of MDNR closure reports. The QAPP explains the procedures and means to be applied in the field and laboratory to achieve project sampling and analysis requirements. The CQP explains the procedures to be applied while implementing remediation activities outlined in the Work Plan.

3.6.3 Costs

Costs are reviewed every week by the Delivery Order Manager (DOM) utilizing the Dames & Moore Job Reporting System (JRS). The weekly JRS tracks charges against the job the previous week, making it a very powerful tool for monitoring and controlling costs. The DOM can evaluate the status of costs each week by task, site or overall objective for the life of the job. This enables the DOM to make corrections or reallocate resources if costs vary from the estimate.

3.7 DATA AND SUBMITTAL REQUIREMENTS

Analytical and field collected data will be compiled and evaluated during the entire project. A summary report will be prepared after the project has been completed. Monthly progress meetings will be held at the site.

3.8 RECORDKEEPING AND REPORTING

Records, such as sampling data and permits, will be continually updated during the project and will be summarized and submitted to the Contracting Officer upon completion of the project. Copies of permits will be given to the Contracting Officer before permit-requiring actions are initiated. Periodic meetings with the Contracting Officer's Representative, the Delivery Order Manager, and all subcontractors will provide a forum to discuss ongoing issues. Reports required by the contract will be submitted each month. Certified payrolls will be submitted at the end of each pay period.

3.9 PERMIT AND RECORDKEEPING REQUIREMENTS

Permit and recordkeeping requirements are discussed in detail in Section 5.0, Field Activities.

4.0 PROJECT AND SITE PREPARATION

4.1 GENERAL

Advanced planning will be necessary prior to initiation of field activities. These preparations include coordination with AFBCA for site access, utility clearance, and security; mobilization to the site; location of underground utilities; identification of work areas; and installation of erosion control.

Figures addressing health and safety issues, such as site maps, routes to the nearest hospital, and other required information are provided in the HSP.

4.2 MOBILIZATION

The Dames & Moore field team will mobilize from the Kansas City office. Miscellaneous field supplies will be purchased in Kansas City and transported by the field crew to the site.

Miscellaneous site tasks will be performed prior to the mobilization of the subcontractors, including orientation to the site and the procurement of necessary utilities, including telephone access, water, and sanitary facilities.

4.3 COORDINATION AND SECURITY PROCEDURES

On-site coordination with the AFBCA will be required to ensure work will begin and progress in a safe, efficient manner. Dames & Moore will coordinate with the AFBCA to secure access to the field investigation areas, clear underground utilities or stand pipes, obtain approval from Kansas City, Missouri Water Services Department to discharge stormwater from construction sites and monitoring well development water to storm drains, and store materials (e.g., equipment, excavated soil, decontamination water, etc.) at the site.

Security issues will be discussed with the Contracting Officer and AFBCA personnel prior to beginning field activities. Procedures will be established to identify personnel that require access to the site, and to record the name and purpose of site visitors in the daily logbook. Unauthorized access will be reported immediately to the Contracting Officer and AFBCA personnel and will be so noted in the daily logbook.

The work area at the site will be secured during the removal activities. The work areas are defined as the specific locations (i.e., drilling, excavation sites) where field activities are in progress. The boundaries of the work areas will be identified and marked during site preparation. The work areas will be activated and deactivated and the boundaries relocated, as appropriate, during the course of the remediation activities. An exclusion zone will be delineated around each work area during the field activities. The exclusion zones will extend a minimum of 30 feet from active work areas and will be delinated using cones and/or barrier tape. Exclusion zones will remain in effect 24 hours a day until the completion of the field activities at each location. Only authorized Dames & Moore personnel, Dames & Moore subcontractor personnel, or authorized visitors who have the necessary documentation as described in the Health and Safety Plan will be allowed within the exclusion zones.

4.4 UTILITIES SURVEY

Existing underground and aboveground utilities in the vicinity of the proposed excavations will be field located and marked by the proper authorities. AFBCA personnel at Richards-Gebaur AFB will provide as-built drawings of utilities and references of personnel that have historical knowledge of the location and condition of existing utilities. A magnetometer or other metal detecting device may be utilized to field locate underground utilities. Missouri DIG-RITE will be contacted prior to the start of any field work to locate other utilities in the area not under the control of Kansas City Aviation Department (KCAD).

4.5 SITE CLEARANCE AND PREPARATION

Upon approval of plans and schedules from AFBCA and the Contracting Officer, appropriate notification of the anticipated start of construction shall be made to MDNR and the Richards-Gebaur airport fire station.

A walk-through of the sites will be conducted with base personnel to delineate the areas that will be disturbed during the project. A decontamination pad will be established for use during cleaning and decontamination of the drilling and excavation equipment. The pad will be constructed from a minimum of 0.010-inch (10-mil) poly sheeting placed on pavement with berms of sufficient height to contain the decontamination water. The poly sheeting will be inspected after every decontamination event and replaced as necessary. The pad will be located in proximity to a potable water source and electricity. If electricity is not available, a gasoline powered generator will be used. The pad will collect decontamination water that will be pumped into 55-gallon drums for later disposal.

Decontamination supplies will be obtained in Kansas City and/or purchased in the area prior to the mobilization of the subcontractors to the site. Decontamination supplies will include such items as wash tubs, brushes, Alconox® detergent, Isopropanol, buckets, garbage cans with lids, garbage bags, paper towels, plastic sheeting, hoses, and other items. Supplies will be stored in a secure portable storage structure at the work site.

5.0 FIELD ACTIVITIES

5.1 GENERAL

An overview of the field activities is presented in this section. Specific information on the methodologies and procedures to be followed during the site investigations is presented in the following documents:

- Site Specific Field Sampling Plan, F41624-94-D-8102, DO 0003, prepared by Dames & Moore dated January 26, 1996. The FSP presents the soil and groundwater sampling procedures, analytical requirements and methodologies, and the Quality Assurance/Quality Control (QA/QC) procedures which will be used for this project.

- Site Specific Health and Safety Plan, F41624-94-D-8102, DO 0003, prepared by Dames & Moore dated January 26, 1996. The HSP presents the mandatory health and safety practices and procedures for all personnel involved in the field investigation program. The HSP is designed to help prevent accidents and exposure to hazardous materials, and to explain the proper action to be taken if these events occur.

- Site Specific Construction Quality Plan, F41624-94-D-8102, DO 0003, prepared by Dames & Moore dated January 26, 1996. The CQP describes the quality assurance procedures to be used to ensure consistency with the Contract CQP prepared under DO 0001 and the Dames & Moore QA program.

- Site Specific Quality Assurance Project Plan, F41624-94-D-8102, DO 0003, prepared by Dames & Moore, dated January 26, 1996. The QAPP describes the field and laboratory quality assurance procedures so that the highest quality data will be acquired.

5.2 PLANNED FIELD INVESTIGATIONS

5.2.1 Former Underground Storage Tank Site ST007

Subsurface soil and ground water sampling will be conducted to assess the performance of the passive bioventing remedial action ongoing at the site. Nine soil borings will be advanced and sampled to assess TRPH, BTEX, concentrations in the site soil. Two rounds of seasonal groundwater sampling of three existing monitoring wells will be conducted during dry- and wet-seasons to assess and monitor groundwater contamination. Procedures for confirmatory soil and groundwater sampling, sample matrixes, analytical parameters, location and frequency of sample collection and analysis, and QC sample collection and analysis are detailed in the FSP and QAPP.

If the site soils and groundwater meet MDNR closer criteria, the biovents will be closed. Closure/decommissioning of the passive biovents will be performed in accordance with current MDNR Well Construction Rules by a well driller permitted by the State of Missouri. MDNR established criteria for abandoning a well includes: removal of the entire well casing if possible or the top three-feet of casing (requires MDNR approval); placing a bentonite grout plug (wells about 50 feet depth) the full length of the well and grout into the excavated area; and submitting the Registration Record (Form MO 780-1414) to the MDNR Division of Geology and Land Survey. Dames & Moore will complete and submit the Registration Record to MDNR.

5.2.2 Former Test Cell Area SS008

Eight soil borings will be advanced and sampled to assess the horizontal and vertical extent of soil contamination previously identified at the site. If the soil borings indicate contamination at the groundwater interface, three in situ grab groundwater samples will be collected to assess groundwater contamination. Sample matrixes, analytical parameters, location and frequency of sample collection and analysis, and QC sample collection and analysis are described in the FSP and QAPP.

If the site soils do not meet MDNR closure criteria, the contaminated soil will be excavated. For costing purposes, the estimated volume of contaminated soil to be excavated for remediation is 20 cubic yards. Contaminated soils encountered during excavation will be remediated utilizing a bioremediation landfarming facility or disposed of in accordance with applicable regulations. Procedures for confirmatory soil and groundwater sampling, excavation of contaminated soils, backfilling excavated area and restoration of the site to an acceptable condition are described in the FSP.

5.2.2.1 Excavation

The excavation area will be clearly marked and secured to prevent unauthorized personnel access. Warning signs and warning barriers will be clearly marked and prominently displayed. The open excavation and material stockpiles will be secured using 4-foot high orange, high-density polyethylene temporary fencing, such as Tenax ALPI fencing. Open excavations will be secured while awaiting verification of sample results. The concurrence of the Contracting Officer will be obtained prior to backfilling the excavation with clean soil.

5.2.2.2 Stockpiling

In general, uncontaminated soil will remain in place, and contaminated soil will be hauled to a landfarm or transported off site for disposal. Uncontaminated soil will be stockpiled only if such soil must be removed to access contaminated soil, structures, or appurtenances.

Excavated material considered to be uncontaminated will be temporarily stockpiled until analytical results are received. The temporary stockpile will be a safe distance away from, but adjacent to, the excavation.

If excavated material must be stockpiled, it will be covered with an impermeable geomembrane with a minimum of 0.010-inches (10-mil) thick. The geomembrane will be placed such that the stockpiled soil does not come into contact with surface water runoff. The geomembrane cover will prevent rain or surface water from coming into contact with or ponding in the contaminated soil, as well as limit the escape of the volatile constituents from the stockpile.

5.2.2.3 Soil Loading and Hauling

The soil will be loaded into a transport truck using a track hoe with an excavator bucket or a rubber tired front end loader. A guide at ground level will direct the operator loading the truck to minimize the spread of contaminated soil outside the bed of the truck.

The contaminated soil will not be transported off site unless it is determined that the soil cannot be treated in a biocell. Should off -site disposal be required, the procedures described in Section 5.4 will be followed.

5.2.2.4 Dewatering

Adequate dewatering equipment will be provided and maintained to remove and dispose of rain, surface water, and groundwater entering excavations, trenches, or other portions of the work. Dewatering of the excavations will be limited to that necessary to maintain a safe excavation. Free product will be recovered from the groundwater only as part of necessary dewatering activities. Liquid collected during dewatering will be contained and analyzed to determine appropriate disposition. Groundwater or surface water that enters the excavation will be pumped into 21,000 gallon tanker trucks, sampled, and analyzed. If uncontaminated, water will be discharged into the on-site oil water separator, after notifying the Kansas City Water Services Department. If the water is contaminated, it will be transferred to an approved off-site treatment facility. Copies of required discharge permits will be supplied to MDNR. Surface water will be diverted to prevent direct entry into the excavation as discussed in Section 5.3.

Structures and pavements near excavations will be monitored during dewatering operations. All pipes or conduits will be left clean and free of sediment after disposal. If damage is observed, dewatering activities will be terminated until acceptable measures can be implemented to repair and stabilize adjacent structures or pavements.

5.2.2.5 Backfilling

Excavations will be backfilled only after the analytical results of samples of the soil from the excavation limits have been approved by the Contracting Officer. Backfilling activities will be initiated within 48 hours after it is determined that soil contamination levels are below the action levels established for this delivery order.

Backfill material will be obtained from an off-site source identified by the AFBCA and will be analyzed for VOCs (EPA Method 8240) and TRPH contamination at an off-site laboratory. Borrow material will be selected to meet requirements and conditions of the particular fill for which it is to be used. Backfill will be placed in layers not exceeding 6 inches loose thickness for compaction, by hand-operated machine compactors and 8 inches loose thickness for other than hand-operated machines (i.e., trackhoe or backhoe bucket). Backfill will be aerated or moistened, as necessary to maximize the compaction effort. Engineering judgement will be the basis for determining when sufficient density has been reached for each layer.

After completion of required backfilling operations, all areas will be restored to grade with top soil, seeded, and mulched.

5.3 SURFACE WATER AND GROUNDWATER MANAGEMENT

5.3.1 General

Understanding the local surface and groundwater hydrology is important because of the potential impact the proposed work may have on down gradient areas. Richards-Gebaur AFB falls within the Missouri River drainage basin. Stormwater flow is generally towards Scope Creek, which flows from south to northeast through the base to the Little Blue River, and ultimately discharges to the Missouri River. Although classified as an intermittent stream, Scope Creek contains water much of the time. The depth of the groundwater in the area and current conditions indicate that groundwater will likely be encountered during remedial activities.

5.3.1.1 Potential Contaminants

Potential contaminants to surface waters include sediment pollution due to land disturbance, grading, and excavation activities; discharge of petroleum contaminated liquids due to dewatering of the excavations; and escape of volatile constituents from temporary stockpiles of contaminated soil because of wind, rain, or surface water coming into contact with the stockpiles.

5.3.1.2 Potential Contaminant Release Pathways

The majority of surface water runoff containing a contaminant release would eventually migrate to Scope Creek. However, because of the distance from the sites to the creek and the spill protection procedures that will be implemented, it is unlikely that Scope Creek would be impacted by a release.

Most of the existing storm drain piping is corrugated metal piping that eventually discharges into Scope Creek.

5.3.2 Surface Water Management

A Missouri State Operating Permit for storm water discharge is required for construction activities that will disturb more than 5 acres of surface area. The area to be excavated is estimated to be less than 0.1 acre and the need for a permit is not anticipated.

5.3.3 Groundwater Management and Controls

Dewatering of the excavations will be limited to that necessary to maintain a safe excavation. No excavation will be advanced until after dewatering measures have been installed. Groundwater or perched water shall be maintained below the bottom of the excavation. Once groundwater or perched water has been encountered, dewatering may result in the production of contaminated water and/or free product. Liquid from dewatering activities will be handled as described in Section 5.2.2.4. Adequate dewatering equipment will be provided and maintained to remove and dispose of groundwater entering excavations.

5.3.4 Erosion Control

Erosion control devices will be installed prior to, or as the first step, in excavation activities. All control devices will be properly maintained throughout the extent of the remedial work. Erosion control devices will not be removed until all work is complete and all disturbed areas are restored to original condition, or graded and stabilized by vegetation. This will be complete within 7 days (weather permitting) of closing the excavations. All required notifications and/or inspections prior to removal of sediment control practices will be coordinated through the AFBCA and the Contracting Officer.

Exposed surface area and exposure time will be kept to a minimum during remedial construction activities to lessen the likelihood of sediment pollution from surface water runoff. This will be accomplished by employing a combination of vegetative, structural, and/or site management erosion control practices. Particular attention will be towards preventing siltation of existing drainage structures and waterways.

5.3.4.1 Erosion Control Techniques

Erosion control techniques likely to be used for this project include poly liners, silt fences, berms, and inlet protection devices. The greatest potential for erosion and sediment transport will be from contaminated soils temporarily stockpiled during remedial activities.

If uncontaminated soil is excavated, it will be stockpiled on an impermeable, poly geomembrane (liner), a minimum of 0.010 inches (10 mil) thick. The liner will be placed on a ground surface with a gentle gradient to minimize runoff in all directions. The stockpile will be covered at the end of each working day with similar poly sheeting to prevent rain or surface water from coming into contact with the soil. The covering will be secured in a manner to withstand wind speeds of 60 miles per hour. The stockpiled soil will be monitored daily and, if necessary, a plastic silt fence will be placed around the perimeter of the stockpile to control sediment runoff. Erosion control devices for the stockpiled soils will be maintained until analytical results are received and the soil is placed back into the excavation or hauled to an off-site disposal facility if contaminant level precludes bioremediation.

Sediment laden water will be prevented from entering storm drains and sewers by installing inlet protection devices. These are filtering devices utilized for small drainage areas draining to curb inlets, and/or swale (yard) inlets.

5.4 TRANSPORTATION PLAN

5.4.1 General

This plan addresses the transportation issues which will be implemented for all personnel and property associated with the environmental remediation activities scheduled under this Delivery Order. The Dames & Moore Delivery Order Manager will have overall responsibility for all transportation activities, including those of the subcontractors. Any activities performed outside the scope of this delivery order are the sole responsibility of the performer. Specific safety requirements pertaining to vehicles and personnel are described in the HSP.

An estimated 20 cubic yards of contaminated soil from site SS008 will be transported to an on-base landfarm for treatment or transported off-site as a Class I special waste. The decision to haul contaminated soil off site will be made by the Air Force and Dames & Moore based on the results of the treatability study, results of the sample analysis of the soil in question, and availability of an on-site landfarm. Contaminated groundwater and free product generated at the site will be treated as a hazardous waste.

5.4.2 Staging

There may be a need to stage contaminated soils to be transported. Excavated soils will be staged as discussed in Section 5.2.2.2. In conjunction with the AFBCA, the Dames & Moore Field Team Leader will authorize the staging location during the site preparation. The staging site will be located as close to the excavation site as possible but not interfere with the excavation operations, decrease safety operations (i.e., interrupt traffic flow), or extend the contamination hazard unnecessarily. The soils will be handled according to MDNR regulations pertaining to the material classification.

Contaminated groundwater removed from the site SS008 will be shipped in tanker trucks to the approved treatment, storage, and disposal facility, Essex Waste Management Services. If necessary, residual materials will be containerized using Department of Transportation (DOT) approved 17H steel drums. Each drum will be properly labeled as to its contents and accumulation date, and will be taken to the 90-day hazardous waste storage area on the base until transported for disposal with other wastes.

5.4.3 Loading

The hazardous materials/wastes are anticipated to be of a liquid consistency (free or contaminated groundwater), thus, loading of the tank contents will be by vacuum truck or pump. Only those hoses approved for use with petroleum products will be used, and all seals and connections will be inspected to ensure a safe transfer of material without spills or leaks. Two guides will be used during loading of product into a tank trailer for transport; one for visual inspection at the top manway and one for visual inspection at ground level. The guides will watch for over filling and ensure that faulty connections or leaking hoses do not go unnoticed.

Loading of contaminated soils for transport to a landfarm or off-site for disposal will be by track hoe with an excavator bucket or similar device. To minimize the spread of contaminated soils, one guide at ground level will direct the operator to ensure the bucket is discharged completely into the bed of the transport truck. Soil that spills onto the ground will be immediately scooped up with the bucket or by hand shovels as appropriate. All loads to be transported off-site will be covered with a tarp as required by Missouri DOT regulations.

5.4.4 Decontamination

All vehicles will be inspected prior to leaving the project site to ensure that the least possible amount of soil adheres to wheels and undercarriages. If necessary, vehicles leaving the exclusion zone shall be decontaminated prior to leaving the project site. The wash rack located at Building 920 may be used to clean vehicles, but all decontamination will be done at the decontamination pad constructed for the project. If used, the wash rack will be cleaned of all debris upon completion of the project.

5.4.5 Hauling

Prior to leaving the site, each truck hauling contaminated material will be inspected by the Dames & Moore Field Team Leader to ensure compliance with transportation standards on the vehicle and the load inspection check sheet (Table 2).

Special waste will be transported to Laidlaw (Southeast) Landfill. The proposed route originates from Richards-Gebaur AFB via the Hanger Road Gate. The route continues east onto 155th Street to U.S. Highway 71. Proceeding north, vehicles will exit at 85th Street and then to Hickman Mills Road. Laidlaw Landfill is located on Indiana Avenue, approximately 100 feet to the left off of Hickman Mills Road. There are no weight restrictions for vehicles on this route and height is restricted to the height of the lowest overpass, which is 15 feet, 5 inches.

Hazardous waste will be transported to Essex Waste Management Services. The proposed route is on State Highway 150 east to State Highway 7. The vehicles will continue south on Highway 7 and east on State Highway 58 to the entrance of Essex's facility.

5.4.5.1 Driver Certification

As required by State and Federal law, each driver of a commercial vehicle will possess a valid commercial driver's license (CDL) with certifications appropriate for the vehicle being operated. At a minimum, drivers operating a tanker tractor trailer hauling liquid hazardous waste will possess a Class A CDL with Tanker and Hazardous Materials certifications. Any individual operating an end dump tractor trailer for the transport of construction debris or special waste (contaminated soil) will possess a Class A CDL. The operator of an end-dump tandem axle truck will possess at least a Class B CDL.

The classification and certification of an operator is listed on the front of the drivers license. Dames & Moore will review all drivers' licenses to ensure that properly qualified and certified individuals will be operating a vehicle for transport of hazardous or special wastes.

5.4.5.2 Accidents

In the event of a spill while transporting hazardous waste, personnel protection is the first priority, containment of the spill is second priority, and cleanup of the spill is third priority.

Essex Waste Management Services has a contingency plan for emergency spill response should an accident occur during transport. All vehicles carry a spill containment kit and all operators are trained for rapid response to a small spill. In the event of a bulk tanker spill, the operator of the vehicle would notify the emergency response contact listed on the manifest and at the disposal facility. These emergency response contacts will notify appropriate authorities, providing the description of the material/waste spilled and the location of the accident.

5.4.6 Documentation and Recordkeeping

Manifests for hazardous/special wastes, bills of lading for construction debris and non-hazardous waste, and vehicle and load inspection check sheets will be utilized to document the transporting and receiving of materials leaving Richards-Gebaur AFB. All hazardous waste placed in drums or other approved storage containers will be labeled and clearly marked "Hazardous Waste." Upon receipt of the waste profile sheet, the disposal facility will provide a waste code for the label and initiate a hazardous waste manifest or non-hazardous waste bill of lading. As required by Federal and MDNR regulations, all material classified as hazardous or special waste will be transported under a Hazardous Waste Manifest. The original manifest will be produced by the disposal facility and sent to the generator for their review and approval.

A file for these documents will be maintained by the Field Team Leader and submitted daily to the Delivery Order Manager. The Delivery Order Manager will retain the documents until completion of the remediation activities and submit them with the final reports.

5.5 THIS SECTION NOT USED

5.6 DEMOBILIZATION AND CLOSURE

5.6.1 General

Over the course of the project, there may be multiple demobilizations of equipment and personnel. In each case, demobilization and closure procedures will consist of the following activities.

5.6.2 Decontamination and Dismantling of Equipment and Facilities

A staging area and decontamination pad for personnel and tools will be constructed as a part of the site preparation for the project as described in Section 4.5. All equipment and tools used during site investigation and remediation activities will be subjected to a high pressure low volume hot water wash in the decontamination area established during the site preparation. The rinseate and solid waste generated during decontamination will be drummed for waste characterization and analysis. Decontamination waste materials will be disposed of as a special waste.

The vehicle wash rack at Building 920 is available for use to clean vehicles and large equipment. The rack was previously used to wash and clean the fuel tanker trucks. If the wash rack is used, it will be cleaned of all debris upon completion of the project.

5.6.3 Disposal of Equipment and Waste

After decontamination as described above, all project equipment will be removed and transported back to the contractor and subcontractor offices. No equipment will be kept on site after project closure. Items purchased with contract funds and not consumed will be made available to the Contracting Officer for disposition.

5.6.4 Site Closure and Restoration

5.6.4.1 Former Underground Storage Tank Site ST007

If the site soils and groundwater at the former UST site ST007 meet MDNR closure criteria, the biovents and monitoring wells will closed. Closure/decommissioning of the passive biovents and monitoring wells will be conducted in accordance with applicable MDNR regulations, as described in Section 5.2.1.

5.6.4.2 Former Test Cell Area SS008

Concurrent with disposal activities and prior to backfilling the excavation at the former test cell site SS008, a pre-final inspection will be requested of AFBCA. The excavation will be backfilled only after analytical results for the confirmatory soil samples indicate that soil contamination levels are below the action levels established for this delivery order and approval by the Contracting Officer. After completion of required backfilling operations, the areas will be restored to grade with top soil, seeded, and mulched.

5.6.5 Post Closure Maintenance

After completion of the site restoration activities (regrading and seeding/sodding), maintenance will be the responsibility of the AFBCA.

6.0 POST CONSTRUCTION DOCUMENTATION

Post construction documentation will be submitted in a timely manner at the completion of all field activities and the receipt and confirmation by Dames & Moore of all analytical test results. Documentation will be either closure reports (no further action), recommendation reports (closure not warranted), or Phase II Site Investigation reports.

6.1 CLEAN CLOSURE REPORTS

If confirmation of clean closure is warranted, Dames & Moore will prepare a No Further Response Action Plan (NFRAP) decision document for final site closeout using CDRL A030 as a guide. This report will be generated, if necessary, for both sites ST007 and SS008.

In addition, a Phase II Site Inspection Report will be prepared for Site SS008.

6.2 ADDITIONAL REMEDIAL ACTION REPORTS

If sample results indicate that closure is not warranted, Dames & Moore will prepare a recommendation report addressing what actions are proposed to attain site closure.

TABLE 1

LEAKING UNDERGROUND STORAGE TANK CLEANUP GUIDELINES FOR UNDISTURBED SOIL.

Table 1

Leaking Underground Storage Tank Cleanup Guidelines for Undisturbed Soil

Site Features	Score 15 if True		Score 10 if True		Score 5 if True		Score 0 if True	
Groundwater potable?	No	15	Unknown		Poor		Yes	
Depth to groundwater?	> 100 ft.		51-100 ft.		25-50 ft.		< 25 ft.	0
Natural fractures present?	None		Unknown	10	Present		Predominant	
Man-made vertical conduits?	None		Unknown	10	Present		Predominant	
Man-made horizontal conduits?	None		Unknown		Present	5	Predominant	
Coarse soil or sand present?	None	15	Unknown		Present		Predominant	
Water wells nearby?	> 1,000 ft. away	15	501-1,000 ft. away		100-500 ft. away		< 100 ft. away	
Background levels present?	Above action levels		Unknown	10	Below action level		Non-detectable	
Subtotals		**45**		**30**		**5**		**0**
						Total Score =	**80**	
Soil Cleanup (ppm)								
Total Score	101-120		71-100		41-70		40 or less	
BTEX =	2/10/50/50		1/5/10/10		0.5/1/2/2		B+T+E+X < 2	
TPH =	500		200		100		50	

TABLE 2

SOIL CLEANUP LEVELS

TABLE 2
AIRPORT/INDUSTRIAL USE SOIL CLEANUP LEVELS
RICHARDS-GEBAUR AIR FORCE BASE

benzene	1100 mg/kg
toluene	100,000 mg/kg
ethylbenzene	52,000 mg/kg
xylenes	No limit
trichloroethylene (TCE)	1,700 mg/kg
vinyl chloride	15 mg/kg
ethylene glycol	110,000 mg/kg
arsenic	72 mg/kg
barium	36,000 mg/kg
lead	1,600 mg/kg
acenaphthene	22,000 mg/kg
anthracene	110,000 mg/kg
benzo(a)pyrene	4.4 mg/kg
benzo(a)anthracene	29 mg/kg
benzo(b)fluoranthene	26 mg/kg
benzo(k)fluoranthene	220 mg/kg
chrysene	980 mg/kg
dibenzo(a,h)anthracene	4 mg/kg
fluoranthracene	15,000 mg/kg
fluorene	15,000 mg/kg
indeno(1,2,3-cd)pyrene	78 mg/kg
napthalene	1,500 mg/kg
phenanthrene	110,000 mg/kg
pyrene	11,000 mg/kg
polychlorinated biphenyls (PCBs)	4.2 mg/kg
TRPH [1]	500 mg/kg

[1]: Air Force cleanup standard

TABLE 3

VEHICLE AND LOAD INSPECTION CHECK SHEET

Table 3
VEHICLE & LOAD INSPECTION CHECK SHEET

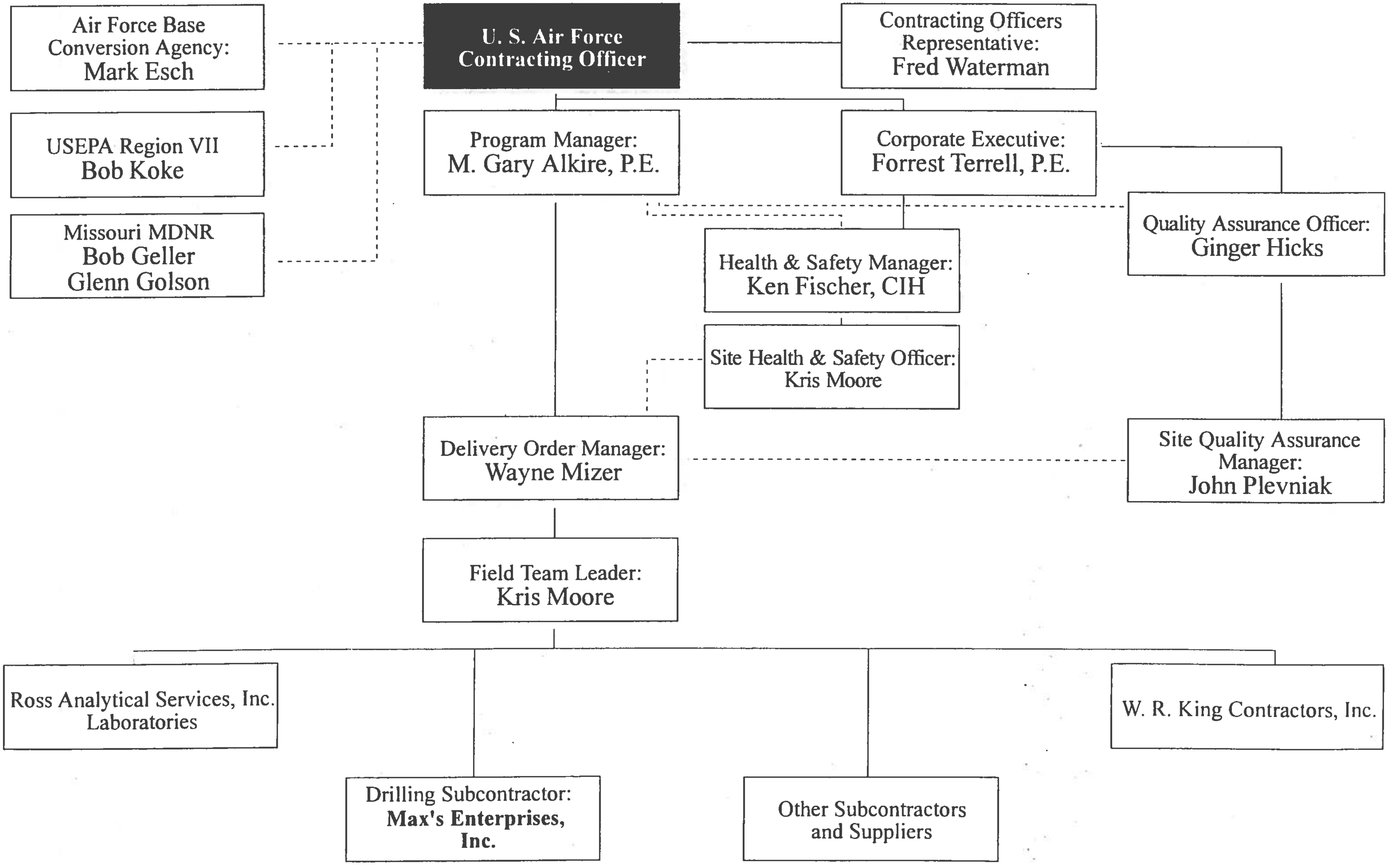
Date	Operator Name	Vehicle Type	Vehicle License #	Operator has updated log book	Vehicle is properly manifested	Vehicle is not overloaded	Vehicle is properly labeled	Contaminated soil on tires	Tarp tied down and covers soil	Field test results

APPENDIX A

ORGANIZATION CHART

Richards - Gebaur Air Force Base Delivery Order No. 3

Organizational Chart



— FINAL —

QUALITY PROGRAM PLAN
Richards-Gebaur Air Force Base

F41624-94-D-8102
Delivery Order 0003

UEBL 95-6004
Close ST007
&
UEBL 95-7001
Phase 2 Site Inspection at SS008

PREPARED FOR:
Air Force Center for Environmental Excellence
Brooks AFB, Texas

This final plan provides for sampling, closure activities and report preparation of Site ST007 and sampling, excavation and report preparation for Site SS008. Contaminated soil will be bioremediated in a landfarm constructed by Delivery Order 0004, if available, or disposed of off base.

Questions regarding this plan may be directed to the Delivery Order Manager, Wayne Mizer, (913) 677-0023, ext. 118.

March 15, 1996

PREPARED BY:

DAMES & MOORE, INC.

FINAL

QUALITY PROGRAM PLAN

RICHARDS-GEBAUR AIR FORCE BASE
F41624-94-D-8102
DELIVERY ORDER 0003

UEBL 95-6004
CLOSE ST007
&
UEBL 95-7001
PHASE 2 SITE INSPECTION AT SS008

Prepared by: DAMES & MOORE, INC.
Prepared for: AFCEE

Approved by:

Fred Waterman, by letter attached — 14 Mar 96
AFCEE Project Manager, Fred Waterman — Date

Gary Alkire — 14 Mar 96
Dames & Moore Program Manager, Gary Alkire — Date

Wayne A. Mizer — 15 MAR 96
Dames & Moore Delivery Order Manager, Wayne Mizer — Date

John E. Plevniak — 15 MAR 96
Dames & Moore QA Manager, John E. Plevniak — Date

for Wayne A. Mizer — 15 MAR 96
Dames & Moore Central Division Health & Safety Manager, Thomas G. Natsch — Date
(VERBAL AUTHORIZATION)

FINAL

HEALTH AND SAFETY PLAN

RICHARDS-GEBAUR AIR FORCE BASE
F41624-94-D-8102
DELIVERY ORDER 0003

UEBL 95-6004
CLOSE ST007
&
UEBL 95-7001
PHASE 2 SITE INSPECTION AT SS008

PREPARED FOR:
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS

March 15, 1996

PREPARED BY:
DAMES & MOORE, INC.

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1.0 INTRODUCTION

The purpose of this Site Specific Health and Safety Plan (HSP) is to assign responsibilities, establish personnel protection standards and mandatory safety practices and procedures, and provide for contingencies that may arise during site operations.

The base-wide (General) Health and Safety Plan and this site-specific addendum together comprise the Health and Safety Plan for this project, and must be kept on site with the Work Plan during all field activities. The Standard Procedures section of the base-wide Health and Safety Plan addresses general procedures that apply to virtually all field activities involving hazardous substances or wastes. The site-specific section addresses items that are site specific to this field activity.

The objective of the health and safety field effort is to provide oversight for the safe performance of field activities including soil borings and sampling, monitoring well installation, groundwater sampling, contaminated soil excavation, backfilling, and site restoration.

2.0 BACKGROUND

The Statement of Work (SOW) for this Delivery Order (DO) includes the confirmatory soil sampling and seasonal ground water sampling at former underground storage tank site ST007 and soil sampling and excavation at former test cell area SS008 at the Richards-Gebaur AFB, Missouri.

2.1 SITE LOCATION AND HISTORY

The locations of site ST007 and SS008 are presented on Figure 1. The background history of Richards-Gebaur AFB is described in Section 2.0 of the General Health & Safety Plan prepared for Delivery Order 0001. Background unique to sites ST007 and SS008 is described in Section 2.2.

2.2 CONCEPTUAL SITE MODEL

A general description of the anticipated tasks at the areas of environmental concern is provided below:

Closure of ST007: Closure/decommissioning of the passive biovents, which have been utilized for soil/ground water remediation, will be conducted in accordance with applicable regulations. Confirmatory soil and groundwater sampling, grouting and closing of biovents, and restoration of the site to an acceptable condition will be completed.

Site Action at SS008: Soil boring and sampling will be conducted to further define the horizontal and vertical soil contamination to determine soil excavation volume. Confirmatory soil and groundwater (if encountered) sampling, backfilling and restoration of the site to an acceptable condition will be completed. Contaminated soils encountered during excavation will be remediated utilizing a bioremediation landfarming facility (to be built under DO 0004), if available, or disposed of off base in accordance with applicable regulations.

2.2.1 Former Underground Storage Tank Site ST007

Four steel 25,000-gallon underground storage tanks (USTs) located at the ST007 site were removed in November 1988. These USTs supplied JP-4 fuel for the aircraft hydrant refueling system from 1954, when they were installed, through 1971. In 1977, the tanks were abandoned in place and filled with water to remove fuel vapors. During the first quarter of 1988 the tanks, pumps, and associated piping were removed. Fuel-contaminated soil was observed when the tanks were removed. Soil borings were completed at the excavation site and analyses confirmed fuel contamination (General Testing Laboratories, Inc., 1989). A passive venting system was installed in 1989 as an initial remediation effort. A site layout and summary of soil analytical data from previous investigations are presented on Figure 2.

2.2.2 Former Test Cell Area SS008

Site SS008 was used from 1956 to 1977 as an aircraft maintenance area with operations such as wash rack, refueling, painting and oil changing. A number of soaps, solvents, oils, and lubricants were stored at Site SS008 for use, and waste materials were stored at the site for disposal after use. During a water line trench excavation on March 13, 1991, a petroleum odor was noted in the excavated soil by Richards-Gebaur AFB personnel. Additionally, approximately one inch of free product was observed on groundwater that had accumulated in some areas of the trench. A site layout and summary of soil analytical data from previous investigations are presented on Figure 3.

2.3 PLANNED ACTIVITIES

Dames & Moore has prepared a Work Plan and a Quality Program Plan to provide the necessary services to conduct site investigations to support the remedial action at various sites at Richards-Gebaur AFB, Missouri. Dames & Moore field activities are described in the Work Plan. The project organization chart (Appendix A) presents Dames & Moore's organization for this project. The Work Plan describes the following general work required to remediate the site.

- Closure of ST007
- Site Action at SS008

Field activities in these areas will include:

- Soil Borings and Sampling
- Closure 18 Vent Wells
- Groundwater Sampling
- Contaminated Soil Remediation
- Excavation Backfilling and Site Restoration

Decontamination will be conducted in accordance with procedures outlined in the General Health and Safety Plan (HSP) submitted with Delivery Order No. 0001, Section 7.10 - Decontamination.

Drilling investigations will be conducted in accordance with the General HSP, Section 5.4 - Drilling Safety.

Excavation activities will be conducted in accordance with the General HSP, Section 5.5- Excavation.

3.0 ORGANIZATION

The safety organizational structure has been established to follow the Organizational Chart provided in the Work Plan. Safety oversight and compliance assurance for this project is provided by Mr. Kenneth E. Fischer, CIH, the Dames & Moore Government Services Division Health and Safety Manager. Specific site safety and health issues which arise during the course of this project are the responsibility of Mr. L. Kristopher Moore, the Site Health and Safety Officer. Decisions concerning the health and safety of the personnel working at the site will be deferred to the Site Health and Safety Officer. The Field Team Leader, Mr. L. Kristopher Moore, will be responsible for supplementing and augmenting the safety and health activities at the work site.

Division Health and Safety Manager	Office (301) 652-2215
Kenneth E. Fischer	Home (301) 424-3452
Site Health and Safety Officer	Office (913) 677-1490
L. Kristopher Moore	Home (913) 894-1378
Field Team Leader	Office (913) 677-1490
L. Kristopher Moore	Home (913) 894-1378
	Cellular (913) 522-0674

The Dames & Moore field team will consist of the following persons:

Delivery Order Manager:	Wayne A. Mizer, PMP
Site Health & Safety Officer:	L. Kristopher Moore
D&M Field Team Leader:	L. Kristopher Moore

The following contractors and subcontractors will be working on site:

Drilling subcontractors:	Max's Enterprises, Inc. PSA Environmental, Inc.
Excavating subcontractor:	W.R. King Contracting, Inc.

4.0 SITE MAP

4.1 SITE MAP

The layouts of sites ST007 and SS008 are present on Figures 2 and 3, respectively. A map showing the route to the hospital is presented as Figure 4.

4.2 LOCATION OF SITE RESOURCES

Water Supply:	Provided by Contractor
Telephone:	Provided by Contractor
Toilet:	Provided by Contractor

4.3 LOCATION OF HOSPITAL/CLINIC

Research Belton Hospital is located approximately four miles from Richards-Gebaur AFB on U.S. Highway 71. From the work site take Andrews Road east to Missouri State Highway 150 for approximately one-eighth mile and turn right (south) on U.S Highway 71; proceed south on Highway 71 approximately four miles to the Missouri Highway 58 exit (third exit). Located immediately east of the Highway exit is the Research Belton Hospital (Figure 3).

5.0 HAZARD ANALYSIS

5.1 HEALTH AND SAFETY RISKS

The following chemical constituents may be encountered during this project:

- Benzene
- Ethylbenzene
- Xylene
- Toluene

The exposure limits, recognition qualities, acute and chronic effects, and first aid treatments for hazardous chemicals expected to be found at the site are presented in Tables 1 (Exposure Limits and Recognition Qualities) and Table 2 (Health Hazards and First Aid).

The waste types which are anticipated to be encountered are:

Liquid: X Solid: X Sludge:__ Gas:__ Vapors: X Asbestos:__
Lead Based Paint: __

During the site investigation, it is probable the field crew will encounter contaminated soil and/or water. This assumption is based on information obtained from previous site studies and background information provided to Dames & Moore.

The characteristics of the wastes anticipated to be encountered are:

Corrosive: __ Ignitable: X Radioactive: __
Volatile: X Toxic: X Reactive: __
Unknown: __

The potential health and safety risks for each work task and operation are identified below:

• Soil Borings and Sampling	Benzene Ethylbenzene Toluene Xylene
• Monitoring Well Installation	Benzene Ethylbenzene Toluene Xylene
• Groundwater Sampling	Benzene Ethylbenzene Toluene Xylene
• Contaminated Soil Remediation	Benzene Ethylbenzene Toluene Xylene
• Excavation Backfilling and Site Restoration	Safety/Physical Hazards

5.2 RISKS

This field effort will involve the potential exposure to a variety of toxic, volatile, and ignitable chemicals. The specific hazards for each are provided in Table 2. Field work will be conducted during daylight hours only. The Delivery Order Manager or Site Health and Safety Manager must grant special permission for any field activities conducted beyond daylight hours. At least two personnel will be in the field at all times.

In the event a release were to occur, the hazardous substances of likely concern would be petroleum products (e.g.,jet fuel). To ensure proper response is taken during a release, material safety data sheets (MSDSs) for these substances and other hazardous materials used during remediation activities will be maintained on-site with the HSP.

The reactivity of jet fuel (JP-4) is reported by various sources as being incompatible with strong acids, alkalis, and strong oxidizers such as liquid chlorine and oxygen. Jet fuels are rated as miscellaneous combustible or flammable materials for compatibility classification purposes. The persistence in the soil-water system for JP-4 hydrocarbons are expected to be relatively mobile and non-persistent in most soil systems. Persistence in deep soils and groundwater may be higher.

5.2.1 Fire and Explosion Hazards

Certain ignitable and volatile chemicals may be encountered during this project; therefore the overall risk for fire and explosion is high since saturated soils are anticipated. Prior to the commencement of field work, possible sources of ignition will be removed from the work area.

5.2.2 Physical Hazards

Physical hazards such as slips, trips, and falls may occur. Workers must walk cautiously at the site to avoid tripping, especially when uneven terrain is present. Falls are more serious when they occur from heights. Extra precautions must be taken if guardrails or railings are absent. Ladders used for access to high places should be securely lashed or otherwise fastened at the top to prevent sliding and the feet must be on a firm and level base. Workers can be struck by vehicles used at the site. While driving in reverse, the operator usually has a more limited field of view than while driving forward and must therefore observe extra caution. Such vehicles must be equipped with a backup alarm to warn workers that the vehicles are moving in reverse.

Material Handling: Accidents in manual handling of materials are primarily the result of unsafe working habits--improper lifting, carrying too heavy of a load, incorrect gripping, or failing to wear personal protective equipment. These may be avoided by testing the weight of an object before attempting to lift and carry it. If it is too heavy get help, and if possible, use mechanical lifting aids. The proper method for lifting is:

- Get a good footing.
- Place feet about shoulder width apart.
- Bend knees to pick up load. Never bend from waist.
- Keep back straight.
- Get a firm hold. Grasp opposite corners of the load, if possible.
- Keep the back as upright as possible.
- Lift gradually by straightening the legs--don't jerk the load.
- Keep the weight as close to the body as possible.
- When changing directions, turn the entire body, including the feet.
- Don't twist the body.

Physical hazards associated with drilling and excavation activities are described under Sections 5.4 and 5.5 of the General HSP, respectively.

5.2.3 Biological Hazards

5.2.3.1 Bloodborne Pathogens

For purposes of this health and safety plan, personnel are placed into classification B of Dames & Moore's Bloodborne Pathogens Program. This classification includes projects where required tasks normally do not, but could, involve exposure to blood, bodily fluids, or tissues--for example, in the event first aid or Cardiopulmonary Resuscitation (CPR) is required. If exposure to blood, bodily fluids, or tissues occurs, Universal Precautions such as the following will minimize the chance of contracting disease.

- Wash hands with soap and water as soon as possible after contact with blood, bodily fluids, or human tissue from an injured worker. When hand washing facilities are not readily available, antiseptic hand cleansers in conjunction with clean cloth/paper towels will be used and hands will be washed with soap and water as soon afterwards as possible.

- Wear gloves when anticipating contact with blood, bodily fluid, tissues, mucous membranes, or contaminated surfaces, or if breaks in the skin are present.

- Wear appropriate protective equipment at all times, including a mask and eye protection, if aerosolization or splattering may occur when attending to an injured worker or when conducting normal work routines.

- Insure that mouthpieces and appropriate personal protective equipment are readily available in first aid kits.

- Report immediately to the Site Health and Safety Officer all sticks (punctures) or cuts, mucosal splashes, or contamination of open wounds with blood or bodily fluids.

- Dispose of all spills which contain or may contain biological contaminants in accordance with policies for biohazard waste disposal. Until cleanup is complete, an accident area must be roped off from other workers.

The following work practice controls will also be used to eliminate or minimize employee exposure. Where occupational exposure remains after instituting these controls, personal protective equipment will also be used.

- Ingestion of bloodborne pathogens - Eating, drinking, smoking, applying cosmetics, and handling contact lenses are prohibited in work areas where there is a reasonable potential for occupational exposure. Food and drink will not be kept in refrigerators, freezers, shelves, cabinets or on countertops or benchtops where blood or other potentially infectious materials are present.

- If handling potentially infectious bodily parts following dismemberment in an accident, specimens of blood or other potentially infectious materials will be placed in a container which prevents leakage during collection, handling, processing, storage, transport, or shipping. The container will be labeled or color coded according to labeling requirements and closed prior to storage, transportation, or shipping. If outside contamination of the primary container occurs, the primary container will be placed within a secondary container that is puncture-resistant in addition to the above characteristics.

- Equipment (such as drill rigs or equipment used in first aid response) which may become contaminated with blood or other potentially infectious materials will be examined prior to servicing or shipping and decontaminated as necessary, unless the site supervisor determines that decontamination of such equipment is not feasible. A readily observable biohazard label will be attached to the equipment stating which portions remain contaminated. The site Field Team Leader will ensure this information is conveyed to all effected employees, the servicing representative and/or manufacturer as appropriate, prior to handling, servicing or shipping so that appropriate precautions may be taken.

- Personal protective equipment - appropriate personal protective equipment will be provided, such as gloves and mouthpieces in the first aid kit.

- All emergency first aid kits will contain red biohazard bags to contain waste created in first aid/emergency situations.

    - Gloves will be worn at all times.

    - Containers will not be overfilled.

    - Containers will be tightly closed or sealed prior to transportation.

    - Pools of blood, bodily fluid, tissue, or spills from biohazard waste containers will be cleaned up with sodium hypochlorite or Chlorox™ bleach, 1 part to 10 parts water.

When an exposure incident is reported, the Delivery Order Manager will complete Form 2, Bloodborne Pathogens Incident Evaluation Form, and will immediately refer the employee for a confidential medical evaluation and follow up. This referral must be made within 24 hours of the incident. This will be completed at a reasonable location and performed by, or under the supervision of, a licensed physician or other licensed health care professional.

The decontamination of the equipment used during a bloodborne pathogen exposure will include the following:

1. Clean spills from around equipment immediately.

2. Employees engaged in cleaning equipment will use personal protective equipment that ensures there is no contact of potentially contaminated material with skin or personal clothing.

3. Clean large equipment with a germicidal detergent or bleach (1 part to 10 parts water), avoiding splatter or dripping. If dripping is reasonably anticipated, use a drop cloth under the equipment being cleaned.

4. Wipe contamination from small, reusable equipment. Label the equipment with warning labels indicating which parts are contaminated before sending it to an appropriate location for reprocessing.

5. All cleaning materials and personal protective equipment will be disposed of as infectious waste or properly prepared for transport to a laundry as potentially infectious laundry.

6. Wash hands after removal of personal protective equipment.

5.2.3.2 Other

Site hazard for other biological agents (such as flora and fauna) is anticipated to be low. General hazards and precautions are provided under Section 5.6 of the General HSP.

5.2.4 Electrical Hazards

Electrical hazards for this project are anticipated to be low. Specific electrical hazards that apply to drilling and excavating activities are described under Section 5.4 (for drilling) and Section 5.5 (for excavation) of the General HSP.

5.2.5 Heat/Cold Stress

The possibility for heat stress and/or cold stress exists for this project based upon the time(s) of the year when work will take place. Section 5.3 of the General HSP describes hazards and precautionary measures for both, which will be discussed during site safety briefings.

5.2.6 Noise Hazards

Personnel working within 15 feet of an operating drill rig, back hoe, or other noise generating equipment will wear appropriate hearing protection (e.g. ear plugs). Appropriate hearing protection will be worn during operations. Other noise hazards are anticipated to be low for this project.

5.2.7 Shipping Hazardous Material

The shipping of identified hazardous materials will be done in accordance with the General HSP, Section 5.8, Identified Hazardous Materials.

6.0 SITE WORKER TRAINING

All employees working on site who may be exposed to risks will be in compliance with the training requirements specified in Section 6.0 of the General Health and Safety Plan. The documents certifying this training will be placed into Appendix B.

The schedule for pre-entry briefings is found in section 6.5 of the General Health and Safety Plan.

Copies of the following forms will be completed in field:

Form 1	Subcontractor Statement of Compliance Form	Required
Form 2	Bloodborne Pathogens Incident Evaluation Form	
Form 3	Accident/Exposure Report Form	
Form 4	Equipment Log Form	Required
Form 5	Air Monitoring Data Form	Required
Form 6	Site Safety Briefing Form	Required
Form 7	Site Specific Health and Safety Plan/ Exposure History Form	Required
Form 8	OSHA Poster for Private Industry Form	Required
Form 9	Plan Acceptance Form	Required
Form 10	Plan Feedback Form (Optional)	

7.0 PERSONNEL PROTECTION

This project will be conducted using the following initial level of protection:

Level A ___ Level B ___ Level C ___ Level D X

The types of monitoring instruments used, as well as the action levels to upgrade personal protection are shown on Table 3, Hazard Monitoring Methods, Action Levels, and Protective Measures. Table 4 provides a specific description of the levels of protection for this field effort.

8.0 MEDICAL SURVEILLANCE

The medical surveillance program for site workers on this project is found in section 8.0 of the General Health and Safety Plan.

9.0 MONITORING

Air monitoring will be conducted for the chemical hazards described earlier. The equipment necessary for exposure monitoring at this site consists of the photoionization detector (PID) equipped with a 10.2 eV ultraviolet lamp. The Site Health and Safety Officer will ensure that this instrument is calibrated in accordance with manufacturer's instructions (and logged) prior to use. Air monitoring will be conducted by the Site Safety Officer and/or the Field Team Leader. Both the Site Safety Officer and the Field Team Leader will be responsible for the enforcement of the safety procedures during this project. Air monitoring concentrations will be recorded on the attached form (Form 5). The procedures for upgrading personal protective equipment are contained in Table 2. Other details regarding air monitoring are provided on Table 3.

10.0 SITE CONTROL

To prevent the accidental spread of contaminants, as a minimum, three zones will be delineated on the site:

- Exclusion Zone: The exclusion zone will be visually identifiable by placing barrier tape, cones, etc. at the periphery. Only authorized personnel may enter this zone and will be equipped with proper personal protective equipment (PPE). At a minimum, this zone will include all areas within a 20 foot radius of any invasive field activity (e.g. drilling, excavating, sampling, etc.). This zone may be modified in size at the discretion of the Site Health and Safety Officer.

- Contamination Reduction Zone: The contamination reduction zone (CRZ) will include the area immediately outside the exclusion zone. This is the zone where personnel and equipment decontamination will take place. Only authorized personnel wearing appropriate PPE may enter this area. The CRZ may be discontiguous and may occupy more than one identifiable location at the site. The specific boundaries will be established by the Site Health and Safety Officer.

- Support Zone: The support zone, also referred as the work staging area, shall include all areas at the site which have not been specifically identified as exclusion or CRZ areas. No specific field effort-related PPE is required in this area.

The safety of personnel is paramount in any spill situation. The following guidelines are general safety procedures to follow if a spill occurs:

- Personnel will maintain proper ventilation, wear appropriate personal protective equipment (PPE), and will not work alone.

- Flush eyes with water a minimum of 15 minutes and wash skin with soap and water if contact occurs. Remove clothing if exposed and wash affected area with soap and water, preferably at a shower facility. Contact the nearest medical facility as specified in the HSP for additional guidance.

The key to controlling a discharge is to stop the source and contain the spill before it spreads and reaches greater proportions. As a result, the first line of defense lies with the personnel at the site or personnel in charge of the facility. In order to minimize the clean-up operation, spilled wastes must be contained and controlled at the original site by implementing the following guidelines:

- Restrict access to the area by unauthorized personnel.
- Notify the AFBCA and/or the individual in charge of the immediate facility.
- Wear appropriate PPE such as rubber gloves, apron, boots, and goggles. If the spill is large (Class II or III) only personnel trained in handling flammable liquids will be permitted to remain or enter the area with proper PPE.
- Remove sources of ignition in close proximity to the spill. Notify the Fire Department if sources are burning or cannot be removed and stay clear of the area.

11.0 DECONTAMINATION PROCEDURES

The decontamination procedures established for this project are located in Section 7.10 of the General Health and Safety Plan.

12.0 CONFINED SPACE ENTRY PROCEDURES

Confined space entry is not planned for this project. No employees will be allowed to enter a confined space during this project.

13.0 EMERGENCY RESPONSE PLAN

13.1 EMERGENCY RESPONSE PLAN

The emergency response plan is located as Section 7.8 of the General Health and Safety Plan. The following table is further provided to aid in emergency contacts:

Contact	Person or Agency	Telephone No.
Police	Kansas City, Mo	911
Fire	Grandview Fire Dept KCFD Richards-Gebaur	911 (816) 331-2121 911
Ambulance	Kansas City, Missouri	911
Hospital	Research Belton Hospital	(816)348-1200
Poison Center	Poison Control Center	(816) 234-3434 (800) 366-8888
Client Contact	P. Mark Esch	(816)348-2514
D&M Delivery Order Manager	Wayne A. Mizer	(913)677-1490W (913)642-2987H
D&M Office Safety Coordinator /Site Health & Safety Officer	L. Kristopher Moore	(913)677-1490W (913)894-1378H

Contact	Person or Agency	Telephone No.
Division H&S Manager	Ken Fischer, CIH	(301)652-2215 W
Firmwide H&S Director	Dr. Gary Krieger	(303)294-9100 W
Other Resources:		
Missouri DNR	Glenn Golson	(314)751-3176
U.S. EPA	Spill Line	(913)236-3778
U.S. EPA	Region VII	(800)424-9346
National Response Center	--	(800)424-8802
ATSDR	--	(404)639-3111 (404)329-2889
CHEMTREC	24 Hour Phone No.	(800)424-9300

13.2 ADDITIONAL ARTICLES TO BE TAKEN IN THE FIELD

The following additional articles will be taken into the field for safety purposes:

- Air monitoring equipment (i.e. PID and calibration supplies)
- First aid kit
- Fire extinguisher
- Portable eye wash
- Bloodborne pathogen kit
- Decontamination supplies
- Barrier tape
- Duct tape

TABLES

TABLE 1
EXPOSURE LIMITS AND RECOGNITION QUALITIES

COMPOUND	Exposure Standards TLV/PEL (a) (ppm)	 STEL (b) (ppm)	 IDLH © (ppm)	Skin Designation	Recognition Qualities Odor/ Threshold (ppm)	 LEL (d) (%)	 Ionization Potential (ev)
Benzene	1.0	--	3,000	--	12	1.30	9.24
Ethyl benzene	100.0	125	2,000	--	2.3	1.00	8.76
Tetraethyl lead	0.08^1	--	40^1	Yes	musty	--	11.10
Toluene	100.0	150	2,000	--	2.9	1.20	8.82
Xylenes	100.0	150	1,000	--	1.1	1.00	8.56
Ethylene Glycol	50.0	-	100^2	--	odorless	--	--
PCB - Aroclor® 1254^3	0.5^1	1^1	5^1	Yes	mild hydrocarbon	--	--

1	mg/m^3
2	mL
3	One of several trade or common names which also include Aroclor® Series 1016, 1221,1232, 1242, 1248, 1260.
(a)	The more stringent of either the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limit (PEL) or the American Conference Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV).
(b)	Short Term Exposure Limit - 15 minute exposure.
©	Immediately Dangerous to Life and Health.
(d)	Lower Explosive Limit.

TABLE 2
HEALTH HAZARDS AND FIRST AID

Compound	Routes of Entry	Eye Irritation	Symptoms	Target Organs
Benzene	Ingestion Absorption Contact Inhalation	Yes	Irritated nose & respiratory system, giddy, headache, nausea, staggered gait, fatigue, anorexia, lassitude, dermatitis, bone marrow depression, carcinogenic	Blood, central nervous system, skin, bone marrow, eyes, respiratory system
Ethyl benzene	Ingestion Inhalation Contact	Yes	Irritated mucous membranes, headache, dermatitis, narcosis, coma	Eyes, upper respiratory system, skin, central nervous system
Tetraethyl lead	Ingestion Absorption Contact Inhalation	Yes	Insomnia, lassitude, anxiety, tremors, hyperreflexia, hypotension, pallor, nausea, convulsions, coma, low weight, disorientation, psychosis	Central nervous system, cardiovascular system, kidneys, eyes
Toluene	Ingestion Absorption Contact Inhalation		Fatigue, weakness, confusion, euphoria, dizziness, headache, dilated pupils, muscle fatigue, insomnia, dermatitis	Central nervous system, liver kidneys, skin
Xylenes	Ingestion Absorption Contact Inhalation	Yes	Dizziness, excitement, drowsiness, incoherent staggering gait, irritated nose & throat, anorexia, nausea, vomiting, abdominal pain, dermatitis	Central nervous system, eyes, gastrointestinal tract, blood, liver, kidneys, skin
Ethylene Glycol	Ingestion Inhalation	Yes	Ingestion can lead to prostration or unconsciousness, accompanied by metabolic acidosis and renal damage. Inhalation exposure can cause throat irritation , mild headache, and possible lower back pain.	Eyes, upper respiratory system, gastrointestinal tract, kidneys
PCB - Aroclor® 1254	Ingestion Absorption Inhalation	Yes	Irritation to eyes, skin chlora-acne, nausea, edema of face and hand, abdominal pain, anorexia	Skin, eyes, liver

NOTE: General First Aid Treatment

Eye:	**IRRIGATE IMMEDIATELY**
Skin:	**SOAP WASH PROMPTLY**
Inhalation:	**MOVE TO FRESH AIR - RESPIRATORY SUPPORT**
Ingestion:	**GET MEDICAL ATTENTION IMMEDIATELY**

TABLE 3
HAZARD MONITORING METHODS, ACTION LEVELS, AND PROTECTIVE MEASURES

Hazard	Monitoring Method	Action Level	Monitoring Schedule	Protective Measures
Organic vapors	PID (with 10.2eV lamp)	Up to 5 ppm above background in the breathing zone	Periodically (every 30 minutes) during invasive field activities	Level D
		5-50 ppm	Periodically (every 30 minutes) during invasive field activities	Level C
		>50 ppm	Periodically (every 30 minutes) during invasive field activities	Level B or EVACUATE AREA
Oxygen deficient atmosphere	O_2 meter	25%-20.8%	Continue operations	
		<20.8%	Continuous monitoring	
		$\leq$19.5%	Do not enter. Ventilate and determine if supplied air is required.	Level B
		>25%	Fire explosion hazard. Withdraw from area immediately	
Explosion	CGI	< 5% LEL	Continue investigation	
		5-10% LEL	Continue monitoring with caution as high levels are encountered	
		> 10% LEL	Explosion hazard. Withdraw from area immediately	

TABLE 4

PROTECTIVE EQUIPMENT FOR ONSITE ACTIVITIES

ACTIVITY	LEVEL	PROTECTIVE EQUIPMENT
Site remediation, oversight of AST, demolition, excavation, removal and disposal; site restoration, subsurface soil and ground water sampling.	C	- Full facepiece air purifying respirator - Chemical-resistant clothing - Inner and outer chemical-resistant gloves - Safety boots - Hard hat - Hearing protection *
Same as above	D	- Work clothes or coveralls - Safety boots - Safety glasses or goggles - Hard hat - Hearing protection *

* Mandatory only when working in proximity of high noise generating equipment (e.g., generator, drill rig, etc.)

FIGURES

FIGURE 1 - SITE LOCATION MAP

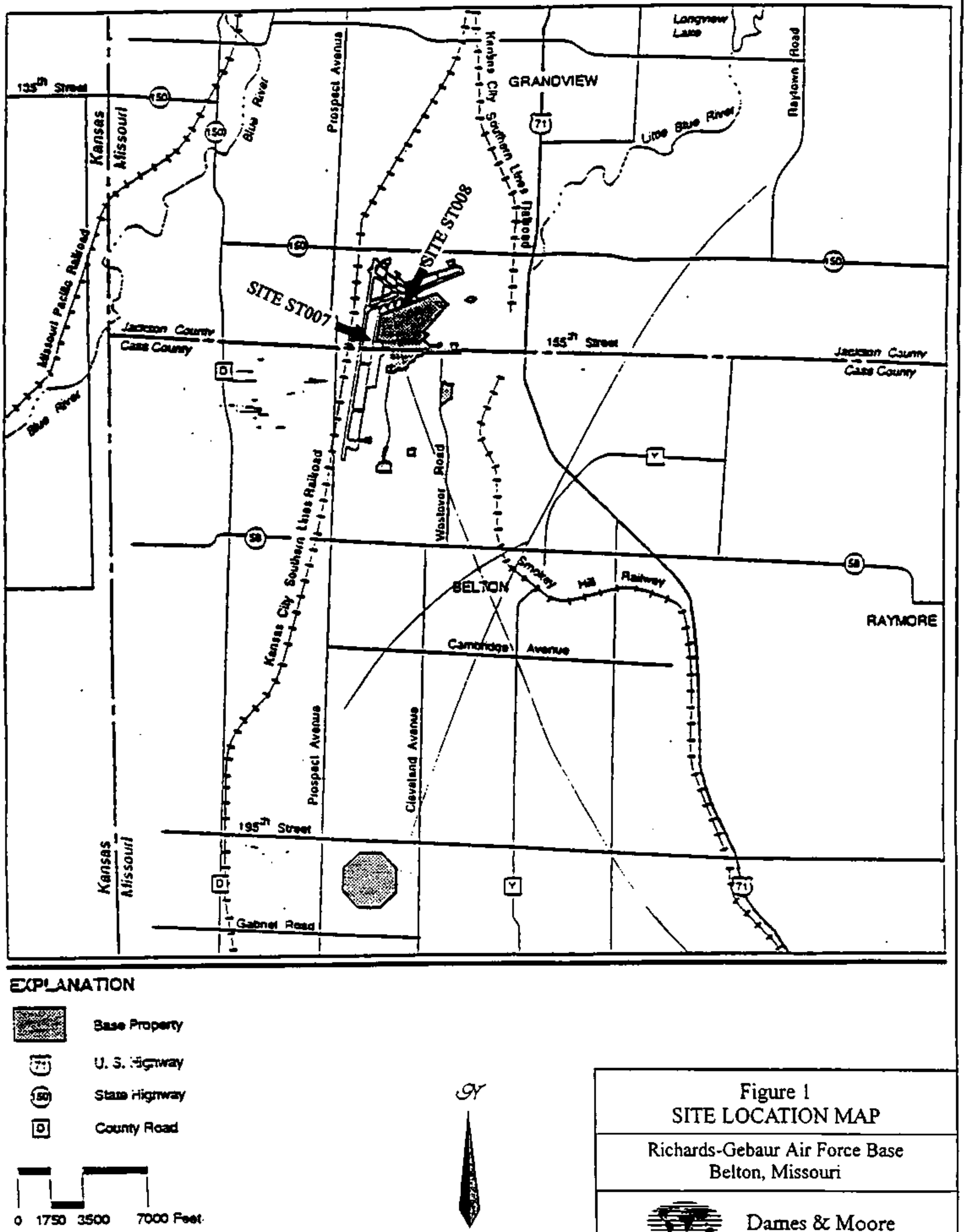


Figure 1
SITE LOCATION MAP

Richards-Gebaur Air Force Base
Belton, Missouri

Dames & Moore

FIGURES 2 AND 3 - SITE LAYOUT DIAGRAMS

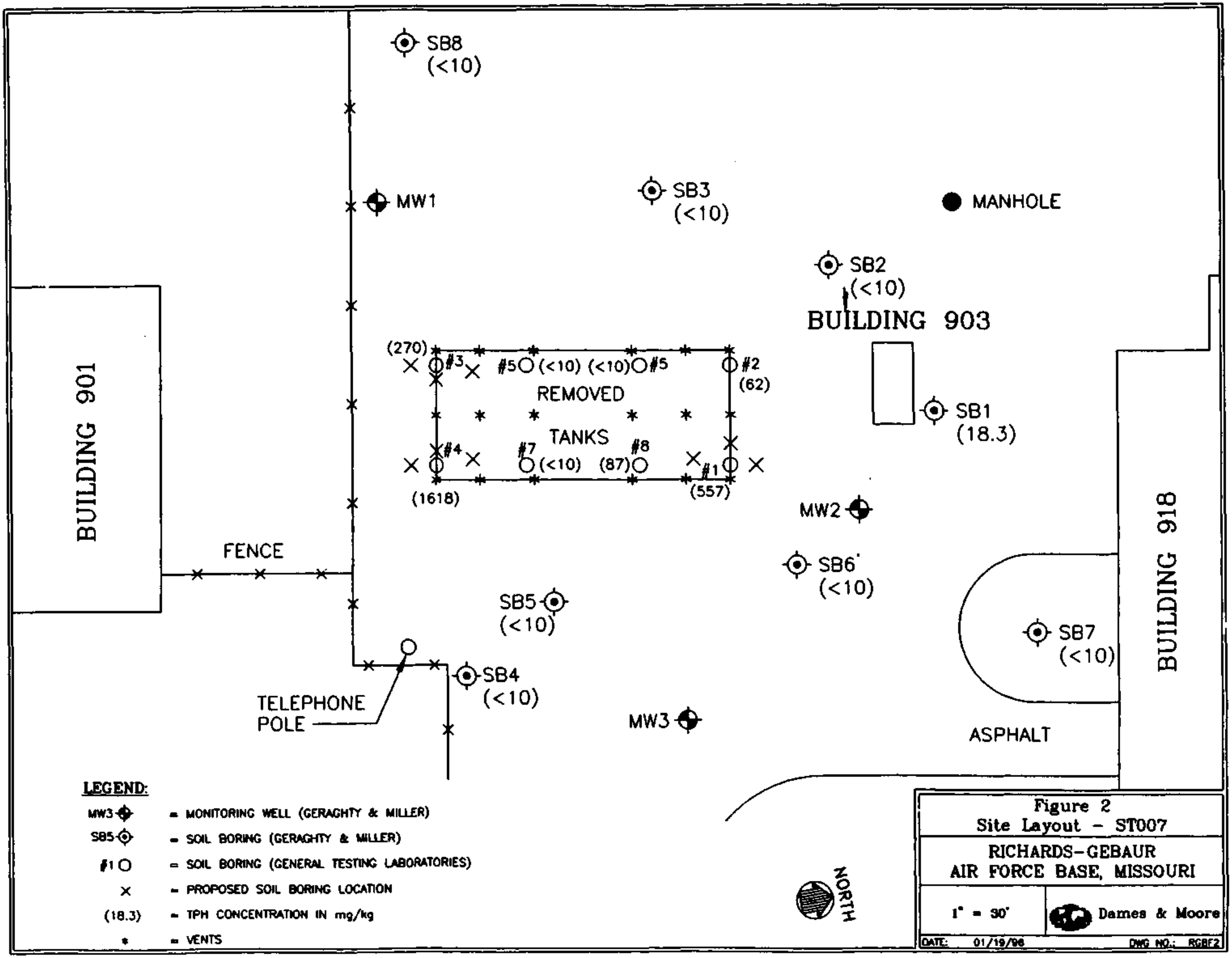


Figure 2
Site Layout - ST007

RICHARDS-GEBAUR
AIR FORCE BASE, MISSOURI

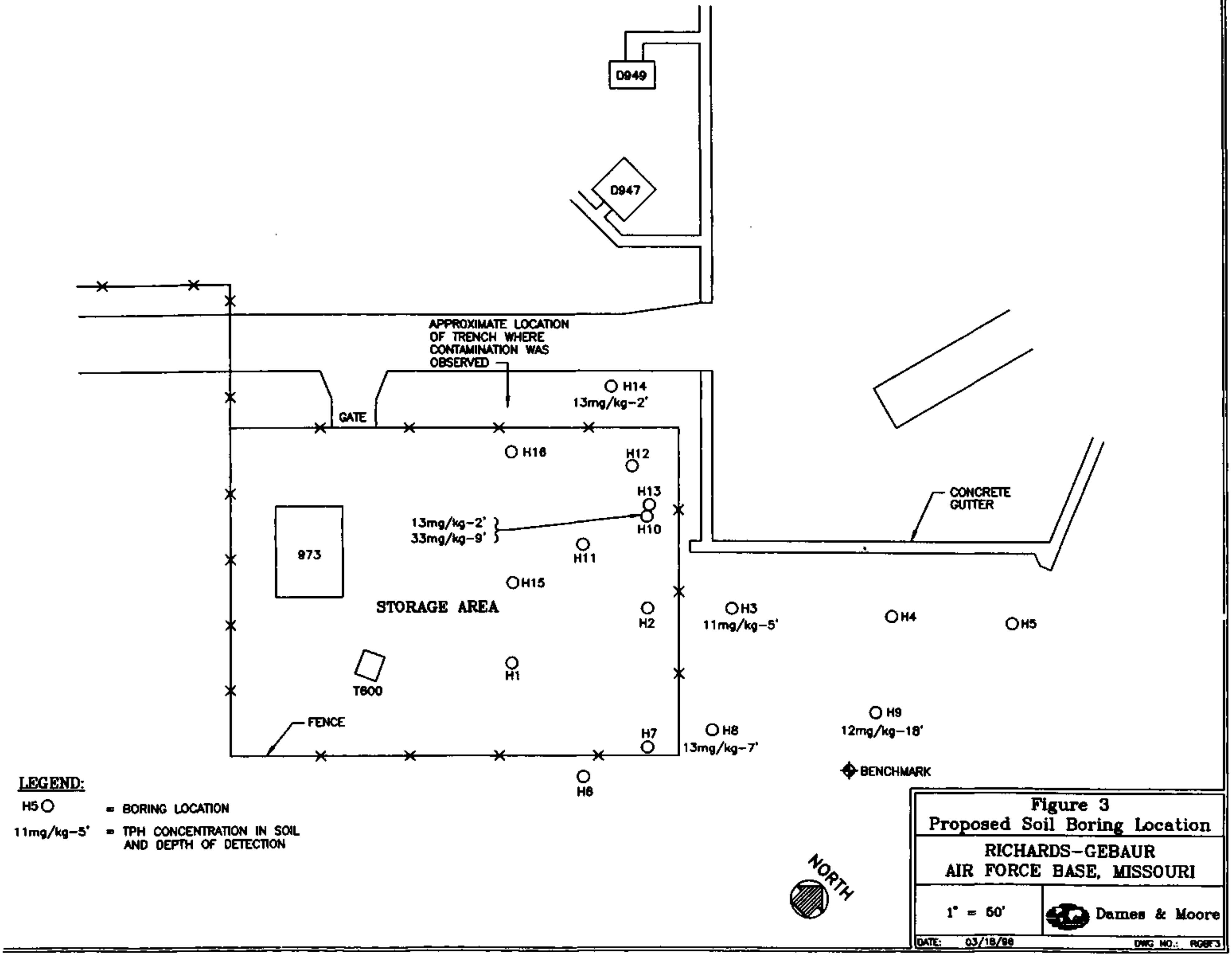


Figure 3
Proposed Soil Boring Location

RICHARDS-GEBAUR
AIR FORCE BASE, MISSOURI

FIGURE 4 - EMERGENCY ROUTE TO HOSPITAL

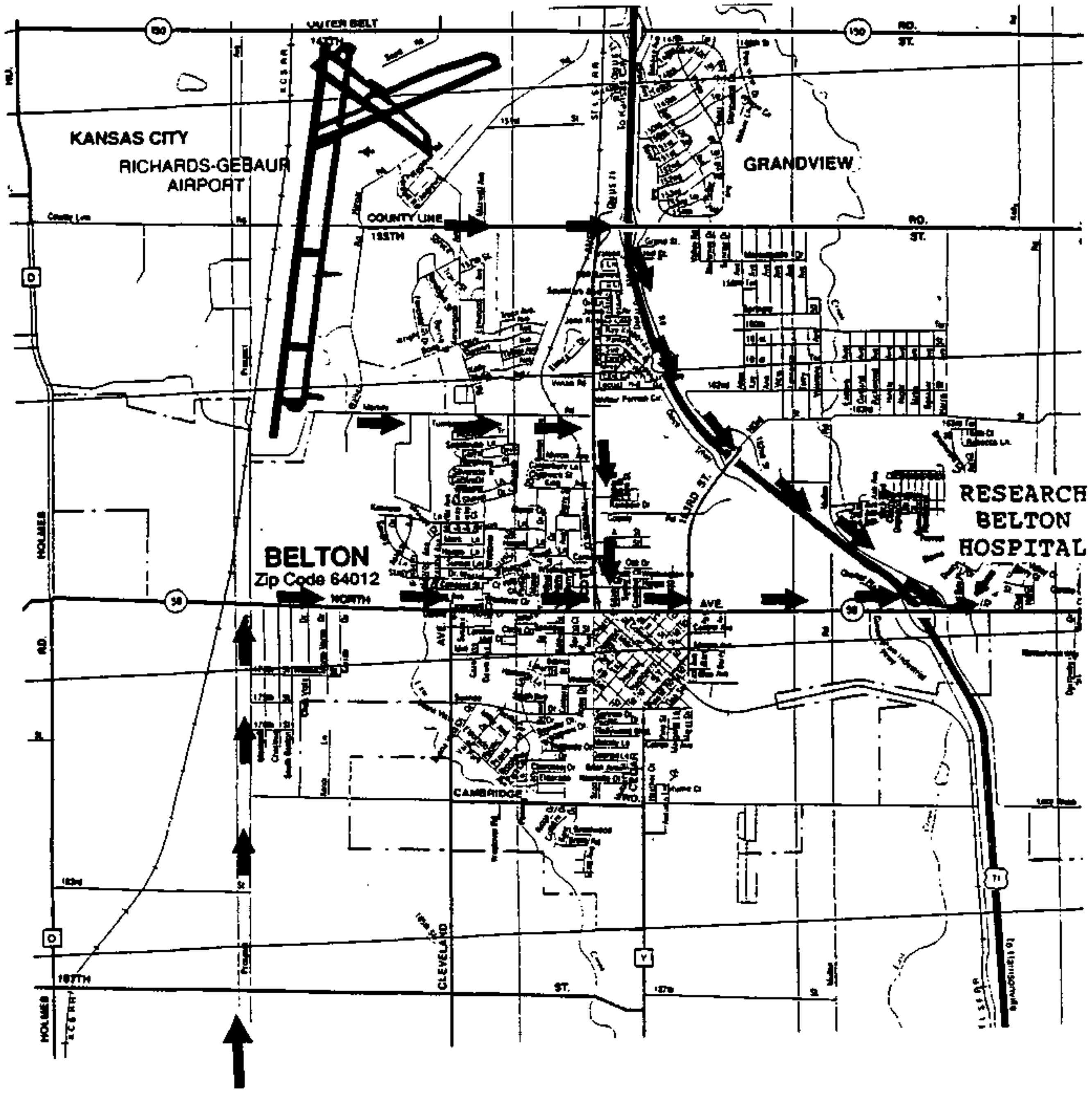


Figure 4
EMERGENCY ROUTE TO HOSPITAL

Richards-Gebaur Air Force Base
Belton, Missouri

Dames & Moore

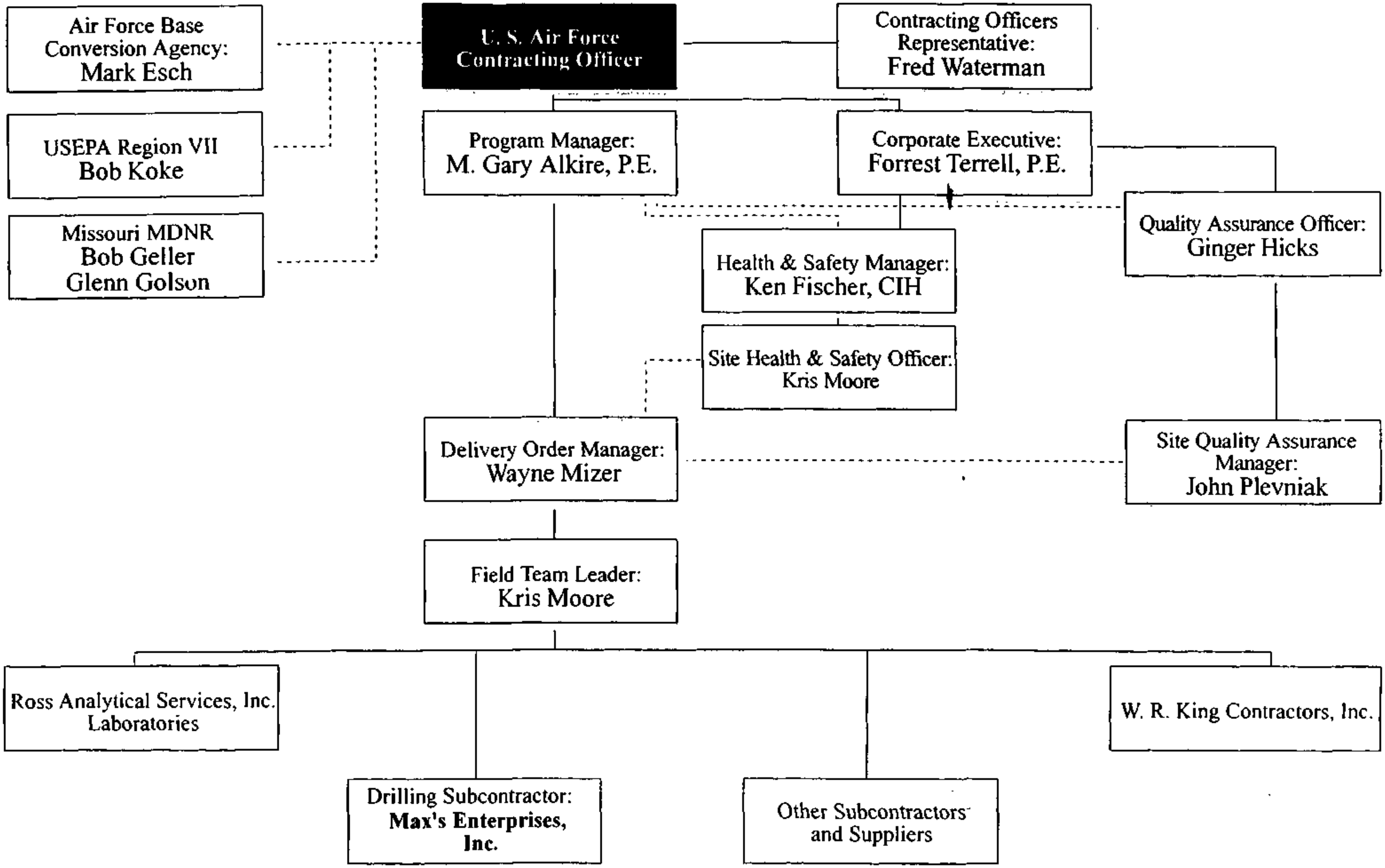
APPENDICES

APPENDIX A

Project Organization Chart

Richards - Gebaur Air Force Base Delivery Order No. 3

Organizational Chart



APPENDIX B

Worker Training & Medical Surveillance Records

MEDICAL SURVEILLANCE NOTIFICATION

Dames & Moore Health Services Group
Denver, CO

Employee Name: Scott Davis
Exam Date: 01/08/96

Company: Dames & Moore
Location: KSC

Job Title: Field Tech.

Exam Type: Base

This individual's medical status was reviewed according to 29 CFR 1910.120, 1910.1001, 1910.134 and:

_X_ Is qualified for full participation in hazardous waste or asbestos site work when conducted under the conditions of adequate training and a health and safety plan.

___ Is qualified at this time for participation in hazardous waste or asbestos site work when conducted under the conditions of adequate training and a health and safety plan. These work modifications are required.

___ Is NOT QUALIFIED at this time for full participation in hazardous waste or asbestos work. See below.

_X_ Qualified to use a respirator.

___ NOT QUALIFIED to use a respirator.

___ Follow-up under Dames & Moore account.

_X_ Follow-up with personal physician under personal health insurance.

1-19-96
Date

Gary R. Krieger MD/mzb
Gary R. Krieger, MD, MPH, DABT
Dames & Moore Medical Director

THE INFORMATION PROVIDED ON THIS FORM WILL BE CONSIDERED INVALID ON 1-8-97
For information needed after the expiration date, contact the Dames & Moore Medical Surveillance Group, Denver, Colorado (303) 299-7978

Supervisor: Wayne Mizer
Manager: Gary Russ
Division Health & Safety Manager: Tom Natsch
Office Safety Coordinator: Gary Russ

American Red Cross

This certifies that

Scott Davis

has completed the requirements for

ADULT CPR

sponsored by

Greater KC Chapter

Date completed

[illegible]

American Red Cross

This certifies that

Scott Davis

has completed the requirements for

STANDARD FIRST AID

sponsored by

Greater KC Chapter

Date completed

[illegible]

Instructor's Signature

Chairman, American Red Cross

Instructor's Signature

Chairman, American Red Cross

O.S.H.A. 1910.120

HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE

This is to certify that **SCOTT DAVIS**

has successfully completed the 40 hour training required within O.S.H.A. 1910.120 (q), and is hereby certified as a

"HAZARDOUS MATERIALS TECHNICIAN"

Organization: University of Missouri at Rolla
Dates: January 2 - 5, 1996
Certified By: Consolidated Resources Inc.
Instructors Signature Mel Leibach
Date 1/5/96

MEDICAL SURVEILLANCE NOTIFICATION
Dames & Moore Health Services Group
Denver, CO

Employee Name: Meera Desai

Exam Date: 02/28/95

Company: Dames & Moore

Location: KSC

Job Title: Asst. Engineer

Exam Type: Base

This individual's medical status was reviewed according to 29 CFR 1910.120, 1910.1001, 1910.134 and:

X Is qualified for full participation in hazardous waste or asbestos site work when conducted under the conditions of adequate training and a health and safety plan.

___ Is qualified at this time for participation in hazardous waste or asbestos site work when conducted under the conditions of adequate training and a health and safety plan. These work modifications are required.

___ Is NOT QUALIFIED at this time for full participation in hazardous waste or asbestos work. See below.

X Qualified to use a respirator.

___ NOT QUALIFIED to use a respirator.

___ Follow-up under Dames & Moore account.

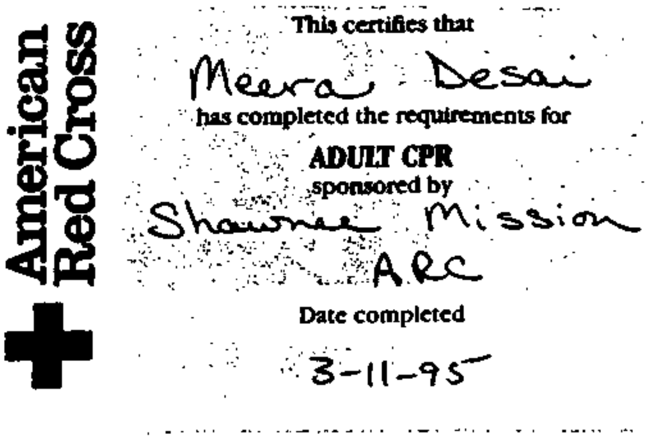
X Follow-up with personal physician under health insurance.

3-20-95
Date

Gary R. Krieger MD
Gary R. Krieger, MD, MPH, DABT
Dames & Moore Medical Director

THE INFORMATION PROVIDED ON THIS FORM WILL BE CONSIDERED INVALID ON 2-28-96
For information needed after the expiration date, contact the Dames & Moore Medical Surveillance Group, Denver, Colorado (303) 299-7978

Supervisor: Dave Van Dyke
Manager:
Division Health & Safety Manager: Tom Covilli
Office Safety Coordinator: Dave Van Dyke



American Red Cross

This certifies that

Meera Desai

has completed the requirements for

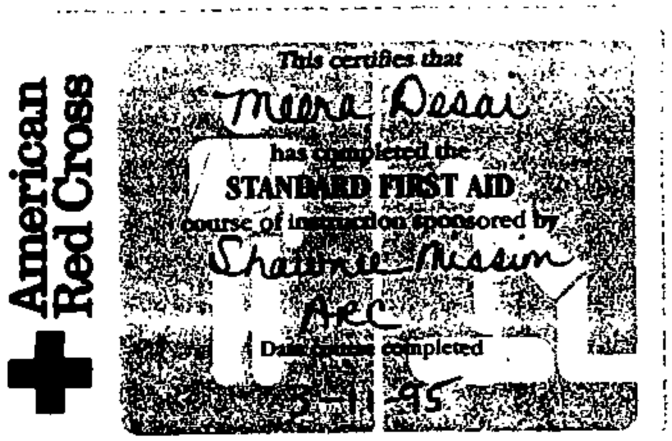
ADULT CPR

sponsored by

Shawnee Mission ARC

Date completed

3-11-95



American Red Cross

This certifies that

Meera Desai

has completed the

STANDARD FIRST AID

course of instruction sponsored by

Shawnee Mission ARC

Date course completed

3-11-95

Certificate of Completion

This Certifies That

Meera Desai

has completed 8-hour OSHA Refresher Course
in accordance with 29 CFR 1910.120

Presented by:

DAMES & MOORE

Overland Park, Kansas
June 23, 1995

Training Director

PHILLIPS ENVIRONMENTAL TRAINING INC.

Certificate of Completion
presented to

Meera Desai

40 - Hour Initial Training

Hazardous Waste Operation and Emergency Response
29 CFR 1910.120

MAY 16 - 20, 1994
DATE OF INSTRUCTION

FRANKLIN A. PHILLIPS
Certified Environmental Trainer
Certified Hazardous Materials Manager

MEDICAL SURVEILLANCE NOTIFICATION

Dames & Moore Health Services Group
Denver, CO

Employee Name: Laurence K. Moore Exam Date: 11/28/95

Company: Dames & Moore Location: KSC

Job Title: Geologist

Exam Type: Annual, ECG

This individual's medical status was reviewed according to 29 CFR 1910.120, 1910.1001, 1910.134 and:

___ Is qualified for full participation in hazardous waste or asbestos site work when conducted under the conditions of adequate training and a health and safety plan.

_X_ Is qualified at this time for participation in hazardous waste or asbestos site work when conducted under the conditions of adequate training and a health and safety plan. These work modifications are required.
Must wear hearing protection in high noise areas.

___ Is NOT QUALIFIED at this time for full participation in hazardous waste or asbestos work. See below.

_X_ Qualified to use a respirator.

___ NOT QUALIFIED to use a respirator.

___ Follow-up under Dames & Moore account.

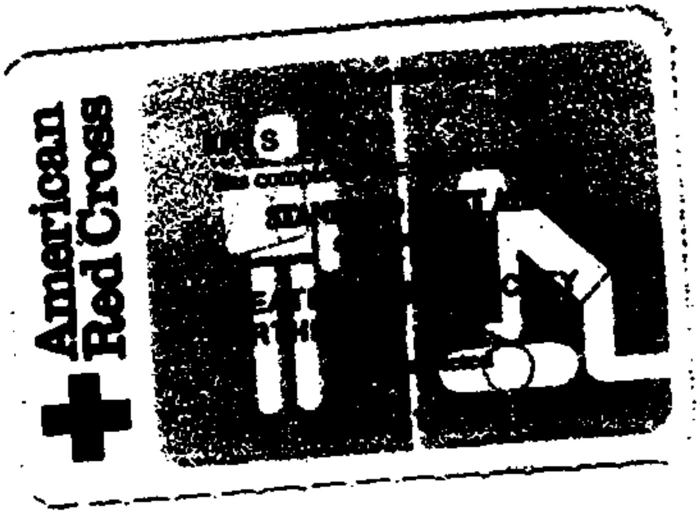
___ Follow-up with personal physician under personal health insurance.

1-4-96 Gary R. Krieger MD
Date Gary R. Krieger, MD, MPH, DABT
Dames & Moore Medical Director

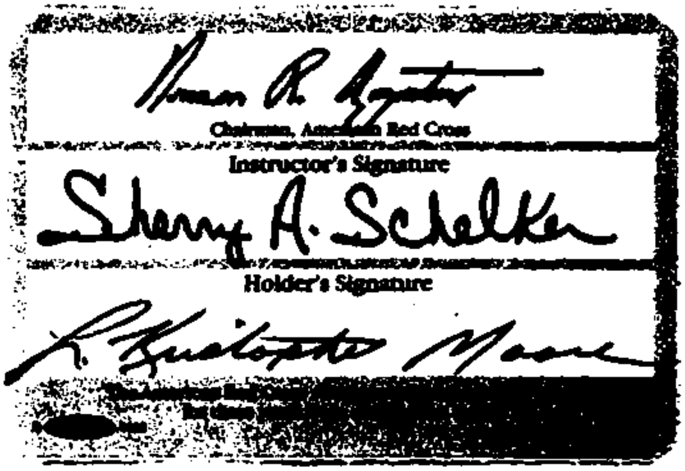
THE INFORMATION PROVIDED ON THIS FORM WILL BE CONSIDERED INVALID ON 11-28-96
For information needed after the expiration date, contact the Dames & Moore Medical Surveillance Group, Denver, Colorado (303) 299-7978

Supervisor: Wayne Mizer
Manager: Gary Russ
Division Health & Safety Manager: Tom Natsch
Office Safety Coordinator: Gary Russ

mb



American Red Cross

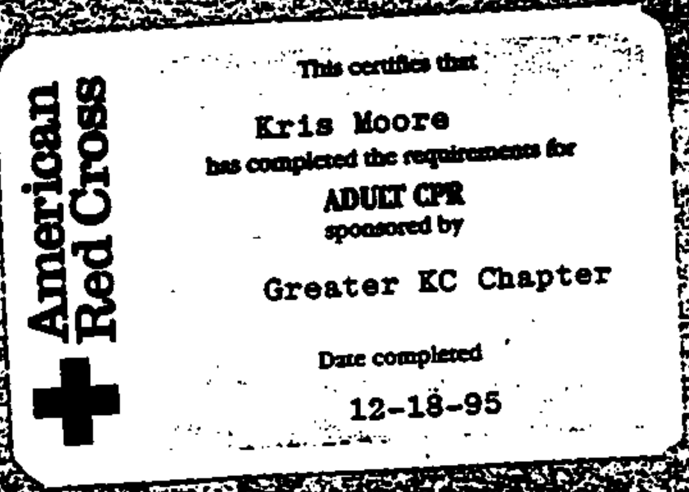


Chairman, American Red Cross

Instructor's Signature

Sherry A. Schelker

Holder's Signature



American Red Cross

This certifies that

Kris Moore

has completed the requirements for

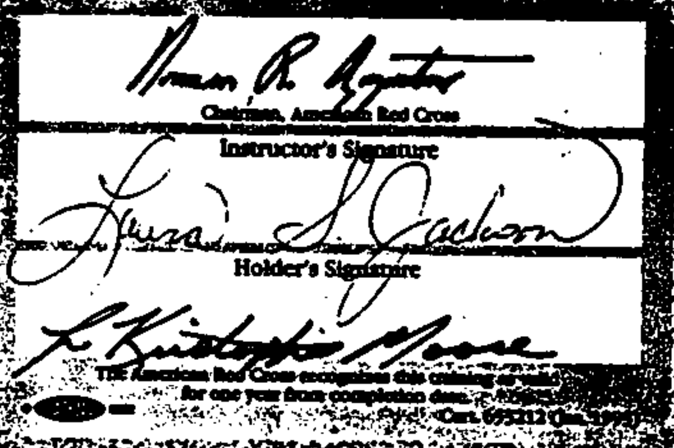
ADULT CPR

sponsored by

Greater KC Chapter

Date completed

12-18-95



Norman R. Augustine

Chairman, American Red Cross

Instructor's Signature

Laura S. Jackson

Holder's Signature

L Kristopher Moore

THE American Red Cross recognizes this training as valid for one year from completion date.

Cert. 655212 ([illegible])

Certificate of Completion

This certifies that

Kris Moore

has completed an 8-hour HAZWOPER Refresher Training Course in accordance with 29 CFR 1910.120(e)

Presented by

Dames & Moore

Thomas G Natsch

Thomas G. Natsch, CIH
Central Division Health & Safety Manager

DAMES & MOORE
Kansas City, Missouri
January 2, 1996

Certificate of Completion

In Recognition of Work Performed
and the Satisfactory Demonstration
of a Basic Knowledge of
Field Investigation Techniques to Satisfy
OSHA Rules, 29 CFR Part 1910.120

This Certificate is Awarded to

(40-hour Training for Hazardous Waste Field Investigation)

L. KRISTOPHER MOORE

Presented by:

Dames & Moore

CIH
Course Instructor

September 24-28, 1990
Date

MEDICAL SURVEILLANCE NOTIFICATION
Dames & Moore Health Services Group
Denver, CO

Employee Name: John Plevniak Exam Date: 02/02/96

Company: Dames & Moore Location: KSC

Job Title: Geologist

Exam Type: Biennial, CXR

This individual's medical status was reviewed according to 29 CFR 1910.120, 1910.1001, 1910.134 and:

_X_ Is qualified for full participation in hazardous waste or asbestos site work when conducted under the conditions of adequate training and a health and safety plan.

___ Is qualified at this time for participation in hazardous waste or asbestos site work when conducted under the conditions of adequate training and a health and safety plan. These work modifications are required.

___ Is NOT QUALIFIED at this time for full participation in hazardous waste or asbestos work. See below.

_X_ Qualified to use a respirator.

___ NOT QUALIFIED to use a respirator.

_X_ Follow-up under Dames & Moore account.

___ Follow-up with personal physician under personal health insurance.

___ Qualified for non-hazardous work requiring hearing protection.

2-21-96 Gary R. Krieger

Date Gary R. Krieger, MD, MPH, DABT
Dames & Moore Medical Director

THE INFORMATION PROVIDED ON THIS FORM WILL BE CONSIDERED INVALID ON 2-2-98
For information needed after the expiration date, contact the Dames & Moore Medical Surveillance Group, Denver, Colorado (303) 299-7978

Supervisor: Wayne Mizer
Manager: Gary Russ
Division Health & Safety Manager: Tom Natsch
Office Safety Coordinator: Gary Russ

American Red Cross

This certifies that

John Plewniak

has completed the requirements for

ADULT CPR

sponsored by

Shawnee Mission
ARC

Date completed

3-11-95

THIS IS TO CERTIFY THAT

JOHN E. PLEVNIAK

satisfactorily completed a program of

BASIC FIRST AID

(date) 01/19/93

R.H. Sanders & Assoc.
7807 - 15th Avenue
Kenosha, WI 53140
1-800-869-9289

Certificate of Completion

This Certifies That

John Plevniak

has completed 8-hour OSHA Refresher Course
in accordance with 29 CFR 1910.120

Presented by:

DAMES & MOORE

Training Director

Overland Park, Kansas
June 23, 1995

EMILCOTT
ASSOCIATES, INC.

HEALTH, SAFETY AND ENVIRONMENTAL TRAINING PROGRAM

This Certifies That

John Plevniak

Has Successfully Completed

40 Hour Health and Safety Training Course for Hazardous Waste Operations

Date **August 31, 1989** Location **Madison, NJ**

Bruce D Groves

BRUCE D. GROVES, CIH
Course Director

DAMES & MOORE MEDICAL SURVEILLANCE PROGRAM
EMPLOYEE NOTIFICATION LETTER

Dear Gary Ross

This letter is a written report regarding the results of your examination as required by the OSHA Hazardous Waste and Emergency Response Standard (1910.120). Although exposure to toxic substances may be hazardous, an individual's risk may be controlled by meticulous observation of safe work practices and the use of personal protective equipment.

It is important to note that this type of examination does not substitute for ongoing care by your personal physician. Additional aspects of routine health care should be discussed with your own physician. Summarized below are abnormalities noted during your exam.

Medical Surveillance findings: Nl exam

Non-work related medical conditions which require follow-up: ______

X Qualified for full participation in hazardous waste work when conducted under the conditions of adequate training and a health and safety plan.

______ The examination disclosed a medical condition which requires these special modifications or work restrictions.

______ Is not qualified at this time for full participation in hazardous waste work. See comments below.

X Qualified to use a respirator.

______ Not qualified to use a respirator.

JOHN S. HUGHES, MD

Examining Physician's Printed Name

Examining Physician's Signature

c: Gary R. Krieger, MD, MPH, DABT
Medical Director, Dames & Moore

American Red Cross

This certifies that

GARY RUSS

has completed the requirements for

ADULT CPR

sponsored by

GREATER KANSAS CITY
AMERICAN RED CROSS-SM

Date completed

12/07/95

Norman R. Augustine

Chairman, American Red Cross

Instructor's Signature

Laura S. Jackson

Holder's Signature

Gary R Russ

The American Red Cross recognizes this training as valid for one year from completion date.

Cert. 653212 (Jan. 1993)

American Red Cross

This certifies that

Gary Russ

has completed the requirements for

ADULT CPR

sponsored by

Shawnee Mission Branch

Date completed

11/19/94

Chairman, American Red Cross

Instructor's Signature

Joan S. Green

Holder's Signature

The American Red Cross recognizes this training as valid for one year from completion date.

Cert. 653212 (Jan. 1993)

American Red Cross

This certifies that

Gary Russ

has completed the requirements for

STANDARD FIRST AID

sponsored by

Shawnee Mission Branch

Date completed

11/19/94

Chairman, American Red Cross

Instructor's Signature

Joan S. Green MSEd, BSW

Holder's Signature

The American Red Cross recognizes this training as valid for three years from completion date.

Cert. 653207 (Jan. 1993)

Certificate of Completion

This Certifies That

Gary Russ

has completed 8-hour OSHA Refresher Course
in accordance with 29 CFR 1910.120

Presented by:

DAMES & MOORE

Training Director

Overland Park, Kansas
June 23, 1995

Certificate of Completion

This Certifies That

Gary R. Russ

has completed 8-hour OSHA Supervisor Course
in accordance with 29 CFR 1910.120

D&M
Seal

Presented by:

DAMES & MOORE

Overland Park, Kansas
April 15, 1995

Training Director

Certificate of Achievement

for the 40-Hour Emergency Response Course
Haz-Mat Technician

This document is to certify that

Gary Russ

has fulfilled the requirements of the
Occupational Safety and Health Administration
under 29 CFR 1910.120

Course Date: May 16-20, 1994
Course Location: Olathe, KS

Social Security Number: 526-59-7347
Certification Number: HRIK6V9FI-0185

Sam L. Hutchings
Haz-Mat Response, Inc. ®
Instructor

MEDICAL SURVEILLANCE NOTIFICATION
Dames & Moore Health Services Group
Denver, CO

Employee Name: Sam St. John Exam Date: 01/09/96

Company: Dames & Moore Location: KSC

Job Title: Field Tech.

Exam Type: Base

This individual's medical status was reviewed according to 29 CFR 1910.120, 1910.1001, 1910.134 and:

_X_ Is qualified for full participation in hazardous waste or asbestos site work when conducted under the conditions of adequate training and a health and safety plan.

___ Is qualified at this time for participation in hazardous waste or asbestos site work when conducted under the conditions of adequate training and a health and safety plan. These work modifications are required.

___ Is NOT QUALIFIED at this time for full participation in hazardous waste or asbestos work. See below.

_X_ Qualified to use a respirator.

___ NOT QUALIFIED to use a respirator.

___ Follow-up under Dames & Moore account.

___ Follow-up with personal physician under personal health insurance.

1-19-96 Gary R. Krieger MD /mzs
Date
Gary R. Krieger, MD, MPH, DABT
Dames & Moore Medical Director

THE INFORMATION PROVIDED ON THIS FORM WILL BE CONSIDERED INVALID ON 1-9-97
For information needed after the expiration date, contact the Dames & Moore Medical Surveillance Group, Denver, Colorado (303) 299-7978

Supervisor: Wayne Mizer
Manager: Gary Russ
Division Health & Safety Manager: Tom Natsch
Office Safety Coordinator: Gary Russ

O.S.H.A. 1910.120

HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE

This is to certify that <u>SAM ST. JOHN</u>
has successfully completed the 40 hour training required within O.S.H.A. 1910.120 (q), and is hereby certified as a

"HAZARDOUS MATERIALS TECHNICIAN"

Organization: University of Missouri at Rolla
Dates: January 2 - 5, 1996
Certified By: Consolidated Resources Inc.
Instructors Signature Mel Leibach
Date 1/5/96

American Red Cross

This certifies that

Sam St. John

has completed the requirements for

STANDARD FIRST AID

sponsored by

Greater KC Chapter

Date completed

1-9-96

Chairman, American Red Cross

Instructor's Signature

Laura S. Jackson

Holder's Signature

The American Red Cross recognizes this training as valid for three years from completion date.

Cert. 653207 (Jan. 1993)

American Red Cross

This certifies that

Sam St. John

has completed the requirements for

ADULT CPR

sponsored by

Greater KC Chapter

Date completed

1-9-96

Chairman, American Red Cross

Instructor's Signature

Laura S. Jackson

Holder's Signature

The American Red Cross recognizes this training as valid for one year from completion date.

Cert. 653212 (Jan. 1993)

APPENDIX C

Field Forms

FORM 1

SUBCONTRACTOR STATEMENT OF COMPLIANCE FORM

This is to confirm that the employees listed below are qualified by virtue of training and experience to engage in field activities at ________________ _____________ located in __________________________, ______________, in connection with the applicable Subcontract Agreement between Dames & Moore and ______________________________ dated _____________, 19___. Further, all said employees have been determined to be properly trained and medically fit to perform those activities prescribed by said subcontract and to use the respiratory protective equipment necessary to perform the job safely in accordance with 29 CFR 1910 and 1926 and any other Federal, State, or local requirements.

Employee Names

1. ____________________________
2. ____________________________
3. ____________________________
4. ____________________________
5. ____________________________
6. ____________________________
7. ____________________________
8. ____________________________
9. ____________________________
10. ____________________________

____
Name of Subcontractor

____
Signature of Authorized Subcontractor Representative

____
Printed Name of Authorized Subcontractor Representative

FORM 2

BLOODBORNE PATHOGENS INCIDENT EVALUATION FORM

Employee Name: ____
Office/Location: ____
Date: ______________ Time: ______________ a.m./p.m.

Circumstances: Supervisor's Assessment of the Following Control Measures Used at the Time of the Exposure (see definition below):

Route of Exposure: ____
____

Engineering: ____
____

Work Practice: ____
____

Personal Protective Equipment: ______________________________
____

Reason for Failure of the Control Measures or Failure to Comply with Recommended Protective Measures:
____
____

Measures Taken to Minimize Reoccurrence of Incident: ______________________
____
____

Supervisor's Signature: ____

Definitions:

Exposure Incident: a specific eye, mouth, other mucous membrane, non-intact skin, or parenteral contact with blood or other potentially infectious materials that result from the performance of an employee's duties.

Engineering Controls: controls (e.g., sharps, disposal containers, self-sheathing needles) that isolate or remove the bloodborne pathogens hazard from the workplace.

Work Practice Controls: controls that reduce the likelihood of exposure by altering the manner in which a task is performed (e.g., prohibiting recapping of needles by a two-handed technique).

Personal Protective Equipment is specialized clothing or equipment worn by an employee for protection against a hazard. General work clothes not intended to function as protection against a hazard are not considered to be personal protective equipment.

FORM 3

ACCIDENT/EXPOSURE REPORT FORM

EMPLOYEE NAME ______________________ DATE OF BIRTH __________

HOME ADDRESS ______________________ PHONE NO. __________

SEX: ☐ MALE ☐ FEMALE JOB TITLE ______________ SOCIAL SECURITY NO. __________

OFFICE NO. _______ OFFICE LOCATION ______________ DATE OF HIRE __________

HOURS USUALLY WORKED: HOURS PER DAY ______ HOURS PER WEEK ______ TOTAL HOURS WEEKLY ______

WHERE DID ACCIDENT OR EXPOSURE OCCUR? (INCLUDE ADDRESS) ______________________

COUNTY ______________ ON EMPLOYER'S PREMISES? ☐ YES ☐ NO

WHAT WAS EMPLOYEE DOING WHEN INJURED? (BE SPECIFIC) ______________________

HOW DID THE ACCIDENT OR EXPOSURE OCCUR? (DESCRIBE FULLY) ______________________

WHAT STEPS COULD BE TAKEN TO PREVENT SUCH AN OCCURRENCE: ______________________

OBJECT OR SUBSTANCE THAT DIRECTLY INJURED EMPLOYEE: ______________________

DESCRIBE THE INJURY OR ILLNESS ______________ PART OF BODY AFFECTED ______________

NAME AND ADDRESS OF PHYSICIAN ______________________

IF HOSPITALIZED, NAME AND ADDRESS OF HOSPITAL ______________________

DATE OF INJURY/ILLNESS ________ TIME OF DAY ______

LOSS OF ONE OR MORE DAYS OF WORK? YES/NO __________ IF YES - DATE LAST WORKED ______________

COMPLETED BY (PRINT) ______________ SIGNATURE ______________

TITLE ______________ DATE ______________

Immediately upon learning of the incident, an Accident/Exposure Report Form must be completed by the supervisor or Site Health and Safety Officer and the injured person(s) for submittal to the Project Manager and Office Safety Coordinator. The completed report must then be immediately transmitted to the Regional H&S Manager and the firmwide H&S Director.

FORM 4

EQUIPMENT LOG FORM

PROJECT NAME: ______________________________ INSTRUMENT: ______________________________
PROJECT NUMBER: ______________________________ SERIAL NUMBER: ______________________________

DATE	PERFORMED/ CALIBRATED BY	HOURS USED	CALIBRATION STANDARD *	INITIAL READING *	CORRECTED READING *	BATTERY CHECK (Y/N)	MAINTENANCE AND REPAIR

*Specify Units

FORM 5
AIR MONITORING DATA FORM

PROJECT NAME: ______________________
PROJECT NUMBER: ______________________
DATE: ______________________

INSTRUMENT USED: ______________________
SAMPLES BY: ______________________
CALIBRATION DATE: ______________________

ESTIMATED WIND DIRECTION: ☐ N ☐ S ☐ E ☐ W ☐ NE ☐ NW ☐ SE ☐ SW
ESTIMATED WIND SPEED: ☐ Calm ☐ Moderate ☐ Strong

FIELD ACTIVITIES: ____

BACKGROUND LEVEL: ______________________ LOCATION: ______________________

SAMPLE NUMBER	TIME	DURATION (MINUTES)	LOCATION	READING (PPM)	COMMENTS
1					
2					
3					
4					
5					
6					
7					

FORM 6

SITE SAFETY BRIEFING FORM

PROJECT NAME ______________________ PROJECT NUMBER ______________

DATE ____________ START TIME __________ COMPLETED ______________

SITE LOCATION ____

TYPE OF WORK (GENERAL) ____

SAFETY ISSUES

TASKS (THIS SHIFT): ____

PROTECTIVE CLOTHING/EQUIPMENT: _________________________________

CHEMICAL HAZARDS: ____

PHYSICAL HAZARDS: ____

CONTROL METHODS: ____

SPECIAL EQUIPMENT/TECHNIQUES: __________________________________

NEAREST PHONE: ____

HOSPITAL NAME/ADDRESS: ____

EMERGENCY RESPONSE PLAN REVIEW INCLUDING EMERGENCY EVACUATION ROUTE: ______________

SPECIAL TOPICS (INCIDENTS, ACTIONS TAKEN, ETC.) ____________________

ATTENDEES

PRINT NAME	SIGN NAME

MEETING CONDUCTED BY: ____

FORM 7

SITE SPECIFIC HEALTH & SAFETY PLAN

EXPOSURE HISTORY FORM

(To be Completed by Project Manager)

Job Name ______________________________ Job No: ______________________________

Employee Name ______________________________ Signed: ______________________________

Dates From/To: ______________________________

Hours on Site: ______________________________

Suspected Contaminants	**Verified Contaminants and** ***Airborne Concentration Thereof***

FORM 8

OSHA POSTER FOR PRIVATE INDUSTRY FORM

FORM 9

PLAN ACCEPTANCE FORM

INSTRUCTIONS: This form is to be completed by each employee to work on the subject project work site and returned to the Office Safety Coordinator (OSC) prior to site activities.

Project Name: ______________________________

Project Number: ______________________________

Date: ______________________________

I represent that I have read and understand the contents of the above Plan and agree to perform my work in accordance with it.

____
Signed

____
Print Name

____
Date

FORM 10

PLAN FEEDBACK FORM

Project Name: ______________________________

Project Number: ______________________________

Date: ______________________________

Problems with plan requirements:

____

____

____

____

Unexpected situations encountered:

____

____

____

____

Recommendations for future revisions:

____

____

APPENDIX D

Material Safety Data Sheets

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification 32

Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a constuction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.
Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

R 0
I 4
S -
K 0

Genium
1
3 0
-

HMIS
H 3
F 1
R 0
PPG*
* Sec. 8

Cautions: *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 μg/m³
Action Level TWA*: 30 μg/m³

29 CFR 1910.1025 Lead Standard
Blood Lead Level: 40 μg/100 g

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 μg/m³

1988 NIOSH REL
10-hr TWA: <100 μg/m³

1985-86 Toxicity Data†
Human, inhalation, TC_{Lo}: 10 μg/m³ affects gastrointestinal tract and liver
Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)
Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*

Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

Flash Point: None reported	**Autoignition Temperature:** None reported	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
Unusual Fire or Explosion Hazards: Flammable and moderately explosive in the form of dust when exposed to heat or flame.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
Conditions to Avoid: Rubber gloves containing lead may ignite in nitric acid.
Hazardous Products of Decomposition: Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

Section 6. Health Hazard Data

Carcinogenicity: Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
Summary of Risks: Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system . The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
Medical Conditions Aggravated by Exposure: Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

Continue on next page

Section 6. Health Hazard Data, *continued*

Target Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.(109)
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.
Engineering Controls: Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
Other Precautions: Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Lead compounds, soluble, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN2291
IMO Label: *St. Andrews Cross (X, Stow away from foodstuffs)*
IMDG Packaging Group: III

***MSDS Collection* References:** 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 385
Ethylbenzene

Issued: 8/78 Revision: B, 9/92

Section 1. Material Identification 39

Ethylbenzene ($C_6H_5C_2H_5$) Description: Derived by heating benzene and ethylene in presence of aluminum chloride with subsequent distillation, by fractionation directly from the mixed xylene stream in petroleum refining, or dehydrogenation of naphthenes. Used as a solvent, an antiknock agent in gasoline; and as an intermediate in production of synthetic rubber, styrene, cellulose acetate, diethylbenzene, acetophenone, ethyl anthraquinone, propyl oxide, and α-methylbenzol alcohol.
Other Designations: CAS No. 100-41-4, ethylbenzol, EB, phenylethane, NCI-C56393.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Ethylbenzene is a skin and mucous membrane irritant considered the most irritating of the benzene series. Inhalation causes acute and chronic central nervous system (CNS) effects. It is highly flammable and forms explosive mixtures with air.

R 1
I 3
S 2*
K 4
* Skin absorption

NFPA
3
2 0
-

HMIS
H 2†
F 3
R 0
PPE - Sec. 8
† Chronic effects

Section 2. Ingredients and Occupational Exposure Limits

Ethylbenzene, ca >99.0%. Impurities include ~ 0.1% *meta & para* xylene, ~ 0.1% cumene, and ~ 0.1% toluene.

1991 OSHA PELs
8-hr TWA: 100 ppm (435 mg/m^3)
15-min STEL: 125 ppm (545 mg/m^3)
Action Level: 50 ppm (217 mg/m^3)

1990 IDLH Level
2000 ppm

1990 NIOSH REL
TWA: 100 ppm (435 mg/m^3)
STEL: 125 ppm (545 mg/m^3)

1992-93 ACGIH TLVs
TWA: 100 ppm (434 mg/m^3)
STEL: 125 ppm (545 mg/m^3)

1990 DFG (Germany) MAK
TWA: 100 ppm (440 mg/m^3)
Category 1: local irritants
Peak Exposure Limit: 200 ppm, 5 min momentary value, max of 8/shift
Danger of cutaneous absorption

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 100 ppm/8 hr caused eye effects, sleep, and respiratory changes.
Human, lymphocyte: 1 mmol/L induced sister chromatid exchange.
Rat, oral, LD_{50}: 3500 mg/kg; toxic effects not yet reviewed
Rat (female), inhalation, TC_{Lo}: 1000 ppm/7 hr/day, 5 days/wk, for 3 wk prior to mating and daily for 19 days of gestation produced pups with high incidence of extra ribs.(179)

* See NIOSH, *RTECS* (DA0700000), for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 277 °F (136 °C)
Melting Point: -139 °F (-95 °C)
Surface Tension: 31.5 dyne/cm
Ionization Potential: 8.76 eV
Viscosity: 0.64 cP at 77 °F (25 °C)
Refraction Index: 1.4959 at 68 °F (20 °C)
Relative Evaporation Rate (ether = 1): 0.0106
Bulk Density: 7.21 lb/Gal at 77 °F (25 °C)
Critical Temperature: 651 °F (343.9 °C)
Critical Pressure: 35.6 atm
Molecular Weight: 106.16
Density: 0.863 at 77 °F (25 °C)
Water Solubility: Slightly, 14 mg/100 mL at 59 °F (15 °C)
Other Solubilities: Miscible in alcohol, ether; soluble in carbon tetrachloride, benzene, sulfur dioxide, and many organic solvents; insoluble in ammonia
Odor Threshold: 2.3 ppm
Vapor Pressure: 7.1 mm Hg at 68 °F (20 °C); 10 mmHg at 78.62 °F (25.9 °C); 100 mm Hg 165.38 °F (74.1 °C)
Saturated Vapor Density (Air = 0.075 lb/ft^3 or 1.2 kg/m^3): 0.0768 lb/ft^3 or 1.2298 kg/m^3

Appearance and Odor: Colorless, flammable liquid with a pungent odor.

Section 4. Fire and Explosion Data

Flash Point: 64 °F (18 °C) CC	**Autoignition Temperature:** 810 °F (432 °C)	**LEL:** 1.0% v/v	**UEL:** 6.7% v/v

Extinguishing Media: Class 1B Flammable liquid. For small fires, use dry chemical, carbon dioxide, or 'alcohol-resistant' foam. For large fires, use fog or 'alcohol-resistant' foam. Use water only if other agents are unavailable; EB floats on water and may travel to an ignition source and spread fire. **Unusual Fire or Explosion Hazards:** Burning rate = 5.8 mm/min. Vapors may travel to an ignition source and flash back. Container may explode in heat of fire. EB poses a vapor explosion hazard indoors, outdoors, and in sewers. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Cool container sides with water until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. Withdraw immediately if you hear rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Ethylbenzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Reacts vigorously with oxidizers.
Conditions to Avoid: Exposure to heat and oxidizers.
Hazardous Products of Decomposition: Thermal oxidative decomposition of EB can produce acrid smoke and irritating fumes.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list EB as a carcinogen. **Summary of Risks:** Occupational exposure to EB alone is rare since it is usually present together with other solvents. EB is irritating to the eyes, skin, and respiratory tract. Vapor inhalation produces varying degrees of CNS effects depending on concentration. The liquid is absorbed through the skin but vapors are not. 56 to 64% of inhaled ethylbenzene is retained and metabolized. Urinary metabolites following exposure to 23 to 85 ppm for 8 hr are mandelic acid (64%), phenylglyoxylic acid (25%), and methylphenylcarbinol/1-phenyl ethanol (5%). Concurrent exposure to xylene and ethylbenzene causes slower excretion of EB metabolites. Based on the rat LD_{50}, one manufacturer gives 3 to 4 oz. as the lethal dose for a 100 lb person.

Continue on next page

Section 6. Health Hazard Data

Medical Conditions Aggravated by Long-Term Exposure: Skin and CNS diseases and impaired pulmonary function (especially obstructive airway disease). **Target Organs:** Eyes, respiratory system, skin, CNS, blood. **Primary Entry Routes:** Inhalation, skin and eye contact. **Acute Effects:** Vapor inhalation of 200 ppm caused transient eye irritation; 1000 ppm caused eye irritation with profuse watering (tolerance developed rapidly); 2000 ppm caused severe and immediate eye irritation and watering, nasal irritation, chest constriction, and vertigo; 5000 ppm was intolerable and caused eye and nose irritation. Inhalation of high concentrations may cause narcosis, cramps, and death due to respiratory paralysis. Skin exposed to pure ethylbenzene for 10 to 15 min absorbed 22 to 33 mg/cm^2/hr. Immersion of hand in solutions of 112 & 156 mg/L for 1 hr absorbed 118 & 215.7 μg/cm^2/hr, respectively. **Chronic Effects:** Repeated skin contact may cause dryness, scaling, and fissuring. Workers chronically exposed to > 100 ppm complained of fatigue, sleepiness, headache, and mild irritation of the eyes and respiratory tract. Repeated vapor inhalation may result in blood disorders, particularly leukopenia (abnormally low level of white blood cells) and lymphocytosis.

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting! Aspiration of even a small amount of EB in vomitus can cause severe damage since its low viscosity and surface tension will cause it to spread over a large area of the lung tissue.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: BEI = mandelic acid in urine (1.5 g/g of creatinine), sample at end of shift at workweeks end. Since this test is not specific, test for EB in expired air for confirmation.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel. Isolate and ventilate area, deny entry and stay upwind. Shut off all ignition sources. Cleanup personnel should protect against vapor inhalation and skin/eye contact. Take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container. Dike far ahead of large spill for later reclamation or disposal. Report any release >1000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** If released to soil, EB partially evaporates into the atmosphere, with a half-life of hrs to wks, and some leaches into groundwater, especially in soil with low organic carbon content. Biodegradation occurs with a half-life of 2 days. Some EB may absorb to sediment or bioconcentrate in fish. Evidence points to slow biodegradation in groundwater. In air, it reacts with photochemically produced hydroxyl radicals with a half-life of hrs to 2 days. Additional amounts may be removed by rain. **Ecotoxicity Values:** Shrimp (*Mysidopsis bahia*), LC_{50} = 87.6 mg/L/96 hr; sheepshead minnow (*Cyprinodon variegatus*) LC_{50} = 275 mg/L/96 hr; fathead minnow (*Pimephales promelas*) LC_{50} = 42.3 mg/L/96 hr in hard water & 48.5 mg/L/96 hr in softwater. **Disposal:** A candidate for rotary kiln incineration at 1508 to 2912°F (820 to 1600°C), liquid injection incineration at 1202 to 2912°F (650 to 1600°C), and fluidized bed incineration at 842 to 1796°F (450 to 980°C). Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.21): No. D001

Listed as a SARA Toxic Chemical (40 CFR 372.65)

SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311 (b)(4) & CWA, Sec. 307 (a)]

OSHA Designations

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 1000 ppm, use a powered air-purifying respirator with an appropriate organic vapor cartridge, a supplied-air respirator (SAR), SCBA, or chemical cartridge respirator with appropriate organic vapor cartridge. For < 2000 ppm, use a SAR or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets made of Viton or polyvinylchloride to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a cool, dry, well-ventilated area away from ignition sources and oxidizers. Outside or detached storage is preferred. If inside, store in a standard flammable liquids cabinet. Containers should have flame-arrester or pressure-vacuum venting. To prevent static sparks, electrically ground and bond all equipment used with ethylbenzene. Install Class 1, Group D electrical equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain levels as low as possible. Purge and ventilate reaction vessels before workers are allowed to enter for maintenance or cleanup. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the CNS, skin, blood, and respiratory system.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Ethylbenzene
DOT Hazard Class: 3
ID No.: UN1175
DOT Packing Group: II
DOT Label: Flammable liquid
Special Provisions (172.102): T1

Packaging Authorizations
a) Exceptions: 173.150
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger Aircraft or Railcar: 5L
b) Cargo Aircraft Only: 60 L
Vessel Stowage Requirements
a) Vessel Stowage: B
b) Other: —

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 148, 153, 159, 162, 163, 164, 167, 168, 171, 176, 179

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** D Wilson, CIH; **Medical Review:** W Silverman, MD

Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 359
ETHYLENE DICHLORIDE
(Formerly 1,2-Dichloroethane)
(Revision C)
Issued: November 1978
Revised: August 1987

SECTION 1. MATERIAL IDENTIFICATION

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CHEMICAL NAME: ETHYLENE DICHLORIDE (Changed to reflect common industrial practice)
DESCRIPTION (Origin/Uses): Made from acetylene and HCl. Used as a degreaser, a scavenger in leaded gasoline, as an intermediate in the manufacture of vinyl chloride, in paint removers, in wetting and penetration agents, in ore flotation processes, as a fumigant, and as a solvent for fats, oils, waxes, and gums.
OTHER DESIGNATIONS: 1,2-Dichloroethane; *sym*-Dichloroethane; Dutch Liquid; Dutch Oil; EDC; Ethane Dichloride; Ethylene Chloride; 1,2-Ethylene Dichloride; Glycol Dichloride; $C_2H_4Cl_2$; NIOSH *RTECS* KI0525000; CAS #0107-06-2
MANUFACTURERS/SUPPLIERS: Available from several suppliers, including:
Dow Chemical USA, 2020 Dow Center, Midland, MI 48640; Telephone: (517) 636-1000

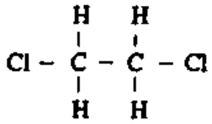
HMIS			
H	1	R	1
F	3	I	4
R	0	S	2
PPE*		K	4

* See Sect. 8

COMMENTS: Ethylene dichloride is a flammable, toxic liquid.

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
Ethylene Dichloride, CAS #0107-06-2; NIOSH *RTECS* #KI0525000	100	ACGIH Values 1987-88 TLV-TWA: 10 ppm, 40 mg/m^3 OSHA PEL* 1986-87 8-Hr TWA: 50 ppm; Ceiling: 100 ppm (15 Min.) NIOSH REL 1986-87 10-Hr TWA: 1 ppm Ceiling: 2 ppm (15 Min.) Toxicity Data Man, Inhalation, TC_{Lo}: 4000 ppm/1 Hr Human, Oral, TD_{Lo}: 428 mg/kg Man, Oral, TD_{Lo}: 892 mg/kg Man, Oral, LD_{Lo}: 714 mg/kg Rat, Oral, LD_{50}: 670 mg/kg


$Cl-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-Cl$

*The maximum allowable peak concentration (above the ceiling level value) of ethylene dichloride is 200 ppm for 5 minutes in any 3-hour period.
COMMENTS: Additional data concerning toxic doses and tumorigenic, reproductive, and mutagenic effects is listed (with references) in the NIOSH *RTECS* 1983-84 supplement, pages 865-66.

SECTION 3. PHYSICAL DATA

Boiling Point ... 182.3°F (83.5°C)
Vapor Pressure ... 87 Torr at 77°F (25°C)
Water Solubility ... Soluble in about 120 Parts Water
Vapor Density (Air = 1) ... 3.4
Evaporation Rate (n-BuAc = 1) ... Not Listed
Specific Gravity ... 1.2569 at 69°F (20°C)
Freezing Point ... -31.9°F (-35.5°C)
Molecular Weight ... 98.96 Grams/Mole

Appearance and odor: Colorless, clear liquid. Sweet, chloroformlike odor is typical of chlorinated hydrocarbons. The recognition threshold (100% of test panel) for ethylene dichloride is 40 ppm. Odor detection probably indicates an excessive exposure to vapor. High volatility and flammability, coupled with its toxicity and carcinogenic potential, make this material a major health hazard.
COMMENTS: Ethylene dichloride is miscible with alcohol, chloroform, and ether.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temperature	Flammability Limits in Air	LOWER	UPPER
See Below	775°F (413°C)	% by Volume	6.2	15.9

EXTINGUISHING MEDIA: Use chemical, carbon dioxide, alcohol foam, water spray/fog, or dry sand to fight fires involving ethylene dichloride. Direct water sprays may be ineffective extinguishing agents, but they may be successfully used to cool fire-exposed containers. Use a smothering effect to extinguish fires involving this material. UNUSUAL FIRE/EXPLOSION HAZARDS: Ethylene dichloride is a dangerous fire and explosion hazard when exposed to sources of ignition such as heat, open flames, sparks, etc. Its vapors are heavier than air and can flow along surfaces to distant, low-lying sources of ignition and flash back. If it is safe to do so, remove this material from the fire area. Ethylene dichloride burns with a smoky flame.
SPECIAL FIRE-FIGHTING PROCEDURES: Wear a self-contained breathing apparatus with a full facepiece operated in a pressure-demand or another positive-pressure mode.
COMMENTS: Flash Point and Method: 56°F (13°C) CC; 65°F (18°C) OC.
OSHA Flammability Class (29 CFR 1910.106): IB. DOT Flammability Class (49 CFR 173.115): Flammable Liquid

SECTION 5. REACTIVITY DATA

Ethylene dichloride is stable. Hazardous polymerization cannot occur.

CHEMICAL INCOMPATIBILITIES include strong oxidizing agents. Explosions have occurred with mixtures of this material and liquid ammonia or dimethylaminopropylamine. Finely divided aluminum or magnesium metal may be hazardous in contact with ethylene dichloride.
CONDITIONS TO AVOID: Eliminate sources of ignition such as excessive heat, open flames, or electrical sparks, particularly in low-lying areas, because the explosive, heavier-than-air vapors will concentrate there.
PRODUCTS OF HAZARDOUS DECOMPOSITION can include vinyl chloride, chloride fumes, and phosgene. Phosgene is an extremely poisonous gas. Products of thermal-oxidative degradation (i.e., fire conditions) must be treated with appropriate caution.

SECTION 6. HEALTH HAZARD INFORMATION

Ethylene dichloride is listed as an anticipated human carcinogen by the NTP and as a probable human carcinogen (Group 2B), by the IARC. It was found to be an animal-positive carcinogen by the IARC. NCI reported positive results (mouse, rat) from its carcinogenesis bioassay. SUMMARY OF RISKS: Ethylene dichloride is considered to be one of the more toxic of the common chlorinated hydrocarbons. Deaths from accidental ingestion of this material have been reported. Inhalation of vapors reportedly caused three fatalities. Excessive inhalation of ethylene dichloride vapors can cause respiratory irritation, intoxication, narcotic and anesthetic effects, vomiting, dizziness, depression, and diarrhea. The hepatoxic (injurious to liver) effects of this material are significant. The systemic effects from overexposure can appear in the liver, kidneys, digestive tract, blood, lungs, adrenal glands, and the central nervous system. Tests on animals have revealed reproductive failure and fetal resorption. There may be increased risk to nursing infants of exposed mothers. TARGET ORGANS: Central nervous system, eyes, kidneys, liver, heart, adrenal glands, and skin. PRIMARY ENTRY: Inhalation, absorption through skin, oral, or eye contact. ACUTE EFFECTS: Skin contact causes irritation, defatting, and, if repeated or prolonged, burning. Eye contact causes irritation and serious injury (clouding of the cornea) if it is not removed promptly. CHRONIC EFFECTS: Injuries to the liver (hepatoxicity) and kidneys, weight loss, low blood pressure, jaundice, oliguria (reduced excretion of urine), or anemia. MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE: Persons taking anticoagulants could experience an increase in tendency to bleed. Persons taking insulin face an increased risk of lowered blood sugar. FIRST AID: Be prepared to restrain a hyperactive victim. EYE CONTACT: Flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Immediately flush the affected area with water. Wash thoroughly with soap and water. Remove and launder contaminated clothing before wearing it again; clean material from shoes and equipment. Get medical help.* INHALATION: Remove victim to fresh air; restore and/or support his breathing as needed. Get medical help.* INGESTION: Never give anything by mouth to someone who is unconscious or convulsing. Rinse victim's mouth with water. Oxygen and artificial respiration may be needed. Get medical help.* * GET MEDICAL ASSISTANCE = IN PLANT, PARAMEDIC, COMMUNITY. Get prompt medical assistance for further treatment, observation, and support after first aid.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Before using ethylene dichloride, it is essential that proper emergency procedures be established and made known to all personnel involved in handling it. Notify safety personnel of ethylene dichloride spills or leaks and implement containment procedures. Remove and eliminate all possible sources of ignition such as heat, sparks, and open flames from the area. Cleanup personnel should use protection against inhalation of vapors and contact with liquid. Contain spills by using an absorbent material such as dry sand or vermiculite. Use nonsparking tools to mix waste material thoroughly with absorbent and place it in an appropriate container for disposal. Flush trace residues with large amounts of water. Do not flush waste to sewers or open waterways. WASTE DISPOSAL: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Waste may be burned in an approved incinerator equipped with an afterburner and a scrubber. Follow Federal, state, and local regulations.

Ethylene dichloride is designated as a hazardous substance by the EPA (40 CFR 116.4). Ethylene dichloride is reported in the 1983 EPA TSCA Inventory.

EPA Hazardous Waste Number (40 CFR 261.33): U077
EPA Reportable Quantity (40 CFR 117.3): 5000 lbs (2270 kgs)
Aquatic Toxicity Rating, TLm 96: 1000 - 100 ppm

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Always wear protective eyeglasses or chemical safety goggles. Ethylene dichloride is particularly harmful to the eyes, and direct contact results in corneal opacity (permanent clouding of the eye). GLOVES: Wear impervious rubber gloves to prevent skin contact. RESPIRATOR: Use a NIOSH-approved respirator per the NIOSH *Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. Any detectable concentration of ethylene dichloride requires an SCBA, full facepiece, and pressure-demand/positive-pressure modes. Warning: Air-purifying respirators will not protect workers from oxygen-deficient atmospheres. OTHER: Wear rubber boots, aprons, and other protective clothing suitable for use conditions to prevent skin contact. Remove contaminated clothing and launder it before wearing it again. Discard contaminated shoes. VENTILATION: Provide maximum explosion-proof local fume exhaust ventilation systems to maintain the airborne concentrations of ethylene dichloride vapors below the exposure limits cited in section 2. Install properly designed hoods that maintain a minimum face velocity of 100 lfm (linear feet per minute). SAFETY STATIONS: Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. SPECIAL CONSIDERATIONS: Vapors are heavier than air and will collect in low-lying areas. Eliminate sources of ignition in these areas and again provide good ventilation there. COMMENTS: Practice good personal hygiene. Keep materials off of your clothes and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Immediately remove ethylene dichloride-saturated clothing to avoid flammability and health hazards. Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store ethylene dichloride in tightly closed containers in a cool, dry, well-ventilated area away from sources of ignition. Protect containers from physical damage and from exposure to excessive heat. Avoid direct physical contact with strong acids, bases, oxidizing agents, and reducing agents. SPECIAL HANDLING/STORAGE: Use nonsparking tools. Outside or detached storage is preferred. Store and handle ethylene dichloride in accordance with the regulations concerning OSHA class IB flammable liquids. ENGINEERING CONTROLS: During transfer operations involving ethylene dichloride, the liquid and its vapors must not be exposed to nearby sources of ignition from engineering systems that are not explosion proof. Preplan emergency response procedures.

TRANSPORTATION DATA (per 49 CFR 172.101-2):
DOT Hazard Class: Flammable Liquid
DOT Label: Flammable Liquid
IMO Class: 3.2
DOT Shipping Name: Ethylene Dichloride
DOT ID No. UN 1184
IMO Label: Flammable Liquid, Poison

References: 1-9, 12, 19, 21, 26, 43, 47, 73, 87-102. CK

Approvals
Indust. Hygiene/Safety 11-18-87
Medical Review 11-30-87

NO. 15A

MATERIAL SAFETY DATA SHEET

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GENIUM PUBLISHING CORP.

CHRYSOTILE ASBESTOS

Date November 1979

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: CHRYSOTILE ASBESTOS

DESCRIPTION: A crystalline serpentine mineral, or layered, hydrated magnesium silicate in fine fiber form (asbestiform). The end of a sliver of this material with a cross-section of 0.1 mm^2 can show about 20 million tubules (scroll-like fibrils about 0.01 μm diameter) in approximate parallel orientation. It is possible to strip from a fiber bundle very fine chrysotile threads, each an agglomerate of hundreds or thousands of hollow fibrils. (90% of asbestos used is chrysotile.)

OTHER DESIGNATIONS: Asbestos, CAS #001 332 214, GE Material D4E11

SECTION II. INGREDIENTS AND HAZARDS

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Idealized Chrysotile (unit cell) - $Mg_3Si_2O_5(OH)_4$*	ca 95	8-hr TWA 2 fibers/cc,** Ceiling 10 fibers/cc (>5 μm in length) "Asbestos" Human, inhal. TDLo 1.2 fb/cc for 19 years (Pulmonary effects)

*Impurities include low levels of Mn, Fe^{+2}, Fe^{+3}, and Al in the structure, replacing randomly 4% av. of the Mg atoms. Impurities depend on the mineral source; the unit cell hydroxyl content can also vary with an average of 4.25.

**Current OSHA TLV. OSHA (1975) proposed TLV of 0.5 fb/cc with a Ceiling of 5 fb/cc (15 min. sample). NIOSH (1976) proposed 0.1 fb/cc. ACGIH (1979 Intended Changes List) has retained TLV of 2 fb/cc for chrysotile asbestos. Asbestos is carcinogenic and/or co-carcinogenic for humans!

SECTION III. PHYSICAL DATA

Melting point -------------------- Decomposes (see Sect. V)
Vapor pressure ------------------- Nil
Water solubility ----------------- Insoluble (slowly breaks down in hot water)

Appearance: White, fibrous solid, as long flexible textile fibers down to dust-like filler power. [Milled chrysotile asbestos (powder-like) has an aspect ratio (ratio of length/diameter) as high as 50 for most particles.]

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
N/A	N/A	N/A		

This material is not combustible in air. Use extinguishing media as appropriate for the surrounding materials in a fire situation.

SECTION V. REACTIVITY DATA

This material is inert under ordinary room temperature and heated use conditions. It is resistant to heat, but it will decompose and alter its microscopic fiber structure (see Sect. I) above 600 C (1112 F): Chrysotile dehydroxylates at 600-780 C; the "asbestos anhydride" in turn breaks down to mixture of silica (SiO_2) and fosterite (Mg_2SiO_4) at 800-850 C. Above 1000 C (1832 F) magnesium pyroxenes are formed which melt at about 1450 C.

Strong acids can attack chrysotile and rapidly extract its MgO and H_2O content; it can be decomposed by glacial acetic acid. Hot water slowly breaks down chrysotile. It, like other forms of asbestos, resists strong alkali (5 M NaOH at least up to 100 C).

NO. 15A

SECTION VI. HEALTH HAZARD INFORMATION	TLV 2 fibers/cc >5 um in length (See Sect.II)

As a particulate material, chrysotile asbestos can be irritating to the respiratory tract, skin or eyes. However, the significant industrial hazards arise from excessive dust inhalation with damage requiring years to become evident. Chronic inhalation of high levels of asbestos particles can produce asbestosis, a disabling fibrosis of the lungs which gradually reduces lung capacity and efficiency. (Usually over 4 years is required for a serious condition to develop.) Excessive inhalation can also cause pleural plaque, a thickening of the lung lining. Compliance with TLV is expected to control these hazards.

Cancer can result from excessive inhalation of asbestos particulate, which may require decades to develop. Lung cancer is a special risk to those who smoke cigarettes regularly in addition to having asbestos exposure. Rare mesotheliomas of the pleura and peritoneum (lining around the lungs or abdominal cavity) and possibly cancers of the GI tract and larynx (also smoking related) have been associated with inhalation exposure to asbestos particles. (Crocidolite asbestos has been suggested as the major mesothelioma risk.)

In groups of workers exposed to asbestos, lung cancer death is 3 or 4 times more common than mesothelioma death, and 97.5% of asbestos-related lung cancers occur with those workers who also smoke cigarettes! For non-smokers asbestos exposure increases risk of lung cancer 5X.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of spills! Exclude all from spill area except trained clean-up personnel who have approved respiratory protection against dust. Provide exhaust ventilation with capture filtration, but do not stir up the dust. Use a wet method or an approved vacuum cleaning system to pick up spills. The techniques used must collect particulate without dispersing dust into the air. Waste must be placed in dust-tight containers or sealed plastic bags for disposal. Label properly!

DISPOSAL: Deposit waste containers in a secured landfill where asbestos will remain buried. Follow Federal, State and local regulations. Also note that chrysotile can be converted into non-asbestos waste by heating at high temperature (see Sect.V).

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide exhaust ventilation and capture filtration to remove airborne asbestos particulate from the workplace (as much as possible) without dispersing it into the environment. Isolate work areas (also post signs) where asbestos particulate may occur at excessive levels.

For nonroutine or emergency conditions where excessive dust is present, approved respirators must be used: Single use or re-usable air-purifying respiratory up to 10X TLV; full-facepiece powered air-purifying respirator up to 100X TLV; full-facepiece air-supplied (continuous flow or pressure-demand type) respirator above 100X TLV.

Depending on exposure levels, it may be necessary to provide body-covering work clothes, special vacuuming facilities for clothes and suitable laundering or disposal arrangements, change areas with dual lockering facilities, showers before changing to street clothing after work, etc. Be sure workers do not carry asbestos dust home on their clothing or person. Prevent asbestos dust from being carried to rest rooms, to eating areas, to non-asbestos workplaces, etc.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store asbestos in closed containers (dust tight) in a clean, secure area. Protect containers from physical damage. Do not open containers that can release asbestos dust without providing proper enclosure or control measures. Use dust suppression control measures at all stages of asbestos handling, use and disposal. Follow good housekeeping practices to prevent accumulations of asbestos-containing dust. Avoid inhalation of asbestos. The effects on cancer incidence of chronic exposure are not yet fully known. Monitor areas where asbestos dust is present to be sure of worker exposure levels; keep records to define exposures and retain for at least 20 years. Provide preplacement and annual medical examinations for those exposed in the workplace to 8-hr TWA of 0.1 asbestos fibers or more/cc which are >5 um in length. Retain medical records for at least 20 years.

DATA SOURCE(S) CODE: 2-4,6,12,14,20,26,32

APPROVALS: MIS, CRD

Industrial Hygiene and Safety

MEDICAL REVIEW: 12/79

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Material Safety Data Sheets Collection:

Sheet No. 316
Benzene

Issued: 11/78 **Revision: E, 8/90**

Section 1. Material Identification

32

Benzene (C_6H_6) Description: Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.
Other Designations: CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R 1
I 4
S 2*
K 4
*Skin absorption

NFPA
3
2 0
-

HMIS
H 3
F 3
R 0
PPG†
† Sec. 8

Cautions: Benzene is a confirmed *human carcinogen* by the IARC. *Chronic low-level exposure may cause cancer (leukemia) and bone marrow damage, with injury to blood-forming tissue.* It is also a dangerous fire hazard when exposed to heat or flame.

Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

1989 OSHA PELs
(29 CFR 1910.1000, Table Z-1-A)
8-hr TWA: 1 ppm, 3 mg/m³
15-min STEL: 5 ppm, 15 mg/m³

(29 CFR 1910.1000, Table Z-2)
8-hr TWA: 10 ppm
Acceptable Ceiling Concentration: 25 ppm
Acceptable Maximum Peak: 50 ppm (10 min)†

1989-90 ACGIH
TLV-TWA: 10 ppm, 32 mg/m³

1988 NIOSH RELs
TWA: 0.1 ppm, 0.3 mg/m³
Ceiling: 1 ppm, 3 mg/m³

1985-86 Toxicity Data‡
Man, oral, LD_{Lo}: 50 mg/kg; no toxic effect noted
Man, inhalation, TC_{Lo}: 150 ppm inhaled intermittently over 1 yr in a number of discrete, separate doses affects the blood (other changes) and nutritional and gross metabolism (body temperature increase)
Rabbit, eye: 2 mg administered over 24 hr produces severe irritation

* OSHA 29 CFR 1910.1000, Subpart Z, states that the final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limits in Table Z-2 apply.
† Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift.
‡ See NIOSH, *RTECS* (CY1400000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 176 °F (80 °C)
Melting Point: 42 °F (5.5 °C)
Vapor Pressure: 100 mm Hg at 79 °F (26.1 °C)
Vapor Density (Air = 1): 2.7
Evaporation Rate (Ether = 1): 2.8

Molecular Weight: 78.11
Specific Gravity (15 °C/4 °C): 0.8787
Water Solubility: Slightly (0.180 g/100 g of H_2O at 25 °C)
% Volatile by Volume: 100
Viscosity: 0.6468 mPa at 20 °C

Appearance and Odor: A colorless liquid with a characteristic sweet, aromatic odor. The odor recognition threshold (100% of panel) is approximately 5 ppm (unfatigued) in air. Odor *is not* an adequate warning of hazard.

Section 4. Fire and Explosion Data

Flash Point: 12 °F (-11.1 °C), CC	**Autoignition Temperature:** 928 °F (498 °C)	**LEL:** 1.3% v/v	**UEL:** 7.1% v/v

Extinguishing Media: Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can scatter and spread the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an unignited benzene leak.
Unusual Fire or Explosion Hazards: Benzene is a Class 1B flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Structural firefighter's protective clothing provides limited protection. Stay out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Runoff to sewer can create pollution, fire, and explosion hazard.

Section 5. Reactivity Data

Stability/Polymerization: Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Benzene explodes on contact with diborane, permanganic acid, bromine pentafluoride, peroxodisulfuric acid, and peroxomonosulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxide + water. Benzene forms sensitive, explosive mixture with iodine pentafluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentafluoride + potassium methoxide (explodes above 30 °C). A vigorous or incandescent reaction occurs with bromine trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.

Section 6. Health Hazard Data

Carcinogenicity: The ACGIH, OSHA, and IARC list benzene as, respectively, a supected human carcinogen, a cancer hazard, and, based on sufficient human and animal evidence, a human carcinogen (Group 1).
Summary of Risks: Prolonged skin contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher level exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.
Medical Conditions Aggravated by Long-Term Exposure: Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.
Target Organs: Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.
Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).
Chronic Effects: Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Immediately rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* since aspiration may be fatal. Call a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure. Acute management is primarily supportive for CNS depression.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: *Design and practice a benzene spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. Absorb as much benzene as possible with an inert, noncombustible material. For large spills, dike far ahead of spill and contain liquid. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of confined spaces such as sewers, watersheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), 311 (b)(4), 112; and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations at least below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.(107)
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials. *Caution! Benzene vapor may form explosive mixtures in air.* To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. When opening or closing benzene containers, use nonsparking tools. Keep fire extinguishers readily available.
Engineering Controls: Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD."
Other Precautions: Provide preplacement and periodic medical examinations with emphasis on a history of blood disease or previous exposure.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Benzene (*benzol*)
DOT Hazard Class: Flammable liquid
ID No.: UN1114
DOT Label: Flammable liquid
DOT Packaging Exceptions: 173.118
DOT Packaging Requirements: 173.119

IMO Shipping Name: Benzene
IMO Hazard Class: 3.2
ID No.: UN1114
IMO Label: Flammable liquid
IMDG Packaging Group: II

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE–NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

MSDS Collection **References:** 1, 2, 12, 26, 73, 84-94, 100, 101, 103, 109, 124, 126, 127, 132, 134, 136, 138, 139, 143
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

MATERIAL SAFETY DATA SHEET	Ashland	ASHLAND CHEMICAL, INC. Subsidiary Of Ashland Oil, Inc P.O. BOX 2219 COLUMBUS, OHIO 43216 (614) 889-3333	24-HOUR Emergency Telephone 1(800) 274-5263 or 1(800) ASHLAND

002488

XYLENE

THIS MSDS COMPLIES WITH 29 CFR 1910.1200 (THE HAZARD COMMUNICATION STANDARD)

Product Name: -XYLENE
CAS NUMBER: 1330-20-7

9

Data Sheet No: 0004340-004.000
Prepared: 12/22/88
Supersedes: 08/01/86

08 50 028 3289800-

FIRESTONE INDUSTRIAL PRODUCTS
DIV-BRIDGESTONE FIRESTONE INC
ACCOUNTS PAYABLE DEPT.

1700 FIRESTONE BOULEVARD
NOBLESVILLE IN 46060

ATTN: PLANT MGR./SAFETY DIR.

PRODUCT: 2196000
INVOICE: 235828
INVOICE DATE: 01/04/89
TO: FIRESTONE INDUSTRIAL PROD
1700 FIRESTONE BOULEVARD
NOBLESVILLE IN 46060

SECTION I-PRODUCT IDENTIFICATION

General or Generic ID: AROMATIC HYDROCARBON

DOT Hazard Classification: FLAMMABLE LIQUID (173.115)

SECTION II-COMPONENTS

IF PRESENT, IARC, NTP AND OSHA CARCINOGENS AND CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SARA TITLE III SECTION 313 ARE IDENTIFIED IN THIS SECTION. SEE DEFINITION PAGE FOR CLARIFICATION

INGREDIENT	% (By WT)	PEL	TLV	Note
XYLENE CAS #: 1330-20-7	100	100 PPM	100 PPM	(1)

Notes:

(1) TECHNICAL GRADE XYLENE CONTAINS 10-20% ETHYL BENZENE. ETHYL BENZENE HAS A PEL/TLV OF 100 PPM (125 PPM - STEL). IT HAS A CAS # OF 100-41-4. ETHYL BENZENE IS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF SARA TITLE III.

OSHA/ACGIH SHORT TERM EXPOSURE LIMIT (STEL) FOR XYLENE IS 150 PPM. NIOSH RECOMMENDS A LIMIT OF 100 PPM, 8-HOUR TWA; 200 PPM 10 MINUTE CEILING.

THIS CHEMICAL IS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF SARA TITLE III.

SECTION III-PHYSICAL DATA

Boiling Point	for PRODUCT	279.00 Deg F (137.22 Deg C) @ 760.00 mm Hg
Vapor Pressure	for PRODUCT	5.10 mm Hg @ 68.00 Deg F (20.00 Deg C)
Specific Vapor Density	AIR = 1	3.6
Specific Gravity		.872 @ 60.00 Deg F (15.55 Deg C)
Percent Volatiles		100.00%
Evaporation Rate	(N-BUTYL ACETATE = 1)	.86
Appearance		CLEAR, APHA COLOR 15 MAX
State		LIQUID
Form		NEAT

SECTION IV-FIRE AND EXPLOSION INFORMATION

FLASH POINT(TCC) 80.0 Deg F (26.7 Deg C)

EXPLOSIVE LIMIT (PRODUCT) LOWER - 1.0%

EXTINGUISHING MEDIA: REGULAR FOAM OR CARBON DIOXIDE OR DRY CHEMICAL

HAZARDOUS DECOMPOSITION PRODUCTS: MAY FORM TOXIC MATERIALS:, CARBON DIOXIDE AND CARBON MONOXIDE, VARIOUS HYDROCARBONS, ETC.

FIREFIGHTING PROCEDURES: WEAR SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN THE POSITIVE PRESSURE DEMAND MODE WHEN FIGHTING FIRES.

SPECIAL FIRE & EXPLOSION HAZARDS: VAPORS ARE HEAVIER THAN AIR AND MAY TRAVEL ALONG THE GROUND OR MAY BE MOVED BY VENTILATION AND IGNITED BY PILOT LIGHTS, OTHER FLAMES, SPARKS, HEATERS, SMOKING, ELECTRIC MOTORS, STATIC DISCHARGE, OR OTHER IGNITION SOURCES AT LOCATIONS DISTANT FROM MATERIAL HANDLING POINT.

NEVER USE WELDING OR CUTTING TORCH ON OR NEAR DRUM (EVEN EMPTY) BECAUSE PRODUCT (EVEN JUST RESIDUE) CAN IGNITE EXPLOSIVELY.

ALL FIVE GALLON PAILS AND LARGER METAL CONTAINERS INCLUDING TANK CARS AND TANK TRUCKS SHOULD BE GROUNDED AND/OR BONDED WHEN MATERIAL IS TRANSFERRED.

NFPA CODES: HEALTH- 2 FLAMMABILITY- 3 REACTIVITY- 0

SECTION VI-HEALTH HAZARD DATA

PERMISSIBLE EXPOSURE LEVEL	100	PPM
THRESHOLD LIMIT VALUE	100	PPM

EFFECTS OF ACUTE OVEREXPOSURE:

EYES - CAN CAUSE SEVERE IRRITATION, REDNESS, TEARING, BLURRED VISION.
SKIN - PROLONGED OR REPEATED CONTACT CAN CAUSE MODERATE IRRITATION, DEFATTING, DERMATITIS.
BREATHING - EXCESSIVE INHALATION OF VAPORS CAN CAUSE NASAL AND RESPIRATORY IRRITATION, CENTRAL NERVOUS SYSTEM EFFECTS INCLUDING DIZZINESS, WEAKNESS, FATIGUE, NAUSEA, HEADACHE AND POSSIBLE UNCONSCIOUSNESS, AND EVEN DEATH.
SWALLOWING - CAN CAUSE GASTROINTESTINAL IRRITATION, NAUSEA, VOMITING, AND DIARRHEA. ASPIRATION OF MATERIAL INTO THE LUNGS CAN CAUSE CHEMICAL PNEUMONITIS WHICH CAN BE FATAL.

FIRST AID:

IF ON SKIN: THOROUGHLY WASH EXPOSED AREA WITH SOAP AND WATER. REMOVE CONTAMINATED CLOTHING. LAUNDER CONTAMINATED CLOTHING BEFORE RE-USE.

IF IN EYES: FLUSH WITH LARGE AMOUNTS OF WATER, LIFTING UPPER AND LOWER LIDS OCCASIONALLY. GET MEDICAL ATTENTION.

IF SWALLOWED: DO NOT INDUCE VOMITING. KEEP PERSON WARM, QUIET, AND GET MEDICAL ATTENTION. ASPIRATION OF MATERIAL INTO THE LUNGS DUE TO VOMITING CAN CAUSE CHEMICAL PNEUMONITIS WHICH CAN BE FATAL.

IF BREATHED: IF AFFECTED, REMOVE INDIVIDUAL TO FRESH AIR. IF BREATHING IS DIFFICULT, ADMINISTER OXYGEN. IF BREATHING HAS STOPPED GIVE ARTIFICIAL RESPIRATION. KEEP PERSON WARM, QUIET AND GET MEDICAL ATTENTION.

PRIMARY ROUTE(S) OF ENTRY:

INHALATION, SKIN CONTACT

EFFECTS OF CHRONIC OVEREXPOSURE:

OVEREXPOSURE TO THIS MATERIAL (OR ITS COMPONENTS) HAS APPARENTLY BEEN FOUND TO CAUSE THE FOLLOWING EFFECTS IN LABORATORY ANIMALS:, ANEMIA, LIVER ABNORMALITIES, KIDNEY DAMAGE, EYE DAMAGE

OVEREXPOSURE TO THIS MATERIAL (OR ITS COMPONENTS) HAS BEEN SUGGESTED AS A CAUSE OF THE FOLLOWING EFFECTS IN HUMANS:, CARDIAC ABNORMALITY

SECTION VI-REACTIVITY DATA

HAZARDOUS POLYMERIZATION: CANNOT OCCUR

STABILITY: STABLE

INCOMPATIBILITY: AVOID CONTACT WITH:, STRONG OXIDIZING AGENTS

SECTION VII-SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:

SMALL SPILL: ABSORB LIQUID ON VERMICULITE, FLOOR ABSORBENT, OR OTHER ABSORBENT MATERIAL AND TRANSFER TO HOOD.

LARGE SPILL: ELIMINATE ALL IGNITION SOURCES (FLARES, FLAMES INCLUDING PILOT LIGHTS, ELECTRICAL SPARKS). PERSONS NOT WEARING PROTECTIVE EQUIPMENT SHOULD BE EXCLUDED FROM AREA OF SPILL UNTIL CLEAN-UP HAS BEEN COMPLETED. STOP SPILL AT SOURCE, PREVENT FROM ENTERING DRAINS, SEWERS, STREAMS OR OTHER BODIES OF WATER. PREVENT FROM SPREADING. IF RUNOFF OCCURS, NOTIFY AUTHORITIES AS REQUIRED. PUMP OR VACUUM TRANSFER SPILLED PRODUCT TO CLEAN CONTAINERS FOR RECOVERY. ABSORB UNRECOVERABLE PRODUCT. TRANSFER CONTAMINATED ABSORBENT, SOIL AND OTHER MATERIALS TO CONTAINERS FOR DISPOSAL.

PREVENT RUN-OFF TO SEWERS, STREAMS OR OTHER BODIES OF WATER. IF RUN-OFF OCCURS, NOTIFY PROPER AUTHORITIES AS REQUIRED, THAT A SPILL HAS OCCURED.

WASTE DISPOSAL METHOD:

SMALL SPILL: ALLOW VOLATILE PORTION TO EVAPORATE IN HOOD. ALLOW SUFFICIENT TIME FOR VAPORS TO COMPLETELY CLEAR HOOD DUCT WORK. DISPOSE OF REMAINING MATERIAL IN ACCORDANCE WITH APPLICABLE REGULATIONS.

DISPOSE OF IN ACCORDANCE WITH ALL LOCAL, STATE AND FEDERAL REGULATIONS.

LARGE SPILL: DESTROY BY LIQUID INCINERATION.

DISPOSE OF IN ACCORDANCE WITH ALL LOCAL, STATE AND FEDERAL REGULATIONS.

SECTION VIII-PROTECTIVE EQUIPMENT TO BE USED

RESPIRATORY PROTECTION: IF WORKPLACE EXPOSURE LIMIT(S) OF PRODUCT OR ANY COMPONENT IS EXCEEDED (SEE SECTION II), A NIOSH/MSHA APPROVED AIR SUPPLIED RESPIRATOR IS ADVISED IN ABSENCE OF PROPER ENVIRONMENTAL CONTROL. OSHA REGULATIONS ALSO PERMIT OTHER NIOSH/MSHA RESPIRATORS (NEGATIVE PRESSURE TYPE) UNDER SPECIFIED CONDITIONS (SEE YOUR SAFETY EQUIPMENT SUPPLIER). ENGINEERING OR ADMINISTRATIVE CONTROLS SHOULD BE IMPLEMENTED TO REDUCE EXPOSURE.

VENTILATION: PROVIDE SUFFICIENT MECHANICAL (GENERAL AND/OR LOCAL EXHAUST) VENTILATION TO MAINTAIN EXPOSURE BELOW TLV(S).

PROTECTIVE GLOVES: WEAR RESISTANT GLOVES SUCH AS:, NITRILE RUBBER

EYE PROTECTION: CHEMICAL SPLASH GOGGLES IN COMPLIANCE WITH OSHA REGULATIONS ARE ADVISED; HOWEVER, OSHA REGULATIONS ALSO PERMIT OTHER TYPE SAFETY GLASSES. (CONSULT YOUR SAFETY EQUIPMENT SUPPLIER)

OTHER PROTECTIVE EQUIPMENT: TO PREVENT REPEATED OR PROLONGED SKIN CONTACT, WEAR IMPERVIOUS CLOTHING AND BOOTS.

CONTINUED ON PAGE: 3

SECTION IX-SPECIAL PRECAUTIONS OR OTHER COMMENTS

CONTAINERS OF THIS MATERIAL MAY BE HAZARDOUS WHEN EMPTIED.SINCE EMPTIED CONTAINERS RETAIN PRODUCT RESIDUES (VAPOR, LIQUID, AND/OR SOLID), ALL HAZARD PRECAUTIONS GIVEN IN THE DATA SHEET MUST BE OBSERVED.

THE INFORMATION ACCUMULATED HEREIN IS BELIEVED TO BE ACCURATE BUT IS NOT WARRANTED TO BE WHETHER ORIGINATING WITH THE COMPANY OR NOT. RECIPIENTS ARE ADVISED TO CONFIRM IN ADVANCE OF NEED THAT THE INFORMATION IS CURRENT, APPLICABLE, AND SUITABLE TO THEIR CIRCUMSTANCES.

MATERIAL SAFETY DATA SHEET	Ashland	**ASHLAND CHEMICAL, INC.** Subsidiary of Ashland Oil, Inc. P.O. BOX 2219 COLUMBUS, OHIO 43216 (614) 889-3333	24-HOUR Emergency Telephone 1(800) 274-5263 or 1(800) ASHLAND

DEFINITIONS

This definition page is intended for use with *Material Safety Data Sheets* supplied by the Ashland Chemical Company. Recipients of these data sheets should consult the OSHA Safety and Health Standards (29 CFR 1910), particularly subpart G – Occupational Health and Environmental Control, and subpart I – Personal Protective Equipment, for general guidance on control of potential Occupational Health and Safety Hazards.

SECTION I
PRODUCT IDENTIFICATION

GENERAL OR GENERIC ID: Chemical family or product description.

DOT HAZARD CLASSIFICATION: Product meets DOT criteria for hazards listed.

SECTION II
COMPONENTS

Components are listed in this section if they present a physical or health hazard and are present at or above 1% in the mixture. If a component is identified as a CARCINOGEN by NTP, IARC, or OSHA as of the date on the MSDS, it will be listed and footnoted in this section when present at or above 0.1% in the product. Negative conclusions concerning carcinogenicity are not reported. Additional health information may be found in Section V. Components subject to the reporting requirements of Section 313 of SARA Title III are identified in the footnotes in this section, along with typical percentages. Other components may be listed if deemed appropriate.

Exposure recommendations are for components. OSHA Permissible Exposure Limits (PELS) and American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLVs) appear on the line with the component identification. Other recommendations appear as footnotes.

SECTION III
PHYSICAL DATA

BOILING POINT: Of product if known. The lowest value of the components is listed for mixtures.

VAPOR PRESSURE: Of product if known. The highest value of the components is listed for mixtures.

SPECIFIC VAPOR DENSITY: Compared to AIR = 1. If the Specific Vapor Density of a product is not known, the value is expressed as lighter or greater than air.

SPECIFIC GRAVITY: Compared to WATER = 1. If Specific Gravity of product is not known, the value is expressed as less than or greater than water.

pH: If applicable.

PERCENT VOLATILES: Percentage of material with initial boiling point below 425 degrees Fahrenheit and vapor pressure above 0.1mm Hg at 68 F.

EVAPORATION RATE: Indicated as faster or slower than ETHYL ETHER, unless otherwise stated.

SECTION IV
FIRE AND EXPLOSION DATA

FLASH POINT: Method identified.

EXPLOSION LIMITS: For product if known. The lowest value of the components is listed for mixtures.

HAZARDOUS DECOMPOSITION PRODUCTS: Known or expected hazardous products resulting from heating, burning or other reactions.

SECTION IV (cont.)

EXTINGUISHING MEDIA: Following National Fire Protection Association criteria.

FIREFIGHTING PROCEDURES: Minimum equipment to protect firefighters from toxic products of vaporization, combustion or decomposition in fire situations. Other firefighting hazards may also be indicated.

SPECIAL FIRE AND EXPLOSION HAZARDS: States hazards not covered by other sections.

NFPA CODES: Hazard ratings assigned by the National Fire Protection Association.

SECTION V
HEALTH HAZARD DATA

PERMISSIBLE EXPOSURE LIMIT: For product.

THRESHOLD LIMIT VALUE: For product.

EFFECTS OF ACUTE OVEREXPOSURE: Potential local and systemic effects due to single or short term overexposure to the eyes and skin or through inhalation or ingestion.

EFFECTS OF CHRONIC OVEREXPOSURE: Potential local and systemic effects due to repeated or long term overexposure to the eyes and skin or through inhalation or ingestion.

FIRST AID: Procedures to be followed when dealing with accidental overexposure.

PRIMARY ROUTE OF ENTRY: Based on properties and expected use.

SECTION VI
REACTIVITY DATA

HAZARDOUS POLYMERIZATION: Conditions to avoid to prevent hazardous polymerization resulting in a large release of energy.

STABILITY: Conditions to avoid to prevent hazardous or violent decomposition.

INCOMPATIBILITY: Materials and conditions to avoid to prevent hazardous reactions.

SECTION VII
SPILL OR LEAK PROCEDURES

Reasonable precautions to be taken and methods of containment, clean-up and disposal. Consult federal, state and local regulations for accepted procedures and any reporting or notification requirements.

SECTION VIII
PROTECTIVE EQUIPMENT TO BE USED

Protective equipment which may be needed when handling the product.

SECTION IX
SPECIAL PRECAUTIONS OR OTHER COMMENTS

Covers any relevant points not previously mentioned.

ADDITIONAL COMMENTS

Containers should be either reconditioned by CERTIFIED firms or properly disposed of by APPROVED firms. Disposal of containers should be in accordance with applicable laws and regulations. "EMPTY" drums should not be given to

MATERIAL SAFETY DATA SHEET

Ashland

Subsidiary of Ashland Oil Inc
P.O. BOX 2219
COLUMBUS, OHIO 43216
(614) 889-3333

Emergency Telephone
1(800) 274-5263
1(800) ASHLAND

Page

TOLUENE

007089

THIS MSDS COMPLIES WITH 29 CFR 1910.1200 (THE HAZARD COMMUNICATION STANDARD)

Product Name: TOLUENE
CAS NUMBER: 108-88-3

Data Sheet No: 0000565-007.000
Prepared: 06/24/92
Supersedes: 08/31/89

05 028

DISTRICT MANAGER
ASHLAND CHEMICAL, INC.
IC&S DIVISION
8315 E. 33RD STREET
INDIANAPOLIS, IN 46226

PRODUCT: 2185000
INVOICE: ACCLOC
INVOICE DATE: 08/09/92
TO:

**** INTERCOMPANY MAIL ****

SECTION I - PRODUCT IDENTIFICATION

General or Generic ID: AROMATIC HYDROCARBON

DOT Hazard Classification: FLAMMABLE LIQUID (173.115)

SECTION II - COMPONENTS

IF PRESENT, IARC, NTP AND OSHA CARCINOGENS AND CHEMICALS SUBJECT TO THE REPORTING REQUIREMENTS OF SARA TITLE III SECTION 313 ARE IDENTIFIED IN THIS SECTION. SEE DEFINITION PAGE FOR CLARIFICATION

INGREDIENT	% (by WT)	PEL	TLV	Note
TOLUENE CAS #: 108-88-3	100	100 PPM	100 PPM	(1)

Notes:

(1) ACGIH/OSHA - SHORT TERM EXPOSURE LIMIT (STEL) FOR TOLUENE IS 150 PPM. NIOSH RECOMMENDS A LIMIT OF 100 PPM, 8-HOUR TWA; 200 PPM 10 MINUTE CEILING.

THIS CHEMICAL IS SUBJECT TO THE REPORTING REQUIREMENTS OF SECTION 313 OF SARA TITLE III.

SECTION III - PHYSICAL DATA

Boiling Point	for PRODUCT	232.00 Deg F (111.11 Deg C) @ 760.00 mm Hg
Vapor Pressure	for PRODUCT	22.00 mm Hg @ 68.00 Deg F (20.00 Deg C)
Specific Vapor Density	AIR = 1	3.2
Specific Gravity		.872 @ 60.00 Deg F (15.56 Deg C)
Percent Volatiles		100.00%
Evaporation Rate	(N-BUTYL ACETATE = 1)	2.00
Appearance		CLEAR, SAYBOLT COLOR 30 MIN
State		LIQUID
Form		NEAT

SECTION IV - FIRE AND EXPLOSION INFORMATION

FLASH POINT(TCC) 45.0 Deg F (7.2 Deg C)

EXPLOSIVE LIMIT (PRODUCT) LOWER - 1.2% UPPER - 7.0%

EXTINGUISHING MEDIA: REGULAR FOAM OR CARBON DIOXIDE OR DRY CHEMICAL

HAZARDOUS DECOMPOSITION PRODUCTS: MAY FORM TOXIC MATERIALS:, CARBON DIOXIDE AND CARBON MONOXIDE, VARIOUS HYDROCARBONS, ETC.

FIREFIGHTING PROCEDURES: WEAR SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN THE POSITIVE PRESSURE DEMAND MODE WHEN FIGHTING FIRES.

SPECIAL FIRE & EXPLOSION HAZARDS: VAPORS ARE HEAVIER THAN AIR AND MAY TRAVEL ALONG THE GROUND OR MAY BE MOVED BY VENTILATION AND IGNITED BY PILOT LIGHTS, OTHER FLAMES, SPARKS, HEATERS, SMOKING, ELECTRIC MOTORS, STATIC DISCHARGE, OR OTHER IGNITION SOURCES AT LOCATIONS DISTANT FROM MATERIAL HANDLING POINT.

NEVER USE WELDING OR CUTTING TORCH ON OR NEAR DRUM (EVEN EMPTY) BECAUSE PRODUCT (EVEN JUST RESIDUE) CAN IGNITE EXPLOSIVELY.

ALL FIVE GALLON PAILS AND LARGER METAL CONTAINERS INCLUDING TANK CARS AND TANK TRUCKS SHOULD BE GROUNDED AND/OR BONDED WHEN MATERIAL IS TRANSFERRED.

NFPA CODES: HEALTH- 2 FLAMMABILITY- 3 REACTIVITY- 0

SAFETY
SHEET

Ashland

P.O. BOX 2219
COLUMBUS, OHIO 43216
(614) 889-3333

Telephone
1(800) 274-5263 or
1(800) ASHLAND

SECTION V-HEALTH HAZARD DATA

PERMISSIBLE EXPOSURE LEVEL 100 PPM

THRESHOLD LIMIT VALUE 100 PPM

EFFECTS OF ACUTE OVEREXPOSURE:

EYES - EXPOSURE TO LIQUID OR VAPOR MAY CAUSE EYE IRRITATION. SYMPTOMS MAY INCLUDE BURNING, TEARING, REDNESS, AND SWELLING.

SKIN - EXPOSURE MAY CAUSE MILD SKIN IRRITATION. PROLONGED OR REPEATED EXPOSURE MAY DRY THE SKIN. SYMPTOMS MAY INCLUDE REDNESS, BURNING, DRYING AND CRACKING, AND SKIN BURNS.

BREATHING - EXCESSIVE INHALATION OF VAPORS CAN CAUSE NASAL AND RESPIRATORY IRRITATION, CENTRAL NERVOUS SYSTEM EFFECTS INCLUDING DIZZINESS, WEAKNESS, FATIGUE, NAUSEA, HEADACHE AND POSSIBLE UNCONSCIOUSNESS, AND EVEN DEATH.

SWALLOWING - CAN CAUSE GASTROINTESTINAL IRRITATION, NAUSEA, VOMITING, AND DIARRHEA. ASPIRATION OF MATERIAL INTO THE LUNGS CAN CAUSE CHEMICAL PNEUMONITIS WHICH CAN BE FATAL.

FIRST AID:

IF ON SKIN: REMOVE CONTAMINATED CLOTHING. WASH EXPOSED AREA WITH SOAP AND WATER. LAUNDER CONTAMINATED CLOTHING BEFORE REUSE. IF SYMPTOMS PERSIST, SEEK MEDICAL ATTENTION.

IF IN EYES: IF SYMPTOMS DEVELOP, MOVE INDIVIDUAL AWAY FROM EXPOSURE AND INTO FRESH AIR. FLUSH EYES FOR AT LEAST 15 MINUTES WHILE HOLDING EYELIDS APART.

IF SWALLOWED: DO NOT INDUCE VOMITING. KEEP PERSON WARM, QUIET, AND GET MEDICAL ATTENTION. ASPIRATION OF MATERIAL INTO THE LUNGS DUE TO VOMITING CAN CAUSE CHEMICAL PNEUMONITIS WHICH CAN BE FATAL.

IF BREATHED: IF AFFECTED, REMOVE INDIVIDUAL TO FRESH AIR. IF BREATHING IS DIFFICULT, ADMINISTER OXYGEN. IF BREATHING HAS STOPPED GIVE ARTIFICIAL RESPIRATION. KEEP PERSON WARM, QUIET AND GET MEDICAL ATTENTION.

PRIMARY ROUTE(S) OF ENTRY:

INHALATION, SKIN CONTACT

EFFECTS OF CHRONIC OVEREXPOSURE:

TOLUENE MAY BE HARMFUL TO THE FETUS BASED ON LABORATORY ANIMAL STUDIES. INTENTIONAL MISUSE BY DELIBERATE INHALATION OF TOLUENE HAS BEEN ASSOCIATED WITH LIVER, KIDNEY AND BRAIN DAMAGE IN HUMANS. REPEATED EXPOSURE TO TOLUENE HAS BEEN ASSOCIATED WITH HIGH FREQUENCY HEARING LOSS BASED ON EVIDENCE IN LABORATORY ANIMALS; THE HUMAN HEALTH CONSEQUENCES OF THIS FINDING IS UNCERTAIN.

SOME REPORTS HAVE ASSOCIATED REPEATED AND PROLONGED EXPOSURE TO SOLVENTS WITH PERMANENT BRAIN AND NERVOUS SYSTEM DAMAGE (SOMETIMES REFERRED TO AS SOLVENT OR PAINTER'S SYNDROME). SYMPTOMS REPORTED INCLUDE FATIGUE, CONCENTRATION DIFFICULTIES, ANXIETY, DEPRESSION, RAPID MOOD SWINGS, AND SHORT-TERM MEMORY LOSS. THESE REPORTS ARE NOT CLEAR WITH REGARD TO THE TYPE OF SOLVENTS THAT CAUSE THESE SYMPTOMS. THERE ALSO IS CONTROVERSY AMONG SCIENTISTS AS TO WHETHER THE CONDITION EXISTS OR IS CAUSED BY THIS TYPE OF PRODUCT. SINCE MANY DISEASES CAUSE SOME OR ALL OF THESE SYMPTOMS, A DOCTOR SHOULD BE CONSULTED IF ANY SYMPTOMS APPEAR.

OVEREXPOSURE TO THIS MATERIAL (OR ITS COMPONENTS) HAS APPARENTLY BEEN FOUND TO CAUSE THE FOLLOWING EFFECTS IN LABORATORY ANIMALS: LIVER ABNORMALITIES, KIDNEY DAMAGE, NASAL DAMAGE, BRAIN DAMAGE

SECTION VI-REACTIVITY DATA

HAZARDOUS POLYMERIZATION: CANNOT OCCUR

STABILITY: STABLE

INCOMPATIBILITY: AVOID CONTACT WITH:, STRONG OXIDIZING AGENTS

SECTION VII-SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:

SMALL SPILL: ELIMINATE ALL SOURCES OF IGNITION SUCH AS FLARES, FLAMES (INCLUDING PILOT LIGHTS), AND ELECTRICAL SPARKS.

ABSORB LIQUID ON VERMICULITE, FLOOR ABSORBENT, OR OTHER ABSORBENT MATERIAL AND TRANSFER TO HOOD.

LARGE SPILL: ELIMINATE ALL IGNITION SOURCES (FLARES, FLAMES INCLUDING PILOT LIGHTS, ELECTRICAL SPARKS). PERSONS NOT WEARING PROTECTIVE EQUIPMENT SHOULD BE EXCLUDED FROM AREA OF SPILL UNTIL CLEAN-UP HAS BEEN COMPLETED. STOP SPILL AT SOURCE, PREVENT FROM ENTERING DRAINS, SEWERS, STREAMS OR OTHER BODIES OF WATER.PREVENT FROM SPREADING. IF RUNOFF OCCURS, NOTIFY AUTHORITIES AS REQUIRED. PUMP OR VACUUM TRANSFER SPILLED PRODUCT TO CLEAN CONTAINERS FOR RECOVERY. ABSORB UNRECOVERABLE PRODUCT.TRANSFER CONTAMINATED ABSORBENT, SOIL AND OTHER MATERIALS TO CONTAINERS FOR DISPOSAL.

WASTE DISPOSAL METHOD:

SMALL SPILL: DISPOSE OF IN ACCORDANCE WITH ALL LOCAL, STATE AND FEDERAL REGULATIONS.

LARGE SPILL: DISPOSE OF IN ACCORDANCE WITH ALL LOCAL, STATE AND FEDERAL REGULATIONS.

SECTION VIII-PROTECTIVE EQUIPMENT TO BE USED

RESPIRATORY PROTECTION: IF WORKPLACE EXPOSURE LIMIT(S) OF PRODUCT OR ANY COMPONENT IS EXCEEDED (SEE SECTION II), A NIOSH/MSHA APPROVED AIR SUPPLIED RESPIRATOR IS ADVISED IN ABSENCE OF PROPER ENVIRONMENTAL CONTROL. OSHA REGULATIONS ALSO PERMIT OTHER NIOSH/MSHA RESPIRATORS (NEGATIVE PRESSURE TYPE) UNDER SPECIFIED CONDITIONS (SEE YOUR SAFETY EQUIPMENT SUPPLIER). ENGINEERING OR ADMINISTRATIVE CONTROLS SHOULD BE IMPLEMENTED TO REDUCE EXPOSURE.

VENTILATION: PROVIDE SUFFICIENT MECHANICAL (GENERAL AND/OR LOCAL EXHAUST) VENTILATION TO MAINTAIN EXPOSURE BELOW TLV(S).

PROTECTIVE GLOVES: WEAR RESISTANT GLOVES SUCH AS:, NITRILE RUBBER

CONTINUED ON PAGE: 3

SAFETY
SHEET

Ashland

Subsidiary of Ashland Oil, Inc
P.O. BOX 2219
COLUMBUS, OHIO 43216
(614) 889-3333

Emergency
Telephone
1(800) 274-5263
1(800) ASHLAND

TOLUENE

Page:

SECTION VIII - PROTECTIVE EQUIPMENT TO BE USED (CONTINUED)

EYE PROTECTION: CHEMICAL SPLASH GOGGLES IN COMPLIANCE WITH OSHA REGULATIONS ARE ADVISED; HOWEVER, OSHA REGULATIONS ALSO PERMIT OTHER TYPE SAFETY GLASSES. (CONSULT YOUR SAFETY EQUIPMENT SUPPLIER)

OTHER PROTECTIVE EQUIPMENT: TO PREVENT REPEATED OR PROLONGED SKIN CONTACT, WEAR IMPERVIOUS CLOTHING AND BOOTS.

SECTION IX - SPECIAL PRECAUTIONS OR OTHER COMMENTS

CONTAINERS OF THIS MATERIAL MAY BE HAZARDOUS WHEN EMPTIED. SINCE EMPTIED CONTAINERS RETAIN PRODUCT RESIDUES (VAPOR, LIQUID, AND/OR SOLID), ALL HAZARD PRECAUTIONS GIVEN IN THE DATA SHEET MUST BE OBSERVED.

HYDROCARBON SOLVENTS ARE BASICALLY NON-CONDUCTORS OF ELECTRICITY AND CAN BECOME ELECTROSTATICALLY CHARGED DURING MIXING, FILTERING OR PUMPING AT HIGH FLOW RATES. IF THIS CHARGE REACHES A SUFFICIENTLY HIGH LEVEL, SPARKS CAN FORM THAT MAY IGNITE THE VAPORS OF FLAMMABLE LIQUIDS.

WARNING!!! SUDDEN RELEASE OF HOT ORGANIC CHEMICAL VAPORS OR MISTS FROM PROCESS EQUIPMENT OPERATING AT ELEVATED TEMPERATURE AND PRESSURE, OR SUDDEN INGRESS OF AIR INTO VACUUM EQUIPMENT, MAY RESULT IN IGNITIONS WITHOUT THE PRESENCE OF OBVIOUS IGNITION SOURCES. PUBLISHED "AUTOIGNITION" OR "IGNITION" TEMPERATURE VALUES CANNOT BE TREATED AS SAFE OPERATING TEMPERATURES IN CHEMICAL PROCESSES WITHOUT ANALYSIS OF THE ACTUAL PROCESS CONDITIONS. ANY USE OF THIS PRODUCT IN ELEVATED TEMPERATURE PROCESSES SHOULD BE THOROUGHLY EVALUATED TO ESTABLISH AND MAINTAIN SAFE OPERATING CONDITIONS.

THE INFORMATION ACCUMULATED HEREIN IS BELIEVED TO BE ACCURATE BUT IS NOT WARRANTED TO BE WHETHER ORIGINATING WITH THE COMPANY OR NOT. RECIPIENTS ARE ADVISED TO CONFIRM IN ADVANCE OF NEED THAT THE INFORMATION IS CURRENT, APPLICABLE, AND SUITABLE TO THEIR CIRCUMSTANCES.

LAST PAGE

MONSANTO PRODUCT NAME

Polychlorinated Biphenyls (PCBs)

MONSANTO COMPANY
800 N. LINDBERGH BLVD.
ST. LOUIS, MO 63167

Emergency Phone No.
(Call Collect)
314-694-1000

Date: 10/88

PRODUCT IDENTIFICATION

Synonyms:

PCBs
Chlorodiphenyl (__% Cl)
Chlorinated biphenyl
Polychlorinated biphenyl
Chlorinated biphenyls
(approx. __% Cl)

Trade Names/ Common Names:

Aroclor®[1] Series 1016, 1221, 1232, 1242, 1248, 1254, 1260
Therminol®[1] FR Series

PYRANOL®[2] and INERTEEN®[3] are trademarks for commonly used dielectric fluids that may have contained varying amounts of PCBs as well as other components including chlorinated benzenes.

ASKAREL - Generic name for a broad class of fire-resistant synthetic chlorinated hydrocarbons and mixtures used as dielectric fluids that commonly contained about 30-70% PCBs. Some ASKAREL fluids contained 99% or greater PCBs and some contained no PCBs.

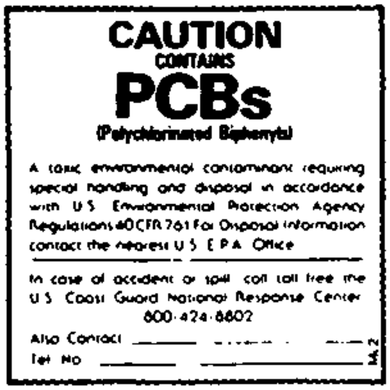
This list of trade names is representative of several commonly used Monsanto products (or products formulated with Monsanto products). Other trademarked PCB products were marketed by Monsanto and other manufacturers. PCBs were also manufactured and sold by several European and Japanese companies. Contact the manufacturer of the trademarked product, if not in this listing, to determine if the formulation contained PCBs.

®[1] Registered trademark of Monsanto Company
®[2] Registered trademark of General Electric Company
®[3] Registered trademark of Westinghouse Electric Corporation

CAS No.'s: 001336363, 053469219, 021672296, 01109769, 011096825 and others

WARNING STATEMENTS

Federal regulations under the Toxic Substances Control Act require PCBs, PCB items, storage areas, transformer vaults, and transport vehicles to be marked. (check regulations, 40 CFR 761, for details)



CAUTION
CONTAINS
PCBs
(Polychlorinated Biphenyls)

A toxic environmental contaminant requiring special handling and disposal in accordance with U.S. Environmental Protection Agency Regulations 40 CFR 761 For Disposal information contact the nearest U.S. E.P.A. Office

In case of accident or spill call toll free the U.S. Coast Guard National Response Center 800-424-8802

Also Contact ________________
Tel No ________________

CAUTION —
CONTAINS
PCBs
(Polychlorinated Biphenyls)
FOR PROPER DISPOSAL INFORMATION
CONTACT U.S. ENVIRONMENTAL
PROTECTION AGENCY

RECEIVED
NOV 25 1988
ENVIRONMENTAL AFFAIRS
(AIR)

OCCUPATIONAL CONTROL PROCEDURES *(continued)*

Airborne Exposure Limits (Continued): Chlorinated biphenyl (approximately 54% chlorine)

OSHA PEL: 0.5 mg/m^3 8-hour time-weighted average - Skin*
ACGIH TLV: 0.5 mg/m^3 8-hour time-weighted average - Skin*
1 mg/m^3 short-term exposure limit - Skin*

**Skin notation means that skin absorption of this material may add to the overall exposure. Avoid skin contact.*

FIRE PROTECTION INFORMATION

Fire and Explosion: PCBs are fire-resistant compounds. They may decompose to form CO, CO_2, HCl, phenolics, aldehydes and other toxic combustion products under severe conditions such as exposure to flame or hot surfaces.

At temperatures in the range of 600-650°C in the presence of excess of oxygen PCBs may form polychlorinated dibenzofurans (PCDFs). Laboratory studies under similar conditions have demonstrated that PCBs do not produce polychlorinated dibenzo-p-dioxins (PCDDs).

PCBs in electrical equipment have been reported to produce both chlorinated dioxins (PCDDs) and furans (PCDFs) during fire situations. These combustion products may result all, or in part, from non-PCB components of the dielectric fluids or other combusted materials. Consult the equipment manufacturer for information regarding composition of the dielectric fluids in electrical apparatus.

Standard fire fighting wearing apparel and self-contained breathing apparatus should be worn when fighting fires that involve possible exposure to chemical combustion products. Fire fighting equipment should be thoroughly cleaned and decontaminated after use.

Federal regulations require all PCB transformers to be registered with fire response personnel.

If a PCB transformer is involved in a fire-related incident, the owner of the transformer may be required to report the incident. Consult and follow appropriate federal, state, and local regulations.

REACTIVITY DATA

PCBs are very stable, fire-resistant compounds.

HEALTH EFFECTS SUMMARY

Skin Contact: PCBs can be absorbed through intact skin. Local action on skin is similar to that of common organic solvents where contact leads to removal of natural fats and oils with subsequent drying and cracking of the skin. A potential exists for contracting chloracne.

Eye Contact: The liquid products and their vapors are moderately irritating to eye tissues.

Ingestion: The acute oral toxicities of the undiluted compounds are: LD_{50} rats—8.65 gm/kg for 42% chlorinated, and 11.9 gm/kg for 54% chlorinated—"slightly toxic."

Inhalation: Animal experiments of varying duration and at different air concentrations show that for similar exposure conditions, the 54% chlorinated material produces more liver injury than the 42% chlorinated material.

(HEALTH EFFECTS SUMMARY continued on page 4)

HEALTH EFFECTS SUMMARY *(continued)*

Other: There are literature reports that PCBs can impair reproductive functions in monkeys. The National Cancer Institute performed a study in 1977 using Aroclor 1254 with both sexes of rats. NCI stated that the PCB, Aroclor 1254, was not carcinogenic under the conditions of their bioassay. There is sufficient evidence in the scientific literature to conclude that Aroclor 1260 can cause liver cancer when fed to rodents at high doses. Similar experiments with less chlorinated PCB products have produced negative or equivocal results.

The consistent finding in animal studies is that PCBs produce liver injury following prolonged and repeated exposure by any route, if the exposure is of sufficient degree and duration. Liver injury is produced first, and by exposures that are less than those reported to cause cancer in rodents. Therefore, exposure by all routes should be kept sufficiently low to prevent liver injury.

Numerous epidemiological studies of humans, both occupationally exposed and non-worker environmentally exposed populations, have not demonstrated any causal relationship between PCB exposures and chronic human illnesses such as cancer or neurological or cardiovascular effects. PCBs can cause dermatological symptoms; however, these are reversible upon removal of exposure source.

PCBs are identified as hazardous chemicals under criteria of the OSHA Hazard Communication Standard (29 CFR Part 1910.1200). PCBs have been listed in the International Agency for Research on Cancer (IARC) Monographs (1987)-Group 2A and in the National Toxicology Program (NTP) Annual Report on Carcinogens (Fourth).

PHYSICAL DATA

PROPERTIES OF SELECTED AROCLORS®							
PROPERTY	**1016**	**1221**	**1232**	**1242**	**1248**	**1254**	**1260**
Color (APHA)	40	100	100	100	100	100	150
Physical state	mobile oil	mobile oil	mobile oil	mobile oil	mobile oil	viscous liquid	sticky resin
Stability	inert	inert	inert	inert	inert	inert	inert
Density (lb/gal 25°C)	11.40	9.85	10.55	11.50	12.04	12.82	13.50
Specific gravity x/15.5°C	1.36-1.37 x-25°	1.18-1.19 x-25°	1.27-1.28 x-25°	1.30-1.39 x-25°	1.40-1.41 x-65°	1.49-1.50 x-65°	1.55-1.56 x-90°
Distillation range (°C)	323-356	275-320	290-325	325-366	340-375	365-390	385-420
Acidity mg KOH/g, maximum	.010	.014	.014	.015	.010	.010	.014
Fire point (°C)	none to boiling point	176	238	none to boiling point	none to boiling point	none to boiling point	none to boiling point
Flash point (°C)	170	141-150	152-154	176-180	193-196	none	none
Vapor pressure (mm Hg @ 100°F)	NA	NA	0.005	0.001	0.00037	0.00006	NA
Viscosity (Saybolt Univ. Sec. @ 100°F) (centistokes)	71-81 13-16	38-41 3.6-4.6	44-51 5.5-7.7	82-92 16-19	185-240 42-52	1800-2500 390-540	— —

NA—*Not Available*

SPILL, LEAK & DISPOSAL INFORMATION

Cleanup and disposal of liquid PCBs and other PCB items are strictly regulated by the federal government. The regulations are found at 40 CFR Part 761. Consult these regulations as well as applicable state and local regulations prior to any disposal of PCBs, PCB items, or PCB-contaminated items.

If PCBs leak or are spilled, the following steps should be taken immediately:

All non-essential personnel should leave the leak or spill area.

The area should be adequately ventilated to prevent the accumulation of vapors.

The spill/leak should be contained. Loss to sewer systems, navigable waterways and streams should be prevented. Spills/leaks should be removed promptly by means of absorptive material, such as sawdust, vermiculite, dry sand, clay, dirt or other similar materials, or trapped and removed by pumping or other suitable means (traps, drip-pans, trays, etc.).

Personnel entering the spill or leak area should be furnished with appropriate personal protective equipment and clothing as needed. See Occupational Control Procedures section of this MSDS.

Personnel trained in the emergency procedures and protected against the attendant hazards should shut off sources of PCBs, clean up spills, control and repair leaks and fight fires in PCB areas.

All wastes and residues containing PCBs (e.g., wiping cloths, absorbent material, used disposable protective gloves, clothing, etc.) should be collected, placed in proper containers, marked and disposed of in the manner prescribed by EPA regulations (40 CFR Part 761) and applicable state and local regulations.

Various federal, state and local regulations may require immediate reporting of PCB spills and may also define spill clean-up levels. Consult your attorney or appropriate regulatory officials for information relating to spill reporting and spill clean-up.

ENVIRONMENTAL INFORMATION

Care should be taken to prevent entry of PCBs into the environment through spills, leakage, use, vaporization or disposal of liquids or solids. PCBs can accumulate in the environment and can adversely affect some animals and aquatic life. In general, PCBs have low solubility in water, are strongly bound to soils and sediments, and are slowly degraded by natural processes in the environment.

ADDITIONAL COMMENTS

Polychlorinated Biphenyls

For regulatory purposes, under the Toxic Substances Control Act the term "PCBs" refers to a chemical substance limited to the biphenyl molecule that has been chlorinated to varying degrees or any combination of substances which contain such substance (40 CFR Part 761).

Chemically, commercial PCBs are defined as a series of technical mixtures, consisting of many isomers and compounds that vary from mobile oily liquids to white crystalline solids and hard non-crystalline resins. Technical products vary in composition, in the degree of chlorination and possibly according to batch.

The mixtures generally used contain an average of 3 atoms of chlorine per molecule (42% chlorine) to 5 atoms of chlorine per molecule (54% chlorine). They are used as components of dielectric fluids in transformers and capacitors. Prior to 1972, PCB applications included heat transfer media, hydraulic and other industrial fluids, plasticizers, carbonless paper, paints, inks and adhesives.

In 1972 Monsanto restricted sales of PCBs to applications involving only closed electrical systems (transformers and capacitors). In 1977 all manufacturing and sales were voluntarily terminated. In 1979 EPA restricted the manufacture, processing, use, and distribution of PCBs to specifically exempted and authorized activities.

FOR ADDITIONAL NON-EMERGENCY INFORMATION, CONTACT:

John H. Craddock
Product & Environmental Safety Director

Paul R. Michael
Product & Environmental Safety Manager

Environmental Policy Staff
Monsanto Company
800 North Lindbergh Boulevard
St. Louis, Missouri 63167
(314) 694-4764

FINAL

CONSTRUCTION QUALITY PLAN

RICHARDS-GEBAUR AIR FORCE BASE
F41624-94-D-8102
DELIVERY ORDER 0003

UEBL 95-6004
CLOSE ST007

AND

UEBL 95-7001
PHASE 2 SITE INSPECTION AT SS008

PREPARED FOR
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS

March 15, 1996

PREPARED BY
DAMES & MOORE, INC.

TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

This Construction Quality Plan (CQP) has been prepared to ensure that the completed remedial activities under Delivery Order 0003 are consistent with the Contract CQP prepared for Richards-Gebaur AFB under Delivery Order 0001, except as noted herein by amendments and/or additions. This CQP will be implemented during construction of remedial activities under Delivery Order 0003.

2.0 RESPONSIBILITY AND AUTHORITY

2.1 GENERAL

Responsibility and authority for quality assurance is described in the Contract CQP prepared under Delivery Order 0001, except as noted herein.

Dames & Moore

- Delivery Order Management
- Field Inspection
- Environmental Services
- Program Quality Control
- Reports and Documentation

W R King Contracting

- Excavate and haul approximately 20 cubic yards of soil. Backfill and restoring the site to its original condition.

Ross Analytical Services, Inc.

- Chemical analysis

Max's Enterprises

•Environmental drilling, soil sampling, and well installation

PSA Environmental, Inc.

•Environmental drilling, soil sampling, and well installation

2.2 QUALITY ASSURANCE PERSONNEL QUALIFICATIONS

The qualifications of the Site Quality Assurance Manager and supporting quality assurance inspection personnel are contained in Appendix A.

2.3 INSPECTION ACTIVITIES

The observations and tests that will be used to ensure that the field investigation and construction activities meet all criteria, plans and specifications are described in this CQP.

2.4 SAMPLING STRATEGIES

Sampling activities, sample size, methods for determining sample locations, frequency of sampling, acceptance and rejection criteria, and methods for ensuring that corrective measures are implemented as addressed in the statement of work are presented in the Field Sampling Plan.

2.5 PROJECT DOCUMENTATION

Reporting requirements are described in the Contract CQP prepared under Delivery Order 0001. Additional reports shall include:

•<u>ST007</u> - No Further Response Action Planned Report, or Recommendation Report
•<u>SS008</u> - No Further Response Action Planned Report and Phase II Site Investigation Report

•

3.0 CONSTRUCTION QUALITY CONTROLS

Responsibilities for the construction quality of this remedial action are described in the Contract CQP prepared under Delivery Order 0001, except as noted herein.

3.1 SECURITY

An exclusion zone will be delineated around each work area during the field activities. The exclusion zones will extend a minimum of 30 feet from active work areas and will be delineated using cones and/or barrier tape. Exclusion zones will remain in effect 24 hours a day until the completion of the field activities at each location. Only authorized Dames & Moore personnel, Dames & Moore subcontractor personnel, or authorized visitors who have the necessary documentation as described in the Health and Safety Plan will be allowed within the exclusion zones.

3.2 SITE PREPARATION

Site preparation will include the construction of a decontamination pad for the cleaning of the drilling and excavation equipment used. The pad will be located in proximity to a potable water source and electricity. No additional site preparation is anticipated.

3.3 EROSION

A combination of vegetative, structural, and/or site management erosion control practices shall be employed during remediation activities. This includes minimizing the exposure time of excavated surfaces and stockpiles to surface water runoff, keeping soil stockpiles covered with poly liner, and preventing siltation of existing drainage structures and waterways using inlet protection devices.

3.4 EXCAVATION

Excavations performed at site SS008 will be inspected to document the quantity of soil removed and that the required contaminated soil has been removed. Appropriate federal and state regulations will be followed for all excavation and backfilling activities.

3.5 SPILLAGE AND DISCHARGE

During excavation, soil boring, and well installation activities, monitoring will be performed so that contaminated soil or ground water is not spilled or discharged.

3.6 SURFACE AND GROUND WATER MANAGEMENT

Surface water runoff shall be controlled by using erosion control methods around remediation areas and dewatering of the open excavations. Dewatering of excavations will be limited to that necessary to maintain a safe excavation.

The depth of the ground water in the area and current conditions indicate that ground water may be encountered during remedial activities. The ground water encountered during remedial activities will be controlled by dewatering the open excavation.

3.7 TRANSPORTATION

The provisions of the site-specific transportation plan, found in the Work Plan, will be monitored to ensure compliance with all appropriate statutes and regulations. Reference is also made to the site-specific health and safety plan (HSP) pertaining to safety issues for vehicle and personnel actions.

3.8 DISPOSAL OF THE PETROLEUM CONTAMINATED SOIL

Contaminated soils encountered during excavation will be remediated utilizing a bioremediation landfarming facility (built by DO# 0004), if available, or disposed of off base in accordance with applicable regulations.

3.9 DEMOBILIZATION

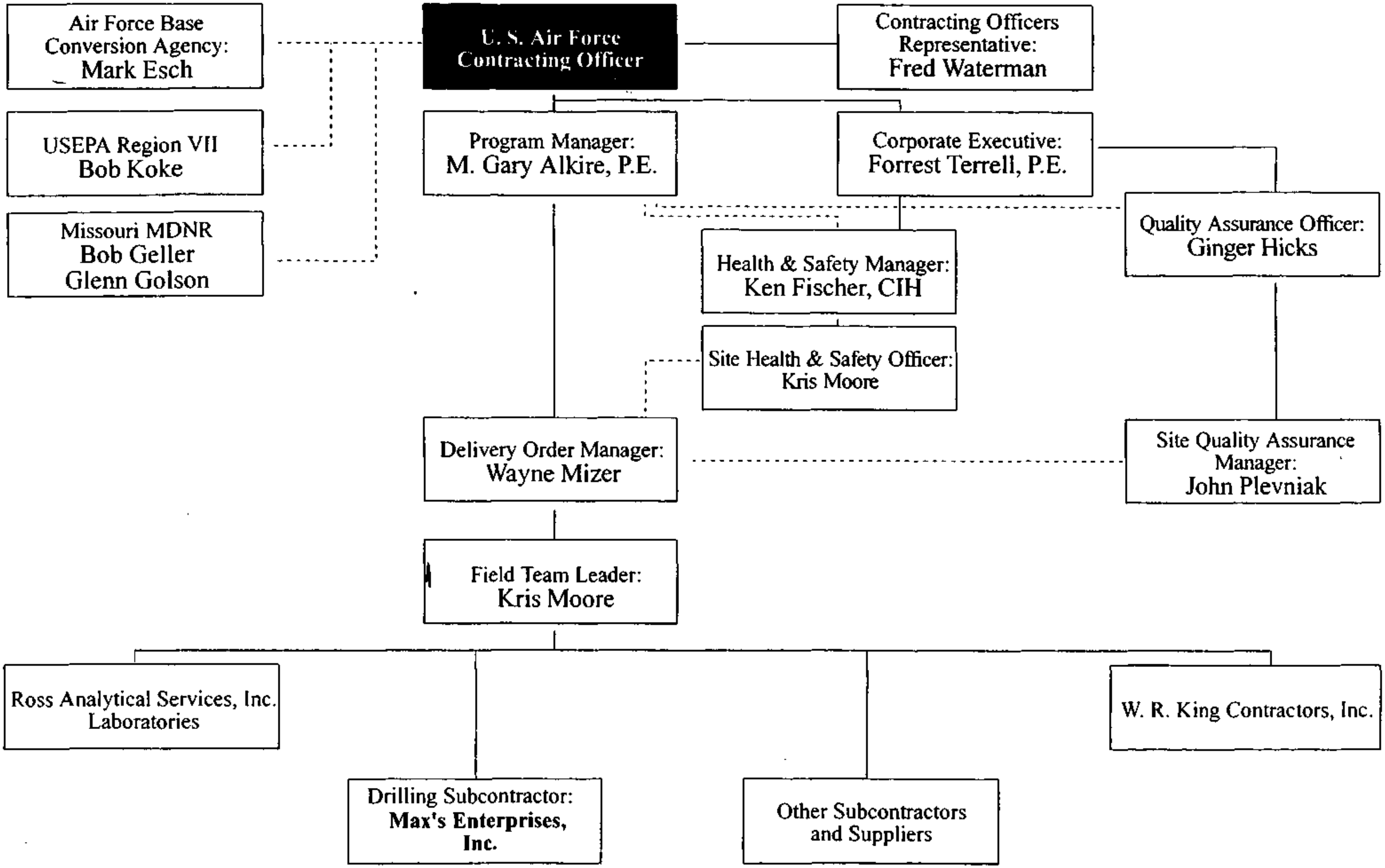
There will be several demobilization events occurring at the completion of various phases of the remedial activities. Prior to any demobilization activities, and final closure of the sites, inspections will be conducted to ensure that project goals have been attained. After an inspection by the AFBCA to certify that the work has been performed successfully and in accordance with the scope of work, demobilization activities will be monitored to ensure that facilities and equipment are properly dismantled and removed.

APPENDIX A

Personnel Qualifications

Richards - Gebaur Air Force Base Delivery Order No. 3

Organizational Chart



U. S. Air Force Contracting Officer

Air Force Base Conversion Agency: Mark Esch

USEPA Region VII Bob Koke

Missouri MDNR Bob Geller Glenn Golson

Contracting Officers Representative: Fred Waterman

Program Manager: M. Gary Alkire, P.E.

Corporate Executive: Forrest Terrell, P.E.

Health & Safety Manager: Ken Fischer, CIH

Quality Assurance Officer: Ginger Hicks

Site Health & Safety Officer: Kris Moore

Delivery Order Manager: Wayne Mizer

Site Quality Assurance Manager: John Plevniak

Field Team Leader: Kris Moore

Ross Analytical Services, Inc. Laboratories

Drilling Subcontractor: **Max's Enterprises, Inc.**

Other Subcontractors and Suppliers

W. R. King Contractors, Inc.

M. Gary Alkire, P.E.

Title

Managing Principal, Government Services Division,
Dames & Moore, Inc., San Antonio, Texas

Academic Background

Baltimore Polytechnic Institute (1953)
B.S. United States Naval Academy (1957)
M.S.C.E. Purdue University (1963)

Registration

Professional Engineer: Virginia and Texas

Experience

<u>1992 - Present</u>: Managing Principal, Dames & Moore Government Services Division, San Antonio, Texas

Program Manager for five United States Air Force environmental contracts valued at $105 million. These contracts provide for environmental remediation of closing United States Air Force bases in Missouri and Arkansas; removal/replacement of leaking fuel tanks and remediation of remaining contaminated soil in twelve western states; and environmental planning services, worldwide. A principal reviewer for all Quality, Health and Safety, Sampling, and Environmental Work Plans.

A consultant to Dames & Moore regarding the worldwide policies, plans, and programs of United States Air Force Civil Engineering, including Environmental Engineering. Provide executive oversight for all Dames & Moore contracts for the United States Air Force.

<u>1957 - 1990</u> : Thirty two years active duty with the United States Air Force, retiring in the grade of Major General.

<u>1984 - 1990</u> : Commander, United States Air Force Commissary System, San Antonio, Texas

Managed and directed worldwide operations of a grocery chain for the use of military personnel and their families; annual sales were more than $2.5 billion (equal to the 9th largest grocery chain in the United States). Experience included:

- Development of a strategic plan to guide growth and resource application.
- Development and installation of computer-based operations.
- Improved productivity such that operating hours for the 39 largest stores were extended 37%.
- Renewed emphasis on personnel management and training programs.
- Upgrade of plant and equipment through an annual $50 million. program (contract cost growth was less than 1% and construction time was reduced from 18 months to approximately 12 months).

The organization was a consistent winner of national awards; in 1989 the Air Force system was the Department of Defense leader in productivity, sales, and customer service.

1982 - 1984 : Deputy Director for Engineering and Services, Headquarters United States Air Force, The Pentagon

Supervised development of policies and procedures for planning, design, construction, operation, maintenance, and disposal of United states Air Fore facilities and real property. The work included:

- Direction of an executive review committee tasked to assure on time/in budget completion of $200 million space tracking base in Colorado, a $70 million hospital restoration in Ohio, and missile support facilities in Wyoming valued at $50 million.
- Technical direction of studies, by the United States Air Force Scientific Advisory Board, that lead to new emphasis on research and development of technologies for rapid repair of bomb damaged runways. A second study focused on priorities and resources for hazardous waste/material storage and management.
- Development of computer hardware and software for a new generation of facility maintenance management that improved the productively of maintenance personnel, reduced cost, improved customer satisfaction with base maintenance personnel.

Responsibilities also included oversight of fire protection, environmental protection, energy conservation, design and construction, Civil Engineering research, and United States Air Force services programs such as dinning hall operation, billeting, mortuary, wartime feeding programs.

1981 - 1982 : Deputy Chief of Staff, Engineering and Services, United States Air Force Logistics Command, Dayton, Ohio

Supervised engineering and services activities needed to design, construct, operate, maintain, and upgrade five major industrial complexes. The work included:

- Environmental protection, energy conservation, and comprehensive base development planning.
- Development of programs valued more than $6 million for complete rehabilitation of enlisted housing and dining halls.
- Expediting identification of hazardous waste sites and coordination of work to begin restoration of contaminated sites in California that were migrating off base and impacting private domestic water sources.
- Direction of design and construction of bases in the Kingdom of Saudi Arabia to support F15 aircraft. The program, funded by the Kingdom of Saudi Arabia, cost more than $1 billion and was accomplished with designs by United States firms and construction by foreign contractors with workers imported generally from the third world. The work included purchase of furniture and accessories for "turn Key" occupancy by the Saudi Arabia Air Force.
- Directing construction of a base in Egypt using materials purchased in the United States for use by Egyptian contractors.

Responsibilities also included oversight of command fire protection, environmental protection, energy conservation, design and construction, and services programs such as dinning hall operation, billeting, mortuary and commissary.

1978 - 1981 : Deputy Chief of Staff, Engineering and Services, United States Air Force Air Training Command.

Supervised engineering and services activities needed to operate, maintain, and upgrade five major flight training centers, six technical training centers, and one university. The work included:

- Development of state - of - the art concepts for energy. conservation by coordination with the Department of Energy to establish a geothermal production well in Arizona. Also, directed purchase and installion of computer managed energy monitoring and control centers at each technical center.
- Establishment of the first architectural compatibility program in the United States Air Force to guide future airbase design.
- Establishment of an office for interior design to provide maintainable, cost effective, and pleasant work environments.
- Recovery of Keesler Air Force Base, Mississippi, from effects of Hurricane Frederic by rapid identification of materials required for repair, purchase away from the storm damaged area, and deployment of engineering craftsmen from other installations to aid with recovery construction.

Responsibilities also included oversight of command fire protection, environmental protection, energy conservation, design and construction, and services programs such as dinning hall operation, billeting, mortuary and commissary.

1975 - 1978 : Assistant to the Deputy Chief of Staff, Engineering and Services, United States Air Force in Europe, Germany

Supervised engineering and services activities needed to construct, operate, maintain 24 main air bases, hundreds of dispersed sites, and more than 14,500 family housing units in nine European countries. The work included:

- Oversight of design and construction valued more than $1 billion.
- Expediting planning and execution of construction programs designed to protect military forces from Warsaw Pact weapon blast effects. Lead limited research activities to devise aircraft shelter modifications to accommodate growing aircraft wingspans.
- Directing construction of facility modifications to improve the survivability of Air Force units, including "toning down" facilities and pavement so that they would be less visible from the air, constructing redundant aircraft pavement, and revetments around key facilities.
- Directing negotiations with foreign officials in Spain, England and the Netherlands to obtain third party financing for build lease family housing units.
- Directing reconstruction of all dormitories and dining halls in Germany through a fund established by the German government.

Responsibilities also included oversight of command fire protection, environmental protection, energy conservation, and services programs such as dinning hall operation, billeting, mortuary and commissary operations.

1973 - 1975 : Chief of the Construction Division, Headquaters, United States Air Force, The Pentagon

Managed design and construction of the United States Air Force worldwide program valued at approximately $1 billion. The work included:

- Development of policies for management of design and construction.
- Establishment of a constructability review at 35% design completion to focus user requirements and reduce design cost and changes during construction.
- Completion of an earlier program to design and construct relocatable dormitories at selected bases in the United States.

Contract award rates during this period were the best in the Department of Defense.

1971 - 1973 : Base Civil Engineer at England Air Force Base, Louisiana.

Supervised facility maintenance, utility operation, design and construction, fire protection, and master planning through "in-house" work force and contract employees.

England Air Force Base included more than 300 buildings, airfield pavement, and utility systems. Work was accomplished by 336 employees and the contractor work force. Work included development of a real time management information system to improve maintenance response.

Major tasks involved development of ten projects valued at approximately $1 million, for support of a new weapon system. Work was designed and constructed in less than 18 months and was completed on time and within budget.

1970 - 1971 : Chief of Operations and Management Division, Military Assistance Command, South Vietnam

Responsible for programming, budgeting, real estate acquisition, design, and construction management activities related to reconstruction of the primary highway and bridge system in South Vietnam.

Experience included development of new highway construction criteria designed to reduce time and resource requirements, doubling production of aggregate for highways in the Delta, and development of systems to track construction progress.

1966 - 1970 : Project Officer, Overseas Construction Branch, Headquarters, United States Air Force, The Pentagon

Responsible for financial management and design and construction management for construction in Vietnam, Thailand, Korea, and the Pacific.

Work included development of simplified status and analysis of design and construction supporting the United States Air Force in Vietnam. Total program exceeded $1 billion. Work lead to development of an innovative cash flow construction management concept.

Responsible for preparation of economic analyses, construction standards, construction cost estimates, and area cost factors, and materials for Congressional hearings.

1963 - 1966 : Chief Engineer, Toul Rosieres Air Base, France

Responsible for master planning, budgeting, design and construction management, and technical review of construction plans and specifications. Additional responsibilities included preparation of budget documents for the North Atlantic Treaty Organization.

Work included selecting architect engineers, negotiating design and construction cost with French officials, supervising reconstruction of the primary runway, and oversight of the largest maintenance, repair, and construction effort in the history of the base for support of new aircraft.

1961 - 1963 : Attended Purdue University, West Lafayette, Indiana.

1957 - 1961 : Planning and Programming Officer, Warren Air Force Base, Wyoming.

Responsible for development of master plans, facility reuse plans, budgeting, and management of design and construction.

Responsible for development of facility reuse plans to convert Warren Air Force Base from technical training to missile base. Work included programming and oversight of the largest maintenance, repair, and construction program in the history of the base.

Citizenship	United States
Countries Worked In	France, Germany, Vietnam
Language Proficiency	English
Professional Affiliations	Society of American Military Engineers American Society of Civil Engineers Tau Beta Pi (Alpha of Indiana) First Air Force Engineer inducted into the Order of the Sword Member of the Air Force Village Foundation Board of Trustees

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FORREST A. TERRELL, PE

Title	Principal
Expertise	Environmental Program Management Construction Program Management Civil Engineering - Structures Mechanical Engineering
Experience	Twenty-one years experience with the Corps of Engineers in various positions from Project Engineer to Deputy District Engineer. Provided project/program oversight on significant flood control, navigation, hurricane protection, military facilities, nation building, and environmental projects in the United States, Europe, Middle East, and Central America.
Experience With Firm	Joined Dames & Moore in October 1992
Past Experience	Deputy District Engineer/Chief of Staff, Kansas City District, US Army Corps of Engineers (1987-1992)_

- Program Director/Contracting Officer for a $450m Hazardous Waste Program within a 23 state area across five EPA Regions in support of EPA's Superfund Program and the DOD's Defense Environmental Restoration Program.
- Project Director/Contracting Officer for an asbestos survey of 444 buildings at Fort Leavenworth, Kansas followed by a design and abatement project for 129 administration buildings and 115 family housing buildings.
- Project Director/Contracting Officer for an asbestos survey of 859 buildings at Fort Leonard Wood, Missouri.
- Project Director/Contracting officer for an asbestos survey of 1353 administrative buildings and 948 family housing units at Fort Riley, Kansas.
- Program Director/Contracting Officer for the $200m facilities construction program at McConnell Air Force Base, Wichita, Kansas in support of the beddown of the B-1B bomber.
- Program Director/Contracting Officer for a $175m facility construction program at Fort Riley, Kansas providing maintenance and training facilities for the Army's new M-1 Main Battle Tank, M-2 Bradley Fighting Vehicle, and AH-64 Apache Attack Helicopter.
- Program Director/Contracting Officer for a $600m facility construction program at Whiteman Air Force Base, Missouri in support of the beddown of the B-2 "Stealth" Bomber.

Deputy Chief of Staff, Engineer, Joint Task Force B,
Honduras (1989 - 1990)

- Program Director responsible for construction of war contingency facilities including three tactical airfields, a heliport, a petroleum tank farm, and 15KM of two lane all weather roads.
- Program Director responsible for nation building projects including 45 schools, two clinics, and a gymnasium.

Engineering Division Chief, Saudi Arabian National Guard
Modernization Program (1983-1985)

- Developed design criteria and guide specifications for a $127m facilities construction program.
- Led a design/planning team of engineers and architects in providing engineer installation support for three family housing compounds and an administrative office complex.

Area Engineer, New Orleans District Corps of Engineers (1980-1983)

- Project Engineer/Program Director responsible for the execution of a $400m program of major flood control, navigation, and hurricane protection projects.

Numerous assignments in Germany and the United States managing construction projects (1971 - 1979)

Academic Background

B.S. Mechanical Engineering, University of Houston, Texas 1971
M.S. Civil Engineering, Southern Methodist University, Dallas, Texas 1979

Citizenship

United States

Countries Worked In

United States, Germany, Saudi Arabia, Honduras

Professional Registration

Professional Engineer, Louisiana 1983

Professional Affiliations

American Society of Civil Engineers
Society of American Military Engineers
The Army Engineer Regimental Association
Hazardous Materials Control Resource Institute
Visiting Professor, University of Missouri Environmental
Engineering Extension Program
Panelist for Truman Scholars Leadership Week 1992

Curriculum Vitae

GINGER L. HICKS

TITLE Manager of Quality Assurance

EXPERTISE Quality Assurance/Aquatic Biology

EXPERIENCE WITH FIRM

Manager of Quality Assurance

- Develops and implements the firm-wide quality assurance policies and objectives.
- Maintains liaison with management and provides guidance to professionals on quality assurance matters.
- Coordinates and approves preparation of the Quality Assurance Manual and revisions thereto, subject to review and approval by appropriate management.
- Reviews and approves subcontractor quality assurance programs.
- Reviews the performance of quality assurance staff and audits their project files.
- Reviews applicable federal, state, and local quality assurance requirements and provides guidance to QA and technical staff on their use/interpretation.
- Participates in client and agency audits.

Certified Lead Auditor (NQA-1)

- Performs audits on nuclear, hydropower, geotechnical, and environmental projects. Conducted and/or participated in approximately 30 audits to date.

Assistant Manager of Quality Assurance

- Acted on behalf of Manager of Quality Assurance in all areas.
- Co-authored 5th edition of Dames & Moore Quality Assurance Manual.

Coordinator of Quality Assurance

- Responsible for implementation of quality assurance requirements for the following projects:
    - Management Licensing Effort for the Illinois Low-Level Radioactive Waste Disposal Facility.
    - Phase II Site Characterization, LEHR Environmental Restoration, University of California, Davis.
    - Dames & Moore's Biological Monitoring Program for Exxon Corporation, Valdez, Alaska.

  - Dames & Moore management and technical activities required for FERC Exhibit E for Pickens County, Georgia. Pumped Storage Hydroelectric Project for Oglethorpe Power Corporation.
  - Meteorological Tower Instrument Calibration Project for Georgia Power Company's Nuclear Plant Hatch.
  - Meteorological Monitoring Program for Southern California Edison Company's San Onofre Nuclear Generating Station.
  - United States Department of Energy, Savannah River Plant, RCRA Part B Application for E.I. du Pont de Nemours & Company, Inc.
  - United States Department of Energy's Nevada Test Site, Management Support Services for Reynolds Electrical & Engineering Company, Inc.
  - Environmental studies for Department of Energy's Crystalline Rock Program for Storage of High-level Radioactive Waste for the Northeastern and Southeastern United States.

- Prepared project specific data collection quality assurance plans for a secondary lead smelter under hazardous waste regulations.

Biology - Laboratory Responsibilities

- Identification and enumeration of ichthyoplankton samples, maintenance of laboratory records, and data reduction and handling, for:

  - Ecological field studies in support of FERC relicensing of Upper Peninsula Power Company's Bond Falls Project, Upper Peninsula, Michigan.
  - Biological studies on Middle Oconee River near Athens, Georgia.
  - Biological Monitoring Program for Virgil C. Summer Nuclear Station, Fairfield County, South Carolina.

Biology - Field Experience

- Collection of ichthyoplankton, zooplankton, phytoplankton, and adult fish from the Broad River and Parr and Monticello Reservoirs, Virgil C. Summer Nuclear Station in Fairfield County, South Carolina.

- Collection of adult and larval fish and benthic macroinvertebrates for biological studies to evaluate the potential impacts on a low head hydroelectric facility during minimum flow conditions on the Middle Oconee River near Athens, Georgia.

- Collection of ichthyoplankton, zooplankton, phytoplankton, and adult fish for Oglethorpe Power Pumped Storage Hydroelectric Project, Pickens County, Georgia.

- Collection of larval and adult fish for Bond Falls Project, Upper Peninsula Power Company.

Project Coordination

- Responsible for all record keeping, sample processing, data reporting, equipment maintenance, and management of field office for Upper Peninsula Power Company's, Bond Falls Project, Upper Peninsula, Michigan.

- Contacted both state and federal agencies for information on the status of various types of land for the Department of Energy's National Waste Terminal Storage Program.
- Editing and preparation of numerous proposals and reports.

ACADEMIC BACKGROUND	BA, Psychology, 1992, Agnes Scott College, Decatur, Georgia A.A.S. Fish & Wildlife Management, 1982, Haywood Technical College, Clyde, North Carolina.
PREVIOUS EMPLOYMENT	U.S. Forest Service, Highlands, NC, 1983 Forestry Technician
PROFESSIONAL AFFILIATIONS	American Society for Quality Control
REGISTRATIONS	Certified Lead Auditor, Dames & Moore, 1987 Flying Scot & Associates Lead Auditor Training Course and Exam, 1986.
PUBLICATIONS	Layman, Steven R. and Ginger L. Hicks. "Abundance and Chronology of Appearance of Larval Fish in FourLakes in the Upper Peninsula of Michigan," 1988. Poster presented at Annual Meeting of American Society of Ichthyologists and Herpetologists, Ann Arbor, Michigan.

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CURRICULUM VITAE

JOHN E. PLEVNIAK

TITLE

Senior Geologist/Geophysicist
Remedial Investigations Group Leader
Dames & Moore, Kansas City Office

EXPERTISE

Geology, Geophysics (Gravity, Magnetic, Electrical, Seismic Reflection and Seismic Refraction Investigations, borehole logging)

EXPERIENCE WITH FIRM

Mr. Plevniak provides geologic, hydrogeologic, and geophysical consultation for environmental audits, environmental site investigations, and site remediation projects. A partial listing of projects follows.

- Senior Geophysicist for a non-intrusive geophysical investigation for suspected chemical warfare material (CWM) and ordnance and explosive waste (OEW) disposal sites at the former Black Hills Army Depot, Edgemont, South Dakota. Responsible for project technical activities, data reduction and data analysis.

- Senior Geophysicist for a non-intrusive geophysical investigation for suspected unexploded ordnance (UXO) sites at the former Nebraska Ordnance Plant in Mead, Nebraska. Responsible for project technical activities, data reduction and data analysis.

- Principal Investigator, Phase II investigations of 17 former underground storage tank (UST) sites at Fort Riley, Kansas. Responsible for project technical activities, report preparation, and remedial action plans.

- Project Manager, multi-phase environmental site assessment/remediation of an electrical power substation site in Ohio.

  Performed magnetic and electromagnetic geophysical surveys to non-intrusively identify potential electrical equipment disposal sites.

  Investigated the potential disposal areas identified during the geophysical investigation by shallow trenching. Assessed the lateral and vertical extent of buried materials and apparent environmental contamination.

  Conducted a limited ground water investigation and developed work plan for remediation of the site.

  Assisted client in negotiations with the Ohio EPA.

Developed and implemented work plan for the remediation of PCB and oil contaminated soils and ground water.

- Project Manager, hydrogeologic and geologic investigations at a major oil refinery in Illinois. Coordinated replacement of monitoring well network and assessment of subsurface hydrocarbon plume. Utilized fracture trace analysis, ground penetrating radar (GPR), and electromagnetic ground conductivity (EM) methods to locate bedrock fractures for the placement of ground water monitoring wells.

  Investigated the source of a hydrocarbon plume beneath the refinery process block. Assessed the horizontal and vertical extent of hydrocarbon plume, overburden thickness, and bedrock topography to identify the likely source area.

- Project Manager, historical environmental site investigation of a 120-acre railyard in Illinois.

- Project Manager, Phase 2 environmental site assessment at a manufacturing facility in Illinois to define the extent of on-site and off-site freon contamination in the soil and ground water.

  Assisted client in negotiations with the Illinois EPA.

  Developed and implemented work plan for site remediation.

- Project manager for site assessments and UST removals at service stations in Illinois and Ohio.

- Project Manager, RCRA facility investigation at a major steel making facility in Pennsylvania. Performed historical investigation and sampling of solid waste management units (SWMUs). Coordinated Toxic Reduction Evaluation (TRE) of the facility's waste stream.

- Performed reduction and analysis of magnetic survey data for two landfills in central Indiana to assess distribution of buried drums.

- Conducted electrical resistivity investigation at a central Indiana landfill to map the top of a confining clay layer underlying the site.

- Conducted borehole geophysical logging of the monitoring well network at a Mississippi manufacturing facility.

- Performed environmental audit and RCRA Part B permit review for proposed expansion of a Hazardous Waste Treatment, Storage, and Disposal (TSD) Facility.
- Developed Industrial Water Conservation Plan for a major chemical plant in New Jersey. Project involved plant visit, review of documents, and final report to client for submission to the State of New Jersey Department of Environmental Protection.
- Performed geologic and hydrogeologic investigation of a drum disposal site in southeastern Pennsylvania. Project involved soil borings, monitoring well installations, and soil and ground water sampling.

PAST EXPERIENCE

UNIVERSITY OF DELAWARE

- Six years experience managing a geological and geophysical research and teaching facility. Participated in geological and geophysical research. Provided technical guidance to researchers and students using laboratory and field equipment, and advised faculty on the use of computer hardware and software. Taught courses in earth science, geology, and geophysics.
- Performed seismic refraction investigation of the Cockeysville Marble aquifer, Hockessen, Delaware, as part of an environmental impact study for proposed land development. Coordinated data acquisition and conducted preliminary data processing and interpretation.
- Performed paleomagnetic analysis of Quaternary sediments from west central Indiana. Measured remanent magnetization and calculated magnetic polarity reversals for correlation with amino acid racemization age dates.

ACADEMIC BACKGROUND

Ph.D. program, applied geology, Kent State University
Course work and exams completed.
M.S. (1980), geology, Kent State University,
Thesis: Gravity Survey of Buried Glacial Valleys in Hiram and Nelson Townships, Portage County, Ohio.
B.S. (1977), physics, Youngstown State University

CITIZENSHIP

United States

COUNTRIES WORKED IN	United States
LANGUAGE PROFICIENCY	English
PROFESSIONAL AFFILIATIONS	American Geophysical Union National Ground Water Association
PROFESSIONAL REGISTRATION	1992, Indiana Certified Professional Geologist, No. 1217 1993, Kentucky Licensed Professional Geologist, No. 852 1995, Iowa Registered Groundwater Professional, No. 1493
PUBLICATIONS	Co-author of abstracts on the paleomagnetic analysis of Quaternary Sediments from west central Indiana. Miller, Palmer, Plevniak, McCoy, and Bleuer, 1986, A fossiliferous magnetically reversed Quaternary site from Pike, County, Indiana: GSA Abstracts with program, v. 18, p. 316. Palmer, Miller, and Plevniak, 1987, Magnetostratigraphy of two Pre-Illinoisan sites in West Central Indiana: GSA Abstracts with program, v. 19, p. 798 Miller, Palmer, and Plevniak, 1988, detection in Indiana of a possible magnetic polarity excursion during the Brunhes: American Quaternary Association Program and Abstracts, Tenth Biennial Meeting, p. 138.

KENNETH E. FISCHER, PE, CIH

Title

Principal

Expertise

Industrial Hygiene
Health and Safety
Environmental Compliance and Remediation
Expert Testimony

Academic Background

M.S., Physics and Biomedical Engineering, Catholic University, 1970
B.A., Physics and Liberal Arts, Fordham University, 1964

Professional Registration

Certified Industrial Hygienist
Registered Professional Engineer: Maryland, Virginia, Colorado
Accredited Asbestos Inspector and Management Planner (under Asbestos Hazard Emergency Response Act regulations). EPA and state licenses. NIOSH 582 trained.

Experience

Associate and Senior Scientist, 1989-Present

- Management of asbestos projects for the U.S. Army Corps of Engineers at Letterkenny Army Depot, Dover Air Force Base, Walter Reed Army Medical Center, a former Nike missile site, bases in the Military District of Washington, and numerous private clients. The projects include asbestos surveys, specification preparation, air monitoring, and contractor oversight.

- Management of indoor air quality projects for clients such as JBG Rock, Arlington, Virginia; the West Group, Rockville, Maryland; and Leeds & Northrop, Philadelphia, Pennsylvania. Identified and quantified chemical and microbiological contaminants, including carpet-related chemicals, in office and manufacturing areas; determined their origins; reviewed building ventilation systems; and recommended corrective measures.

- Conduct of a sampling study in a former metal plating shop, and remedial design and contractor oversight to remove heavy metal, corrosives, leaded paint, and organic chemicals from structural surfaces, and dispose of plating fixtures. The work included a risk assessment for levels of contaminant removal, review of contractor submittals, preparation of a safety plan, and daily air monitoring during remediation.

- Planning of property transfer audits for residential and industrial clients.

- Management of a program to sample and evaluate lead in drinking water in a group of high-rise buildings to determine the contribution of lead from solders, brass fixtures, drinking fountains, and other plumbing fixtures. Provided expert testimony for arbitration.

- Oversight of PCB and hazardous materials removal and PCB transformer replacement at the former American Can Company plant and for Baltimore News-American site, Baltimore, Maryland.

- Evaluation of a silver recovery process from a photographic laboratory to assess the environmental impact of silver discharges into the sanitary sewer and cesspool system.

Samples were collected from a lift station, holding tanks, and soil borings in a drain field to determine compliance with EPA regulations.

- Management of an air monitoring study in a photographic laboratory to determine the effectiveness of a new ventilation design for the area. Air samples were collected to test for formaldehyde and other chemicals, the use of protective clothing was evaluated, and the hazard communication program was reviewed.
- Preparation and presentation of oil spill emergency response and hazardous waste operations and emergency response training for Aramco Services Company, U.S. Army Toxic and Hazardous Materials Agency (USATHAMA), and other clients.
- Presentation of hazardous waste operations and emergency response training to over 75 personnel from England, Scotland, the Netherlands, France, Germany, Spain, and Italy. The training sessions incorporated European Community and country standards and were based on universal best management practices for health and safety.
- As Eastern Division Health and Safety Manager, review of plans and direction of health and safety training, medical surveillance programs, and accident prevention measures for Dames & Moore offices in the eastern United States. Drafted the Dames & Moore Firmwide Health and Safety Manual.

Professional History

Manager, Environmental Compliance, Health and Safety, and Facilities, U.S. Environmental Protection Agency (EPA) National Enforcement Investigations Center, 1979-1989

- Investigation of numerous natural gas pipeline facilities for PCB handling practices as senior auditor, for Texas Eastern, Inc.
- Oversight of asbestos abatement projects, environmental audits, and health and safety inspections.
- Safety audits of EPA facilities nationwide.
- Preparation of EPA facilities Safety Manual.
- Preparation of safety protocols, review of safety plans, management of asbestos removal projects, and direction of training and medical monitoring programs.
- Management of regulated materials and worker and community right-to-know programs.
- Management of laboratory and office construction, maintenance, and physical security operations.
- Advisor to 27 EPA nationwide laboratory waste disposal operations.
- Resolution of indoor air quality complaints in an analytical laboratory facility through odor detection and ventilation system improvements.
- Instructor for health, safety, and compliance curricula at the Federal Law Enforcement Training Center, Glynco, Georgia.

- Responsibility for packing, manifesting, shipping, and disposal of hundreds of drums of hazardous waste.

- Preparation of safety plans for site responses, Laboratory activities, and related training.

- Hazardous waste worker safety (OSHA 29 CFR 1910.120) and worker right-to-know (1910.1200) instructor.

- Participation in setting up national contract and staff to manage waste from former sites of illegal drug manufacturing.

- Consultant to public and private sector on packaging, transportation, and disposal of hazardous waste, including:

    - U.S. Mine Safety and Health Administration
    - U.S. General Services Administration
    - U.S. Air Force
    - U.S. Drug Enforcement Agency
    - Federal Bureau of Investigation
    - U.S. Navy
    - U.S. Department of Agriculture
    - U.S. Food and Drug Administration
    - National Institutes of Health
    - U.S. Geological Survey
    - American Council of Independent Labs
    - ALCOA
    - Litton Data Systems
    - Monsanto

Program Analyst, EPA, 1976-1979

- Analysis, evaluation, and coordination of national programs regulating the use of pesticides and toxic substances. Prepared studies for management analysis and value of research output using linear programming.

Resident Engineer, Western Electric, Washington, D.C., Service Center, 1970-1976

- Management of cost reduction program and local industrial hygiene efforts. Reduced emissions from plastics refinishing operation and established new techniques for repair of communications equipment.

Assistant, Vitreous State Laboratory, Catholic University, 1968-1970

- Design of environmental temperature control equipment; responsibility for interface and maintenance of ultrasonic, laser, and temperature control equipment for laboratory experiments.

Chairman, Department of Physical Sciences, Colegio San Ignacio, San Juan, Puerto Rico, 1966-1968

Professional Affiliation

Member, American Academy of Industrial Hygiene
Member and Past Chair, AIHA/ACGIH Joint Hazardous Wastes Committee

Member, American Industrial Hygiene Association (AIHA)
Member, Human Factors and Ergonomics Society
Member, Chemical Health and Safety Division, American Chemical Society
Past Director, Institute for Environmental Auditing
Affiliate Member, American Conference of Governmental Industrial Hygienists (ACGIH)

Honors

"Drum Buster" Award for Outstanding Achievement in Field of Hazardous Waste Operations, by American Industrial Hygiene Association/American Conference of Governmental Industrial *Hygienists Joint Hazardous Wastes Committee (May 1991).*
Listed in Who's Who in the Safety Profession, 1990-1991 Edition
Listed in Directory of Occupational Health and Safety Specialists, 1st Edition
Listed in Who's Who in the West, 21st Edition
Listed in Who's Who of Emerging Leaders in America, 2nd Edition

Training Presentations

Hazardous Waste Operations and Emergency Response Training and Management, Dames & Moore, Manchester, England (November 1992); Frankfurt, Germany (April-May 1993); and Paris, France (May 1993).

RTC Asbestos-Containing Materials Policy, 8-hour course, Resolution Trust Corporation, Dallas, Texas (December 1992).

Laboratory Waste Disposal and Environmental Compliance, 2-day course, Association of Official Analytical Chemists (AOAC), Phoenix, Arizona (August 1991); Durham, North Carolina (December 1991); and Cincinnati, Ohio (August 1992).

OSHA Marine Oil Spill Emergency Response and Refresher Training, 40-, 24-, and 8-hour courses, Aramco Services Company, Houston, Texas (November 1991 and October 1990).

OSHA Construction Risk Awareness, 8-hour course, Dames & Moore, Annapolis, Maryland (April and July 1991).

Health Protection Measures at PCB Remediation Sites, American Industrial Hygiene Conference (AIHC) and Exposition, Salt Lake City, Utah (May 1991).

AHERA Building Inspector Annual Update Training, Georgia Tech Research Institute, Columbia, Maryland (April 1991).

Hazard Communication for the Medical Community, Medical Group Management Association, Baltimore, Maryland (March 1991).

OSHA On-Scene Commander, First Responder, Hazard Communication, and RCRA Generator courses, Comsat Corporation, Clarksburg, Maryland (December 1990).

RCRA Generator Refresher Training, Aristech Chemical Corporation, Florence, Kentucky (December 1990).

OSHA Hazardous Waste Operations Training, 40-hour course, Umatilla Army Depot, Umatilla, Oregon (October 1989), and Newport Army Ammunitions Plant (October-November 1990).

Environmental Cleanups at Sites of Former Clandestine Drug Manufacturing, AIHC, Orlando, Florida (May 1990).

OSHA Refresher Training for Hazardous Waste Operations, 8-hour course, Dames & Moore, Bethesda, Maryland (bi-monthly 1989-92); Tampa, Florida (March 1990); Atlanta, Georgia (December 1989); Philadelphia, Pennsylvania (October 1989).

OSHA Supervisory Course for Hazardous Waste Operations, 8-hour course, Dames & Moore, Bethesda, Maryland (bi-monthly 1989-92); Philadelphia, Pennsylvania (October 1989); St. Louis, Missouri (March 1990); Tampa, Florida (March 1990).

How to Conduct a Laboratory Waste Audit, AOAC, St. Louis, Missouri (September 1989).

Respiratory Protection and Other Safety, Absorbency, and Cost Considerations With the Use of Cat Litter for Packaging Hazardous Waste, AIHC, St. Louis, Missouri (May 1989).

Sampling and Safety, Federal Law Enforcement Training Center, Brunswick, Georgia (1986-88); Front Range Community College (March 1988).

Certifications Competing With That of the Industrial Hygienist, AIHC, San Francisco, California (May 1988).

Key Features of a Model Regulated Waste Disposal Program for Generators, AIHC, San Francisco, California (May 1988).

Auditing Laboratories, Environmental Auditing Conference for Federal Agencies, Atlanta, Georgia (March 1988).

Disposing of Hazardous Wastes, University of Colorado, Boulder, Colorado (December 1987, December 1986, and December 1984).

Good Management Practices for Hazardous Wastes Generated in Laboratories, Invited Paper, World Conference on Hazardous Wastes, Budapest, Hungary (October 1987).

Laboratory Waste Disposal, American Council of Independent Laboratories (ACIL), Risk Management Seminar, Denver, Colorado (June 1986).

Key Elements of an Exemplary Generator, Haztech International Conference, Denver, Colorado (August 1986).

Contracting to Dispose of Laboratory Hazardous Waste, American Industrial Hygiene Association (AIHA) Conference, Dallas, Texas (May 1986).

Developing a Plan for and Instructing Laboratory Personnel in the Proper Disposal of Hazardous Laboratory Waste, Hazardous Materials Management Conference/West-85, Long Beach, California (December 1985).

Laboratory Hazardous Waste Disposal, AIHA Conference, Las Vegas, Nevada (May 1985).

Disposal of Regulated Lab Wastes, Rocky Mountain AIHA Sectional Meeting, Denver, Colorado (May 1985).

EPA Safety Program, EPA Response Safety Decision Making Workshop, Seattle, Washington (August 1984).

Laboratory Hazardous Waste Disposal, Rocky Mountain AIHA Fall Technical Conference, Denver, Colorado (October 1984).

Security Clearances

U.S. Office of Personnel Management Critical-Sensitive (EPA)
U.S. Department of Defense Secret
U.S. Department of Energy L

Selected Publications

Fischer, Kenneth E., "Remediating a Former Plating Shop: Health Protection for Workers and Future Tenants," Plating and Surface Finishing (May 1993).

Fischer, Kenneth E., "EPA and OSHA Compliance," Metropolitan Tenant's Guide to Business Properties (June 1992).

Fischer, Kenneth E., "Health and Safety for PCB Remediation," Pollution Engineering (February 1992).

Fischer, Kenneth E., "Under the Microscope," Environmental Lab (June/July 1991).

Fischer, Kenneth E., "Illegal Drug Labs Pose Cleanup Problems," Pollution Engineering (November 1990).

Fischer, Kenneth E., "Safety in the Chemical Laboratory-Certifications for Professional Hazardous Materials and Waste Management," Journal of Chemical Education (November 1988).

Fischer, Kenneth E., "Self Audits of Hazardous Waste Operations in Laboratories," Journal of Chemical Education (September 1987).

Fischer, Kenneth E., "Contracts to Dispose of Laboratory Waste," Journal of Chemical Education (April 1985).

Fischer, Kenneth E., "Containment Laboratories: Design Considerations," Occupational Health and Safety (November-December 1983).

WAYNE A. MIZER, PMP

Title:	Project Manager/Environmental Specialist
Expertise:	Program and Project Management Environmental Compliance Project Controls Performance Measurement Systems Total Quality Management (TQM)

Experience with Firm:

Wayne Mizer is an experienced, professional manager having worked on large environmental restoration and waste management programs at several Department of Energy and Department of Defense sites. His expertise extends from the total program level down to the detailed sub-project level. He has specialized experience in strategic planning for environmental restoration including CERCLA and RCRA remedial action as well as decontamination and decommissioning of surplus facilities.

Mr. Mizer served as the senior environmental specialist in support of the DOE/Richland Laboratory Management Division. In this capacity, he was responsible for supporting both the Facilities Team Leader and the Program Team Leader within the Laboratory Management Division. Work included project management, project controls support, surveillance planning, site representative support, RCRA and OSHA assessments, surveillances, and walkthroughs.

As Cost Account Manager on the General Support Services Contract (GSSC), provided support to the Division Directors in the management formulation, execution, and evaluation activities for the $200 million/year Environmental Restoration program. Assigned to DOE/RL as Cost Account Manager for Environmental Operations Division of the Office of Assistant Manager of Environmental Restoration. Tasks included assisting in development of the ER program documentation and procedures pertaining to ER program management; also in review of ER Program and Project plans, Fiscal Year Work Plans, program reviews and audits, records management, and as deputy facilitator and on-site coordinator of the Refocusing Environmental Restoration Project.

Deputy Facilitator on the Optimized Baseline Project at DOE/RL. This planning initiative optimized available technological and budgetary resources to establish a comprehensive strategy for environmental restoration of the Hanford site including the program as it currently exists and as additional facilities and programs are transitioned to Environmental Restoration. Specific tasks included: pre-planning, topical sessions, draft strategic planning, public involvement, regulatory compliance and final planning.

Task Manager to provide full time support to Department of Energy/Albuquerque (DOE/AL) Environmental Restoration Program Office in areas of project controls, performance measurement, and project management systems. Coordinated successful end of year meetings/reviews, and Independent Cost Estimate reviews. Contributed to: preparation of Project Management Plan draft; development of Baseline Management Guidance; and implementation of PTS Version 2. Managed review of cost estimating incorporated in baselines, and of baselines from DOE area offices, four national laboratories, four production facilities, one Superfund site, and support contractors. Resulted in approval of Major Systems Acquisition baselines on first submittal to DOE headquarters.

Past Experience:

Total of 25 years domestic and international project management and manufacturing management experience; including Department of Energy and Department of Defense projects. Expertise includes project planning, cost and scheduling controls, budgeting, estimating, bid specifications, contracting and subcontracting, facilities relocations, quality controls and management, and environmental compliance.

Assistant Department Manager/Lead Compliance Engineer, EG&G Rocky Flats, Golden, Colorado (1991-1992)

Supervised staff of eleven as acting Department Head of Support Services Operations Compliance during manager's absence. Implemented Company Compliance Schedule Agreements to meet Department of Energy directives and interfaced with DOE. Directed compliance activities for Joint Company/Union Safety Committee, Non Conformance Reporting for Operations Support Services, Occurrence Reporting, and surveillance for OSHA, EPA, and state regulatory agencies.

Program Manager, Honeywell Inc., Defense Avionics Systems Division, Albuquerque, New Mexico (1986-1991)

Program Manager - AH64 Apache/Combat Talon II

Successfully implemented program management plan for a program which completed on schedule and below budget. Directed major division program with sales of $12 million annually which was completed on schedule and within budget. Exceeded 1990 revenue projections by $3 million.

Negotiated production deliveries and engineering changes in excess of $55 million. Recovered 56% of an earlier program write-off.

Directed and integrated activities for program team of 50 persons comprised of design engineers, quality engineers, production managers, and procurement managers.

Production Planner, Honeywell, Albuquerque, New Mexico (1984-1986)
Coordinated program management and operations for production for major clients. Directed first production program to successful completion ahead of schedule.

Program Management Council Representative-Honeywell. Member of the council of program managers to provide the following: formal education in program management; seminars; and practical assistance to program managers in the principles and practice of program management.

Materials Resource Planning (MRP II) Facilitator-Honeywell. Program Management facilitator during Honeywell's conversion to MRP II. Was instrumental in training and implementing MRP II in program management and operations.

Manager of the Plant Relocation Project-Honeywell. Planned and directed relocation of the Honeywell, High Voltage Power Supply and Cathode Ray Tube manufacturing facility from Phoenix, Arizona to Defense Avionics Systems Division manufacturing in Albuquerque, New Mexico. Relocation was completed on schedule with no impact to production deliveries.

Project and Construction Planning/Scheduling Engineer, The Pritchard Corporation, Kansas City, Missouri, (1981-1983)-Division of Keang Nam Enterprises, Seoul, Korea (now a division of Black and Veatch)

Coordinated international engineering, procurement and construction projects to $25 million in the chemical, gas, petroleum and petrochemical industries. Intermediary for Project Manager and customer representatives on both domestic and international projects.

Prepared and monitored Construction Progress Plan, developed bid packages, and interfaced with subcontract bidders.

Manager of Project Management, Standard Havens Inc, Kansas City, Missouri (1977-1981)

Directed project management of environmental projects exceeding $2 million in the Air Pollution Control Division.

Supervised staff of seven responsible for $11 million in annual sales of domestic and overseas operations.

Formulated policies which lowered post contract costs from 12% to 8% of cost of sales. Improved final gross margin by 2.3% while operating 6% below budget.

Production Control Manager, Kuhlman Diecasting Company, Stanley, Kansas (1970-1977)

Responsible for production for manufacturing plant employing 120 persons on two shifts. Performed production planning, customer service, inventory control, and cost accounting.

Squadron Commander and Liaison Officer, United States Air Force Reserves (1972-1993)

Squadron Commander for 270 coalition forces during Operation "Desert Storm" and Liaison Officer to the Royal Air Force. Prior duties included Squadron Commander, Executive Officer, Administrative Officer, Operations Officer, Safety Officer, Security Manager, and Total Quality Management Facilitator/Instructor.

Academic Background:

Graduate Studies - Business and Public Administration, University of Missouri at Kansas City, MO 1975-1976

Bachelor of Arts, Political Science, University of Missouri at Kansas City, MO 1970 Emphasis Area-International Relations
Minors in Geology/Geography and English

Professional Affiliations:

Project Management Institute (national)
Project Management Institute
    -Columbia Basin Chapter (Charter member)
    -Rio Grande Chapter (former VP Programs)
Reserve Officers Association (Life member)

Certification:

Certified Project Management Professional #02968
    -Project Management Institute, 1994

Education/ Training:

1) Project Management Certification Program/Washington State University,
2) Project Management Institute seminar for professional registration,
3) Honeywell/DoD Program Management Development Program,
4) Continuing Education in Project Management-Univ. of New Mexico,
5) Conduct of Operations (DOE Order 5480.19),
6) DoD Total Quality Management Instructor/Facilitator training,

7) Advanced RCRA Topics Seminar,
8) Radiological Worker II Training,
9) Quality Assurance,
10) Quality Decision Systems,
11) Performance Measurements Systems,
12) DOE Project Control (C/SCSC) Workshop,
13) DOE/EM Progress Tracking System Workshop,
14) DOE Hazardous Waste Operations and Emergency Preparedness,
(29 CFR 1910.120(e)(3)(i)),
15) DOE Engineering Change Orders,
16) Value Engineering Change Proposals,
17) Conduct of Critiques,
18) Occurrence Reporting Process,
19) Root Cause Analysis Program,
20) Implementation of Lessons Learned Program,
21) Technical Writing,
22) DOE Hazard Communications,
23) Waste Management,
24) Industrial Hygiene,
25) Radiation, Fire, and Industrial Safety,
26) Intensity of Governmental Regulations,
27) Managing Constructive Change,
28) Quality Circles (Deming-Juran),
29) Risk Communications,
30) Dealing with Difficult People,
31) Team Building,
32) Certified Hazardous Material Manager Training

Citizenship:	United States
Countries Worked In:	United States, England. Have managed projects in several countries.
Language Proficiency:	English
Security Clearance:	DOE Q Clearance (January 1993) DOD Secret Clearance (Inactive)

L. KRISTOPHER MOORE

Title	Project Geologist
Expertise	Geology Underground Injection Control Regulatory Compliance UST Removal Phase I Site Assessments Phase II Site Assessments
With Firm	Joined firm in September 1990

Geologist for Dames & Moore, September 1990 to present.

Air Force Center for Environmental Excellence. Field Team Leader and Site Health and Safety Officer for UST removal and soil remediation projects. Tasks included supervision of UST removal, tank cleaning and destruction, backfilling and restoration. Supervised the removal of 950 cubic yards of soil contaminated by a leaking jet fuel product distribution line. Installed and sampled monitoring wells and soil borings and conducted daily PID field screening of excavated soil.

United States Army Corps of Engineers in Kansas. Supervised all field activities for POL/UST Investigation at Fort Riley, Kansas. Tasks included research of individual tank history; oversight of soil gas survey, soil borings and monitor well installation; sampling of petroleum contaminated soil; use of Photoionization Detectors, Site Safety Officer.

Conducted site work for UST removals and related site investigations including subcontractor oversight, monitor well installation, soil sampling.

- Emerson Electric in Arkansas and Kentucky;
- Baltimore Ennis Land Company in Missouri and Iowa;
- Venture Stores in Missouri;
- Pillsbury in Nebraska;
- Halliburton Services in Kansas
- United States Army Corps of Engineers in Kansas.

Site work for groundwater investigations including monitor well installation, soil boring and sampling for:

- Pamarco in Batavia, IL;
- Kerr-McGee in Missouri;

- BP Oil/Truck Stops of America in Concordia, MO;
- Schuylkill Metals Corporation in Missouri;
- General Electric in Kansas City, MO;
- Excel Corporation in Illinois

Air Sparging

- Trained to operate Air Sparging system owned by US Army Corps of Engineers (Kansas City District) at the Hastings East Industrial Park site in Hastings, NE.

Landfill Operations

- Conducted regular monitoring and construction oversight for closure of hazardous waste landfill at lead smelter in Missouri.
- Project Manger for several Phase I and Phase II Environmental Due Diligence Audits (EDDAs) for the Federal Aviation Administration in Kansas, Missouri, Iowa, and Nebraska.
- Conducted investigation to detect leaks in primary liner system of hazardous waste landfill in Missouri.
- Performed oversight in the repair of liner and replacement of liner penetration seals at hazardous waste landfill in Missouri.
- Project Manager for the permitting, excavation, and removal of solvent contaminated soil for AIS in Haldredge, NE.

Performed Phase One Environmental audits for:

- Federal Aviation Administration in Kansas, Iowa and Missouri.
- Prudential Insurance Company in Kansas and Missouri (20 sites).
- Food-4-Less in Kansas and Missouri (15 sites).
- Kansas City Southern Railway in Independence, MO, Waco, MO, Baxter Springs, KS
- BancOhio in Iowa
- OneComm in Kansas City, Kansas
- Hallmark Cards in Missouri (3 sites).

Performed Phase II Projects for:

- Federal Aviation Administration (sites in KS, MO, IA)
- Zimmer Realty (4 sites in KS and MO)
- Allco Chemical(Galena, Kansas)
- Team Ford (Sioux City, Iowa)
- Pfizer (Lincoln, NE)

Conducted field work at Cam-Or, a National Priority List (NPL) site in Westville, Indiana

Experience

Over sixteen years of experience in geology, hydrogeology, regulatory enforcement and technical computer applications

Geologist, Kansas Corporation Commission, UIC Section, Wichita, Kansas (1988-1990).

- Evaluated UIC applications to assure well construction of applicant well and surrounding wells met regulatory minimums for the protection of fresh and usable water. Evaluation included the use of cement bond logs, temperature surveys, scout card information, and downhole electrical surveys.

- Reviewed plugging reports for proper placement of plugs to protect fresh and usable water.

- Analyzed geologic data necessary to formulate regulation changes.

- Geologic field work to determine source of natural gas blow outs near Arkansas City, Kansas.

- Researched source and extent of underground caverns and sink holes in central Kansas.

- Assisted consulting firm in establishing nomenclature for computerized Risk Management System of all Kansas injection wells.

Eight years experience in geology, well construction, geophysics and computer applications.

- Supervised the drilling of exploratory wells in central and western Kansas for logistical and economical continuity of operation.

- Operated hydrocarbon detection equipment at well site and used electric logs, drilling time and bore hole cuttings for subsurface correlation.

- Generated Authority for Expenditure for economic analysis of future drilling projects.

Additional Training	Dames & Moore 40 Hour Health & Safety Training Course, 1990 Red Cross Certifications in Adult CPR (12-95) and Standard First Aid (2-96) FAA Licensed Private Pilot
Academic Background	Hydrogeology course, Wichita State University, 1987 B.S. (1979), Geology, University of Kansas
Citizenship	United States
Countries Worked In	United States
Language Proficiency	English
Professional Affiliations	Kansas Geological Society

(KSC) MOORE.CV

FINAL

FIELD SAMPLING PLAN

RICHARDS-GEBAUR AIR FORCE BASE
F41624-94-D-8102
DELIVERY ORDER 0003

UEBL 95-6004
CLOSE ST007
&
UEBL 95-7001
PHASE 2 SITE INSPECTION AT SS008

PREPARED FOR
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS

March 15, 1996

PREPARED BY
DAMES & MOORE, INC.

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AFB - Air Force Base
AFBCA - Air Force Base Conversion Agency
AFCEE - Air Force Center for Environmental Excellence
BTEX - Benzene, Toluene, Ethylbenzene, and Xylenes
CME - Central Mine Equipment
CQP - Construction Quality Plan
DO - Delivery Order
DOM - Delivery Order Manager
DRO - Diesel Range Organics
FID - Flame Ionization Detector
FS - Feasibility Study
FSP - Field Sampling Plan
GC - Gas Chromatograph
GRO - Gasoline Range Organics
GSA - General Services Administration
HSP - Health & Safety Plan
HTW - Hazardous and Toxic Waste
IRP - Installation Restoration Program
MAC - Military Airlift Command
MS - Matrix Spike
MSD - Matrix Spike Duplicate
MSHA - Mine Safety and Health Administration
NFRAP - No Further Response Action Plan
NIOSH - National Institute for Occupational Safety and Health
NTU - Nephelometric Turbidity Units
NX - "x" Design Flush Coupled Casing, 3-½" outside diameter, 3-3/16" inside diameter
OWS - Oil Water Separator
PA - Preliminary Assessment
PID - Photo Ionization Detector
PCB - Polychlorinated Biphenyl
PVC - Poly Vinyl Chloride
QAPP - Quality Assurance Project Plan
QA/QC - Quality Assurance/Quality Control
RA - Remedial Action
RCRA - Resource Conservation and Recovery Act
SI - Site Investigation
SOW - Statement of Work
TRPH - Total Recoverable Petroleum Hydrocarbons
TVH - Total Volatile Hydrocarbons
USCS - Unified Soil Classification System
VOC - Volatile Organic Compound

1.0 INTRODUCTION

The Statement of Work (SOW) for this Delivery Order (DO) includes the confirmatory soil sampling and seasonal ground water sampling at site ST007 and soil sampling and excavation at site SS008 at the Richards-Gebaur AFB. This site specific Field Sampling Plan (FSP) has been prepared by Dames & Moore on behalf of the Air Force Center for Environmental Excellence (AFCEE), the Air Force Base Conversion Agency (AFBCA), and Richards-Gebaur AFB, to support the implementation of the site investigation (SI); remedial action; and final site closure at the aforementioned locations. This FSP is included with the site specific Quality Assurance Project Plan (QAPP), a Health and Safety Plan (HSP) and a Construction Quality Plan (CQP) in support of the Delivery Order.

A general description of the anticipated tasks at the areas of environmental concern is provided below:

Closure of ST007: Closure/decommissioning of the passive biovents, which have been utilized for soil/ground water remediation, will be conducted in accordance with applicable regulations. Confirmatory soil and groundwater sampling, grouting and closing of biovents, and restoration of the site to an acceptable condition will be completed.

Site Action at SS008: Soil boring and sampling will be conducted to further define the horizontal and vertical soil contamination to determine soil excavation volume. Confirmatory soil and groundwater (if encountered) sampling, backfilling and restoration of the site to an acceptable condition will be completed. Contaminated soils encountered during excavation will be remediated utilizing a bioremediation landfarming facility (to be built under DO 0004), if available, or disposed of off base in accordance with applicable regulations.

At each site, if site closure is not warranted by test results, Dames & Moore will prepare reports addressing actions proposed for clean closure.

1.1 SITE BACKGROUND INFORMATION

Richards-Gebaur AFB is located in western Missouri, approximately 18 miles south of downtown Kansas City, Missouri. The northern portion of the base is located in Jackson County and the southern portion of the base is located in Cass County. Primary access to the base is by U.S. Highway 71. A Site Location Map is provided as Figure 1.

1.2 SAMPLING OBJECTIVES

The objectives of this field sampling plan are to collect data of sufficient quality to support Delivery Order 0003 (DO 0003) requirements at Richards-Gebaur AFB. These requirement include confirmatory sampling at the ST007 to assess whether the site has met the cleanup objectives required by the MDNR for abandoning in place the existing bioventing system and prepare a No Further Response Action Plan (NFRAP) decision document for final site closure; and collection of soil samples at SS008 to assess the extent of contaminated soils, confirm clean closure following excavation of the soils, and prepare the NFRAP decision document.

2.0 SAMPLE LOCATION AND FREQUENCY

Sample frequency, sample locations, sample objectives, and the analytical parameters selected are discussed in the following sections. Chain-of-Custody procedures will be followed each time a sample is collected. Sampling procedures are discussed in Section 4.0. Sample handling and shipping will be in accordance with the procedures outlined in Section 5.0.

2.1 SITE ST007

Subsurface soil and ground water sampling will be conducted to evaluate the passive bioventing remedial action conducted at the site and to supplement previous sampling efforts conducted by Geraghty & Miller, Inc. in 1991 and General Testing Laboratories, Inc. in 1989. Sample matrixes, analytical parameters, frequencies of sample collection and analysis, and QC sample collection and analysis are detailed on Table 1.

2.1.1 Soil Sampling

Nine soil borings will be advanced at the site to assess whether or not MDNR soil cleanup objectives have been met. The borings will be advanced within and adjacent to areas of soil contamination exceeding MDNR guidelines identified during the 1989 General Testing Laboratories, Inc. site investigation. The proposed soil boring locations are presented in Figure 2.

The soil borings will be advanced to a depth of eight feet following the procedures described in Section 4.2. Soil samples will be collected continuously during drilling for the purpose of soil classification, field headspace analysis, and possible laboratory analysis as described in Section 4.2. Headspace analysis of soil samples using a photo ionization detector (PID) or flame ionization detector (FID), along with field observations of visual staining and odors, will be used to assess the potential for petroleum contamination. Soil samples collected from the interval with the highest head space reading and at the first interval of non-impacted soils or from the sample interval above the bottom of the borehole will be selected for laboratory analysis. A total of 18 soil samples (two per boring) and two QC samples will be submitted to the laboratory for total recoverable petroleum hydrocarbon (TRPH), and volatile organic compound (VOC) analysis for benzene, toluene, ethylbenzene and xylenes (BTEX). The sampling tools will be decontaminated prior to and between sampling location as described in Section 4.4.2.

2.1.2 Ground Water Sampling

Two rounds of seasonal ground water sampling will be conducted during dry- and wet-seasons to assess and monitor ground water contamination. A total of six ground water samples will be obtained from the three existing monitoring wells. Ground water samples will be collected from monitoring wells as described in Section 4.3.1.4. Ground water samples will be submitted to the laboratory for TRPH and VOC analyses. The sampling tools will be decontaminated prior to and between sampling location as described in Section 4.4.2.

2.2 SITE SS008

Subsurface soil sampling will be conducted to assess the presence of suspected soil contamination at the site. Ground water samples, if warranted, will also be collected to assess ground water contamination. Sample matrixes, analytical parameters, the number of samples collected and analyzed, and QC sample collection and analysis are detailed on Table 1.

2.2.1 Soil Sampling

Eight soil borings will be advanced to assess the horizontal and vertical extent of suspected soil contamination at the site. One boring will be advanced in the area where workers reported suspected petroleum contamination during the excavation of a utility trench. This area will be field located with Richards-Gebaur personnel prior to initiating sampling activities. The location of the remaining borings will be selected in the field and will be advanced to the north, east, south and west of the first boring to delineate the extent of contamination. The approximate location of the trench where workers reported suspected petroleum contamination is presented in Figure 3.

The soil borings will be advanced to a depth of five feet following the procedures described in Section 4.2. If impacted soil is encountered, the soil borings will be advanced further until one of the following conditions is encountered: 1) ground water is detected; 2) refusal is encountered; or 3) based upon field screening, non-impacted soils are encountered.

Soil samples will be collected during drilling for soil classification, field headspace analysis and possible laboratory analysis as described in Section 4.2. Headspace analysis of soil samples using a PID or FID, along with field observations of visual staining and odors, will be used to assess the potential for petroleum contamination. Soil samples collected from the interval with the highest head space reading and at the first interval of non-impacted soils or from the sample interval above the water table or the bedrock surface will be selected for laboratory analysis. A total of 16 soil samples (two per boring) and two QC samples will be submitted to the laboratory for TRPH, RCRA metals, polychlorinated biphenyl (PCB), VOC, semi-volatile organic compound (SVOC) and ethylene glycol analyses. The sampling tools will be decontaminated prior to and between sampling location as described in Section 4.4.2.

2.2.2 Ground Water Sampling

If the soil borings indicate contamination at the ground water interface, three in situ grab ground water samples will be collected to assess ground water contamination. The grab ground water samples will be collected using direct-push sample methods as described in Section 4.3.3. Ground water samples will be submitted to the laboratory for TRPH, RCRA metals, PCB, VOC, SVOC, and ethylene glycol analyses.

2.2.3 Excavation Sampling

If impacted soil is found during the soil sampling program, the contaminated soil volume will be excavated and confirmatory soil samples collected from the base and side walls of the excavation to verify the adequacy of the removal efforts. Five soil samples will be collected from the excavation.

Visual observations, PID head space readings, and odors will be utilized to determine the adequacy of soil removal. If visual observations and PID headspace readings indicate the soil is not contaminated, confirmatory soil samples will be collected for laboratory analysis and excavation will be stopped. Otherwise, excavation will proceed until the above conditions are met or ground water enters the excavation.

A stainless steel hand auger and scoop will be used to collect the confirmatory samples from the backhoe bucket following the procedures outlined in Section 4.1. The sampling tools will be decontaminated prior to and between sampling locations as described in Section 4.4.2. The samples will be submitted to the laboratory for TRPH, RCRA metals, PCB, VOC, SVOC, and/or ethylene glycol analyses, as appropriate. Selection of the analytical parameters will be based on the analytical results of the soil boring samples. One soil sample will be submitted for QA/QC analyses as described in Section 7.0.

3.0 SAMPLE DESIGNATION

A unique sample numbering system will be used to identify each sample for chemical or field screening analysis. In addition, this sample numbering system will be used to identify trip blanks, field blanks, equipment blanks, field duplicates and QA/QC. Each unique sample number will consist of the components described below.

The first 3-letter designation will be used to identify the Richards-Gebaur Delivery Order 0003 field samples:

RG3 = Richards-Gebaur Delivery Order 0003

Each sample type will be identified by an alpha-code. The alpha codes for sample type are as follows:

SS = soil sample
GW = ground water sample

Each sample location will be identified by an alpha-code corresponding to the sample type, followed by a 2- or 3-alpha/digit sample location number, as appropriate. The alpha codes are as follows:

SB = soil boring
MW = monitoring well
EP = excavation pit

The following codes will be used for QC samples and will be added as prefixes to the sample location:

TB = trip blank
FB = field blank
EB = equipment blank
MS/MSD = matrix spike/matrix spike duplicate

NOTE: Field duplicates will be utilized but not identified to the laboratory.

The sampling depths will be designated by the depth of the bottom of the 2-foot sample interval (i.e., a soil sample from a depth of 8 to 10 feet would be given the suffix "10").

The following are examples of the sample numbering to be used during the project:

RG3-GW-MW07:	Richards-Gebaur D.O. 0003, ground water sample collected from monitoring well 07.
RG3-SS-SB03-10':	Richards-Gebaur D.O. 0003, soil sample collected from soil boring 3 at a depth interval of 8 to 10 feet
RG3-SS-MW03-4':	Richards-Gebaur D.O. 0003, soil sample collected from monitoring well 03 during installation at a depth interval of 2 to 4 feet.

A field sketch showing sample locations on site will be drawn following sample collection.

4.0 SAMPLING EQUIPMENT AND PROCEDURES

4.1 SURFACE SOIL SAMPLING METHODS (CONFIRMATORY AND MONITORING)

Soils will be collected through the use of hand augers and trowels. The surface soils to be sampled must be exposed prior to sample acquisition. If the sample is to represent a discrete interval of 6 inches or greater depth, the overlying soils may be removed with a shovel or hand auger.

4.1.1 Hand Auger

In general, hand-operated augers are useful for sampling all types of soil/sediments except cohesionless materials below the water table and hard or cemented soil/sediment. Hand auger samples will be collected as follows:

1. Attach the auger bit to a drill rod extension, and further attach the "T" handle to the drill rod.

2. Begin auguring, periodically removing accumulated soil/sediment.

3. After reaching the desired depth, slowly and carefully remove auger from boring and fill VOC, TRPH, SVOC sampling jars immediately.

4. Remove soil cuttings and place into a precleaned stainless steel bowl.

5. Care should be taken to avoid scraping the borehole sides if sampling different interval is desired. If the wall of borehole collapses, an adjacent hole can be dug for the next deeper sampling interval.

6. Homogenize the soil as applicable, place the sample in the appropriate containers, and cap.

4.1.2 Scoop/Spade/Shovel

This is the simplest and most direct method of collecting soils. This method can be used in most soil/sediment types but is limited somewhat to sampling near the surface.

1. Carefully remove the top layer of soil/sediment to the desired sample depth with a precleaned spade.

2. Using a precleaned stainless steel scoop or trowel, remove and discard a thin layer of soil/sediment from the area that comes in contact with the shovel.

3. Transfer the sample into an appropriate sample bottle with a stainless steel spatula, spoon, or equivalent and cap container.

4.2 SUBSURFACE SAMPLING METHODS

Drilling will be performed using a truck-mounted drill rig or direct-push hydraulic probe unit. The choice of drilling methods is influenced by two main factors: (1) the need to minimize the introduction of foreign materials that may influence the results of analysis and (2) the need to penetrate diverse geologic materials.

In unconsolidated materials, environmental borings will be advanced using 3¼-inch to 6¼-inch inside diameter hollow stem augers or 3/4- to 2-inch diameter probe rods. Soil samples will be collected utilizing a split-spoon sampler, CME (Central Mine Equipment) continuous sampler, or Geoprobe Systems® Probe-Drive System (or equivalent) sampler. In the event that a continuous or semi-continuous rock unit is encountered, mud rotary drilling may be employed to advance a boring for the installation of a monitoring well. Rock samples will be collected using an NX size core barrel. No oils or lubricants will be used on the drill rods, augers, sampling, or other equipment used in drilling and sampling the borings.

Each boring will be continuously sampled and logged by an experienced Dames & Moore field geologist or engineer using a standard Hazardous and Toxic Waste (HTW) Drilling Log, MRK Form 55 (June 1989), as shown in Figure 4. Information recorded on this log will include boring location, drilling and sampling method, sampling interval, and sample descriptions using the Unified Soil Classification System (USCS). A copy of the USCS is shown in Figure 5. Unusual characteristics observed during drilling activities, such as discoloration of soil, odors, or air monitoring results, will also be noted on the drilling log.

A description of the borehole drilling, sampling, and logging methods and procedures is presented below.

4.2.1 Description of Drilling Methods

4.2.1.1 Hollow-Stem Auger Drilling

Hollow-stem auger drilling uses interconnected hollow auger flights equipped with a cutting head. The screw action of the augers as they are rotated and pressed into the ground pulls the soil cuttings to the surface. The bottom of the auger flight is fitted with a pilot bit and center plug attached to drill rods which prevent material from entering the augers during drilling. Soil samples are collected by removing the drill rods and center plug and advancing a sampler ahead of the augers.

4.2.1.2 Air Rotary Drilling

Air rotary drilling uses a rotating rock bit attached to drill rods. Air is used as the drilling fluid to lift rock cuttings from the borehole as the bit is advanced. Equipment needed for air rotary include a large air compressor, a swivel hose assembly connected to the top of the drill pipe or kelly, and a rock bit (i.e., tricone, roller type). Air is forced down through the center of the drill pipe and exits through small openings at the bottom of the drill bit. The cuttings are lifted along the annular space of the borehole, forced out the top of the borehole, and deposited on the surface. Air rotary allows cuttings to be removed rapidly, increases penetration rates, and extreme cold does not impede drilling operations. This method of drilling can only be performed in consolidated or semi-consolidated materials.

4.2.1.3 Direct-Push Drilling

Direct-push drilling uses a hydraulic probe unit to advance ¾-inch to 2-inch diameter probe rods. Soil or ground water samples are collected using specialized samplers attached to the rods and advanced to the desired sampling depth.

4.2.1.4 Borehole Abandonment

The borings will be backfilled to the ground surface upon their completion. The purpose of the backfilling procedure is to prevent foreign materials from entering the boring and possibly contaminating the ground water, and to prevent cross contamination between two separate water bearing zones.

The boreholes will be backfilled with a 94:3 cement-bentonite grout via a tremie pipe to within two feet of the ground surface. The top two feet of the borehole will then be backfilled with soil. These procedures are in accordance with MDNR Test Hole Construction and Plugging Code 10 CSR 23-6.050.

In areas where the boreholes penetrate existing pavement (concrete or asphalt), the backfilled boreholes will be capped with like material. The caps will have a minimum thickness equivalent to the surrounding concrete or asphalt.

4.2.1.5 Plugging of Monitoring Wells

The purpose of well abandonment is to eliminate vertical fluid migration along the borehole. Therefore, the preferred method of abandonment is the removal of the protective casing, riser pipe, and well screen, if possible. MDNR approval must be obtained to leave the casing in place.

The borehole will be backfilled with a 94:3 cement-bentonite grout via a tremie pipe to within two feet of the ground surface. The top two feet of the borehole will then be backfilled with soil. In areas where the boreholes penetrate existing pavement (concrete or asphalt), the backfilled boreholes will be capped with like material. The caps will have a minimum thickness equivalent to the surrounding concrete or asphalt.

If the borehole begins to collapse when removing the casing, the grout must be simultaneously emplaced while the casing is removed. When casing removal is not required or is not possible, then a three foot deep hole must be dug around the casing and the riser pipe cut off at that depth. These procedures are in accordance with MDNR Plugging of Monitoring Well Code 10 CSR 23-4.080.

The plugging or excavation of all monitoring wells must be reported on registration forms supplied by MDNR. These forms, along with the fee, must be submitted within 60 days of the plugging.

4.2.2 Installation of Surface Casing

In the event that a surfacing casing is to be installed prior to completing a boring to the planned depth, the borehole will be overdrilled and an 8-, 10- or 12-inch PVC surface casing installed. Hollow stem auger or air rotary drilling will be used to overdrill the borehole for surface casing installation.

The surface casing will be installed by filling the bottom one foot of the boring with grout, inserting the casing, and tremie grouting the annular space outside the casing. The grout will consist of approximately 94 parts Portland cement and 3 parts bentonite (94:3 cement-bentonite grout) and will be placed in the annulus around the surface casing from the bottom to the surface using a side discharge tremie pipe. No more than 6.0 gallons of water per sack of cement will be used. The grout will be allowed to set for at least 48 hours and accumulated water removed using a sand pump prior to advancing the boring to the required depth.

4.2.3 Description of Sampling Methods

4.2.3.1 Soil Sampling

Many different types of soil samplers are available, and several different samplers may be used in a single boring. The type of sampler used will depend on the subsurface conditions and the sophistication of analyses required for the proposed laboratory testing program. A description of the types of sampling tools and procedures is provided in the following Sections.

Standard Split-Spoon Sampler -A split-spoon sampler is so named because the main section of the sampler consists of a section of pipe that splits into two pieces along the axis of the pipe. A driving shoe and waste barrel screwed to the ends hold the split sections together during driving. A diagram of the split-spoon sampler is shown in Figure 6, Split Spoon Sampler.

To collect a soil sample, a split-spoon sampler (outside diameter 2.0 inches; inside diameter 1.375 inches) is attached to 1⅝-inch "A" rod or larger drill rods. A soil sample is then obtained by driving the sampler into the soil. The sampler is driven by a 140-pound hammer free-falling a distance of 30 inches onto a collar on the drill rods. The sampler is driven a total of 24 inches into the undisturbed soil. The sampler, containing a soil sample, is then removed from the borehole. The end connections are removed and the split portion is pried open to reveal the sample. The sample is then identified and placed in airtight storage containers. Aids for sample retention, including catchers, spring or gravity traps (in the lower end), and check valves (in the top end) may be incorporated in a split-spoon sampler.

CME Continuous Sampler - The CME continuous sampler is a 2½-inch I.D. five foot long split barrel. The sampler is attached to non-rotating drill rods mounted inside the hollow stem augers and is advanced along with the augers. The split barrel extends below the hollow stem augers and collects a relatively undisturbed soil core as the augers are advanced. A pilot bit and center plug are not used with the continuous sampler.

After advancing through the interval to be sampled, the split barrel is removed from the borehole without removing the hollow stem augers. The split barrel may be reused after emptying the soil core, or a different split barrel may be utilized so that drilling and sampling operations may continue.

If soil sample recovery falls below 70%, the field engineer/geologist will switch to standard split spoon sampling.

Geoprobe Systems®Probe-Drive Soil Sampling System

The Probe-Drive System is a unique soil sampling system designed for use with the Geoprobe® hydraulic probe unit. Unlike split-spoon samplers, the Probe-Drive sampler remains completely sealed by a piston tip at the end of the sample tube while it is pushed or driven to the desired sampling depth. A piston stop-pin at the opposite end of the sampler is then removed, enabling the piston to retract into the sample tube while the sampler is driven to collect a sample.

Sampling Guidelines - Since the sampling techniques used in the field can influence the laboratory test results, the engineering analyses, and the validity of the resulting recommendations, care must be used to maintain sampling consistency from borehole to borehole. The following guidelines will be observed during sampling:

1. If the boring is too small, material from the side wall may be scraped into the sampler; therefore, the drill bit will be of sufficient size to allow free passage of the sampler as it is lowered to the bottom of the borehole.

2. The hole must be drilled to the last depth sampled before the next sample is taken. When the hole is open, the bit of the sampler (without predriving) will be at the last depth drilled. If a cave-in has occurred and/or cuttings have settled to the bottom of the borehole, this extraneous material will be removed by capturing it in the sampler and a clean sampler will be used to take the sample.

3. The hole will not be drilled to the sample depth and left overnight before the next sample is taken. This procedure will be followed: (1) take a sample at the end of the day; and (2) at the beginning of the next day, drill to the next sample interval and take a sample. This procedure helps eliminate pressure release expansion of samples.

4. The geologist or field engineer will note the length of rods and bit or sampler in the hole. The boring depth is then calculated by subtracting the amount of "stick-up" from the ground

surface from this total length. By constantly knowing the depth of the borehole, the depth of lithologic change indicated by changes in drill speed, the color of the drilling fluid, or other indications of strata change may be noted and properly logged.

4.2.3.2 Rock Coring

If bedrock is encountered in a soil boring before the planned depth of the boring is reached, the bedrock will be cored to the planned depth of the boring. If bedrock is encountered in a monitoring well boring, the rock will be cored to a depth of five feet below the static water level and the monitoring well installed.

To obtain a rock core, a carbide- or diamond-tipped bit is attached to the lower end of a core barrel. As the bit cuts deeper, the formation sample moves up the inside of the core tube. The rock coring will be performed using an NX size double tube core barrel. The double tube core barrel consists of an inner tube core recovery barrel and an outer barrel with a diamond bit. Potable water from the approved site source will be used as the drilling fluid during rock coring.

4.2.4 Sample Labeling

Improper sample labeling can result in misleading laboratory data. Therefore, each soil sample jar lid will be initially labeled with the sample identification, collection date and time, and sample depth using indelible ink.

Complete information for each sample selected for analysis will be written by the field geologist/engineer on a label affixed to the sample jars. The label information will include: (1) job number, (2) owner, (3) location, (4) boring (5) sample number, (6) depth, (7) date and time, (8) collector, and (9) comments. A description of the sample numbering designation system is provided in Section 3.0 of this FSP. Bottles for water samples will be labeled immediately after sample collection and after they have been wiped dry.

4.2.5 Sample Logging

The borehole logs will contain a detailed description of the soil strata encountered and pertinent information regarding drilling operations and estimated soil properties. Field sample data will be recorded in a bound log.

4.2.6 Soil Sampling for Chemical Analyses

The following procedures will be followed during soil sampling:

1. Set up the decontamination area, sample preparation area, and support area near the borehole location.

2. Decontaminate all equipment, samplers, and tools that will come in contact with the soil sample.

3. Inform the driller of the sample interval(s) for the borehole and oversee the sampling process.

4. Prepare and label the sample containers. Label the containers with the location, depth, date, and time of sampling.

5. Have the driller prepare the sampler for opening, but do not allow the driller to completely open the sampler.

6. Open the sampler slowly while it is lying on a clean sheet of plastic. As the sampler is being opened, the surface of the core should be screened with the PID/FID, with the probe of the instrument about one inch from the sample. Record the instrument readings in the log book.

7. Obtain grab soil samples for VOC and TRPH (GRO) analyses first and place into 4-ounce septa sample jars. Completely fill the sample jars to minimize the loss of volatiles.

8. Samples for TRPH (DRO), PCB, SVOC and ethylene glycol analyses will then be collected and placed into appropriate sample jars (See Table 2). Sample for RCRA metals will be collected last and placed into 8-ounce sample jars

9. Log the core, recording percent recovery; color; texture; clay, sand, and gravel content; and other notable characteristics on the boring log. Sketch the confirmatory sample location.

10. Perform head space analyses on the soils. Record this reading in the appropriate place on the borehole log and in the field log book.

11. Deposit soil cuttings, wastewater, and waste generated during the decontamination process into 55-gallon 17 E/H steel drums for disposal after the results of chemical analyses of the soil and ground water at that location are known.

4.2.7 Sample Head Space Analysis

Head space analysis will be performed on each soil sample interval to provide information on volatile organic constituents in the soils. Soil samples will be collected continuously at 2-foot intervals to the depth of each borehole or to top of bedrock. A portion of the sample will immediately be collected for VOC analysis. Temporary labels will be placed on the sample containers and the containers placed into an iced cooler.

A portion of the remaining sample then will be placed loosely into a clean 16-ounce jar until it is approximately half full, the jar opening covered with aluminum foil, and the jar capped. The jar will be marked with the same identification number as the filled jars containing the portion of the sample for possible laboratory analysis, and placed in a warm location.

After a period of at least 15 minutes, the cap will be removed and the probe of a PID or FID will be pushed through the aluminum foil. The initial highest meter response will be recorded as the head space concentration. PID/FID instrument calibration will be checked at least every 10 analyses or daily, whichever is more stringent.

4.3 GROUND WATER SAMPLING

4.3.1 Monitoring Well Installation and Ground Water Sampling

4.3.1.1 Monitoring Well Drilling

The monitoring well borings will be advanced to a depth of approximately six feet below the first water-bearing zone using 6¼-inch inside diameter hollow-stem augers. A description of the hollow-stem auger drilling method is provided in Section 4.2.1. Each boring will be sampled and logged as described in Section 4.2.

If heaving sands are encountered or available information indicates the potential for heaving sands at a site, the monitoring well boring may be pre-drilled and sampled using smaller diameter augers. The boring will then be overdrilled to the planned depth of the monitoring well using 6¼-inch I.D. augers fitted with a PVC plug. The PVC plug will be knocked out prior to installation of the well. If necessary, non-chlorinated potable water will be introduced into the boring via the augers to increase hydraulic head and minimize the inflow and bridging of sand within the bottom of the augers. The potable water will be obtained from an approved source.

If bedrock is encountered prior to the planned depth for completion of the monitoring well boring, rock coring will be performed. Construction of monitoring wells is discussed in the following section.

4.3.1.2 Monitoring Well Construction and Completion

Overburden Wells: Overburden monitoring well borings will be advanced approximately six feet below the top of the upper water bearing zone. The monitoring wells will be constructed of 2-inch diameter Schedule 40 PVC riser pipe and screen (0.010 inch slot) with threaded joints (glued joints will not be used). The riser and a 10-foot section of screen will be installed through the augers with the screen set to straddle the water table. The augers will then be extracted as a filter pack consisting 20/40-grade silica sand is tremied from the bottom of the borehole to approximately 2 feet above the screened section. If the well screen and riser are installed in an open borehole, two centralizers will be placed on the well riser pipe (not on well screen) to keep the screen and riser centered in the borehole during completion of the well. A bentonite seal with a minimum thickness of 2 feet will be placed above the sand pack. The bentonite seal will consist of a high solids bentonite slurry and will be placed using a side discharge tremie pipe. The slurry will be allowed to set up per manufactures specifications prior to placing the cement-bentonite grout. A 94:3 cement-bentonite grout will be tremied in the annulus around the well casing from the top of the bentonite seal to the surface. No more than 6.0 gallons of water per sack of cement will be used. During installation, the depths of the well, sand pack and bentonite seal will be verified using a weighted tape. The monitoring wells will be capped and locked during any delays of field activities.

If the stable ground water level is at less than 12 feet, the well completion will be modified as follows:

1. Top of screen shall be at a minimum depth of 7.5 feet.

2. Filter pack sand shall extent approximately one foot above the screened section.

3. A bentonite seal consisting of a minimum 2 feet high solids bentonite slurry will be poured on top of the filter pack. The slurry will be allowed to set up for 8 hours prior to placing a minimum one foot cement-bentonite grout.

4. The remainder of the installation will be completed as described above..

If the stable ground water level is at less than 8.5 feet or other conditions encountered prevent completion as specified above, AFCEE will be consulted on well completion specifications.

A protective steel collar with weep holes and a locking cap will be cemented in place over the PVC casing to prevent damage to the well. The protective collar will be seated in a concrete surface pad with approximate dimensions of 4 feet by 4 feet (or 48 inch diameter) by 4 inches thick. Three 2-inch diameter steel pipes, rising to a height approximately equal to the well, will be installed in concrete to further protect the well. The protective casing and the steel pipes will be primed and painted brown. Reflection tape will be placed on the painted pipes. Alternately, a flush mount protective cover may be installed. Information regarding the construction of each monitoring well will be recorded on a Dames & Moore Monitoring Well Information Sheet as shown in Figure 7.

Bedrock Wells: If a monitoring well boring reaches bedrock prior to encountering ground water, the rock will be cored and overdrilled to two feet below the bedrock surface and an 8-, 10- or 12-inch PVC surface casing installed. Hollow stem auger or air rotary drilling will be used to overdrill the borehole for surface casing installation. The surface casing will be installed as described in Section 4.2.2.

The boring will then be advanced at least five feet below the depth where static ground water is first encountered in the bedrock. The monitoring well will be constructed of 2-inch diameter Schedule 40 PVC riser pipe and 10-foot screen (0.010 inch slot) with threaded joints (glued joints will not be used). A filter pack consisting 20/40-grade silica sand will be tremied from the bottom of the borehole to approximately 2 feet above the screened section. A bentonite seal with a minimum thickness of 2 feet will be placed above the sand pack. The bentonite seal will consist of bentonite pellets if the seal is within the saturated zone. A high solids bentonite slurry shall be used in place of the pellets if the seal is placed above the saturated zone.

Dependent upon site requirements and subsurface conditions, certain wells may be installed uncased (without a well screen) within the bedrock. The boring will be cored and overdrilled to two feet below the bedrock surface and a 4-inch PVC casing installed. The boring will then be cored a minimum of 10 feet into bedrock and completed as an uncased well.

4.3.1.3 Monitoring Well Development

Monitoring wells will be developed no sooner than 48-hours after grouting is completed. During development, each well will be mechanically surged for 15 minutes followed by the purging of a minimum of three well casing volumes. Surging and purging will continue until the pH, temperature, conductivity, and turbidity are stabilized; or for a maximum of 4 hours. To perform the stabilization test, the pH, temperature, specific conductance, and turbidity of the development water will be monitored. The wells will be considered developed when readings remain stable within plus or minus 10 percent between three consecutive measurements and the turbidity remains within a 10 nephelometric turbidity unit (NTUs) range for at least 30 minutes. An example of the form to be filled out during well development is shown in Figure 8.

A minimum of three well volumes will be purged from each well during development. In addition, three times the volume of any water introduced into the well borehole during drilling and monitoring well installation (i.e. water loss during coring) will also be removed during development.

4.3.1.4 Monitoring Well Sampling

A minimum of one week will be allowed for a well to recover after development prior to collecting a ground water sample. The well will be sampled when a minimum of three well casing volumes have been purged from the well and ground water parameters remain stable within plus or minus 10 percent between three consecutive readings. An example of the form to be filled out during the stabilization test is shown in Figure 9.

Ground water samples will be collected using dedicated disposable Teflon® bailers, or by using either a submersible or bladder pump. The ground water samples will be transferred directly to laboratory-supplied sample containers. Containers for VOC samples will be filled such that no head space remains. Turbulence will be minimized during the transfer to prevent the loss of volatile organics. The sample containers will be labeled appropriately, stored in a cooler containing ice, and kept at approximately 4°C during storage and shipment to the laboratory. A full description of sampling procedures follows:

Sample Collection Using a Teflon® Bailer: The following steps will be used when collecting a groundwater sample using a Teflon® bailer:

1. On arrival at the well head, remove the locking and protective cap. Measure depth-to-water with an electric measurement tape (e- tape), and depth to bottom of the well to the nearest 0.01 foot, and record the values in the field logbook. An oil/water interface probe will be used to check for immiscible hydrocarbons (gasoline, diesel, etc.) floating on the surface in the well at the time the water level measurements are made.

2. Calculate the volume of water in the well to include the water in the filter pack. Begin purging the well and measure and record the temperature, pH, conductivity, and turbidity of each borehole volume during purging. The sample may be collected after three borehole volumes have been removed and the temperature, pH, and conductivity have stabilized

within 10 percent for two consecutive reading. If these parameters do not stabilize the sample shall be taken after six borehole volumes have been removed. The sample will be collected after the water level has recovered to 80 percent of its static level or 16 hours after completion of purging, whichever occurs first. If a well is purged dry before three well volumes have been removed, the sample will be collected as soon as enough fluid to collect the sample has reentered the well.

3. To collect the sample, slowly lower the bailer into the water. Do not drop the bailer into the well as this may cause degassing of volatile organics. Allow about 30 seconds for the sample tube to fill. Slowly raise the Teflon® bailer to the surface.

4. Unscrew the cap of the sample container, being careful not to touch the lip of the bottle or the inside of the Teflon® liner. Avoid touching the mouth of the Teflon® bailer.

5. Unclasp the Teflon® bailer.

6. Pour the water from the bailer into the sample container slowly to prevent trapping any air bubbles (VOC Samples). Avoid splashing or agitating the water while the sample container is being filled.

Sample Collection Using a Submersible Pump: The following steps will be used to collect a sample from a well using a submersible pump.

1. On arrival at the well head, remove the locking and protective cap. Measure depth-to-water and total depth of the well and calculate purge volume. Check for immiscible hydrocarbons as described above.

2. Slowly lower the submersible pump into the well.

3. Turn the power switch on to begin the pumping process. Do not handle energized power cords. If the pump does not work properly, as indicated by a lack of air flow out the discharge hose or by generator "lug" down, turn the switch off immediately. Wait a few seconds, then turn the switch on and off several times rapidly, finally pausing in the ON

position to determine if the pump has started to function properly. Repeat this several times. If the sample pump still doesn't work, it needs repair. If the breakers or fuses on the generator disengage, an electrical short in the system is indicated, and repair is needed. Record problems in the field logbook.

4. Pump for a minimum of three well volumes, and check for stabilization of the pH, temperature, and specific conductivity. The sample may be collected after three borehole volumes have been removed and the temperature, pH, and conductivity have stabilized within 10 percent for two consecutive reading. If these parameters do not stabilize the sample shall be taken after six borehole volumes have been removed.

5. The sample will be collected after the water level has recovered to 80 percent of its static level or 16 hours after completion of purging, whichever occurs first. Measure the pH, temperature, and specific conductivity of the discharged water and record in the field logbook.

   NOTE: If the well pumps dry while purging, it does not generally mean that a sample cannot be collected. A sample can still be obtained by following these steps after all other steps have been completed:

   a. When the well pumps dry, turn off the pump.

   b. Wait for the well to recharge sufficiently to draw a sample.

   c. Measure the depth-to-water using the electrical tape. Make sure that the water level is above the pump intake.

   d. Turn the pump on.

   e. Measure pH, temperature, and specific conductivity once and record on the Ground Water Sample Report.

   f. Collect the samples that are designated for collection with the pump.

g. The well may pump dry during the collection of samples. If this occurs, repeat steps (a.) through (d.) before collecting the remaining samples.

h. If sufficient water to sample has not recharged into well after a total of 16 hours, report the problem in the field logbook and discontinue sampling at that well.

6. Place sample numbers or description of the samples on the Ground Water Sample Report or field logbook as required and Chain of Custody forms.

7. Fill the appropriate sample containers.

4.3.2 Ground Water Level Measurement

Following development of the monitoring wells, the water level in each well will be allowed to stabilize for a minimum of 48-hours prior to collecting a water level measurement. The depth to ground water and/or free product in each well will be measured to the nearest 0.01 foot using an oil/water interface probe or other electronic water level meter.

If free product is encountered in a monitoring well, the depth to the air/free product interface will be recorded to the nearest 0.01 foot from the top of the PVC casing. The probe will be advanced through the free product until the free product/water interface is encountered. This depth will be recorded to the nearest 0.01 foot from the top of the PVC casing. The thickness of free product will be determined by subtracting the depth to the air/free product interface from the depth to the free product/water interface. If only ground water is encountered, the depth to the air/ground water interface will be recorded to the nearest 0.01 foot from the top of the PVC casing.

Water level/free product level measurements from the existing and newly installed monitoring wells on site will be obtained on the same day. If free product is detected in a monitoring well, this information will be provided to AFCEE and the Richards-Gebaur site representative personnel so that MDNR can be notified in accordance with MDNR and Federal regulations.

4.3.3 In Situ Ground Water Sampling

A Geoprobe Systems® or similar hydraulic probe unit is used to advance a slotted well point or specialized screen sampler fitted with an expendable drive point to the desired sampling depth. At the desired sampling depth the probe rod chain is withdrawn six inches from the expendable point to allow water to enter. A length of 3/8-inch Teflon tubing equipped with a stainless steel ball valve is then inserted into the probe rods from the ground surface to the bottom of the rods. The tubing is oscillated up and down to obtain a ground water sample.

4.4 DECONTAMINATION

4.4.1 Personnel

Persons working on the site shall undergo decontamination before leaving the site. In most instances, removal of protective clothing will suffice for decontamination. Facilities for storage of reusable protective clothing and for the disposal of clothing contaminated beyond reuse will be constructed or placed on site. Facilities for decontaminating hands, boots, and gloves, consisting of a detergent wash and water rinse will also be provided.

Decontamination of personnel and miscellaneous small tools will be in accordance with the Site Health and Safety Plan.

4.4.2 Equipment

Precautions will be taken to prevent the potential transfer of contamination from one boring location to another during the field activities. Equipment used to advance and sample soil borings will be decontaminated prior to use at each boring location. This equipment includes but is not limited to the drill rig, augers, drill rods, soil and ground water samplers, and pumps. The following sections describe the decontamination procedures that will be used at the site.

4.4.2.1 Drilling and Soil Sampling Equipment

The drill rig and other surface drilling equipment will be decontaminated prior to use at each site. Downhole equipment including reusable casing augers, rods, bits and related equipment will be decontaminated between the sampling locations. The procedure for decontaminating equipment will consist of manually scraping visible soil and mud from the equipment, applying a high-pressure low-volume hot water and Alconox® wash, and rinsing with potable water.

Soil samplers used to obtain soil samples for chemical or geotechnical analyses, along with head space analysis jars, knives, stainless steel trowels, spoons, and mixing bowls, will be decontaminated after each use according to the following procedure:

1. Scrub off a majority of the soil using potable water. Sampling equipment may also be washed by performing a high-pressure low-volume hot water and Alconox® wash of the disassembled parts.
2. Wash with a mixture of potable water and Alconox® detergent;.
3. Rinse three times with potable water.
4. Rinse with a laboratory certified Type II Reagent-Grade Water.
5. Rinse equipment with pesticide-grade methanol.
6. Rinse equipment with pesticide-grade hexane.
7. Air dry on a clean elevated surface and then wrap in aluminum foil if not used immediately.

To facilitate the decontamination process, decontamination zones will be constructed. The decontamination zone for the soil samplers, water sampling tools, and miscellaneous small tools will be established near each borehole. The decontamination area will consist of a low-lying area covered with a 6-mil polyethylene sheet and several buckets, one dedicated to each decontamination step. At the completion of decontamination procedures at each boring, the debris will be enclosed in the polyethylene sheet and deposited into 55-gallon type 17 E/H drums for later disposal. The decontamination zone for the rear end of the drill rig, augers, rods, and other large items of equipment used during drilling and sampling will be established in the general vicinity of each sampling area. A low-lying area sloped toward a collection basin, will be covered with a 6-mil polyethylene sheet to collect the water and solid wastes generated during cleaning of the equipment. The water and the debris will be placed into 55-gallon 17 E/H drums for later disposal.

4.4.2.2 Monitoring Well Development, Sampling, and Monitoring Equipment

Equipment used to surge and purge the monitoring wells during development and the probe used for water level measurements will be decontaminated using the following procedure prior to placement into a well:

1. Wash with a potable water and Alconox® detergent solution; and
2. Rinse three times with potable water followed by laboratory certified Type II Reagent-Grade Water wash.
3. Methanol and hexane may be used if particularly oily samples are encountered.

The instruments used to monitor development water during stabilization tests (i.e. pH, temperature, conductance, and turbidity meter) will be triple rinsed with distilled water only to minimize variance from calibration standards. If obvious signs of contamination remain, the instruments will be decontaminated, as described above, and then recalibrated.

Specific procedures for decontaminating the downhole pump and tubing follows:

1. Immerse the pump and tubing into a container of Alconox® detergent solution and pump a minimum of three pump and tubing volumes of the solution through the pump and tubing.

2. Immerse the pump and tubing into a container of distilled water. Pump a minimum of three pump and tubing volumes of distilled water through the pump and tubing.

3. Remove the decontaminated pump and tubing and place into a clean plastic bag/container for transport.

The outside of the pump will be decontamination by washing with an Alconox® and water solution and triple rinsing with laboratory certified Type II Reagent-Grade Water.

Water samples from the developed wells will be obtained using disposable one-time use dedicated Teflon® disposable bailers and nylon rope. A Teflon® bottom discharge device will be used to transfer the water sample from the bailer to the appropriate laboratory container(s).

5.0 ENVIRONMENTAL SAMPLE HANDLING AND PACKING

5.1 SAMPLE CONTAINERS

Sample containers will be provided by the analytical laboratory. The containers will be either high density polyethylene or glass with Teflon®-lined lids and will be pretreated with preservatives as applicable. The type of container, minimum sample volume, preservation method, and holding time for each analytical method that will be used for this project are listed in Table 2.

5.2 SAMPLE HANDLING AND DECONTAMINATION

After sample collection in the field, the exterior of the sample containers will be decontaminated if gross contamination is present. The sample containers will be handled with gloves until decontaminated with a detergent wash and water rinse. Care will be taken to avoid damaging the temporary labeling during decontamination. After decontamination, permanent labels will be placed on clean sample container exteriors.

The sample containers will be well-cushioned with packing materials when they are placed in the insulated cooling chests for transportation to the laboratory. Care will be taken to seal bottle caps tightly. The samples will be shipped via overnight carrier to the laboratory to arrive no later than 48 hours after the time sampled.

5.3 PROCEDURES FOR PACKING & SHIPPING LOW CONCENTRATION SAMPLES

Samples will be packaged as follows:

- Use water-proof metal (or equivalent strength plastic) ice chests or coolers only.
- After determination of specific samples to be submitted and filling out the pertinent information on the sample label and tag, put the label on the bottle or vial prior to packing.
- Place about 3 inches of inert cushioning material such as vermiculite in the bottom of the cooler.

- Enclose the bottles in clear plastic bags through which sample tags and labels are visible, and seal the bag. Place bottles upright in the cooler in such a way that they do not touch and will not touch during shipment.

- Place bubble wrap and/or packing material around and among the sample bottles.

- Add sufficient ice (double bagged) between and on top of the samples to cool them and keep them at approximately 4°C until received by the analytical laboratory.

- Fill cooler with cushioning material.

- Put paperwork (Chain-of-Custody Record) in a waterproof plastic bag and tape it with duct tape to the inside lid of the cooler.

- Tape the drain of the cooler shut with duct tape.

- Secure lid by wrapping the cooler completely with strapping, duct or clear shipping tape at a minimum of two locations. Do not cover any labels.

- Attach completed shipping label to top of the cooler.

- Label "This Side Up" on the top of the cooler, "Up" with arrow denoting direction on all four sides, and "Fragile" on at least two sides.

- Affix numbered and signed custody seals on front right, and back left of cooler. Cover seals with wide, clear tape.

5.4 PROCEDURES FOR PACKING AND SHIPPING MEDIUM CONCENTRATION SAMPLES

An effort will be made to identify samples suspected of having elevated contaminant concentrations based on field observations and screening test. These samples will be segregated and packed in a separate container to the extent allowed by prevailing field conditions. Medium concentration samples will be packed in the same manner as described in Section 5.3 for low concentration samples.

5.5 CHAIN-OF CUSTODY RECORDS

As part of the sampling plan, Chain-of-Custody protocols will be established to provide documentation that samples were handled by authorized individuals as a means to maintain sample integrity. The Chain-of-Custody form will contain the following information:

- Sample identification number;
- Date, time, and depth of sample collection;
- Sample type (e.g. soil);
- Type and number of container;
- Requested analyses;
- Field notes and laboratory notes;
- Project name and location;
- Name of collector;
- Laboratory name and contact person; and
- Signature of persons relinquishing or receiving samples.

A sample Chain-of-Custody form to be used during this investigation is illustrated in Figure 10, Dames & Moore Chain-of-Custody Form. The field sampler is personally responsible for the care and initiation of custody of the samples collected until they are transferred to the Sample Coordinator.

- Sample containers will be labeled/tagged with the sample numbers and locations. The date, time sampled, analyses to be performed and sample collector's signature also will be entered on the tag.

- Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a field logbook notation would explain that a pencil was used to fill out the sample tag because the ballpoint pen would not function in freezing weather.

- Each sample container cap also will have an adhesive label on it indicating the sample number in the event the tag on the sample container becomes loose, or lids are inadvertently placed on the wrong sample container.

- The Field Team Leader will review the field activities to determine whether proper custody procedures were followed during the field work, assess whether proper documentation was filled out, and decide if additional samples are required.

Chain-of-Custody records will be maintained for each laboratory sample. At the end of each day on which samples are obtained, and prior to the transfer of the samples off-site, Chain-of-Custody documentation will be completed for each sample. Information on the Chain-of-Custody form will be verified to ensure that the information is consistent with the information on the container labels and in the field log book.

Upon receipt of the sample cooler at the laboratory, the laboratory custodian will break the shipping container seal, inspect the condition of the samples, and sign the Chain-of-Custody form to document receipt of the sample containers. Information on the Chain-of-Custody form will be verified to ensure that the information is consistent with the information on the container labels. If the sample containers appear to have been opened or tampered with, this should be noted by the person receiving the samples under the section entitled "Remarks." The completed Chain-of-Custody records will be included with the analytical report prepared by the laboratory.

6.0 FIELD EQUIPMENT AND MEASUREMENTS

Dames & Moore field personnel will assemble the required field equipment prior to mobilization to the site. At this time, the equipment will be checked to ensure that it is in proper working order, and required maintenance will be performed. Tools and equipment that may be needed for field maintenance will be assembled at this time, and pertinent sections of the manuals will be photocopied for reference in the field.

Personnel will become familiar with the calibration of the instruments, as outlined in the respective manuals, and will make the calibrations that can be made at that time. Pertinent sections of the respective manuals will be photocopied for reference in the field, and the equipment that will be necessary for field calibration of the instruments, such as buffer solutions and calibration gases, will be assembled for mobilization to the site.

The following parameters will be measured on site during the field investigation:

- USCS soil and sediment classification, including color (Munsell), consistency, structure, mottling, layering, lenses, fractures, organic matter or voids.
- PID screening of VOCs.
- Ground water temperature, pH, turbidity, and conductivity.

Descriptions of the field equipment to be utilized in the field investigation are presented in the following sections.

6.1 PHOTOIONIZATION DETECTOR/FLAME IONIZATION DETECTOR

A PID or FID is a quantitative instrument that measures the total concentration of numerous organic vapors in air. The instrument to be utilized during the field investigation is an HNu PI101 photoionization detector or equivalent. The HNu is battery operated and lightweight, making it very useful in field monitoring projects. The instrument is calibrated by introducing pressurized gas from a cylinder with a known organic vapor concentration into the detector. Once the reading has stabilized, the display of the instrument is adjusted to match the known concentration. A calibration of this type is performed each day prior to using the instrument.

If the output differs greatly from the known concentration of the calibration gas, the initial procedure to remedy the problem is a thorough cleaning of the instrument. The cleaning process normally removes foreign materials (i.e., dust, moisture) that affect the calibration of the instrument. If this procedure does not rectify the problem, further troubleshooting is performed until the problem is resolved. If the problem cannot be resolved by the field personnel, the instrument will be returned to the manufacturer for repair and a replacement unit shipped to the site immediately. The manufacturer's manual will accompany the instrument.

The HNu PI101 detector must be kept clean for accurate operation. Foreign materials can be rinsed or wiped off, or blown out of the detector. The cord between the analyzer and the recorder should not be wound tightly, and will be inspected visually for integrity before going into the field. A new cord will be ordered from the manufacturer if problems are found. A battery check indicator is included on the equipment and will be checked prior to going into the field and prior to use. The batteries will be fully charged each night. The analyzer, probe, and meter will be packed securely and handled so as to minimize the risk of damage.

6.2 CONDUCTANCE, TEMPERATURE, AND PH METER

A HyDAC conductance, temperature, and pH meter, or equivalent, will be used at the site. The unit has the following detection ranges: conductance 0 to 20,000 μmhos/cm; temperature 0 to 160°F; and pH 0 to 14. Conductance and temperature are factory calibrated: however, conductance will be checked against a standard solution of known conductance each day and recalibrated, if necessary.

The pH will be calibrated prior to each use by immersing the pH electrode in a pH 7.0 buffered solution. The electrode is then placed in a pH 4.0 or 10.0 buffered solution and the "SLOPE" potentiometer on the tester adjusted to display the value of the buffer solution chosen. The meter and probes will be packed in a protective case for transport. The probes must be kept clean, and will be rinsed with distilled water after each use. The buffer solutions used in calibration will be packed with the meter.

6.3 OIL/WATER INTERFACE PROBE

The oil water interface probe to be used will be an ORS® brand interface probe or equivalent. This unit gives a single tone when its probe interfaces with hydrocarbons and an intermittent tone when it reaches water. Depth is read directly off the tape. Field calibrating will entail measurement between wire marks with an accurate tape measure to help ensure length validity.

6.4 NEPHELOMETRIC TURBIDITY METER

An HF Scientific DRT nephelometric turbidity meter or equivalent will be used during monitoring well development and sampling. The unit is battery operated and will be fully charged prior to all pertinent field operations. Calibration and other pertinent maintenance and operations information is provided in the operator's manual which will accompany the unit to the field.

6.5 DECONTAMINATION SUPPLIES

The decontamination wash solutions will consist of Alconox® detergent and potable water, distilled water, and hexane/methanol in accordance with procedures suggested by the AFCEE. Other supplies will include buckets, tubs, and brushes. The decontamination supplies will be transported in sealed unbreakable containers. The containers will be inspected visually for leaks or contamination prior to each use.

6.6 RESPIRATORS, CARTRIDGES, AND FILTERS

Air purifying filter/cartridge respirators will be donned by sampling personnel if field situations warrant. The respirators will be fitted with appropriate compatible cartridges meeting NIOSH (National Institute for Occupational Safety and Health) criteria for removal of organic vapors, dusts, and mists. These cartridges are NIOSH and MSHA (Mine Safety and Health Administration)-approved. The cartridge is approved for use in atmospheres containing at least 19.5 percent oxygen and less than 0.1 percent organic vapors by volume.

6.7 LOCKS

Padlocks will be placed on each monitor well to discourage tampering and vandalism. The locks will be purchased from a locksmith supplier or hardware store and will be performance tested at the time of purchase and when placed on a well. The locks will be keyed alike to avoid the possibility of confusion among keys. Three sets of keys will be provided to the Richards-Gebaur personnel.

6.8 ELECTRICAL GENERATOR

A portable gasoline powered electrical generator with a minimum 3,500 watt capacity will be used to provide on-site power for the submersible pump. Care will be taken during the fueling of the generator to prevent the spillage of gasoline at the site.

7.0 QUALITY ASSURANCE/QUALITY CONTROL

The objective of the Quality Assurance/Quality Control (QA/QC) program is to demonstrate that the data produced are scientifically valid, defensible, and of known precision and accuracy. A site Quality Assurance Project Plan has been prepared and is provided as a separate part of the QA/QC program.

QC will be maintained in the field by adhering to the field procedures outlined in the Field Sampling Plan; by properly and fully documenting sample information on chain-of-custody forms; by maintaining field logs documenting field activities; and by the collection of QC samples. The QC samples will be analyzed to assess laboratory performance and to assess the possibility of cross-contamination.

7.1 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

As part of the Quality Control program, QC samples will be prepared and collected to provide data for the subsequent review, interpretation, and validation of the analytical data. Four types of QC samples for soil will be prepared or collected: (1) trip blanks; (2) duplicate (replicate) samples; (3) QA samples, and (4) equipment blanks. The QA/QC samples are discussed in more detail below.

7.1.1 Trip Blanks

Trip blanks will be prepared by the off-site analytical laboratory and shipped to the site with the *sample containers. Two trip blank vials will be pack with each shipment of samples submitted to* the laboratory for VOC analyses. The trip blanks will be analyzed for VOCs and will be used to assess the possibility of cross-contamination of the samples during shipment to the laboratory.

7.1.2 Duplicate Samples

Collection of duplicate samples provides for evaluation of the laboratory's performance by comparing analytical results of two samples from the same location. Duplicate samples will be collected at a rate of 10% (1 in 10). Duplicates will be labeled as independent samples so they can not be identified as duplicates by the laboratory (blind duplicates).

7.1.3 QA Samples

QA samples will be collected to allow for an independent evaluation of the analytical data quality as described in the site QAPP.

7.1.4 Equipment Blanks

One equipment blank will be taken by the sampling team on each day of sampling. Sampling equipment blanks will be collected immediately after the equipment has been decontaminated. This blank will be analyzed for all laboratory analyses requested for environmental samples collected at the site in that particular day.

7.2 QA/QC SAMPLING PROCEDURES

In order for duplicate sample analysis to be valid, the duplicate samples must be as homogeneous as possible. Duplicate soil samples will be split vertically so that vertical stratification of contaminants will be distributed equally between the samples. Half of the sample (one of the split sides) will be transferred to the regular sample container; the duplicate half will be transferred to the similarly labeled duplicate or split sample container. Stainless steel sampling spoons and knives will be used. Samples will be handled by personnel wearing nitrile gloves to avoid contamination.

Soil collected for duplicate samples, or for samples to be split with third parties (QA samples), will be obtained by consecutively filling additional sets of sample jars using the same sampling equipment. Samples collected for VOC analysis will be placed directly into the sample jars. The sample jars will be completely filled to minimize the loss of volatiles.

Composite soil samples obtained for TRPH or SVOC analysis will be homogenized prior to filling the sample jars. Moisture content, particle size, and absorption properties of the soils may inhibit complete homogenization. The soil sample to be homogenized will be place initially in a stainless-steel bowl. After the removal of stones, vegetation, or other debris, the soil will be blended with a stainless-steel sampling trowel or spoon until it appears uniform in color and texture. The samples will then be place into the sample containers.

Duplicate water samples will be obtained by consecutively filling additional sets of sample jars using the same sampling equipment. Duplicate samples for VOC analysis will be filled first from the same bailer.

8.0 SITE DOCUMENTATION

8.1 FIELD LOG BOOKS

Each Dames & Moore Field Team member will maintain a personal field log book while on the site. Information recorded in the log book will be written in an objective, factual manner so that persons reading the entries will be able to determine the sequence of events as they occurred in the field. If notes are made in the log book by someone other than the owner of the book, this will be indicated by the writer's signature and date. Information that may be recorded in the field log book include:

- Date and time of entry;
- Sample number;
- Sample description;
- Method of sampling;
- Location of sampling;
- Sketch of sample location;
- Field measurements such as pH, conductivity, temperature, and water level;
- Names and phone numbers of field contacts, drillers, and persons on-site;
- Materials used in well construction;
- Driller's standby and drilling time; and
- Weather and field conditions during drilling and sampling.

In addition to the above information, the following forms will be used to record detailed data:

- HTW Drilling Log (Figure 4) - used in the field to record detailed sample descriptions and drilling methods;

- Stabilization Test Form (Figure 9) - used to stabilize the wells prior to sampling.

- Monitoring Well Installation Details (Figure 7) - used to record details of well installation.

- Field Memorandum (Figure 11) - used to outline daily activities for information of project manager and file records; and

- Well Development Log (Figure 8) - used to record details of well development.

8.2 CORRECTIONS TO DOCUMENTATION

Errors or mistakes in the original field data will be crossed out with a single line, and the person making the correction will initial it. No data will be erased.

In some circumstances, original documents may be transcribed, making appropriate changes and eliminating errors. In these cases, the successive documents will be dated, numbered as sequential drafts and the originals maintained in the project file.

8.3 SAMPLE TRAFFIC REPORTS

Knowledge of sample status will be maintained through review and evaluation of the Dames & Moore field geologist's/engineer's reports, discussions with field personnel, and through contact with the analytical laboratory on a periodic basis. In this way, a working knowledge of sample traffic will be available throughout the project.

FIGURES

FIGURE 1

SITE LOCATION MAP

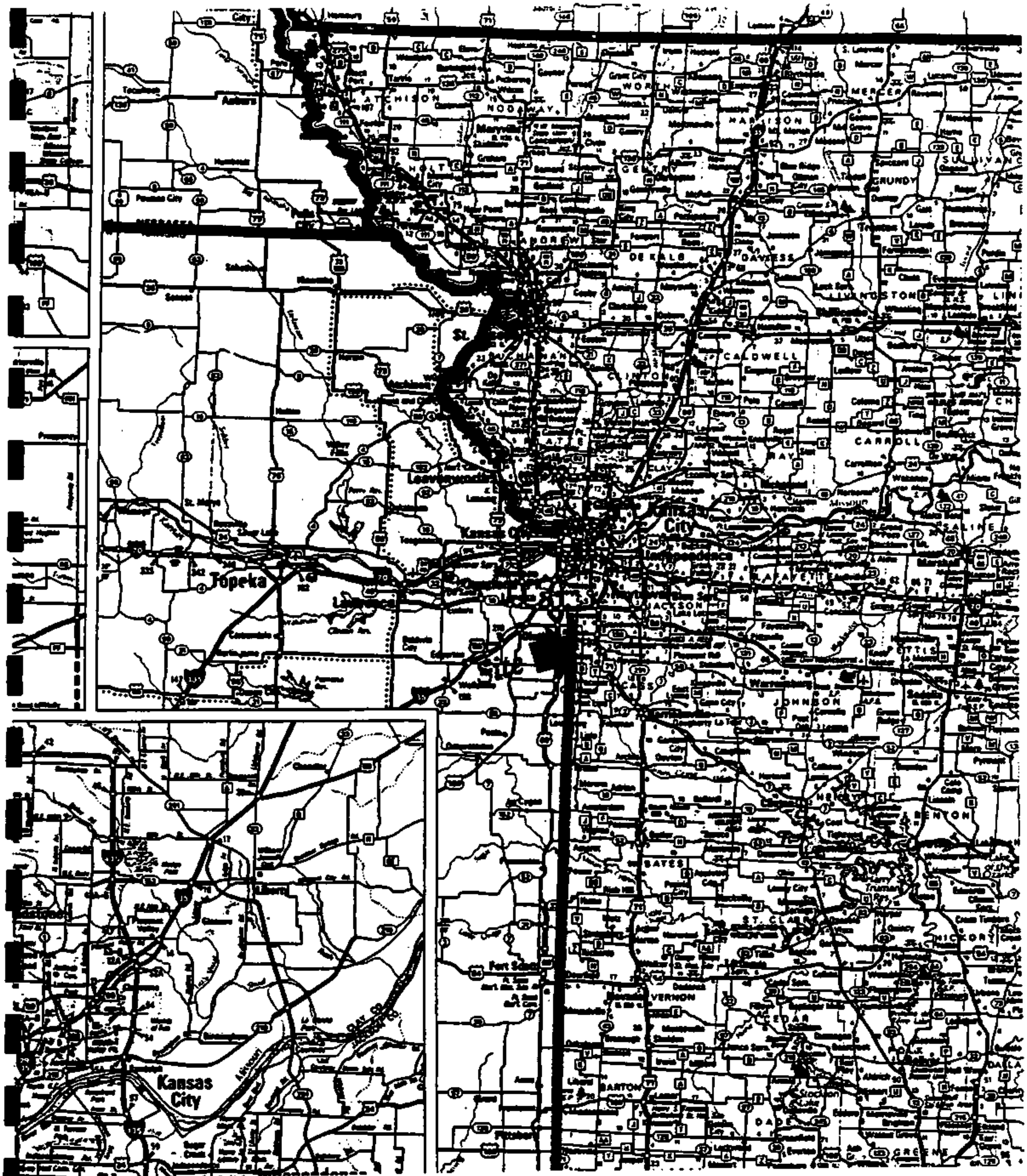


Figure 1
SITE LOCATION MAP

Richards-Gebaur Air Force Base
Belton, Missouri

Dames & Moore

FIGURE 2

PROPOSED BORING LOCATIONS FOR ST007

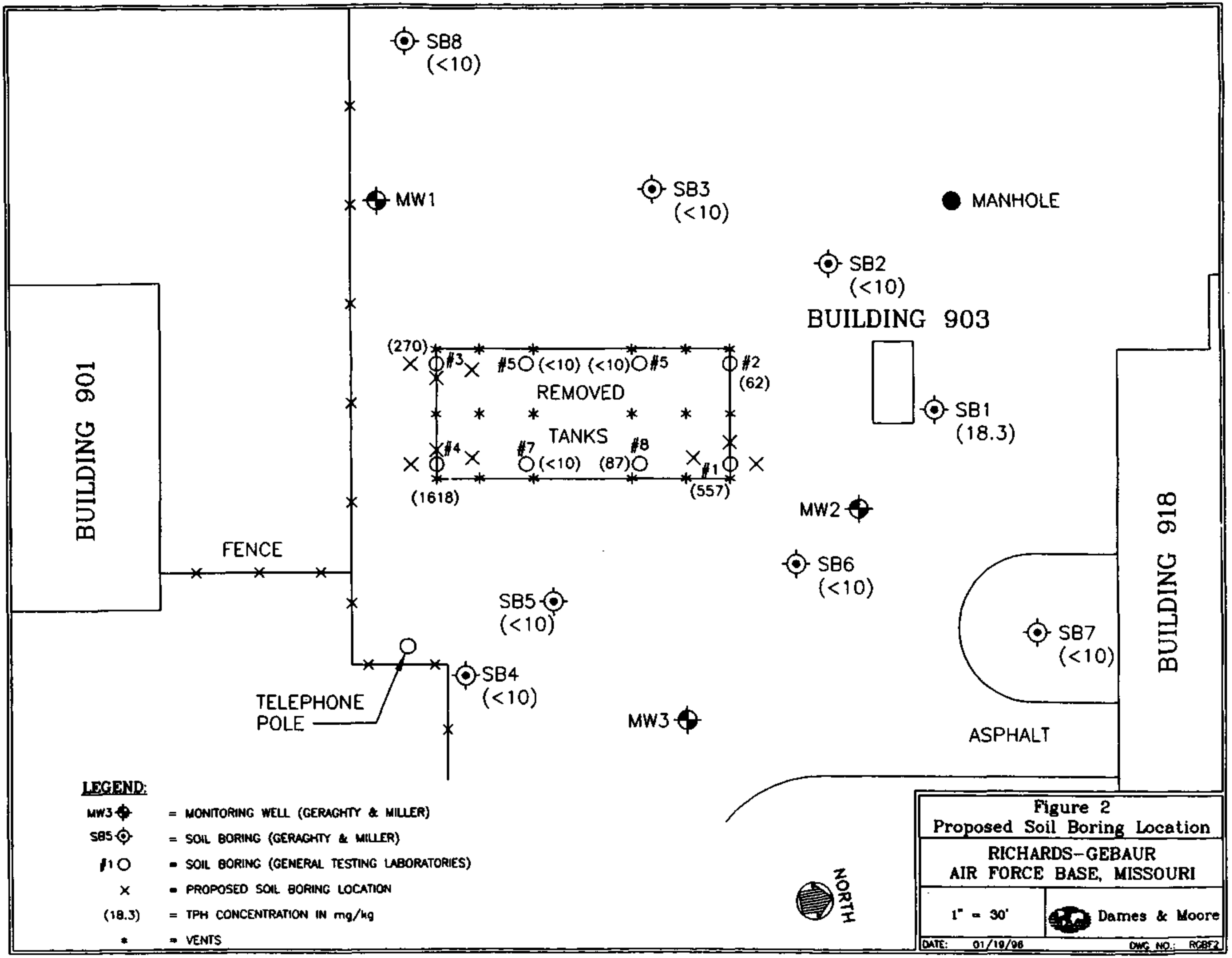


Figure 2
Proposed Soil Boring Location

RICHARDS-GEBAUR
AIR FORCE BASE, MISSOURI

FIGURE 3

PROPOSED BORING LOCATIONS FOR SS008

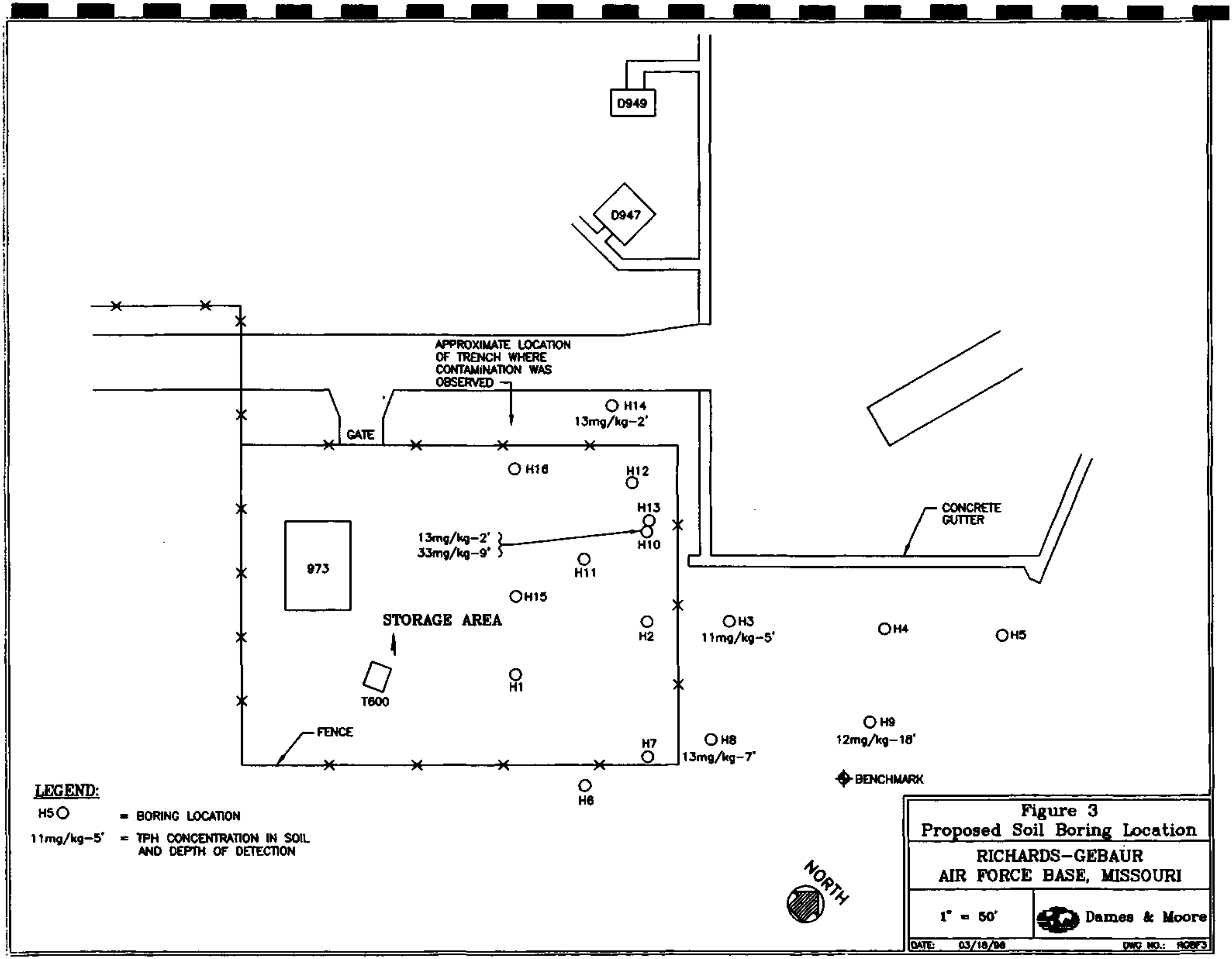
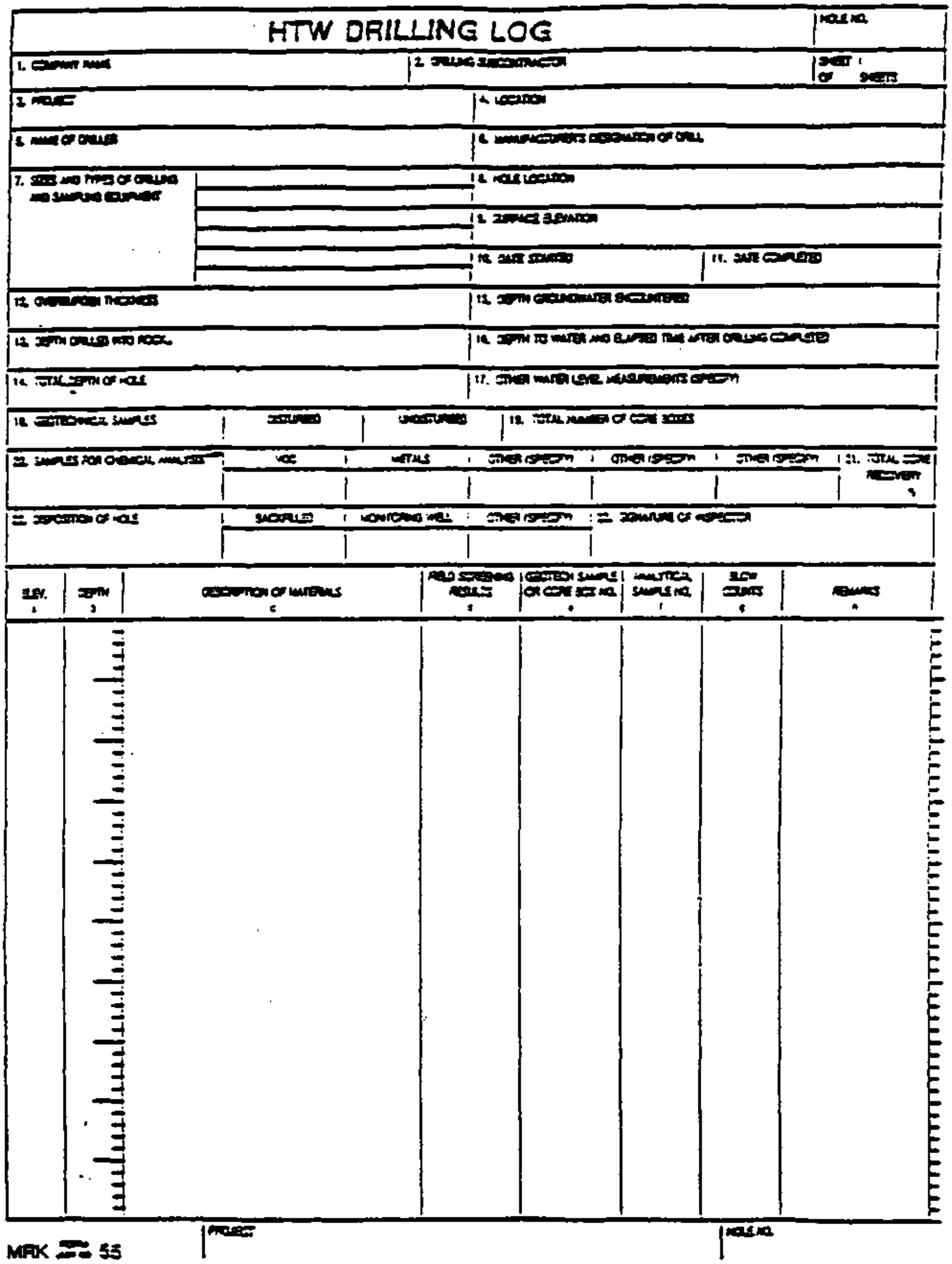


Figure 3
Proposed Soil Boring Location

RICHARDS-GEBAUR
AIR FORCE BASE, MISSOURI

FIGURE 4

HTW DRILLING LOG



HTW DRILLING LOG

1. COMPANY NAME	2. DRILLING SUBCONTRACTOR	HOLE NO. SHEET OF SHEETS
3. PROJECT	4. LOCATION	
5. NAME OF DRILLER	6. MANUFACTURER'S DESIGNATION OF DRILL	
7. SIZES AND TYPES OF DRILLING AND SAMPLING EQUIPMENT	8. HOLE LOCATION	
	9. SURFACE ELEVATION	
	10. DATE STARTED	11. DATE COMPLETED
12. OVERBURDEN THICKNESS	15. DEPTH GROUNDWATER ENCOUNTERED	
13. DEPTH DRILLED INTO ROCK	16. DEPTH TO WATER AND ELAPSED TIME AFTER DRILLING COMPLETED	
14. TOTAL DEPTH OF HOLE	17. OTHER WATER LEVEL MEASUREMENTS (SPECIFY)	

18. GEOTECHNICAL SAMPLES	DISTURBED	UNDISTURBED	19. TOTAL NUMBER OF CORE BOXES

20. SAMPLES FOR CHEMICAL ANALYSIS	VOC	METALS	OTHER (SPECIFY)	OTHER (SPECIFY)	OTHER (SPECIFY)	21. TOTAL CORE RECOVERY %

22. DISPOSITION OF HOLE	BACKFILLED	MONITORING WELL	OTHER (SPECIFY)	23. SIGNATURE OF INSPECTOR

ELEV. a	DEPTH b	DESCRIPTION OF MATERIALS c	FIELD SCREENING RESULTS d	GEOTECH SAMPLE OR CORE BOX NO. e	ANALYTICAL SAMPLE NO. f	BLOW COUNTS g	REMARKS h

MRK FORM 55

PROJECT

HOLE NO.

Figure 4
HTW DRILLING LOG

DAMES & MOORE
Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence

FIGURE 5

UNIFIED SOIL CLASSIFICATION SYSTEM

Test 1 COARSE-GRAINED SOILS More than half of the material (by weight) is individual grains visible to the naked eye.	Test 2a GRAVELLY SOILS–More than half of coarse fraction is larger than 1/4".	Test 2b	CLEAN GRAVELS Will not leave a stain on a wet palm	Test 2c	Substantial amounts of all grain particle sizes	GW
					Predominantly one size or a range of sizes with intermediate sizes missing	GP
			DIRTY GRAVELS Will leave a stain on a wet palm	Test 4	Nonplastic fines	GM
					Plastic fines	GC
	Test 2a SANDY SOILS–More than half of coarse fraction is smaller than 1/4".	Test 2b	CLEAN SANDS Will not leave a stain on a wet palm	Test 2c	Wide range in grain size and substantial amounts of all grain particle sizes	SW
					Predominantly one size or a range of sizes with intermediate sizes missing	SP
			DIRTY SANDS Will leave a stain on a wet palm	Test 4	Nonplastic fines	SM
					Plastic fines	SC

Test 3 FINE-GRAINED SOILS More than half of the material (by weight) is individual grains not visible to the naked eye.	Test 5–RIBBON	Test 6–LIQUID LIMIT	Test 7–DRY CRUSHING STRENGTH	Test 8–DILATANCY REACTION	Test 9 TOUGHNESS	Test 10 STICKINESS	
	None	<50	None to Slight	Rapid	Low	None	ML
	Weak	<50	Medium to High	None to Very Slow	Medium to High	Medium	CL
	Strong	>50	Slight to Medium	Slow to None	Medium	Low	MH
	Very Strong	>50	High to Very High	None	High	Very High	CH
Test 11–HIGHLY ORGANIC SOILS	Readily identified by color, odor, spongy feel, and frequently by fibrous texture.						OL OH Pt

Figure 5

ASTM Soil Classification Chart

Dames & Moore

Richards-Gebaur AFB
for
Air Force Center for Environmental Excellence

FIGURE 6

SPLIT-SPOON SAMPLER

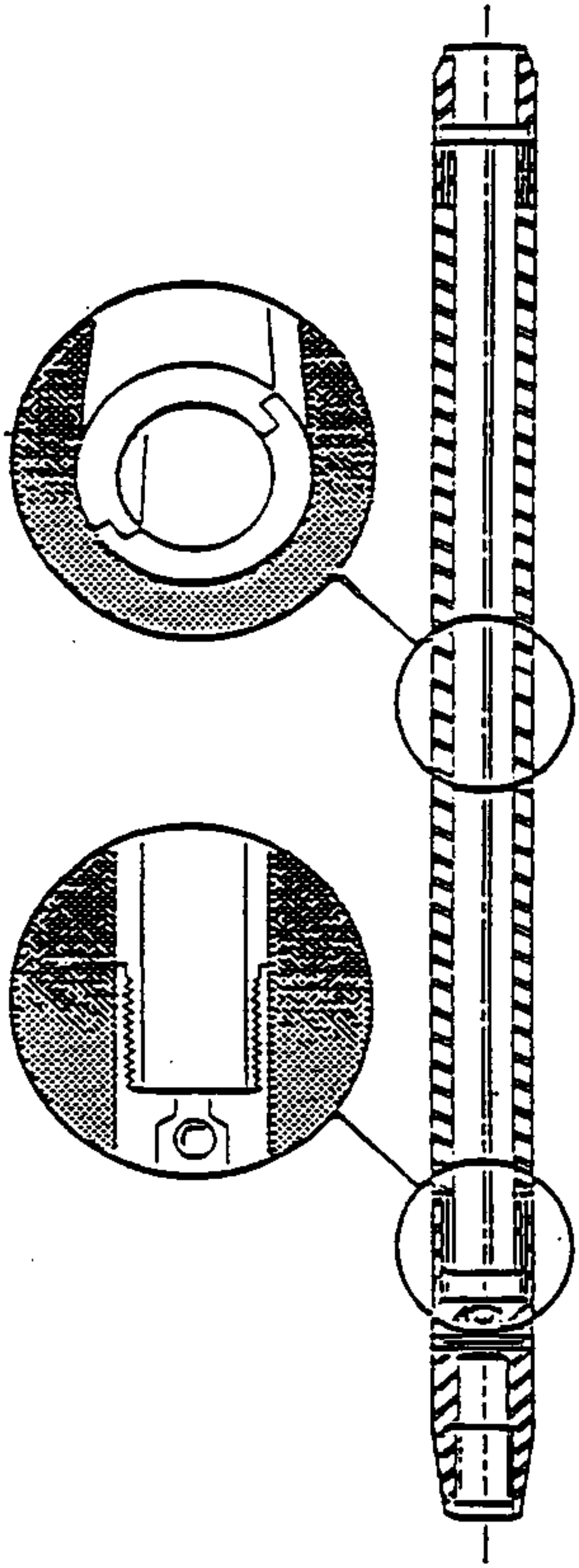


Figure 6
SPLIT-SPOON SAMPLER

DAMES & MOORE

Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence

FIGURE 7

MONITORING WELL INFORMATION SHEET

Figure 7 Monitoring Well Information Sheet

DAMES & MOORE

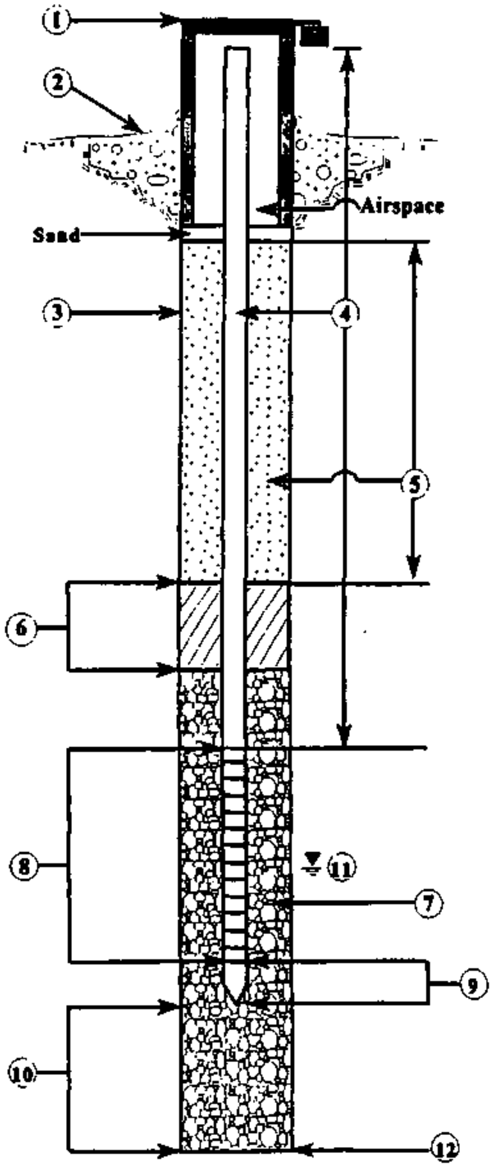
MONITORING WELL INFORMATION SHEET

Client ______________________ ______________________
Job Number ______________________
Boring Number ______________________
Location ______________________
Coordinates ______________________
Ground Surface Elevation ______________________
Top of Well Casing Elevation ______________________
By ______________________
Date ______________________

① Surface Completion Type

______ Protective casing with locking cap.

__X__ Flush-mounted.



1) Surface Completion (see top diagram at left).
Height of well casing above ground____feet.
Locking cap______Yes_______ No.
Bumper posts_______ Yes______No.
Number ____ Size_____________

2) Concrete pad _____ Yes _______ No.
Size (length/width/height)___________

3) Borehole diameter ___ inches.

4) Total length of riser pipe_____feet.
Pipe diameter_____inches.
Pipe material______________________
Schedule______________________
Centralizers _______ Yes ______ No.
Number ______________________
Depths______________________

5) Type of upper backfill __________
____
Depth to top of upper backfill_______feet below surface.

6) Seal Material__________
Depth to top of seal (if installed)_____feet below surface.

7) Type of filter pack material around screen
____
Filter pack_______Yes ______ No.
Depth to top of filter pack_____feet below surface.

8) Length of well screen_____feet.
Diameter of screen_____inches.
Slot size of screen______inches.
Screen Material____
Schedule______.
Depth to top of well screen__feet below surface.

9) Sediment trap (solid pipe below slot)______feet.

10) Type of lower backfill______

11) Depth to ground water_____feet measured on_____(date).

12) Total depth of boring completed at____feet completed on ______.
Quantity of non chlorinated water introduced during installation_____gallons.

FIGURE 8

WELL DEVELOPMENT LOG

1. Date of Development: MM/DD/YY
   Time of Development: Time (AM/PM)

2. Elapsed time between grouting and well development: Hours/Minutes

3. Equipment Description: Equipment Used

4. Water level prior to development: WL (ft) from top of casing
   Total well depth prior to development: TD (ft) from top of casing
   Height of Water Column: TD - WL = WC (ft)

5. Development and Stabilization Data Table:

Parameter	Cycle - (includes 15 minutes of surging followed by submersible pumping)										
	1	2	3	4	5	6	7	8	9	10	11
Gallons Pumped (Total = ___)											
Borehole Volumes Pumped (Vol = ___)											
TDS (Total Dissolved Solids) (ppm)											
pH											
Temperature °F											
Turbidity (NTUs) (>200 = offscale)											
Color											
Remarks: (Odor, Cement & Grout)											

For "Borehole Volume" the following formula is used:

Given:

Borehole Size = 11.25"
PVC Diameter = 2.375"

Water = 7.48 gal/ft³
Pack Porosity = 35%

Z = water column height (ft)
X = gallons/borehole volume

$$Volume = \frac{\pi}{(4)(144)} \times (11.25^2-2.375^2) \times 0.35 + \frac{\pi}{(4)(144)} \times 2.375^2 \times 7.48 = 2.0\ \frac{gallons}{ft.\ water\ column}$$

$$Then,\ 2\ \frac{gallons}{ft.\ water\ column} \times (Z)\ ft.\ water\ column = (X)\ \frac{gallons}{borehole\ volume}$$

6. Development Criteria: The well is considered developed when TDS (tolerance = < 0.75ppm); pH (tolerance = ±0.1 units); temperature (tolerance = ± 1.0 °F) and turbidity (below 100 NTUs for at least 30 minutes) are within tolerance for 3 consecutive cycles. A cycle includes surging followed by the withdrawal of at least one (if possible) borehole volume, as previously defined.

7. Water level following development: WL (ft) from top of casing
   Total well depth following development: TD (ft) from top of casing

   Average pumping rate: GPM (gallons per minute)
   Duration of development: Hours/Minutes

8. Comments: Overall Observations

Figure 8
WELL DEVELOPMENT LOG

DAMES & MOORE
Richards-Gebaur A.F.B.
For
Air Force Center of Environmental Excellence

FIGURE 9

STABILIZATION TEST FORM

DAMES & MOORE

MONITORING WELL SAMPLING FORM

WELL NO. ____________________ - STABILIZATION TESTS

DATE: _______________ Job # 19577-019

PARAMETER	WELL VOLUME EXTRACTED					
	1	2	3			
Time						
Specific conductance (temp. corrected) ±10 μhos/cm						
pH: ± 0.1 pH unit						
Temperature: ±1.0°F						
Turbidity						
Color						
Odor						
Other						

All measurements taken from the north side of the top of riser pipe

Well Diameter (feet) ______________

Depth of well (feet) ______________

Initial depth to water (feet) ______________

Height of water column in riser (feet) ______________

Volume of water in riser (gallons) [A] ___________

Diameter of filter pack (feet) ______________

Height of water in filter pack (feet) ____________________

Volume of water in borehole (gallons) [B] ___________

Volume of water in filter pack (gallons) [1][C] ___________ (B - A) x 0.35

Total volume to be purged (gallons) [D] ___________ (A + C)

Formula for Calculating Purge Volume

$$\frac{\pi D^2 h}{4} X 7.48 =$$

volume in gallons

D = Diameter in feet

h = Height of water column in feet

Final depth to water (feet) ______________

Purged dry? Yes _____ No _____

Time start/Time sampled _____/_____

Product thickness and/or sheen none

Sampler Name(s) (Print):

____

Comments: ____

____

---

[1] "C" is multiplied by 0.35 to account for 35% void space in filter pack.

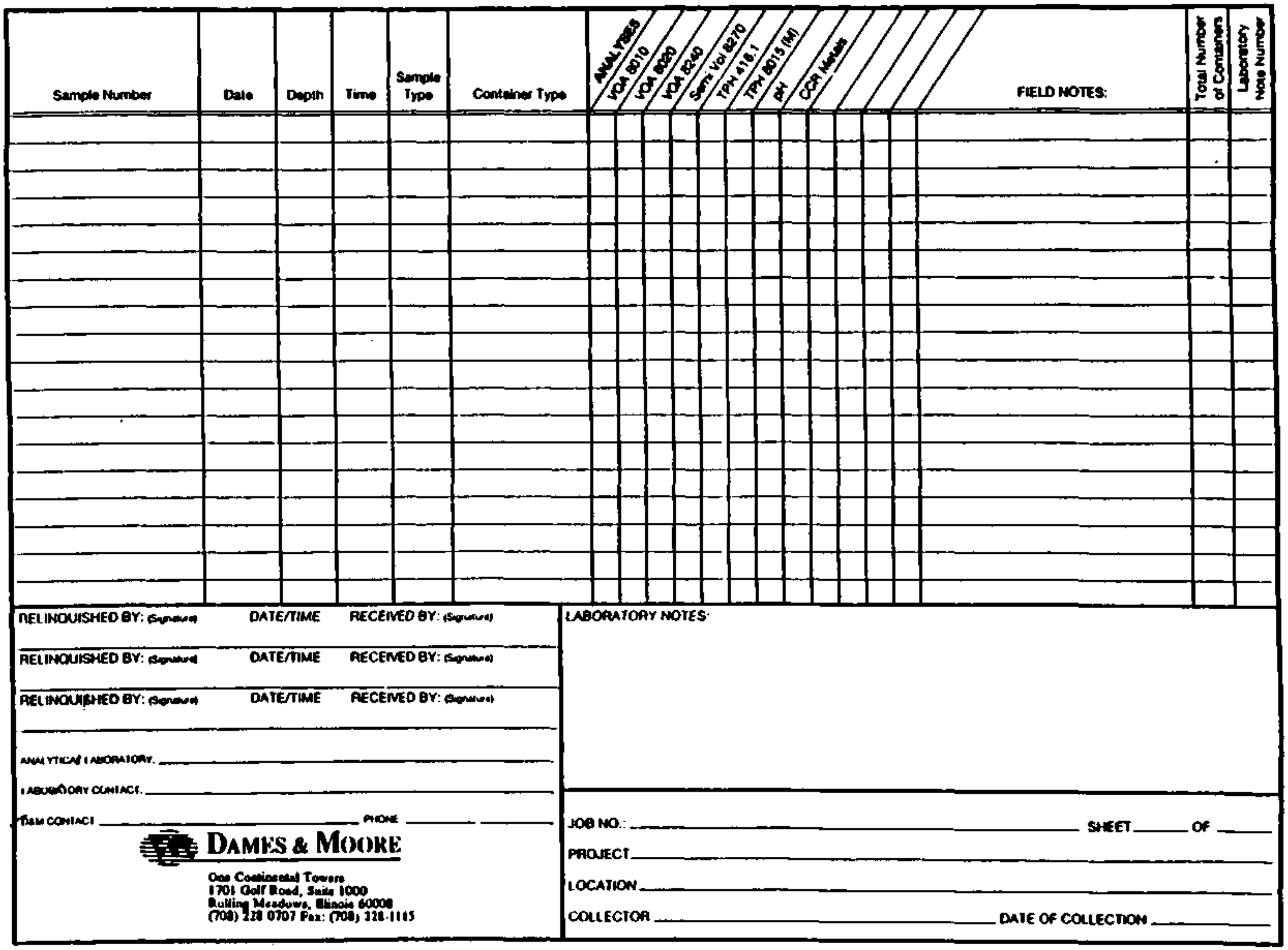
Figure 9

Stabilization Test Form

FIGURE 10

DAMES & MOORE CHAIN-OF-CUSTODY FORM

Figure 10 Dames & Moore Chain-of-custody Form



Sample Number	Date	Depth	Time	Sample Type	Container Type	ANALYSES VOA 8010	VOA 8020	VOA 8240	Semi Vol 8270	TPH 418.1	TPH 8015 (M)	pH	CCR Metals					FIELD NOTES:	Total Number of Containers	Laboratory Note Number

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)

RELINQUISHED BY: (Signature)	DATE/TIME	RECEIVED BY: (Signature)

ANALYTICAL LABORATORY: ____________________

LABORATORY CONTACT: ____________________

DAM CONTACT ____________________ PHONE ____________________

DAMES & MOORE

One Continental Towers
1701 Golf Road, Suite 1000
Rolling Meadows, Illinois 60008
(708) 228 0707 Fax: (708) 228-1115

LABORATORY NOTES:

JOB NO.: ____________________ SHEET ______ OF ______

PROJECT ____________________

LOCATION ____________________

COLLECTOR ____________________ DATE OF COLLECTION ____________________

FIGURE 11

FIELD MEMORANDUM

Figure 11 Field Memorandum

ACTION	INFO	
To:		File:
		X-Ref:
		Date:

From: Reply Required By:

ject:

Reference(s):

ROUTING

TABLES

TABLE 1

SAMPLE MATRIX, ANALYTICAL PARAMETERS AND FREQUENCY OF QC SAMPLING

TABLE 1
RICHARDS-GEBAUR AIR FORCE BASE
DELIVERY ORDER 0003

Sample location, type, analytical method, number of samples, and quality control frequency

Site	Sample Type	Analytical Methods	Number of Samples	Number of QC Samples (10%)	Trip Blank	Equipment Blank
ST007 soil boring	soil	TRPH by EPA Method 8015 modified BTEX by EPA Method 8020.	18	2	①	②
ST007 monitoring well	water	TRPH by EPA Method 8015 modified BTEX by EPA Method 8020	6	1	①	②
SS008 soil boring	soil	TRPH ethylene glycol by EPA Method 8015 modified VOC by EPA Method 8260 RCRA Metals by EPA Method 6010 PCB by EPA Method 8080	16	2	①	②
SS008 excavation	soil	TRPH ethylene glycol by EPA Method 8015 modified VOC by EPA Method 8260 SVOC by EPA Method 8270 RCRA Metals by EPA Method 6010 PCB by EPA Method 8080	5	-	-	-
SS008 in situ ground water	water	TRPH ethylene glycol by EPA Method 8015 modified VOC by EPA Method 8260 SVOC by EPA Method 8270 RCRA Metals by EPA Method 6010 PCB by EPA Method 8080	3	0	0	0

① One trip blank accompanies each VOC shipment

② One equipment blank per sampling team per day

TABLE 2

SAMPLE CONTAINERS AND PRESERVATION REQUIREMENTS

DELIVERY ORDER 0003

Sample Container and Preservation Requirements

Parameter	Reference Method	Container	Minimum Volume	Preservation	Max. Holding Time/Preparation	Max. Holding Time/Analysis
TRPH - soil and ethylene glycol	SW8015	G	8 oz.	4°C	14 days	40 days[2]
TRPH - water and ethylene glycol	SW8015	GA	1000 mL	4°C	7 days	40 days[2]
VOCs - soil	SW8260	G	4 oz.	4°C	14 days	14 days[1]
VOCs - water	SW 8260	G	2 x 40 mL	4°C, HCL to pH <2	14 days	14 days[1]
SVOCs - soil	SW8270	G	4 oz.	4°C	14 days	40 days[2]
SVOCs - water	SW 8270	GA	1000 mL	4°C, HCL to pH <2	7 days	40 days[2]
RCRA metals - soil	SW6010	G	8 oz.	4°C	180 days	180 days[1]
RCRA metals- water	SW6010	P	500 Ml	4°C, HNO tp pH <2	180 days	180 days[1]
PCBs - soil	SW8080	GA	4 oz.	4°C	14 days	40 days[2]
PCBs - water	SW8080	GA	1000 mL	4°C	7 days	7 days[1]

G	Glass wide mouth jar with teflon-lined cap
GA	Glass amber wide-mouth bottle with teflon-lined cap
P	Plastic, polyethylene bottle with polypropylene cap
[1]	Total holding time including sample preparation and analysis
[2]	After sample extraction

FINAL

QUALITY ASSURANCE PROJECT PLAN

RICHARDS-GEBAUR AIR FORCE BASE
F41624-94-D-8102
DELIVERY ORDER 0003

UEBL 95-6004
CLOSE ST007

AND

UEBL 95-7001
PHASE 2 SITE INSPECTION AT SS008

PREPARED FOR
AIR FORCE CENTER FOR ENVIRONMENTAL EXCELLENCE
BROOKS AFB, TEXAS

March 15, 1996

PREPARED BY
DAMES & MOORE, INC.

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1.0 INTRODUCTION

A general description of the project for Richards-Gebaur Air Force Base (AFB) is provided in Section 1.0 the Quality Assurance Project Plan (QAPP) for Delivery Order Number (DO#) 0001. A description of the work proposed for DO# 0003 is provided in Section 1.0 of the Work Plan.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

Dames & Moore has overall responsibility for conducting all phases of the DO activities. Dames & Moore will provide project management, perform field sampling, direct excavation and closure activities, and prepare reports. The review of all sampling data will be conducted by the Dames & Moore Quality Assurance (QA) Manager, Delivery Order Manager, and Project Geologist. Specific information pertaining to managerial, laboratory, and field responsibilities are presented in Sections 2.2 through 2.6 of the QAPP for DO# 0001.

The lines of authority for this project can be found in Figure 1. A brief description of key Dames & Moore personnel shown on this figure are defined below.

2.1 MANAGEMENT RESPONSIBILITIES

The Program Manager is Mr. Gary Alkire, Senior Engineer with Dames & Moore in San Antonio, Texas. Mr. Alkire is responsible for program oversight from both a technical and managerial perspective, and is ultimately responsible for meeting project objectives in terms of scheduling, technical requirements, and budgetary constraints.

The Delivery Order Manager, Mr. Wayne Mizer with the Dames & Moore office in Kansas City, is responsible for daily activities to ensure the DO (as defined by the Construction Quality Plan and Work Plan) meets the objectives of the Air Force Statement of Work, Environmental Protection Agency (EPA), Missouri Department of Natural Resources (MDNR) and Dames & Moore quality standards. Mr. Mizer ensures that the QAPP is distributed to the appropriate parties (Ross Analytica Services, Inc. and other subcontractors, as necessary) connected with the project, and is responsi for technical quality control and project oversight. Mr. Mizer will report directly to both the Dames & Moore Program Manager and the Base Realignment and Closure (BRAC) Environmental Coordinator at the base.

2.2 SITE QUALITY ASSURANCE RESPONSIBILITIES

The site QA Manager, Mr. John Plevniak with the Kansas City Dames & Moore office, is responsible for ongoing surveillance of project activities to help ensure conformance to this QAPP, to evaluate the effectiveness of project requirements, and maintain contact with the laboratory QA officers on data quality issues. The site QA Manager will be responsible for the data validation of sample results received from the analytical laboratories. The specific responsibilities of the site QA Manager are listed in Section 2.3.2 of the DO# 0001 QAPP.

The Dames & Moore site QA Manager reports directly to the Dames & Moore Corporate Quality Assurance Officer and will be responsible for ensuring that all Dames & Moore procedures for this project are being followed. The site QA Manager has access to all personnel and subcontractors, as necessary, to resolve quality problems and has the authority to stop field or laboratory activities if deficiencies in quality occur.

2.3 LABORATORY RESPONSIBILITIES

Ross Analytical Services, Inc. (RASI), 16433 Industrial Parkway, Strongsville, Ohio 44136, (1-800-325-7737) is the analytical laboratory selected for this project to perform the environmental analyses of soil and ground water samples. RASI has a designated Project Manager, Sample Custodian, Analyst, and QA Officer that will be assigned to this project. The RASI organization chart is provided as Figure 2. The laboratory Project Manager for this project is Mr. Jon Sonderman. The specific quality assurance responsibilities of these personnel and their line of authority with Dames & Moore are outlined in Section 2.4 of the DO# 0001 QAPP. (Note: RASI assumes the responsibilities described in the DO #0001 documentation for Chemron.

Each analyst and custodian will perform their assigned tasks according to the applicable laboratory standard operating procedures (SOPs) and QA Plan, and this QAPP. The custodians' are tasked with sample accountability and transfer. The analysts' tasks include performing quality control (QC) analyses as specified in the method SOP and reviewing and entering QC data in the appropriate control file.

Independent quality assurance will be provided by the laboratories' Managers and QA Officers prior to release of sample data to Dames & Moore and/or the Air Force. The managers will take overall responsibility for the technical conduct, evaluation, and reporting of all analytical tasks, and assess quality and take corrective action if necessary, prior to submittal to Dames & Moore. The quality of the analyses and results will be checked against laboratory SOPs and the requirements of this QAPP, and assure that approved procedures are documented and followed.

The QA officers will operate independently from any production and scheduling responsibilities of the site-specific project. They will perform audits and inspections of project analyses and data for compliance with SOPs, QA Plans, and this QAPP to ensure the laboratory is achieving established standards of quality.

2.4 FIELD RESPONSIBILITIES

The Dames & Moore Field Team Leader, Mr. Kris Moore, is responsible for coordinating daily field data collection and sampling activities, and maintaining a general field logbook. Mr. Moore is an experienced environmental professional and will report directly to the Dames & Moore Delivery Order Manager. Specific responsibilities of the Field Team Leader are listed in Section 2.6.1 in the DO# 0001 QAPP.

The Site Health and Safety Officer, Mr. Kris Moore, is responsible for assuring that team members adhere to the requirements of the site-specific Health and Safety Plan. Mr. Moore will provide oversight during the collection of soil and ground water samples.

The technical staff, which will include a project geologist and field sampling technicians, will be responsible for recording sampling data and preparing samples for shipment to the laboratory for analysis. Personnel will adhere to chain-of-custody and field documentation protocols, and will perform field measurements in accordance with Dames & Moore SOPs. The staff will be responsible for analyzing field and sampling data, and preparing various task reports and support materials.

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

Quality assurance objectives are established for both laboratory and field measurements. Objectives focus on precision and accuracy of sampling techniques and analytical results, and the degree to which the data are complete, comparable, and representative of site conditions. Complete explanations of laboratory and field objectives are presented in Sections 3.0 of the DO# 0001 QAPP.

3.1 PROJECT OBJECTIVES

The objective of this project QAPP is to define quality procedures for field sample collection and laboratory analyses to produce defensible data appropriate for recommending closure of the sites, including abandonment of the in-place bioventing system, at Richards-Gebaur AFB. The specific quality objectives for the tasks under this DO are to:

- ST007 - Former UST Site: Sample, analyze, and characterize soil and ground water samples for total petroleum hydrocarbon (TPH) and volatile organic compound (VOC) concentrations to determine if closure of the site is warranted;

- SS008 - Former Test Cell Location: Sample, analyze, and characterize soil and ground water samples for TPH, polychlorinated biphenyl (PCB), VOC, semi-volatile organic compound (SVOC), ethylene glycol and RCRA metals concentrations to determine if closure of the site is warranted;

- Ensure data comparability through the use of standard methods and controlled systems during collection and analysis of samples; and

- Provide defensible analytical results of known and acceptable precision and accuracy.

3.1.1 Project Target Parameters and Intended Data Usages

The project target parameters were chosen based on the knowledge of the contaminants identified during previous environmental investigations at the site and MDNR requirements. Detailed information on sampling locations, sampling rationale, and numbers of samples is provided in the FSP.

3.1.1.1 Field Parameters

During soil sampling, visual observations and photo-ionization detector (PID) headspace readings will be used to assess the potential presence of petroleum contamination. The soil color (Munsell), consistency, structure, mottling, layering, and the presence of lenses, fractures, organic matter or voids will be recorded from soil borings and during the installation of monitoring wells.

During monitoring well development and sampling, the temperature, pH, turbidity, and conductivity of the ground water will be recorded.

3.1.1.2 Laboratory Parameters

The parameters and analytical methods proposed for this DO are listed in Table 1. The method detection limits (MDLs) and practical quantitation limits (PQLs) achieved by RASI for the target analytes are presented in Table 1. These MDLs are compared to PQLs, project specific action levels, and MDNR acceptance criteria for soil and ground water to determine the classification of the media as contaminated or uncontaminated.

4.0 SAMPLING PROCEDURES

The field sampling collection procedures are described in detail in the FSP. The FSP specifies the type of collection equipment and field calibration procedures, sample handling and packaging procedures, and decontamination procedures. The order of chemical sample collection will be volatiles first, semi-volatiles, and then metals.

Sample containers, preservatives, and shipping containers for soil and ground water will be provided by the analytical laboratory. The containers will be sealed and certified as clean by the laboratory. A chain-of-custody form will accompany each lot of containers. A record of the lot numbers and preservatives used in the field will be made in the field sampling log; sample container lots and preservatives will be traceable to the field sample numbers. The type of container, minimum sample volume, preservation method, and holding times for the analytical methods that will be used for this project are specified in Table 2 in the FSP.

5.0 CUSTODY PROCEDURES

The sample custody procedures in the field and laboratory are described in Section 5.0 of the DO# 0001 QAPP. (Note: RASI assumes responsibilities described in DO#0001 for Chemron).

5.1 FIELD DOCUMENTATION RESPONSIBILITIES

The Field Team Leader will secure the documents produced in the field (i.e.; geologists' daily logs, lithologic and sampling logs, communications, etc.) at the completion of work each day. The Field Team Leader will be responsible for review of the documents for accuracy against the sample log.

The possession of the field records will be documented; however, only the Field Team Leader and Delivery Order Manager or their representative may remove field data from the site for reduction and evaluation.

5.2 SAMPLE NUMBERING DESIGNATION

A unique sample numbering system will be used to identify each sample for chemical analysis or field screening. In addition, this sample numbering system will be used to identify trip blanks, field blanks, field duplicates, and additional sample volume designated for matrix spike/matrix spike duplicate (MS/MSD) analyses. The sample designation scheme is described in detail in Section 5.1.5 in the DO# 0001 QAPP and Section 3.0 of the FSP.

5.3 LABORATORY CUSTODY PROCEDURES

The custody and documentation of the sample must be traceable and secure after it arrives at the laboratory. Sections 5.2.1 and 5.2.2 of the DO# 0001 QAPP discuss the laboratory operations necessary to ensure sample and document integrity. This discussion includes chain-of-custody documentation, sample receipt and log-in, sample labeling, sample storage, and document control.

The sample custody SOP implemented by RASI is provided in Appendix A.

Soil and ground water samples and QC samples will be shipped daily by overnight express to RASI. The laboratory will be notified one week in advance of the shipments to prepare for the deliveries. If Saturday delivery is required, the laboratory must be contacted prior to shipping to make the necessary arrangements. The following address will be used:

Ross Analytical Services, Inc.
Attn: Jon Sonderman
16433 Foltz Industrial Parkway
Strongsville, Ohio 44136
Telephone: (216) 572-3200, 1-800-325-7737
Fax: (216) 572-7260

6.0 CALIBRATION PROCEDURES AND FREQUENCY

The calibration procedures and the frequency at which these procedures will be performed for both field and laboratory instrumentation and equipment are described in Section 6.0 of the DO# 0001 QAPP. The calibration procedures implemented by RASI are provided in Appendix B.

7.0 ANALYTICAL PROCEDURES

Analytical procedures are detailed descriptions of any and all processing, preparation, and analysis of samples in the laboratory. Selection of the appropriate analytical method is dependent upon data usage and regulatory requirements during the analysis.

7.1 FIELD ANALYTICAL PROCEDURES

The analytical procedures for field measurements of VOC concentration, pH, conductivity, turbidity, water level, and temperature are described in detail in the FSP.

7.2 LABORATORY ANALYTICAL PROCEDURES

Methods for soil and ground water sample analysis to be performed in the laboratory will include the use of gas chromatography with a flame ionization detector (GC), gas chromatography/mass spectrometer (GC/MS), and inductively coupled plasma (ICP). Analytical procedures are conducted in strict adherence with written SOPs. The SOPs implemented by RASI for the analytical methods specific to this project, as well as for their laboratory operations, are provided in Appendix A. References in the DO# 0001 QAPP relative to Chemron procedures are replaced for this delivery order by the attached RASI SOP The SOPs for these methodologies are based on the analytical protocols which include:

- Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Environmental Protection Agency, 11/86, 3rd Edition, Update 1.

- Methods for Chemical Analysis of Water and Wastes, EPA-600/4/79/020 (rev. 3/83), Technical Addition, EPA-600/4-84-017 (rev. 3/84).

- Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act, 40 CFR Part 136, Federal Register 49 (209), October 26, 1984.

No significant deviations from stated EPA reference methods are included in the laboratory-specific SOPs used by RASI.

7.2.1. <u>List of Project Target Compounds and Laboratory Detection Limits</u>

An MDL is the minimum amount of analyte that can be consistently measured and reported with a high degree of confidence that the analyte concentration is above a background response. The PQL is the lowest level that can be reasonably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The laboratory performs MDL and PQL determinations in accordance with EPA protocols. The MDL results are compared to the relevant PQLs for each method to ensure that the MDLs are lower than the PQLs. The laboratory PQLs are reviewed against the PQLs used in the AFCEE program and a variance is requested for any laboratory PQL that exceeds the AFCEE program goals. No variance will be needed for the parameters and methods proposed for this project. The reporting limits (MDLs) that are routinely and reliably achieved by RASI are compared against the PQLs for each parameter in Table 1.

In addition to requiring that the MDL's are lower than the established PQLs, the MDLs must also meet or be less than State requested cleanup criteria for project target compounds. The Missouri Department of Natural Resources (MDNR) specifies soil cleanup guidelines which vary depending upon site features. The soil cleanup guideline for TPH is 200 parts per million (ppm) or milligrams per kilogram (mg/kg), and the soil cleanup guideline for benzene concentration minimum is 1.0 ppm 5 ppm toluene, 10 ppm ethylbenzene, and 10 ppm xylenes. The MDNR cleanup guidelines for non-potable ground water are as follows: TPH - 10,000 parts per billion (ppb) or micrograms per liter (μg/L); total BTEX - 750 μg/L; benzene - 50 μg/L; toluene - 150 μg/L; ethylbenzene and xylenes - 320 μg/L each. The MDLs of RASI meet or are below these MDNR cleanup guidelines.

8.0 INTERNAL QUALITY CONTROL CHECKS

8.1 FIELD QUALITY CONTROL CHECKS

A summary of the sampling and analysis effort and QC samples for the project is provided in Table 1 in the FSP. The field QC samples will consist of trip blanks, field equipment blanks, and field duplicates.

Quality control checks will be used to assess precision and accuracy of field measurements and will consist of repeating a measurement at a frequency of 10 percent; measurements on the tenth sample will be repeated. Quality control procedures for pH, conductivity, and turbidity are limited to checking the reproducibility of the measurement by obtaining multiple readings on a single sample or standard, and by calibrating the instrument. The accuracy objectives for field measurements are presented in Table 9 of the DO# 0001 QAPP.

8.2 LABORATORY QUALITY CONTROL CHECKS

Laboratory quality control checks specified by this DO are described in detail in Sections 8.2 and 8.3 of the DO# 0001 QAPP. (Note: RASI assumes the responsibilities for Chemron as described in the DO# 0001 document). The precision and accuracy limits established by RASI for target analytes in soil and ground water are provided in Table 2. Laboratory quality control program followed by RASI is provided in Appendix B.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

Descriptions of data reduction, validation and reporting for the laboratory, operations, field activities and the classification of the data are discussed in detail in Section 9.0 of the DO# 0001 QAPP. (Note: RASI assumes the responsibilities described in the DO# 0001 document for Chemron). Data reduction, verification, and reporting procedures implemented by RASI are provided in Appendix B.

10.0 PERFORMANCE AND SYSTEM AUDITS

Performance and system audits are discussed in detail in Section 10.0 of the DO# 0001 QAPP. (References to the DO# 0001 QAPP relative to Chemron are replaced by RASI for this DO). Performance and system audits implemented by RASI are provided in Appendix B.

11.0 PREVENTIVE MAINTENANCE

Preventive maintenance techniques and procedures for field and laboratory equipment are described in detail in Section 11.0 of the DO# 0001 QAPP. (Note: RASI assumes the responsibilities described in the DO# 0001 document for Chemron). Preventative maintenance programs implemented by RASI are provided in Appendix B.

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

The routine procedures used to assess data precision, accuracy, and completeness for field and laboratory measurements are described in Section 12.0 of the DO# 0001 QAPP. The assessment methods for data precision, accuracy and completeness implemented by RASI are provided in Appendix B.

13.0 CORRECTIVE ACTION

The corrective action procedures to be used by Dames & Moore and the laboratory are described in Section 13.0 of the DO# 0001 QAPP. The nonconformance and corrective action SOP implemented by RASI is provided in Appendix A.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Progress reports will include a summary of any problems or potential problems encountered during the reporting period and actions being taken to rectify these problems. Accordingly, in order to provide comprehensive information to complete this report, periodic QA reports summarizing the project quality achieved and corrective actions taken will be prepared with input from the Dames & Moore QA Manager and laboratory QA personnel.

Draft and final reports will contain an assessment of the project compliance with the QAPP and FSP, and any limitations of the data obtained. Reconciliation of the data against the project data quality objectives and a summary of the periodic QA reports will also be included.

Additional details on QA reports are discussed in Section 14.0 of the DO# 0001 QAPP. The quality assurance reports to management programs implemented by RASI are provided in Appendix B.

REFERENCES CITED

No additional references for those listed in the DO# 0001 QAPP were used to prepare this project-specific QAPP.

TABLES

TABLE 1
SUMMARY OF ANALYTICAL PARAMETERS AND REPORTING LIMITS

Parameter	Method	Soil (mg/Kg) MDL	Soil (mg/Kg) PQL	Water (µg/L) MDL	Water (µg/L) PQL
VOC's	8260A				
Chloromethane		0.003	0.010	1.4	10
Bromomethane		0.003	0.010	1.3	10
Vinyl Chloride		0.005	0.010	1.4	10
Chloroethane		0.003	0.010	1.3	10
Methylene Chloride		0.00544	0.010	1.1	5
Acetone		0.002	0.100	4.8	100
Carbon Disulfide		0.004	0.005	1.2	5
1,1-Dichloroethene		0.004	0.005	1.3	5
1,1-Dichloroethane		0.004	0.005	1.1	5
1,2-Dichloroethene (total)		0.005	0.005	1.9	5
Chloroform		0.003	0.005	1.0	5
1,2-Dichloroethane		0.003	0.005	1.0	5
2-Butanone		0.007	0.100	4.3	100
1,1,1-Trichlorethane		0.002	0.005	1.5	5
Carbon Tetrachloride		0.002	0.005	2.1	5
Vinyl Acetate		0.002	0.050	1.0	50
Bromodichloromethane		0.002	0.005	1.0	5
1,2-Dichloropropane		0.002	0.005	1.0	5
cis-1,3-Dichloropropene		0.002	0.005	1.1	5
Trichloroethene		0.002	0.005	1.1	5
Dibromochloromethane		0.002	0.005	1.4	5
1,1,2-Trichloroethane		0.002	0.005	1.4	5
Benzene		0.002	0.005	1.0	5
trans-1,3-Dichloropropene		0.002	0.005	1.1	5
Bromoform		0.002	0.005	2.0	5
4-Methyl-2-Pentanone		0.004	0.050	5.6	50
2-Hexanone		0.006	0.050	6.5	50
Tetrachloroethene		0.002	0.005	1.4	5
Toluene		0.002	0.005	3.5	5
1,1,2,2-Tetrachloroethane		0.002	0.005	1.2	5
Chlorobenzene		0.002	0.005	1.2	5
Ethylbenzene		0.002	0.005	1.0	5
Styrene		0.002	0.005	1.0	5
m/p-Xylene		0.003	0.005	2.3	5
o-Xylene		0.002	0.005	1.3	5
TPH - GRO	Mod. 8015A	0.038	0.14	21	140
RCRA Metals	SW-846				
Arsenic	7060A	0.4	0.5	4	5
Barium	6010A	0.2	.4	2	4
Cadmium	6010A	0.2	.5	2	5
Chromium	6010A	0.3	1	6	10
Lead	7421	0.2	0.5	2	5
Mercury	7470A,-71A	0.03	0.08	0.04	0.2
Selenium	7740	0.07	0.5	0.7	5
Silver	6010A	0.4	1	5	10

(cont'd on next page)

TABLE 1 (CONT'D)
SUMMARY OF ANALYTICAL PARAMETERS AND REPORTING LIMITS

Parameter	Method	Soil (mg/Kg) MDL	Soil (mg/Kg) PQL	Water (µg/L) MDL	Water (µg/L) PQL
Ethylene Glycol	Mod. 8015		50		1000
PCB's	8081				
Aroclor 1016			0.020	0.4	1.0
Aroclor 1221			0.040		2.0
Aroclor 1232			0.020		1.0
Aroclor 1242			0.020		1.0
Aroclor 1248		0.010	0.020	0.4	1.0
Aroclor 1254			0.020		1.0
Aroclor 1260			0.020	0.4	1.0

TABLE 2
PRECISION AND ACCURACY FOR TARGET ANALYTES

Parameter	Method	Accuracy Soil	Accuracy Water	Precision Soil	Precision Water
VOC's	8260A				
1,1-Dichloroethene		75-113	75-113	40	40
Trichloroethene		81-127	81-127	40	40
Benzene		77-117	77-117	40	40
Toluene		77-126	77-126	40	40
Chlorobenzene		80-115	80-115	40	40
TPH - GRO	Mod. 8015A	50-150	50-150	50	50
RCRA Metals	SW-846				
Arsenic	7060A	80-120	80-120	20	20
Barium	6010A	80-120	80-120	20	20
Cadmium	6010A	80-120	80-120	20	20
Chromium	6010A	80-120	80-120	20	20
Lead	7421	80-120	80-120	20	20
Mercury	7470A,-71A	80-120	80-120	20	20
Selenium	7740	80-120	80-120	20	20
Silver	6010A	80-120	80-120	20	20
Ethylene Glycol	Mod. 8015	50-150	50-150	50	50
PCB's	8081				
Aroclor 1016		50-150	50-150	40	40
Aroclor 1221		50-150	50-150	40	40
Aroclor 1232		50-150	50-150	40	40
Aroclor 1242		50-150	50-150	40	40
Aroclor 1248		50-150	50-150	40	40
Aroclor 1254		50-150	50-150	40	40
Aroclor 1260		50-150	50-150	40	40

FIGURE 1

PROJECT ORGANIZATION CHART

Richards - Gebaur Air Force Base **Delivery Order No. 3**

Organizational Chart

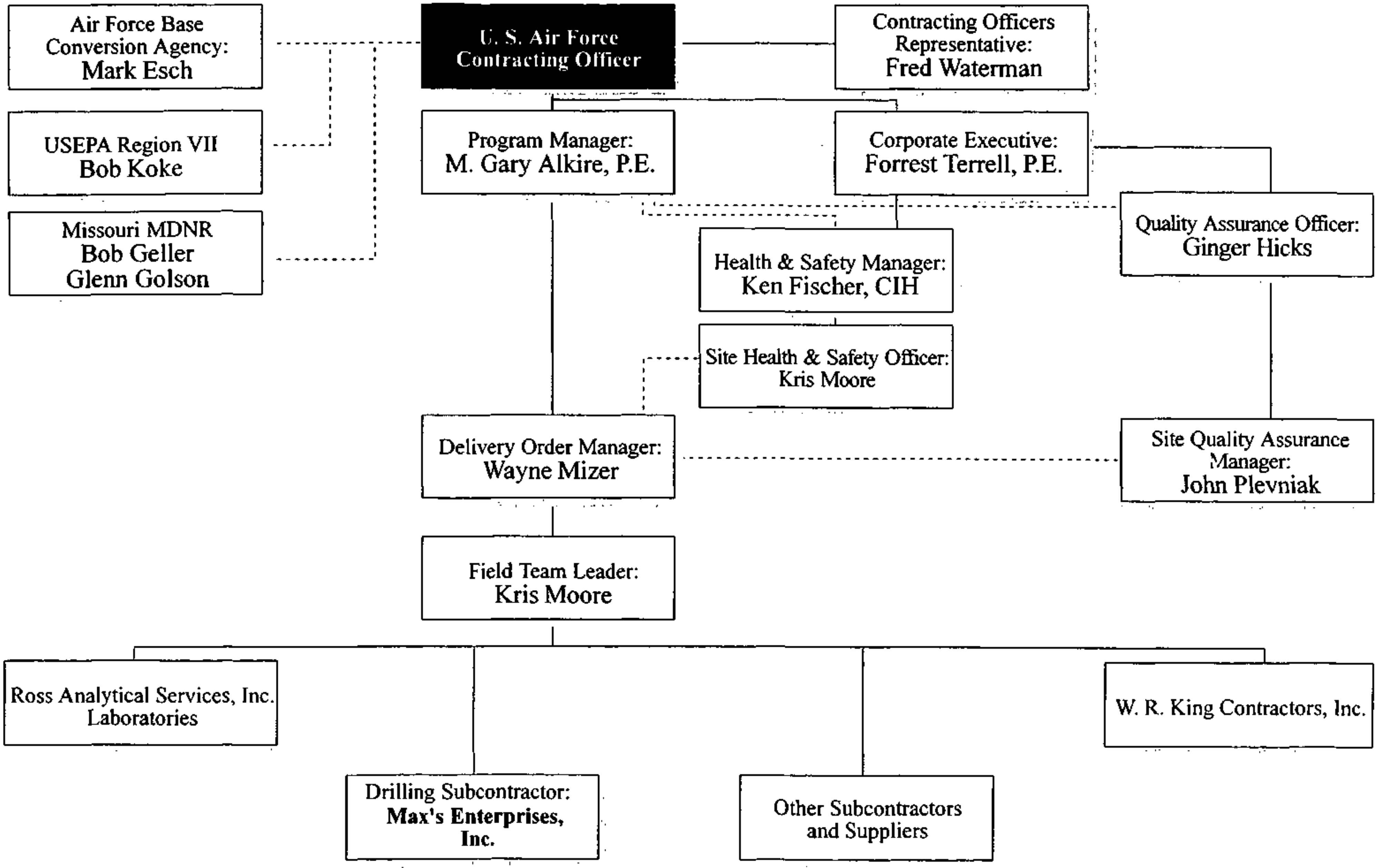
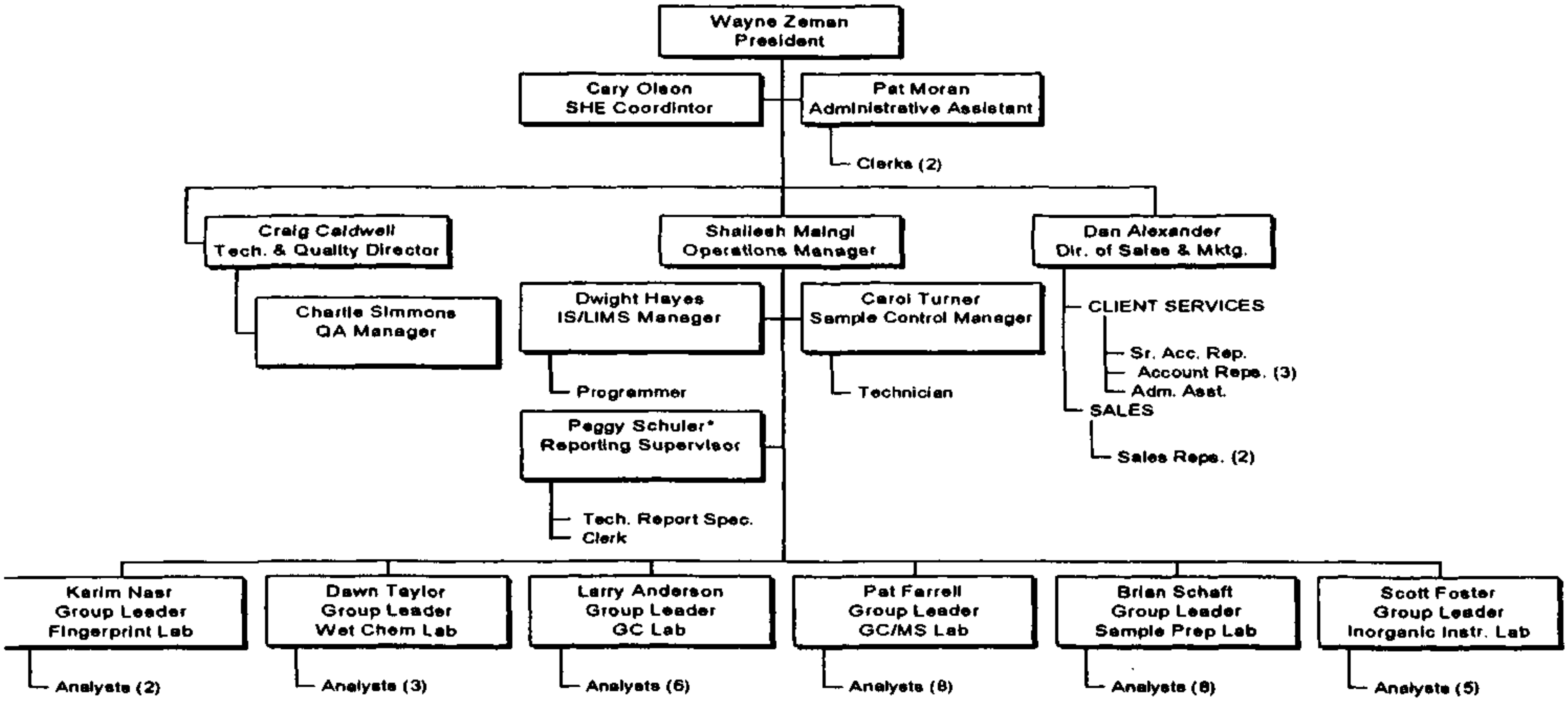


FIGURE 2

ROSS ANALYTICAL SERVICES, INC. ORGANIZATION CHART

Ross Analytical Services, Inc.

August 1, 1995



Total Number of Employees: 61

APPENDIX A

ROSS ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURES

SITE SPECIFIC STANDARD OPERATING PROCEDURES
FOR
ROSS ANALYTICAL SERVICES, INC.

SOP No.	Title
AD-008-02	Laboratory Waste Disposal
GX-007-00	Analysis of Total Petroleum Hydrocarbons by GC/FID
IP-003-01	Digestion Procedure for Metals in Aqueous Samples Using SW-846, Methods 3010A, 3020A
MT-001-02	Determination of Metals Using the Thermo Jarrell Ash Enviro 36 ICP by EPA SW-848 Method 6010A
MT-005-00	Metals Standards Documentation
MV-001-01	Determination of Volatile Organic Compounds by GC/MS by Methods 8240B and 8260A
MV-003-00	Preventative Maintenance in the Gas Chromatography/Mass Spectrometry Lab
QC-001-02	Nonconformances and Corrective Action
QC-006-02	GC/MS Data Review and Verification
QC-008-01	GC Data Validation
QC-010-02	Determining Method Detection Limits (MDLs), Estimated Quantitation Limits (EQLs), and Instrument Detection Limits (IDLs)
QC-012-00	Internal Quality Assurance Audit
SC-001-02	Chain-of-Custody and Sample Security
SC-002-00	Sample Receipt, Log-in and Storage for Non-CLP Samples
SC-003-02	Sample Control Refrigerator Temperature Monitoring

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Ross Analytical Services, Inc.

STANDARD OPERATING PROCEDURE

SOP No.: AD-008-02
Initial Date: 2/1/91
Page 1 of 5
Date Revised: 9/02/93

Title: Laboratory Waste Disposal

Prepared by: CSO Approved by: Date: 9/21/93 QC Approval:

1.0 PURPOSE

To provide a safe, environmentally sound approach for handling, treatment and disposal of common laboratory waste at Ross Analytical Services, Inc. (RAS).

2.0 SCOPE AND APPLICATION

Laboratory waste can be categorized into four groups:

1. Paper, cardboard, plastic and other non-hazardous, non-toxic materials. This material consists primarily of used packaging material and general office waste.

2. Empty reagent and sample bottles.

3. Expired reagents and standard solutions.

4. Analyzed raw samples, sample residues, sample extracts, and sample digestates.

This SOP deals only with waste from these four sources; for other types of waste, contact the Laboratory Waste Coordinator for guidance. Some laboratory waste is hazardous and requires special handling and disposal. The amount of hazardous waste generated by RAS is less than 1000 kg per month. RAS is considered a small quantity generator and is exempt from some of the U.S. and Ohio EPA Regulations impacting hazardous waste generators.

This SOP has been prepared to provide direction for RAS employees for the disposal of all laboratory wastes in a safe and environmentally sound manner.

3.0 REFERENCES

DOT Hazardous Material Regulation, 49 CFR.
RCRA Hazard Characterization and Manifest, 40 CFR.
TSCA PCB Characterization and Manifest, 40 CFR Part 761.
Northeast Ohio Regional Sewer District

4.0 RESPONSIBILITY FOR PROPER WASTE DISPOSAL

4.1 Corporate Commitment

RAS is committed to the disposal of all waste in an environmentally safe manner. In general, non-hazardous waste is placed in a dumpster and removed by a contracted waste removal service. This waste is transported to a sanitary landfill for disposal. Special care is taken at RAS to insure that only non-hazardous waste is disposed of in this manner. Aqueous inorganic waste is neutralized, analyzed, and discharged in accordance with local POTW requirements. Hazardous waste is incinerated whenever possible. When incineration is not possible, hazardous wastes will be treated or landfilled at an EPA approved site.

4.2 Management Responsibilty

A Laboratory Waste Coordinator has been appointed at RAS. This individual should be consulted whenever questions pertaining to laboratory waste disposal arise, whether or not covered by this document.

4.3 Staff Responsibility

All laboratory employees are responsible for the disposal of laboratory wastes in accordance with the guidelines contained within this document.

5.0 PROCEDURE

5.1 Paper, Cardboard, Plastics (Trash)

Within each laboratory and office area, plastic trash containers have been placed for the disposal of non-hazardous non-contact wastes. These containers are emptied by the maintenance staff into the trash dumpster (blue). Cardboard is segregated into a separate dumpster (green) for off-site recycling. To conserve room in the dumpster, all empty cardboard boxes must be broken down and flattened prior to placement into the dumpster. To avoid accidental cuts, DO NOT place broken glass into these trash containers; instead use the metal containers which are designated for broken glass. The glass in these special containers will be crushed as described in section 5.2.2. Trained personnel will dispose of broken glass.

5.2 Empty Reagent and Solvent Bottles

5.2.1 Containers from Acutely Toxic, Carcinogenic and Special Hazard Materials

Certain empty containers, due to their original contents, require special care prior to being determined "empty". If an acutely toxic, carcinogenic or special hazard reagent or solvent is purchased for use at RAS, the container will be flagged for ready identification. When the container is empty, the Laboratory Waste Coordinator must be contacted to determine proper rinsing technique and to determine the destination of rinsate.

5.2.2 Glass Containers

Empty reagent and solvent bottles should be rinsed and the water placed down the drain with the approval of the Laboratory Waste Coordinator. Rinsed bottles are collected in the warehouse pending inspection and crushing. A trained laboratory employee will operate a mechanical glass crushing machine and transfer the broken glass into the dumpster.

5.2.3 Plastic Containers

Plastic containers that previously held chemical reagents can be rinsed when empty and the water placed down the drain with the approval of the Laboratory Waste Coordinator. Rinsed containers are collected in the warehouse pending inspection and shredding. A trained laboratory employee will operate a mechanical shredding machine and transfer the shredded plastic into the dumpster.

5.3 Expired Reagents and Standard Solutions

These laboratory wastes can be broken into two general classes, organic and inorganic.

5.3.1 Organic Reagents and Standard Solutions

Organic reagents and standard solutions should be segregated based on their disposal category or by their Waste Product Survey (WPS) form. These wastes must be collected in compatible containers prior to disposal. A description, hazardous waste label (if appropriate) and accumulation start date must be marked onto the container. The Laboratory Waste Coordinator must be contacted to obtain storage guidance and to arrange off-site removal. Organic laboratory wastes are incinerated whenever possible.

5.3.2 Inorganic Reagent Solutions

Inorganic reagent solutions include acidic, basic, and neutral aqueous reagents and standards. These materials should be segregated based on their disposal category or by their WPS form. These wastes must be collected in compatible containers prior to disposal. A description, hazardous waste label (if appropriate) and accumulation start date must be marked onto the container. The Laboratory Waste Coordinator must be contacted to verify neutralization and analytical efforts prior to discharge to the POTW, or to obtain storage guidance and to make arrangements for off-site removal. Inorganic lasboratory wastes that are not suitable for discharge are incinerated whenever possible. If neither discharge nor incineration is a viable disposal option, chemical treatment queries will be made.

5.4 Analyzed Samples, Sample Residues, Sample Extracts and Sample Digestates.

5.4.1 Aqueous Analyzed Samples and Digestates

Aqueous analyzed samples whose retention time has expired, according to RAS Terms and Conditions, are returned to the client if possible with adherance to EPA and DOT regulations. Remaining samples, metals digestates (e.g. prepared metals fractions), distillates such as those from cyanide analysis, and TCLP leachates should be segregated based on their disposal category or by their WPS form. Storage and Disposal is as described in section 5.3.2.

5.4.2 Non-aqueous Analytical Samples

Non-aqueous samples whose retention time has expired, according to RAS Terms and Conditions, are returned to the client if possible. Remaining samples should be segregated based on their disposal category or by their WPS form. Storage and Disposal is as described in section 5.3.1. (NOTE: RAS MAY, ON A CASE-BY-CASE BASIS, ACCEPT ACUTELY TOXIC AND ASBESTOS SAMPLES FOR ANALYSIS. THESE SAMPLES MUST BE RETURNED TO THE CLIENT.)

5.4.3 Sample Extracts

Organic sample extracts whose retention time has expired, should be segregated and packaged for disposal based on their disposal category and WPS form. Storage and disposal is described in section 5.3.1.

5.4.4 Sample Residues

Sample residues must be characterized to identify hazardous contaminants. The Laboratory Waste Coordinator must be contacted to determine the disposal category or WPS form. The residues must be collected in compatible containers prior to disposal. A description, hazardous waste label (if appropriate) and accumulation start date must be marked on the container. The Laboratory Waste Coordinator will provide storage guidance and make off-site removal arrangements. Sample residues will be incinerated whenever possible.

5.4.5 Contact Non-Hazardous Waste

Due to the "contact" nature of some non-hazardous trash during the analytical process (that is, contact with chemical contaminants) contact non-hazardous waste will be incinerated whenever possible. RAS wishes to eliminate any potential harm that these types of waste could cause. Examples include used gloves, wipes, filters, etc. Contact non-hazardous wastes will be collected in compatible containers prior to disposal. A description, non-hazardous label and accumulation start date must be marked on the container. The Laboratory Waste Coordinator will provide storage guidance and make off-site removal arrangments.

6.0 STORAGE OF MATERIALS PENDING OFF-SITE REMOVAL

6.1 The Laboratory Waste Coordinator will be advised of all waste for off-site removal. This material will be placed into a compatible container that is in good condition. Temporary storage will be established in a location which meets the storage needs for the identified hazard class. Flammable waste will be stored in a flammable cabinet.

6.2 Weekly inspections of the storage area(s) will be conducted by the Laboratory Waste Coordinator. Inspections will include such items as container condition, hazard segregation, container markings, and secondary containment for PCB wastes.

6.3 Weekly inspections of emergency equipment will be conducted by the Laboratory Waste Coordinator. Inspections will include such items as fire protection equipment, spill response equipment and communication systems.

6.4 The Laboratory Waste Coordinator will be responsible for maintaining inventory and arranging off-site removal in accordance with applicable Federal and State requirements. A small quantity generator can accumulate up to 1000 kg of hazardous waste each month provided removal occurs within 180 days (total quantities not to exceed 6000 kg). PCB waste must be removed within 270 days.

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Ross Analytical Services, Inc.
STANDARD OPERATING PROCEDURE

SOP No.: GX-007-00
Initial Date: 8/17/94
Page 1 of 7
Date Revised:

Title: Analysis of Total Petroleum Hydrocarbons by GC/FID			
Prepared by:	Approved by: L. Anderson Philip J Dufresne	Date: 9/13/94	QA Approval:

1.0 PURPOSE

The purpose of this procedure is to describe the analysis of Total Petroleum Hydrocarbons (TPHs) by Gas Chromatography using a Flame Ionization detector (FID).

2.0 APPLICATION

This procedure utilizes information from the Leaking Underground Fuel Tank Field Manual (LUFT). It describes the elements necessary to comply with this method for the quantitative analysis of TPHs. This procedure applies to soil, water, and waste matrices. Table 1 lists the targets and their corresponding EQLs/RLs. Discussion of interferences is found in section 9.0.

3.0 REFERENCES

Leaking Underground Fuel Tank Field Manual: Guidelines for Site Assessment, Cleanup, and Underground Storage Tank Closure, December, 1987, October, 1989. State of California, Leaking Underground Fuel Tank Task Force.

Varian Manual - Publication Number 03-914086-00 ,July, 1986, for Flame Ionization Detectors.

4.0 ASSOCIATED SOPs

OP-021 - Extraction of Water Samples for Petroleum Hydrocarbons, Analysis by Gas Chromatography.

5.0 EQUIPMENT

5.1 Gas Chromatograph - Varian 3400 suitable for direct injections with a Flame Ionization Detector.

5.2 Autosampler - Leap Technologies autosampler capable of being programmed to inject a sequence of samples using a 10uL syringe.

5.3 Gas Chromatographic Column - rt.-5, 0.32mm ID.

5.4 Data System - currently using "Chromperfect," capable of collecting data points to measure peak areas and calculate results. Also includes Perkin-Elmer data boxes which collect data during the run and then transfer that information to the system upon completion of a run.

5.5 Syringes of various volumes.

5.6 Autosampler Vials - 2mL.

5.7 Autosampler Syringe Rinse Bottles for rinsing syringes after an injection.

5.8 10mL volumetric flasks.

6.0 STANDARDS AND SOLUTIONS

6.1 Stock Standards

A diesel standard is purchased from a local vendor and diluted down to the desired concentration. The stock should be between 15,000ug/mL and 20,000ug/mL. To make the stock standard, place 9mLs of methylene chloride into a 10mL glass-stoppered volumetric flask. Allow the flask to stand for a few minutes. Weigh the flask to the nearest 0.0001g. Using a 100uL syringe, immediately add an amount of diesel to the flask and then re-weigh. Add between 0.1500g and 0.2000g. Be sure that the liquid falls directly into the methylene chloride without contacting the neck of the flask. Dilute to volume, stopper, and mix by inverting the flask several times. Calculate the concentration in ug/mL from the net gain in weight. Working calibration standards are then prepared from the stock standards. The purchased diesel and the diesel stock should both be kept in a freezer between -10°C and -18°C and protected from the light. They must be replaced after one year or earlier if there is any indication that the concentrations have changed. All standards must be logged into the standards logbook and given an identification according to the GC system. When these standards are verified, the verifying chromatograms and other information must be placed into the standards logbook behind the logbook page containing the serial dilutions and calculations.

6.2 Calibration Standards

Five levels of working calibration standards are made using the stock standard. They are prepared by adding the following amounts to methylene chloride:

A. 0.10mL of stock
B. 0.50mL of stock
C. 1.00mL of stock
D. 1.50mL of stock
E. 2.00mL of stock

These are all made up to a 10mL final volume. The lowest level is near, but above the method detection limit. The highest level corresponds to the expected upper range of the concentrations in the samples and/or the working range of the detectors. Calibration standards must be replaced after six months or sooner if comparison with a check standard indicates a problem.

6.3 Surrogates

No surrogates are required by the LUFT method.

6.4 Laboratory Control Spikes (LCSs), Matrix Spikes (MSs), and Matrix Spike Duplicates (MSDs).

The diesel standard purchased from a local vendor is diluted down in methylene chloride to make a spike at a concentration of approximately 3,500ug/mL. The organic preparatory lab adds 0.5mL of this spike to a blank to make the LCS. MS and MSDs are made by adding 0.5mL of the spike to each of two sample duplicates. An LCS is extracted with every batch of samples or every twenty samples, whichever is more frequent. MS/MSDs are spiked for every twenty samples and or when specifically requested by the client.

7.0 PROCEDURE

7.1 GC Operating Conditions

Samples are analyzed using a Varian 3400 GC under the following conditions:

7.1.1

Detector: Flame Ionization.
Detector Range: 12.
Column: 30M x 0.32mm ID, 1um df Rt.-5 capillary column.
Injector Temperature: 260°C.
Detector Temperature: 310°C.

7.1.2

Approximate Gas Flows:
Carrier Gas (Helium): 5.1mLs/minute.
Make-up Gas (Helium): 20mLs/minute.
Air: 300mLs. minute.
Hydrogen: 30mLs/minute.

7.1.3

Temperature Program: Initial temperature 100°C, hold for 2.0 minutes.
Ramp 1: 10°C/minute to 270°C, hold for 2.0 minutes.
Ramp 2: 5.0°C/minute to 300°C, hold for 9.0 minutes for a total run time of 36.00 minutes.

The current temperature program should be kept on file in the Analytical Conditions logbook. With any modification of the temperature program, this SOP must be updated accordingly.

7.2 Calibration

7.2.1 Initial Calibration

The LUFT method calls for at least three points in a calibration curve. As stated in section 6.2, the laboratory is currently utilizing a five-point calibration. The working standards are run and response factors (RFs) are generated by dividing peak areas by concentrations in ug/mL. This calculation is done for each level A through E and the average RF is calculated. The %Relative Standard Deviation (RSD) is also calculated using the following formula:

$$\%RSD = \frac{\text{Standard deviation}}{\text{average RF}} \quad x \quad 100$$

If the %RSD is less than 20% over the working range, linearity through the origin can be assumed. An example of a standards calculations sheet follows this SOP as Figure I. Areas are obtained by programming the computer to take a cut across the chromatogram from one specified retention time to another. This is done to ensure a uniform calculation each time and to allow all the peaks seen in the diesel to be part of the calculation instead of choosing a limited number of individual peaks.

7.2.2 Working Calibration Curve Verification

The working calibration curve must be verified on each working day by the measurement of one or more calibration standards. This calibration standard is called the "continuing check" and usually the mid-level standard is used. The LUFT method states that if the response for the continuing check varies from the predicted response by more than + or - 10%, then the test must be repeated using a fresh calibration standard. This + or - 10% is based on a three-point calibration. For the five-point calibration being utilized. + or - 15% defines the limits for passage of the continuing check. The calculation for the verification of the continuing check is as follows:

$$\text{\% Difference (\%D)} = \frac{\text{initial cal RF (mid std) - cont. check RF}}{\text{initial cal RF (mid std)}} \times 100$$

If the %D falls outside of the + or - 15% range, then a new continuing check must be run. If this continuing check is also outside the limits, then a new calibration curve must be run and the samples rerun. Before running a new curve, however, the analyst should establish that the system has not been contaminated from samples by running methylene chloride solvent blanks through the instrument. If it is determined that the system is contaminated, then maintenance may include changing the inserts and/or clipping the column.

7.2.3 Retention Time Windows

There are no retention time windows for Total Petroleum Hydrocarbons. This analysis is based instead on pattern recognition and comparison to diesel. As stated in section 5.2.1 , a cut is taken to calculate the diesel. If a shift is seen in the daily continuing check, then the cut times may need to be updated in order to be more accurate.

7.3 Analysis

Before running any samples, the analyst must demonstrate that the system is interference free by running a solvent blank. After it is determined that the system is clean and the continuing checks match the calibration curve, then blanks, LCSs, samples, MSs, and MSDs are run in that order. If the responses (areas) of a sample exceeds the linear range of the calibration curve, meaning the area exceeds the area of the highest standard, dilute and reanalyze the sample. Continuing calibration checks must be analyzed after every ten runs on the instrument and at the end of the analytical sequence. If continuing checks which run later in the sequence are out of control, that is greater than + or - 15% difference, then the samples must be rerun following a continuing check which is within the passing limits.

7.4 Data Interpretation and Calculations

Normally all samples are calculated as diesel, whether or not their pattern exactly matches diesel . If the pattern does not match diesel, the analyst should note this on the data reporting sheet. Occasionally the client will send a bulk sample of something other than diesel, and/or request that a comparison be done with something other than diesel. In this case, a curve would be run with the other target (such as motor oil) and samples would be worked up against this. In normal cases, however, the concentration of diesel found in the samples is determined by taking the computer-generated area from the cut and dividing it by the mean RF from the calibration curve. This value is then multiplied by the final volume of the extract and divided by the weight in grams or the volume in mLs that was extracted. The calculation is as follows:

$$\text{Concentration} = \frac{\text{Area}}{\text{RF}} \times \frac{\text{Final Volume (mLs)}}{\text{grams or mLs extracted}} = \text{ug/g or ug/mL}$$

The concentration is then recorded on the client data sheet in ug/mL or mg/Kg (which equals ug/g).

8.0 QUALITY CONTROL

Prior to performing this analysis, a one-time analyst proficiency study must take place for each of the individuals who will be performing the analysis. It is the responsibility of the supervisor to read the SOP describing how to perform an analyst proficiency study and to notify the Manager of Quality Assurance to promptly schedule up this study.

Sample extracts from the organic preparatory lab have a hold time of forty days and must by run within that period. Water samples have a hold time of seven days from the date of collection, and soils have a hold time of fourteen days. It is essential that the analyst try to analyze the extracts as soon as they are extracted so that if any deficiencies are identified such as failed blanks due to contamination or low LCS, MS, or MSD recoveries, there is enough time to re-extract before the samples expire.

As stated in Section 7.4, blanks, LCSs, duplicates, and spikes must be analyzed at a minimum of once for every batch or each type of matrix or every twenty samples, whichever is more frequent.

9.0 INTERFERENCES

Extracts from the organic preparatory lab often have a very dark brown color. The analyst should run these extracts at a dilution to prevent contamination of the inserts. If they are found to be free of diesel, then they need to be rerun straight or at a lower dilution. Problems which might arise from this analysis may be due to the condition of the samples themselves. The samples tend to be very "dirty" which can cause deterioration of the inserts. If problems should arise after running samples, then the inserts may need to be cleaned.

10.0 TROUBLESHOOTING

Below are some common problems associated with this analysis and some suggestions for their correction. Analysts should add to this list on a regular basis to develop a more complete troubleshooting guide. Handwritten additions should be placed behind the SOPs in the GC SOP binder.

PROBLEM : CORRECTIVE ACTION

1. Retention times shifting so that the cut taken by the computer is not accurate: Leak detect above the injector to make sure there are no septa leaks. If there are leaks, change the septa. Record this and any other maintenance in the preventive maintenance logbook for this instrument. For further corrective action see #2 below.

2. Decrease or variations in response of peaks: See #1 above. Inserts could be coated with contaminants that are interfering with the responses. Check the inserts for particles, and replace if contaminated. The Flame Ionization detector may also be clogged causing the reduction in response. It is recommended that the analyst read the Varian manual which describes how to dismantle the detector in order to clean it.

TABLE 1. Diesel and its EQL/RL.

Compound	Waters EQL/RL (ug/mL)	Soils EQL/RL (mg/Kg)
Diesel	0.2	6.1

FIGURE I. This figure shows an example of a calibration curve for diesel with the standard concentration levels, area, Response Factors (RFs = area divided by concentration), average RF, and %RSD.

FIGURE I.

STANDARDS CALCULATIONS

Client Engineering Science	**Date** 7-11-94
W.O. # 94-07-032	**Analyst** PJD
Analysis PHCHI - Diesel	**Checker**

Response Factor: $RF = \dfrac{\text{area(standard)}}{\text{std conc. (ug/ml)}}$

% Relative Standard Deviation: $\%RSD = \dfrac{\text{standard deviation (s)}}{\text{average RF}} \times 100$

COMPOUND	Ret Time	std conc.	AREA	RF	AVG. RF	%RSD
Diesel Std 562A	3.5→20 minutes	183 ug/ml	1128,218	6165	7958	18%
B		913	6,317,124	6919		
C		1826	14,812,240	8112		
D		2739	25,277,030	9229		
E		3652	34,200,980	9365		

NOTES

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Ross Analytical Services, Inc.

STANDARD OPERATING PROCEDURE

SOP No.: IP-003-01
Initial Date: 2/1/91
Page 1 of 5
Date Revised: 1/24/95

Title: Digestion Procedure for Metals in Aqueous Samples Using SW-846, Methods 3010A, 3020A

Prepared by: BES/SLS Approved by: CHC Date: 1/25/95 QA Approval:

1.0 PURPOSE

This procedure describes the preparation of aqueous samples for metals analysis by SW-846, Methods 3010A, 3020A.

2.0 APPLICATION

This procedure is applicable to water, wastewater and leachate samples for analysis by inductively coupled plasma (ICP), Method 6010A for the elements listed below:

Al, Sb, As, Ba, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, K, Se, Ag, Na, Tl, V, Zn

This procedure is also applicable for analysis by graphite furnace atomic absorption (GFAA) by 7000 Series Methods elements listed below:

Be, Cd, Cr, Co, Pb, Mo, Tl, V

Possible interferences are discussed in Section 8.0.

3.0 REFERENCES

EPA SW-846, 3rd Edition, Methods 3010A and 3020A

4.0 ASSOCIATED SOPs

IP-012, Wastewater Disposal for the Inorganic Preparation Laboratory

IP-013, Acid Bath Preparation

5.0 REAGENTS/EQUIPMENT

5.1 Reagents

5.1.1 High purity reagent water (HPRW)

5.1.2 Concentrated nitric acid, Mallinkrodt AR Select or equivalent

5.1.3 Concentrated hydrochloric acid, Mallinkrodt AR Select or equivalent

5.1.4 1:1 HCl - add desired volume of concentrated HCl to an equal volume of HPRW and mix

5.1.5 Solutions Plus QC 31 Spike for ICP (see Section 10.0, Table 1)

5.1.6 Solutions Plus QC 31 Dilution Spike for GFAA prepared by the MT lab. The dilution spike is a 1:20 dilution of the Solutions Plus QC 31 Spike.

5.1.7 Solutions Plus TCLP Spike (see Section 10.0, Table 2)

5.2 Equipment

5.2.1 1000 uL Rainin Pipetman

5.2.2 250 mL Beakers, acid washed

5.2.3 Watch glasses, acid washed

5.2.4 Electric hot plate with temperature control

5.2.5 Qualitative filter paper

6.0 PROCEDURE

6.1 Measure a 50 mL aliquot of the well-mixed sample (or an aliquot diluted to 50 mL with HPRW) into a labeled beaker. Record the aliquot used.

NOTE: Use 10 mL for all TCLP leachates and scrubber waters.

6.2 For each batch of 20 or fewer samples, measure out two 50 mL portions of HPRW into labeled beakers for a LCS and a blank.

6.3 Spike samples in beakers selected for a LCS and MS/MSD pairs with standard solutions. The ICP MS/MSD pair is spiked with 500 uL of the Solutions Plus QC 31 standard. The GFAA MS/MSD pair is spiked with 500 uL of the QC 31 Dilution Spike. Prepare a LCS using 500 uL of the same spike standard used for the MS/MSD pairs for ICP or GFAA, depending on which analysis is required. TCLP MS/MSD pairs are spiked with 500 uL of Solutions Plus TCLP Spike.

6.4 Add 1.5 mL of concentrated nitric acid.

6.5 Place beaker on the hot plate and evaporate to between 5 and 10 mL, making certain that the sample does not boil and that no portion of the bottom of the beaker is allowed to go dry. If sample does go to dryness, discard and re-prepare.

6.6 Cool beaker, add 1.5 mL of concentrated nitric acid, cover with a watch glass, and return to the hot plate.

6.7 Allow to reflux gently, adding additional acid if necessary, until the solution is light in color or has no further changes in appearance. Remove from hot plate and allow to cool.

6.8 If the sample is being prepared for GFAA analysis, add an additional 5 mL HPRW and return to the hot plate. If it is for ICP analysis, add 5 mL of 1:1 HCl and return to hot plate.

6.9 Heat for an additional 10 to 15 minutes to help dissolve any precipitate.

6.10 Remove from hot plate and cool.

6.11 Rinse watch glass into beaker and transfer sample to a 50 mL volumetric flask with at least 3 rinses. Filter if necessary.

6.12 Dilute sample to final volume then transfer to a polypropylene screw-cap tube for analysis. Use a blue capped tube for ICP samples and a red capped tube for GFAA samples.

7.0 QUALITY CONTROL

7.1 Prepare one preparation blank using 50 mL of HPRW per batch. Each batch must be no greater than 20 samples, excluding MS/MSD pairs.

7.2 Prepare one LCS using 50 mL of HPRW and spiking with 500 uL of ICP or GFAA spike depending upon the analysis requested.

7.3 Digest an MS/MSD pair per batch.

7.4 Holding time for aqueous samples preserved with nitric acid is 6 months.

8.0 INTERFERENCES

Carryover from previous samples and residual soap on glassware can cause contamination. All glassware must be washed with soap and water, tap water rinsed, soaked in a 1:1 nitric acid:water for 8 to 12 hours then rinsed several times with deionized water. Final rinse should be with HPRW.

9.0 TROUBLESHOOTING

Read work orders thoroughly to ensure that no MS/MSD pairs nor special metals requests are missed.

10.0 TABLE(S)

Table 1
Solutions Plus QC 31 Spiking Solution

Element	Concentration	
Aluminum	2500	mg/L
Antimony	100	mg/L
Arsenic	100	mg/L
Barium	100	mg/L
Beryllium	100	mg/L
Bismuth	100	mg/L
Boron	100	mg/L
Cadmium	100	mg/L
Calcium	2500	mg/L
Chromium	100	mg/L
Cobalt	100	mg/L
Copper	100	mg/L
Iron	2000	mg/L
Lead	100	mg/L
Lithium	100	mg/L
Magnesium	2000	mg/L
Manganese	100	mg/L
Molybdenum	100	mg/L
Nickel	100	mg/L
Potassium	2000	mg/L
Selenium	100	mg/L
Silicon	100	mg/L
Silver	100	mg/L
Sodium	2500	mg/L
Strontium	100	mg/L
Thallium	100	mg/L
Tin	100	mg/L
Titanium	100	mg/L
Vanadium	100	mg/L
Zinc	100	mg/L
Zirconium	100	mg/L

Table 2
Solutions Plus TCLP Spike

Element	Concentration	
Arsenic	500	mg/L
Barium	2500	mg/L
Cadmium	100	mg/L
Chromium	500	mg/L
Lead	500	mg/L
Selenium	100	mg/L
Silver	500	mg/L

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Ross Analytical Services, Inc.

STANDARD OPERATING PROCEDURE

SOP No.: MT-001-02
Initial Date: 2/1/91
Page 1 of 21
Date Revised: 4/19/95

Title: Determination of Metals Using the Thermo Jarrell Ash Enviro 36 ICP by EPA SW-846 Method 6010A

Prepared by: Approved by: Date: 4/26/95 QA Approval:

1.0 PURPOSE

The purpose of this SOP is to describe the determination of metals that have been appropriately prepared, using the Thermo Jarrell Ash Enviro 36 ICP.

2.0 SCOPE AND APPLICATION

This SOP applies to ICP emission analyses performed using the Thermo Jarrell Ash Enviro 36. The method described includes calibration and quality control criteria defined by EPA SW-846 Method 6010A.

The method may be used for all matrices, including ground water, aqueous samples, mobility extracts, industrial and organic wastes, soils, sludges, sediments, biologic substances and other solid or semisolid wastes.

These matrices require digestion prior to analysis. The digestion procedures (e.g., SW-846, Methods 3005 - 3050) are not provided by this document but may be found in other SOPs. When analyzing for dissolved constituents, acid digestion is not necessary if the samples are filtered and acid preserved prior to analysis.

The elements for which this method may be employed and their respective reporting limits for clean aqueous samples using pneumatic nebulization are provided in Section 12.0, Table 1. The reporting limits, called Estimated Quantitation Limits (EQLs), are established by RASI. These have been experimentally verified with the system in use.

The TJA Enviro 36 performs simultaneous detection of elements. The method measures element-emitted light by optical spectrometry. Samples and standards are nebulized and the aerosol transported to the plasma torch. Element-specific atomic-line emission spectra are produced by a radio frequency (RF) generated, inductively coupled plasma. The torch is radially mounted (in a vertical position). The spectra are dispersed by a grating spectrometer, and intensities of the lines are monitored by photomultiplier tubes. Intensities are calibrated using known concentrations and used to quantify sample results.

Note: This SOP combines the former SOP's MT-001-01 (Calibration and Operation of the Thermo Jarrell Ash Enviro 36) and MT-002-00 (Quality Control Procedures for the Thermo Jarrell Ash Enviro 36 Using Method 6010A).

3.0 REFERENCES

ICAP 61E Spectrometer Operators Manual. Thermo Jarrell Ash Corporation, Franklin, MA, Feb. 1991

EPA Test Methods for Evaluating Solid Waste, SW-846 Method 6010A, Rev. 1, July, 1992

4.0 ASSOCIATED SOPs

MT-002, Analysis of Metals Using the Thermo Jarrell Ash Enviro 36 ICP by EPA Method 200.7

IP-003, Digestion Procedure for Metals in Aqueous Samples Using SW-846, Methods 3010A, 3020A

IP-004, Digestion Procedure for Metals in Solids and Non-Aqueous Wastes Using SW-846, Method 3050A

5.0 EQUIPMENT

5.1 Apparatus

5.1.1 Thermo Jarrell Ash Enviro 36 ICAP, with host computer (minimum 386), printer, coolant recirculating pump, autosampler, peristaltic pump and ancillary gas connections

5.1.2 Class A volumetric flasks - 100, 200, 500, 1000 and 2000 mL

5.1.3 Class A volumetric pipets - 1, 2, 5, 10 and 20 mL

5.1.3 Auto pipettors and pipet tips, 1 - 10 mL and 1 - 1000 uL

5.1.4 Ventilation hood with minimum flow of 100 cfm

5.1.5 Peristaltic pump tubing (0.045 mm diameter - red/red)

5.1.6 Autosampler standard cups and sample test tubes

5.1.7 Polyethylene storage bottles

5.2 Reagents

5.2.1 ASTM Type 1 water otherwise known as high purity reagent water

5.2.2 Argon, gaseous bleed from liquid source (minimum 70 psi)

5.2.3 Nitric acid, concentrated

5.2.4 Hydrochloric acid, concentrated

5.2.5 Nitric acid, (1:1) - Add 500 mL concentrated acid to 400 mL water and dilute to 1 liter

5.2.6 Hydrochloric acid, (1:1) - Add 500 mL concentrated acid to 400 mL water and dilute to 1 liter

5.3 Standards

5.3.1 Calibration Blank Standard - 2% HNO_3 / 5% HCl

To a 2 liter flask add approximately 1 liter of reagent water. Then, add 40 mL concentrated HNO_3 and 100 mL concentrated HCl. Bring to volume with reagent water and mix well. Store in a polyethylene bottle.

5.3.2 Calibration Standard (STD95) - mixed element standard in 2% HNO_3 / 5% HCl

To a 500 mL flask add approximately 300 mL reagent water. Then, add 10 mL concentrated HNO_3 and 25 mL concentrated HCl. Then add 5 mL each of Plasmachem XRAS1, XRAS2 and XRAS3. Bring to volume with reagent water and mix well. Store in a polyethylene bottle. Light reduces the stability of several elements in solution. It is preferable to store the solution in the dark when not in use.

The Plasmachem XRAS standards are custom mixes. When prepared as described, the standard will contain the following elements and respective concentrations:

CALIBRATION STD95

ELEMENT	CONCENTRATION (mg/L)
Aluminum	50
Antimony	5.0
Arsenic	10
Barium	1.0
Beryllium	0.5
Boron	2.5
Cadmium	1.0
Calcium	50
Chromium	2.5
Cobalt	2.5
Copper	2.5
Iron	50
Lead	5.0
Lithium	2.5
Magnesium	50
Manganese	1.0
Molybdenum	2.5
Nickel	2.5
Potassium	50
Selenium	10
Silicon	10
Strontium	1.0
Silver	0.5
Sodium	50
Thallium	5.0
Tin	10
Titanium	2.5
Vanadium	1.0
Zinc	1.0
Zirconium	10

5.3.3 Initial Calibration Verification Standard (ICV95) - mixed element standard in 2% HNO_3 / 5% HCl

To a 500 mL flask add approximately 300 mL reagent water. Then, add 10 mL concentrated HNO_3 and 25 mL concentrated HCl. Then add 5 mL each of Exaxol, PE Pure, Plasmachem, Solutions Plus or equivalent QC-19A, QC-19B and QC-19C. Bring to volume with reagent water and mix well. Store in a polyethylene bottle. Light reduces the stability of several elements in solution. It is preferable to store the solution in the dark when not in use.

The Exaxol, PE Pure, Plasmachem, Solutions Plus or equivalent standards are custom mixes. The source for the ICV must be different than that used for the calibration. The same vendor may be used as long as the source is different. Note that different lot numbers for solutions may still be from the same source. When prepared as described, the standard will contain the following elements and respective concentrations:

INITIAL CALIBRATION VERIFICATION STANDARD - ICV95

ELEMENT	CONCENTRATION (mg/L)
Aluminum	10
Antimony	5.0
Arsenic	5.0
Barium	0.5
Beryllium	0.5
Boron	1.0
Cadmium	0.5
Calcium	10
Chromium	1.0
Cobalt	1.0
Copper	1.0
Iron	10
Lead	5.0
Lithium	1.0
Magnesium	10
Manganese	0.5
Molybdenum	1.0
Nickel	1.0
Potassium	10
Selenium	5.0
Silicon	5.0
Strontium	0.5
Silver	0.5
Sodium	10
Thallium	5.0
Tin	5.0
Titanium	1.0
Vanadium	1.0
Zinc	1.0
Zirconium	5.0

5.3.4 Low-Level Check Standard Stock Solution (CRDL-2) - mixed element standard in 2% HNO_3 / 5% HCl

To a 100 mL flask add approximately 10 mL reagent water. Then, add 2 mL concentrated HNO_3 and 5 mL concentrated HCl . Add the following amounts of single element standards and bring to volume. Store in a polyethylene bottle. Light reduces the stability of several elements in solution. It is preferable to store the solution in the dark when not in use. When made as described the following mixture of elements and respective concentrations are achieved:

LOW-LEVEL CHECK STANDARD STOCK SOLUTION - CRDL-2

ELEMENT	STOCK CONC. (mg/L)	VOLUME (uL)	CONCENTRATION(mg/L)
Aluminum	10,000	200	20
Antimony	1000	2000	20
Barium	1000	80	0.8
Arsenic	1000	4000	40
Beryllium	1000	40	0.4
Boron	1000	1000	10
Cadmium	1000	100	1.0
Calcium	10,000	400	40
Chromium	1000	200	2.0
Cobalt	1000	200	2.0
Copper	1000	400	4.0
Iron	10,000	200	20
Lead	1000	1000	10
Lithium	1000	400	4.0
Magnesium	10,000	200	20
Manganese	1000	100	1.0
Molybdenum	1000	200	2.0
Nickel	1000	400	4.0
Potassium	10,000	400	40
Selenium	1000	2000	20
Silicon	1000	10000	100
Strontium	1000	400	4.0
Silver	1000	200	2.0
Sodium	10,000	1000	100
Thallium	1000	4000	40
Tin	1000	2000	20
Titanium	1000	1000	10
Vanadium	1000	200	2.0
Zinc	1000	400	4.0
Zirconium	1000	600	6.0

5.3.5 Low-Level Check Standard (CRI6010A) - mixed element standard in 2% HNO_3 / 5% HCl

To a 100 mL flask add approximately 50 mL reagent water. Add 2 mL concentrated HNO_3 and 5 mL concentrated HCl . Then, add 1 mL of Low Level Check Standard Stock Solution (CRDL-2) and bring to volume. The resulting concentrations will be 100 times lower than that for CRDL-2, provided above. The solution should be prepared more frequently than that for the calibration and ICV standards because the low levels are not as stable for long periods. Weekly preparation of this standard is recommended.

5.3.6 Interference Check Standard solution A. (ICSA) - mixed element standard in 2% HNO_3 / 5% HCl

To a 500 mL flask add approximately 300 mL reagent water. Then, add 10 mL concentrated HNO_3 and 25 mL concentrated HCl. Add 50 mL of Exaxol, PE Pure, Plasmachem, Solutions Plus or equivalent ICSA solution. Listed below are the elements and concentrations for the stock solution of ICSA solution and the final concentration when diluted:

INTERFERENCE CHECK STANDARD A - ICSA

Elements	Stock Concentration (mg/L)	Final Concentration (mg/L)
Al, Ca, Mg	5000	500
Fe	2000	200

5.3.7 Interference Check Standard solution AB (ICSAB95) - mixed element standard in 2% HNO_3 / 5% HCl

This standard is prepared in two parts. The first part consists of preparing the Odd Analytes B Stock Standard. This standard is then added with others to form the final mixture.

Odd Analytes B Solution - To a 100 mL flask add 50 mL reagent water, 2 mL of concentrated HNO_3 and 5 mL concentrated HCl. Add the following amounts of 1000 ppm, single element standards and dilute to a final volume of 100 mL to achieve the following element mix and respective concentrations:

ODD ANALYTES B SOLUTION

ELEMENT	VOLUME (uL)	CONCENTRATION (mg/L)
Lithium	1000	10
Potassium	1000	10
Silicon	5000	50
Strontium	1000	10
Tin	1000	10
Titanium	1000	10
Zirconium	1000	10

Alternatively add 100 uL of 10,000 ppm stock (500 uL for silicon); other analytes may also be added in this manner if needed.

Final ICSAB solution - To a 500 mL volumetric flask add about 250 mL reagent water, 5 mL concentrated HNO_3 and 10 mL concentrated HCl . Then, add 50 mL ICSA solution (see Section 5.3.6), 5 mL ANALYTES B solution, 5 mL ALT ANALYTES B solution, and 50 mL of ODD ANALYTES B solution. The ANALYTES B and ALT ANALYTES B solutions are mixed standards purchased directly from a standard distributor, (e.g. Plasmachem, Exaxol, Solutions Plus, etc.). Bring to a final volume of 500 mL to achieve the following element mix and respective concentrations:

INTERFERENCE CHECK STANDARD WITH ANALYTES SOLUTION - ICSAB95

ELEMENT	CONCENTRATION (mg/L)
Aluminum	500
Antimony	1.0
Arsenic	1.0
Barium	0.5
Beryllium	0.5
Boron	1.0
Cadmium	1.0
Calcium	500
Chromium	0.5
Cobalt	0.5
Copper	0.5
Iron	200
Lead	1.0
Lithium	1.0
Magnesium	500
Manganese	0.5
Molybdenum	1.0
Nickel	1.0
Potassium	1.0
Selenium	1.0
Silicon	5.0
Strontium	1.0
Silver	1.0
Sodium	1.0
Thallium	1.0
Tin	1.0
Titanium	1.0
Vanadium	0.5
Zinc	1.0
Zirconium	1.0

5.3.8 Continuing Calibration Verification Standard (CCV95) - mixed element standard in 2% HNO_3 / 5% HCl

To a 500 mL flask add approximately 100 mL reagent water. Then, add 10 mL concentrated HNO_3 and 25 mL concentrated HCl. Add 10 mL each of QC-19A, QC-19B and QC-19C stock solutions. Bring to volume with reagent water and mix well. Light reduces the stability of several elements in solution. It is preferable to store the solution in the dark when not in use.

The CCV source may be the same as that of the calibration standards. When prepared as described, the standard will contain the following elements and respective concentrations:

CONTINUING CALIBRATION VERIFICATION STANDARD - CCV95

ELEMENT	CONCENTRATION (mg/L)
Aluminum	20
Antimony	10
Arsenic	10
Barium	1.0
Beryllium	1.0
Boron	2.0
Cadmium	1.0
Calcium	20
Chromium	2.0
Cobalt	2.0
Copper	2.0
Iron	20
Lead	10
Lithium	2.0
Magnesium	20
Manganese	1.0
Molybdenum	2.0
Nickel	2.0
Potassium	20
Selenium	10
Silicon	10
Strontium	1.0
Silver	1.0
Sodium	20
Thallium	10
Tin	10
Titanium	2.0
Vanadium	2.0
Zinc	2.0
Zirconium	10

5.3.9 High Calibration Standard Check (HSTD95) - Mixed element check standard

Prepare in the same manner as STD95 described in section 5.3.2, (an aliquot of STD 95 is used for HSTD95).

6.0 PROCEDURE

6.1 Instrument Set-up

6.1.1 The hardware should already be set up. The instrument requires electrical power, coolant water, argon gas and ventilation. It should be operated in a thermally stable environment at a temperature between 15 to 20 °C.

6.1.1 After turning on the computer, the ThermoSPEC software should be booted automatically. If it didn't, type in at the C:\> prompt STNRUN then press ENTER.

6.2 Instrument Ignition.

6.2.1 Check the supply of argon weekly. The tank is located outside. It is filled with liquid argon which gasses to supply the ICP. A gauge displays the volume of argon remaining in the tank. When the gauge drops to 1/4 full level place an order for a refill. Under typical work load the tank will last several months between fillings.

6.2.2 The argon gas is regulated using a single stage regulator prior to connection to the ICP. The regulator pressure should be set to 60 psi. A second regulator is located in the torch chamber of the ICP. The gauge for it can be viewed by looking up from underneath the unit. This regulator has an adjustment valve that is also accessed from under the torch chamber. It should be adjusted to supply a pressure of 50 psi to the unit when the torch is lit.

6.2.3 Check the drain container to make sure that the black drain tube is looped and the end is immersed at least eight inches in the fluid. The container should be empty enough to allow for the drainage of the current run.

6.2.4 The on/off switch for the recirculating pump is located on the power cord. Turn the power on.

6.2.5 Wrap two peristaltic pump tubes (0.045 mm - red/red) around the pump wheel. Rotate the tension arm against the tubing, making sure that the tubing fits in the grove on the tension arm completely. Then rotate the tension arm holder until the holder locks into place. The upper tubing will have one end attached to the capillary tubing coming from the Autosampler and the other end attached to capillary tubing going to the torch nebulizer. The bottom tubing will have one end attached to the capillary tubing coming from the rinse beaker and the other end attached to the capillary tubing going to the rinse tube on the Autosampler. Replace the tubing daily or more frequently if they look worn out or highly discolored. While looking at the front of the pump the right side of the tubing holder will contain the ends that come from the Autosampler probe and from the rinse beaker. Turn the toggle switch to the left and the wheel will be turning counterclockwise. The pump speed must be set at 550 RPM. Check that all flow directions are correct.

6.2.6 Fill the rinse beaker with a 5% solution of nitric acid. Although it has been suggested to match the acid concentration of standards and samples it has been found that excessive carryover occurs for several elements using this protocol.

6.2.7 Raise the argon toggle valves, located to the right of the nebulizer on the front of the instrument, for the TORCH and SAMPLE. Keep the valves in this position for a few minutes before igniting the torch.

6.2.8 Turn the POWER Control knob, located between the FORWARD KILOWATTS RF POWER Meter and the REFLECTED WATTS RF POWER Meter, counterclockwise until it stops.

6.2.9 Turn the AUTOMATIC POWER CONTROL switch, located on the right hand panel in the upper left hand corner, to MANUAL. Check to make sure the FORWARD POWER switch, located below AUTOMATIC FORWARD POWER CONTROL knob, is ON.

6.2.10 The blue RF OFF button should be illuminated. If it isn't, check to make sure all the compartment doors are closed, the argon is on, and the recirculating pump is on.

6.2.11 Lower the argon toggle valve for the SAMPLE. Press the RF ON button. This button should now be illuminated.

6.2.12 Slowly turn the POWER Control Knob clockwise until the Forward RF Power meter reads about 0.5 kilowatts. Press the IGNITOR button located below the TORCH Argon toggle switch. The Argon should be swirling around inside the torch. Slowly, keep turning the POWER Control Knob clockwise until the plasma forms, then immediately turn the AUTOMATIC POWER CONTROL SWITCH up, rotate the POWER CONTROL knob clockwise until it stops, and slowly raise the argon toggle valve for sample. The FORWARD KILOWATTS RF POWER METER should now read about 1 kilowatt.

6.3 Instrument Operation

6.3.1 Before starting any analyses, and after igniting the plasma, let the instrument thermally stabilize for at least 30 minutes.

6.3.2 Profile the instrument by aspirating a manganese standard. Highlight the Setup pulldown menu and then highlight **Profile** and press Enter.

6.3.3 Press F1 for **Manual Profile**, or F3 for **AUTOMATIC PROFILE** then press Enter.

6.3.4 For automatic profiling enter a flush time of 25 seconds and aspirate the manganese standard. Press F1 (run) to begin the automatic profile operation. When profiling is completed check the peak position. If it is greater than ±0.5 perform manual profiling described in Section 6.3.5. If the peak position is less than 0.5, press F1 (calculate SS). When the vernier position comes on the screen press ENTER. The new vernier position will appear on the upper-right of the screen. Move the caliper to the new position and press ESC. Check the precision of the profile by repeating the above steps. When the peak position reads within ±0.1 accept the profile by pressing F9.

6.3.5 For a manual profile enter a flush time of 25 seconds and aspirate the manganese standard. The CONTROLLER meter located on the left-hand side of the instrument must be reading greater than 100. In the event it is not, double check that the standard is being aspirated and that the message "Performing Exposure" is flashing in the upper left-hand corner of the screen.

6.3.5 Open the hatch located at the top-middle of the instrument. Adjust the caliper counterclockwise until the CONTROLLER meter reads exactly 60, then adjust it clockwise to 70. Read the caliper and enter the number for the LOW value, then press Enter. Next, adjust the caliper clockwise until the CONTROLLER meter rises to 100, then back it down to 70. Read the caliper and enter the number for the HIGH value, then press Enter. The software will give the average of the HIGH and LOW values. Adjust the caliper counterclockwise to the average. Press F9 to accept the profile calibration and then ESC to get back to the Main menu.

6.4 Developing an Autosampler Table

6.4.1 There are several useful function keys while editing an Autosampler Table. There are three different menus for the function keys. The first menu is always shown when either the Alt or Crtl key is pressed. The second is the menu shown when the Alt key is held down. The third is the menu shown when the Crtl key is held down. The beginning analyst should use only the main and Alt menu functions. Those two menus allow the editing of the Autosampler Table.

6.4.2 Choose the **OPERATION** pulldown menu.

6.4.3 Under the **OPERATION** Menu Choose **AUTOSAMPLER SETUP**. If a large number of sample positions are needed (more than 40), build the table using ASEDIT.EXE under the **EXIT** menu.

6.4.4 Enter a name for the Autosampler Table. The default is the last one modified. Use the following guideline for naming the autosampler table: Numerical date followed by alphabetical sequence of runs performed that day (i.e. For a table analyzed on the second run of the day on April, 1 1995 the table should be labeled 040195B.) After typing in a name press ENTER.

6.4.5 Press F3 to **ADD SET** to the Autosampler file. The arrow keys will allow the analyst to move between the prompts. For the Set Description type ICP RUN and the date of analysis. For the Method Name type ICP95. The other fields except "Auto-Rinse Between Samples" and "Rinse Time" are not required but are only there to help distinguish between runs for different clients or projects and when used, aid in data base searches. The "Auto-Rinse Between Samples" must be set to YES. Highlight the answer and press the space bar to toggle between "YES" and "NO". Type in 60 for the amount of seconds rinsed between samples. A 60 second rinse has been found to be adequate for most analyses. The analyst can increase this time if carryover is apparent, but must not decrease the time as it is a method requirement.

6.4.6 The next prompt is "# Sample Positions needed". A rule of thumb here is to guess high. It is easier to delete unused sample positions than to add more. The default for the next prompt "Starting Rack Number" is 2, (Rack 1 is used for calibration and QC standards). The default for the prompt "Starting Position Number" is 1. Both of the above can be changed if needed. Highlight the answer area for "Default Sample Name". Press the space bar once and this will delete the default "Sample-1". Highlight the answer area for the prompt "Auto Increment?". Press the space bar to toggle to "No" or "YES" depending on how many sequential sample ID numbers are in the analysis set and the ease afforded the operator in building the table. The prompt "Default Limit Check Table Name" should be left as is. Unless all the samples have the same dilution factors the prompt "Default Correction Factor" should be left at 1.

6.4.7 Press F1 to Edit Samples. Then press F3 and add HSTD95 . While the first sample is highlighted press F5 to Insert Standards. Use the arrow keys to go to the CheckTable column for the ICB. The default is CCB6010A. Use the arrow keys to go to the CheckTable column for CCB. Change the table to reflect the current analysis (CCB6010A.) Press Crtl-F3, and type ICS, then press ENTER to insert the Interference Check Standards. Use the arrow keys to go to the CheckTable column for ICSA and ICSAB. The defaults are ICSA95 and ICSAB95. The analyst may now begin entering samples. Listed below are a few rules for entering samples to make data importation and reduction easier. The series of calibration and check standards should be as follows: Blank, STD95, HSTD95, ICV, ICB, CRI6010A, ICSAI, ICSABI, CCV1 AND CCB1.

6.4.8 Always start off with the Preparation Blank for a set of samples. Enter the method and date of preparation for the set (i.e. if the samples were prepared by Method 3050 on 02/11/91 then type in PB 3050 02/11/91), or use a unique ID provided by sample preparation.

6.4.9 Enter the Laboratory Control Sample for a set of samples, right after the Preparation Blank. Enter the preparation method and the date of preparation (i.e. if the samples were prepared by Method 3010 on 02/11/91 then type in LCS 3010 02/11/91), or use a unique ID provided by sample preparation.

6.4.10 Enter the entire Ross Analytical work order number for the sample, for example 95-00-000-00A. If the sample is a duplicate, enter 95-00-000-00AD. If the sample is a spike or spike duplicate, enter 95-00-000-00AS or 95-00-000-00ASD. On samples that need dilutions, try to fit the whole work order number with the dilution. If necessary, truncate from the left of the work order number until the dilution and sample fit in the space allowed.

6.4.11 After entering each set of 10 samples, (including preparation blanks, LCS, MS/MSD, PS/PSD and other QC samples) insert CCVs and CCBs. The ICS standards must be run at least twice every eight hours or at the beginning and end of an analytical run, which ever is more frequent. If the analysis is anticipated to last more than eight hours insert an ICS macro to conform with this rule. Always end your table with an ICS sequence and CCV/CCB set. Remember to change the CheckTable column to reflect the method QC requirements for the CCV, CCB and ICSAB.

6.4.12 After all the samples have been added to the table, delete any unused sample positions by highlighting the unused position and pressing F2. After all the unused sample positions have been deleted press F9 until the computer displays in the upper left-hand corner the message "Examining Autosampler Table." Press F2 to print a listing of the autosampler table developed. When printing is complete, press F9 to save the autosampler table and return to the main menu.
Update the method as described in the next section.

6.5 Updating the Method

6.5.1 Select the **Development** pulldown menu from the **Main** menu and then select **Methods**.

6.5.2 Type in ICP95, if it is not the default answer to the prompt, then hit Enter.

6.5.3 Highlight the answer to the prompt "Analysis Data File". Type in the date of analysis (i.e. if the date is 04/01/95 type in APR0195.)

6.5.4 Highlight the answer to the prompt "Autosampler Table". Type in the name of the autosampler table (see Section 6.4 for autosampler table set up.)

6.6 Limit Check Tables

6.6.1 Select the **DEVELOPMENT** menu from the main menu by either using the arrow keys or by pressing the letter D.

6.6.2 Select **SAMPLE LIMIT CHECKS** by either using the arrow keys or by pressing the letter L.

6.6.3 Type in the name of the limit table, if known, then press ENTER, or press F6 to get a list of available tables. When choosing from a list enter the number of the corresponding table then press ENTER twice to edit the table.

6.6.4 The table LIM6010A contains the Linear Range for HIGH LIMIT and the EQL for the LOW LIMIT. It is used for checking acceptable result ranges for unknown samples.

6.6.5 The table CCB6010A is set up to flag analyte concentrations that exceed the absolute value of the EQL.

6.6.6 The table ICSA95 is set up to flag concentrations of interferences (i.e. Al, Ca, Fe and Mg) that exceed a range of 80 - 120% of the true value, and to flag analyte concentrations that exceed the absolute value of the EQL .

6.6.7 The table ICSAB95 is set up to flag concentrations of interferences and analytes that exceed a range of 80 - 120% of the true value.

6.7 Quality Control Check Tables

6.7.1 The table CCV95 is set up to flag analyte concentrations which exceed a range of 90 - 110% of the true value.

6.8 Instrument Shutdown Following Completion of Analysis

6.8.1 Extinguish the plasma by pressing the **RF OFF** button located on the middle instrument panel on the right hand side.

6.8.2 Remove the pump tubing from around the pump wheel by pressing the tension arm release located on the right hand side of the peristaltic pump. The pressure must be released when the pump is not turning or it causes deformation of the tubing and will lead to analysis problems.

6.8.3 Turn the **POWER CONTROL** knob counterclockwise until it stops.

6.8.4 Flip the **AUTOMATIC POWER CONTROL** switch to MANUAL.

6.8.5 Flip down the **TORCH** and **SAMPLE** argon toggle switches.

6.8.6 Turn off the timer.

7.0 ANALYSIS

7.1 After starting and equilibrating the instrument, setting up the autosampler table, defining the method, checking and defining limit and QC check tables, and loading samples and standards into their correct positions in the autosampler tray, analysis can begin.

7.1.1 To begin analysis first select **Operation** from the main menu, then select **Analysis**.

7.1.2 The software will prompt what method to use. **ICP95** is currently the method of choice for analyses under SW-846 Method 6010A protocol. If it is not already the default answer for the prompt type in **ICP95** and press ENTER.

7.1.3 Press F9 to run an analysis using a developed autosampler table.

7.1.4 The software will display the autosampler table specified in Section 6.4.4; if it is correct, press ENTER.

7.1.5 The software then displays the first solution to be analyzed. For most cases this will be a blank. This can be changed by using the arrow keys.

7.1.6 Pour at least 5 mL of each sample into a sample tube. Using the printout obtained from development of the autosampler table as a guide (see Section 6.6), place the sample tubes into the correct positions.

7.1.7 Press F1 to begin the analysis. The analysis may be halted when the autosampler is running a sample (not rinsing) by pressing F1 then ENTER twice. Do not stop the system while rinsing, as it can cause the computer software to lock up. The software then displays the same screen as in Section 6.5.6. Repeat procedure from this section to restart analysis.

7.2 Calibration Standards

7.2.1 Section 7.3 of SW-846, Method 6010A states "Profile and calibrate the instrument according to the instrument manufacturer's recommended procedures . . . The calibration curve should consist of a blank and three standards." This statement is contradictory if the "manufacturer's recommended procedures" is a two point calibration, (i.e. a blank and one standard), as is the case with the TJA Enviro 36 ICP. It has been experimentally verified that the procedures recommended by the manufacturer, when followed correctly, produce more accurate data in a more efficient manner than that obtained using a three point calibration curve, especially for data at or near the detection limit. Therefore the manufacturer's recommendations for calibration have been adopted by this SOP. The EPA has confirmed that this procedure is compliant with the method.

7.2.2 Validation of the entire calibration range is accomplished using check standards at low medium and high levels during the analytical run.

7.3 Samples

7.3.1 All samples and quality control checks are analyzed in the same manner. No special consideration which would bias a result is provided to any analysis (such as longer or shorter rinse times). Duplicate readings are achieved for each sample and results averaged.

7.3.2 Sample results must fall within the established linear range. This includes analytes which may not be required for reporting by the client, but whose presence may influence correction factors or target analyte behavior.

7.3.2 Some samples may require dilution due to their viscosity and ability to be handled by the delivery system of the instrument. When performing dilutions use caution to achieve the least dilution possible without affecting the validity of the results or operation of the system.

7.3.3 If a sample is causing contamination problems due to high levels of analyte, the system may be interrupted and allowed to rinse prior to analysis of another sample. The efficiency of the rinse must be verified by running a blank as a sample before continuing analysis. The blank must meet the same acceptance criteria as the CCB.

8.0 CALCULATIONS

8.1 Soil

$$\text{Sample Result (mg/kg)} = \text{instrument result (mg/L)} \times \text{instrument dilution} \times \frac{\text{final prep vol (mL)}}{\text{sample wt (g)}}$$

8.2 Water

$$\text{Sample Result (mg/L)} = \text{instrument result (mg/L)} \times \text{instrument dilution} \times \frac{\text{final prep vol (mL)}}{\text{initial prep vol (mL)}}$$

9.0 QUALITY CONTROL

9.1 Before beginning sample analysis several check standards and other quality control samples must be analyzed.

9.1.1 First, analyze HSTD95 (see Section 5.3.9) as a sample. Results must agree within ±5% of the known values. If this control limit is not met, determine and correct the cause of the problem and reanalyze the standard. Recalibration may be necessary.

9.1.2 Analyze the Initial Calibration Verification Standard(s), ICV, after the highest calibration standard has been reanalyzed. This standard is used to validate the source and correct procedure used for preparation of the calibration standards, and the accuracy of the calibration curve. Results must fall within ± 10% of the true value. If this control limit is not met, determine and correct the cause of the problem and reanalyze the standard. Recalibration may be necessary.

9.1.3 Analyze the Initial Calibration Blank Standard, ICB, after the ICV. This standard is used to verify that carryover is not occurring, and that results near the detection limit are not biased by the slope and intercept of the calibration curve. The absolute value for the results of the ICB shall not be greater than the reported EQL. If this control limit is not met, determine and correct the cause of the problem and reanalyze both the ICV and ICB standards. Recalibration may be necessary. ICB results greater than the EQL may be accepted if they are no higher than 5% of the lowest concentration in the samples.

9.1.4 Analyze the Low-Level Check Standard, CRI, after the ICB. This standard is used to verify the accuracy of results near the detection limit. Results of the CRI must agree within ±20% of the true value. Although this is not a method requirement, this criterion has been adopted to validate the use of the calibration curve described above. If this control limit is not met, determine and correct the cause of the problem, reanalyze the CRI, and all check standards preceding it in their appropriate order. Recalibration may be necessary.

9.1.5 Analyze the Interference Check Standard, ICSA, after the CRI. This standard is used to verify the accuracy of the interferences, the accuracy of correction factors applied, and their effect on results in the absence of analyte. Results for the interfering elements (Al, Ca, Fe, and Mg) must agree within ±20% of the true value. Results for the analytes affected by the interferences, must not be greater than the absolute value of the reported EQL. If these control limits are not met, determine the cause and correct the problem. Reanalyze all check standards previously mentioned in their appropriate order. Recalibration may be necessary. The ICSA must be run at the beginning and end of the analytic run, or twice during each 8-hour shift, whichever is more frequent.

9.1.6 Analyze the Interference Check Standard with Analytes, ICSAB, after the ICSA. This standard is used to verify the accuracy of the interferences, the accuracy of interelement and background correction factors, and their effect on results in the presence of analyte. Results for the interfering elements and the analytes must agree within ± 20% of their true values. If these control limits are not met, determine the cause and correct the problem. Reanalyze all check standards previously mentioned in their appropriate order. Recalibration may be necessary. The ICSAB must be run at the beginning and end of the analytic run, or twice during each 8-hour shift, whichever is more frequent.

9.1.7 Although not a method requirement, it is prudent to "close out" the sequence of check standards that are run just after the calibration with a Continuing Calibration Verification Standard (CCV) and a Continuing Calibration Blank (CCB). Control limit criteria for these standards is the same as that for the ICV and ICB. The CCV and CCB must then be analyzed after every ten samples (Preparation Blanks, LCS, MS/MSD, PS/PSD and other QC samples are counted as samples), and at the end of the analytical run.

9.1.8 A serial dilution of a sample within a batch must be performed if matrix interference is suspected. Dilution results must agree within ± 10% of the original values if the analyte concentrations are greater than a factor of 10 above the EQL after the dilution. Further dilution will be necessary if the criteria is not met.

9.1.9 A minimum of one method blank per sample batch must be prepared and analyzed to determine if contamination from the preparation procedures has occurred. The method blank is carried through the entire process as a sample. Results for the method blank must be less than the reported EQL. If this criteria is not met determine the cause and correct the problem. Repreparation of the blank, and the entire batch associated with it, may be required. Sample results may also be reported when the blank exceeds the EQL if the concentrations in the samples are at a level twenty times that of the EQL.

9.1.10 Analysis of a Laboratory Control Sample (LCS), described as a "quality control sample" in Section 5.8 of Method 6010A, must be performed for each batch. If possible, the LCS matrix should mimic that of the samples in the batch. This helps to validate the applicability of the method utilized for the matrix. Results of the LCS must agree within ± 20% of the theoretical value or within the confidence interval established by the manufacturer. If this criterion is not met reprepare and reanalyze the samples associated with the batch. In some cases repreparation is not possible when all of the sample is used during initial preparation. In these cases flag the data associated with the QC failure using a narrative form and/or a non-conformance report form.

9.1.11 Spiked replicate samples are to be analyzed at a minimum frequency of 5% (one set of replicates per twenty samples) or per analytical batch, whichever is more frequent.. Analyzing spiked replicate samples also fulfills the requirement for analysis of a replicate sample (SW-846 Method 6010A, Section 8.4). The spikes must be made prior to preparative procedures and then processed as samples.

These matrix spikes and matrix spike duplicates are identified by adding MS and MSD, or S and SD to the ends of sample IDs. Spike levels are specific to the matrix and are covered in SOPs for the preparation methods used. Recovery and reproducibility must be determined using results of these samples. The MS and MSD recoveries are to be within ±20% of the theoretical value, as determined using the following formula (note- all dilution factors must be corrected for prior to use in this formula):

$$\%REC = \frac{\text{(spike result - sample result)}}{\text{spike added}} \times 100$$

If the recovery is not within control limits a procedural error or matrix interference may be suspected. Presence of the interference and its effect on the analytic system employed must be determined. This is accomplished by diluting and reanalyzing the replicate spikes and samples until control limits are met, or by performing a post-digestion spike.

The reproducibility, expressed as relative percent difference (RPD), is to be within 20% for sample values greater than ten times the IDL. The following formula is to be used to calculate RPD:

$$RPD = \text{Absolute Value of} \quad \frac{(\text{first sample result - second sample result})}{\text{average of first and second results}} \times 100$$

If the reproducibility is not within control limits a procedural error or matrix effect may be suspected. Analysis of a post digest spike and spike duplicate, and respective RPD values is required to determine the cause of the problem.

9.1.12 Post digest spikes are performed to determine if quality control failures from the MS/MSD analyses are due to matrix effects or to procedural problems, and if the effects are matrix related, what degree of bias is encountered. Post digest spikes and spike duplicate samples are identified with a PS/PSD or A/AD at the end of the sample ID. Post spike recovery and reproducibility are calculated in the same manner as that for matrix spikes. The post spike must recover within 75% to 125% of the theoretical value for analytes whose concentrations are less than 4x the spike level added. If this limit is not met, a matrix interference is suspected and results are flagged using a narrative with the report.

9.1.13 Instrument Detection Limits (IDL) must be determined quarterly and whenever a new element is added. IDLs are determined by running seven replicates of a solution that is at a concentration 3 to 5 times the IDL, then multiplying the standard deviation of the seven replicates by 3. Average results from three, non-consecutive days are used for the final IDL value.

9.1.14 Method Detection Limits (MDL) must be determined annually and whenever a new element is added. The MDL must be determined for each matrix (i.e. aqueous and solid). The MDLs are experimentally determined by averaging results from analysis of seven replicate samples which have been spiked at a level approximating the EQL. Each matrix is spiked and prepared for analysis according to a defined method for that matrix.

9.1.15 The Estimated Quantitation Level (EQL) is a value derived from the MDL which is rounded and adjusted to reflect other laboratory constraints (e.g. background contamination). The EQL is typically one to ten times the MDL, but at no time may it be lower.

9.1.16 Instrument Linear Ranges (LR) must be determined quarterly and whenever a new element is added. The LR of an element is determined by analyzing the element at successively higher concentrations until self absorption or other effects cause the accuracy of results to fall outside a range of ±5 % of the true value. The result for the LR is then rounded to a whole number.

10.0 INTERFERENCES

10.1 Spectral Interferences

Spectral interferences are caused by: (1) overlap of a spectral waveline from another element; (2) unresolved overlap of molecular band spectra; (3) background contribution from continuum or recombinant phenomena; and, (4) stray light from the line emission of high concentration elements. Spectral overlap can be compensated for by computer-correcting the raw data after monitoring and measuring the interfering element (i.e. applying interelement correction factors, IECs). Unresolved overlap requires selection of alternate wavelengths. Background and stray light can be corrected using background correction (BGC) adjacent to the analytic line.

The wavelengths and background correction points utilized in this method have been carefully chosen after extensive experimental evaluation. The IDL, MDL, LR and IEC values are all affected by the choice of the BGC points. Therefore, if the wavelines and BGC points for each element are altered, new IDLs, MDLs, LRs and IECs must be determined.

10.1.1 Element-specific interference is expressed as analyte concentration equivalents (e.g., false analyte concentrations) arising from the interfering elements. The interference effects of each element on every other element must be experimentally determined under conditions which mimic normal operations. The values achieved are used to calculate IECs.

For example: If the effect of 1000 ppm of aluminum produces a false concentration for arsenic of 4.814 ppm the IEC factor is 0.004814 (4.814/1000).

Interference correction is applied during analysis by multiplying the IEC by the concentration of the interfering element in a sample and subtracting or adding the result to the analyte concentration. It is important to use the correct sign (+ or -) for the IEC as there may be additive or subtractive forces at work. If the effect of the interference is additive to analyte concentration, the sign used for the IEC in the ThermoSpec software is also positive. If the effect of the interference is subtractive to analyte concentration, the sign used is negative.

10.2 Physical Interferences

Physical interferences are effects associated with the sample nebulization and transport processes. Differences in viscosity, volatility and surface tension between calibration standards and samples can cause inaccuracies. This is most apparent for organics and samples with high TDS levels or acid concentrations.

10.2.1 Physical interferences can be reduced by diluting the sample, using a peristaltic pump and by normalizing the data with an internal standard.

10.2.2 Salt buildup from samples with high TDS levels can clog the nebulizer tip and torch injector, affecting aerosol flow, and resulting in instrument drift. This problem can be controlled by wetting the argon prior to nebulization, using a tip washer, or diluting the sample. The nebulizer frequently requires cleaning to prevent salt buildup. This is recommended as a daily preventative maintenance task.

10.2.3 Temperature fluctuations in the environment cause differences in the density and surface tension of samples and standards resulting in inaccuracies and instrument drift. This problem is best controlled by maintaining a stable temperature in the room, but can be corrected for using an internal standard.

10.3 Chemical Interferences

Chemical interferences include molecular compound formation, ionization effects and solute vaporization effects.

10.3.1 Molecular compound formation is controlled in part by utilizing preparation procedures that break down complex structures and stabilize dissolved elements. The ICP technique itself aids to minimize this phenomena.

10.3.2 Ionization effects can be overcome by adding high concentrations of alkali salts to force ion equilibrium to favor analytes of interest. Lithium carbonate is typically used for this.

10.3.3 Solute vaporization effects are controlled by matrix matching or by method of standard additions.

11.0 TROUBLESHOOTING

11.1 Printer Does Not Work

11.1.1 Not plugged in

11.1.2 Not turned on

11.1.3 Not connected to computer

11.1.4 Paper jammed or empty

11.2 Burn Will Not Commence

11.2.1 10 Amp fuse on power distribution panel blown

11.2.2 Double toggle on source not on

11.2.3 Double toggle on power distribution panel not on

11.2.4 Reset button not pressed

11.2.5 Unit not warmed up

11.2.6 Door to sample chamber has not been opened and closed since last burn

11.2.7 Source not functioning properly

11.2.8 1 Amp fuse on low-voltage power supply blown

11.2.9 Safety interlock switches not shut off

11.3 Poor Analytical Results

11.3.1 Instrument not profiled correctly

11.3.2 Sample and standards not matrix matched

11.3.3 Argon gas flows and pressures wrong

11.3.4 Leaks in argon system

11.3.5 Poor argon gas quality

11.3.6 Blockage, leaks or disconnections in delivery system tubing

11.3.6 Room temperature not stabilized (2 degrees per hour maximum change)

11.3.7 2 Amp high-voltage power supply fuse blown

11.3.8 Hg alignment lamp in optical path

11.3.9 Standards contaminated

11.3.9 Standards prepared incorrectly

11.3.10 Standards too old

11.3.11 Torch dirty

11.3.12 Pump tubing worn, deformed or contaminated

11.3.13 Peristaltic pump not turning smoothly

11.3.14 BGC points not appropriate

11.3.15 IEC factors not applied, or applied incorrectly

12.0 TABLE(S)

TABLE 1 - ESTIMATED QUANTITATION LIMITS

ELEMENT	EQL (ug/L)
Aluminum	100
Antimony	100
Arsenic	200
Barium	4.0
Beryllium	2.0
Boron	50
Cadmium	5.0
Calcium	200
Chromium	10
Cobalt	10
Copper	20
Iron	100
Lead	50
Lithium	20
Magnesium	100
Manganese	5.0
Molybdenum	10
Nickel	20
Potassium	100
Selenium	100
Silicon	500
Strontium	20
Silver	10
Sodium	500
Thallium	400
Tin	100
Titanium	50
Vanadium	10
Zinc	20
Zirconium	30

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SOP

Standard Operating Procedure

SOP No: MT-005-00
Inital Date: 2/1/91
Page 1 of 4
Date Revised: ______

Title:

Metals Standards Documentation

Prepared by: Belinda Minter
Approved by: CHaldwell
Date: 5/23/91
QC Approval: CHC

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1.0 PURPOSE

To describe the documentation of the preparation of metals standards.

2.0 APPLICATION

The SOP is intended to apply for all stock, intermediate stock, and working standards for use with ICP Emission, Graphite Furnace AA, Flame AA, and Cold Vapor AA.

3.0 REFERENCES

None

4.0 ASSOCIATED SOPs

None

5.0 PROCEDURE

5.1 All stock standard solutions purchased from an outside source must have a Certificate of Analysis and Material Safety Data Sheet. The stock should also be labeled by Sample Control with an appropriate reagent control number.

5.2 Intermediate solutions are be recorded in the Standards Log book located in the desk area of the Inorganic Instrumentation Laboratory. Working standards for Flame AA or ICP must also be recorded, as must dilutions of independent check standards.

5.3 Figure 1 shows a blank sample entry. The name of the standard the analyst is making is entered beside STANDARD. STANDARD NUMBER references the log number for the book. The log number always starts with "II" (for Inorganic Instrumentation) and the entry order number in the book (i.e. II-001, II-002, etc.) The REAGENT NUMBER(S) is for the reagent control number(s) of the stock standard(s) used. Beside CONCENTRATION is the resulting concentration of the standard being made. Because ICP standards frequently have several elements only enter the dilution factor and the name of the stock standard used (i.e. 1:200 of RASI #1.) Enter analyst initials and date made beside PREPARED BY/DATE.

5.3.1 A Standards EXPIRATION DATE is determined by its concentration. For multielement standards the lowest concentration of any element is used to determine the expiration date. Listed below are the concentrations and periods that the standards are good for use.

Concentrations > 100 mg/l: six months
Concentrations > 10 mg/l and < 100 mg/l: three months
Concentrations > 1 mg/l and < 10 mg/l: one month
Concentrations < 1 mg/l made fresh for each days use

Under the METHOD OF PREPARATION, provide a brief description of the standard that was prepared and the matrix used.

5.4 Label the storage bottle the standard will be kept in with a ANALYTICAL STANDARD Label. A blank example label is shown in figure 2. Include the STANDARD name, CONCENTRATION, STANDARD NUMBER, DATE PREPARED, PREPARED BY initials, and EXPIRATION DATE. For Flame AA and ICP standards, write the matrix in the upper right hand corner of the label.

Figure 1

STANDARD____________________ STANDARD NUMBER________________

REAGENT NUMBER(S)________________ CONCENTRATION________________

PREPARED BY/DATE________________ EXPIRATION DATE________________

METHOD OF PREPARATION________________________________

SPECIAL INSTRUCTION:________________________________

Figure 2

ANALYTICAL STANDARD

STANDARD ______________ CONCENTRATION ____________

STANDARD NO. ___________ DATE PREPARED _____________

PREPARED BY ___________ EXPIRATION DATE ____________

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Ross Analytical Services, Inc.

STANDARD OPERATING PROCEDURE

SOP No.: MV-001-01
Initial Date: 2/1/91
Page 1 of 33
Date Revised: 4/5/95

Title: Determination of Volatile Organic Compounds by GC/MS by Methods 8240B and 8260A			
Prepared by:	Approved by:	Date: 4/5/95	QA Approval:

1.0 PURPOSE

The purpose of this procedure is to describe the determination of volatile organic compounds using GC/MS.

2.0 APPLICATION

This procedure may be used for the analysis of water, sediment, soil, sludge, and waste samples for the organic compounds listed in Table 1 and other related compounds. Information from SW-846, Method 8240B and 8260A was used to design this procedure.

This method is divided into the following sections: sample preparation including medium level extraction, screening, and analysis. The screening section contains a technique for estimation of levels of organic materials present in samples. The analysis section contains the GC/MS analytical methods for organics. The purge and trap technique, including related sample preparation, is included in the analysis section. Interferences are described in Section 7.4.

Most RCRA/CERCLA VOA analyses, except those done by CLP methodology, are performed using this method.

3.0 REFERENCES

3.1 EPA SW-846, 3rd Edition, Update II, September 1994, Methods 8240B and 8260A

3.2 RASI Laboratory Quality Assurance Manual

4.0 ASSOCIATED SOPs

MV-006, Analysis of Low Level Purgeable Organic Compounds by GC/MS Using Method 8260A

QC-001, Nonconformance and Corrective Action

QC-006, GC/MS Data Review and Validation

QC-013, Analyst Proficiency Requirements

5.0 EQUIPMENT/APPARATUS

5.1 Micro syringes - 10 uL and larger, 0.006 inch ID needle

5.2 Syringe valve - Two-way, with Luer ends (three each), if applicable to the purging device

5.3 Syringe - 5 mL, gas tight with shut-off valve

5.4 Balance - Analytical, capable of accurately weighing ±0.0001 g and top-loading balance capable of weighing ±0.1 g

5.5 Glassware

5.5.1 Water purge vessels

5.5.2 Soil purge vessels

5.5.3 Bottle - 15 mL, screw cap, with Teflon cap liner

5.5.4 Volumetric flasks - Class A with ground glass stoppers

5.6 Purge and trap

The purge and trap device consists of a Tekmar model ALS2016 autosampler interfaced with a Tekmar model LSC2000 thermal desorber.

5.6.1 The sample sparger for water samples is designed to accept 5 mL samples with a water column at least 3 cm deep. The gaseous head space between the water column and the trap must have a total volume of less than 15 mL. The purge gas must pass through the water column as finely divided bubbles, each with a diameter of less then 3 mm at the origin. The sample purger, illustrated in Figure 1, meets these design criteria. These purge vessels are available from Tekmar. Alternate sample purge devices may be utilized provided equivalent performance is demonstrated. An example of a suitable impinger for low level soil samples is illustrated in Figure 2.

For low level soil samples and some water samples, the purge vessel is covered with a heated jacket capable of maintaining the samples at 40°C ±1°C. If a heated purge is utilized, all standards, blanks, LCSs, and samples are heated, too.

5.6.2 The trap must be at least 25 cm long with an inside diameter of at least 0.105 inch. RASI uses a Vocarb 3000 or a OI Trap 10 multibed purge trap for volatiles. See Figure 3 for product information.

5.6.3 The desorber should be capable of rapidly heating the trap to 240°C. The trap should be able to be heated to 250°C during bakeout mode. The desorber schematic, illustrated in Figure 4, meets these criteria.

5.6.4 The transfer line from the purge and trap unit is coupled directly to the injection port of the gas chromatograph.

5.7 GC/MS

5.7.1 Gas chromatograph - An analytical system complete with a temperature programmable gas chromatograph suitable for on-column injection and all required accessories including syringes, analytical columns, and gases.

5.7.2 Column - A 75 m x 0.53 mm DB-624 fused silica megabore column, with a 3 um mid polarity, stationary phase.

5.7.3 Mass spectrometer - Scanning from 35 to 300 amu every second utilizing 70 volts (nominal) electron energy in the electron impact ionization mode and producing a mass spectrum which meets all the following criteria in Table 2 when 50 ng of p-bromofluorobenzene (BFB) is injected through the gas chromatograph inlet.

5.7.4 GC/MS interface - A glass jet separator is used to interface the gas chromatograph and mass spectrometer.

5.7.5 Data system - A computer is interfaced to the mass spectrometer to allow the continuous acquisition and storage on machine readable media of all mass spectra obtained throughout the duration of the chromatographic program. The computer has software that allows searching any GC/MS data file for ions of a specified mass and plotting such ion abundances versus time or scan number. This type of plot is defined as an Extracted Ion Current Profile (EICP). Software is also available to integrate the abundance in any EICP between specified time or scan number limits.

6.0 STANDARDS AND SOLUTIONS

6.1 Reagents

6.1.1 Reagent water

Reagent water is taken from a 5 gallon glass bottle of LabConco-purified, nitrogen-purged water.

6.1.2 Methanol

B&J Purge and Trap Methanol

6.2 Standards

Great care must be taken to maintain the integrity of all standard solutions. Store all standard solutions at -10 to -20°C in screw-cap amber bottles with Teflon liners.

6.2.1 Stock standard solutions

Stock standard solutions are purchased commercially.

Prepare fresh working standards every week for gases or for reactive compounds such as styrene. All other stock standards must be replaced after three months or sooner if comparison with check standards indicates a problem.

See SOP Modification Form ~~for~~ @ end of SOP.

6.2.2 Calibration standards

cel 8/9/95

~~Prepare calibration standards at five concentration levels in methanol for each target parameter and each surrogate. The concentration levels are 10, 20, 50, 100, and 200 ug/l.~~

6.2.3 Surrogate standard spiking solution

Stock standard solutions for toluene-d8, 4-bromofluorobenzene (BFB), and 1,2-dichloroethane-d4 in methanol are also purchased commercially at concentrations of 2500 ug/mL.

A secondary dilution standard is prepared at 50 ug/mL. The addition of 5 uL of this standard to each 5 mL sample yields a surrogate concentration of 50 ug/L.

6.2.4 Internal standard spiking solution

Stock standard solutions of bromochloromethane, 1,4-difluorobenzene and chlorobenzene-d_5 in methanol are purchased commercially at 2500 ug/mL.

A secondary dilution standard is prepared at a concentration of 50 ug/mL containing each internal standard compound. The addition of 5 uL of this standard solution to 5 mL of sample or calibration standard yields a internal standard concentration of 50 ug/L.

6.2.5 Matrix Standard and Laboratory Control Sample Spiking Solution

Prepare a spiking solution in methanol that contains the following compounds at a concentration of 50 ng/uL:

<u>Matrix spike compounds</u>
1,1-Dichloroethene
Trichloroethene
Chlorobenzene
Toluene
Benzene

Matrix spikes also serve as duplicates; therefore, add an aliquot of this solution to each of two portions from one sample chosen for spiking. It also serves as the laboratory control standard.

6.2.6 BFB Standard

Prepare a 50 ng/uL solution of BFB in methanol.

7.0 PROCEDURE

7.1 <u>Sample Storage and Holding Times</u>

7.1.1 <u>Procedure for Sample Storage</u> - The sample must be protected from light and refrigerated at 4^oC ($\underline{+}$ 2^oC) from the time of receipt until analysis. Samples are stored in a refrigerator used solely for volatiles samples.

7.1.2 <u>Required Holding Times</u> - The holding time for aqueous and non-aqueous samples alike is 14 days from date of collection. Aqueous samples must be preserved with HCl. <u>If samples are not preserved with HCl, data generated from sample analyses must be flagged as being estimated values</u>.

It is common belief that aqueous samples have a seven day holding time, if not preserved. This is not supported by the EPA methods.

7.2 Purging of Water Samples

An inert gas is bubbled through a 5 mL sample contained in a specially designed purging chamber (Figure 1) at either ambient temperature or at 40°C +/- 1°C. If a heated purge is used, all standards, blanks, LCSs, and samples are processed at 40°C +/- 1°C. The purgeables are transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column (Figure 4) where the purgeables are trapped. After purging is completed, the sorbent column is heated and backflushed with the inert gas to desorb the purgeables onto a gas chromatographic column. The gas chromatograph is temperature programmed to separate the purgeables which are then detected with a mass spectrometer.

An aliquot of the sample is diluted with reagent water when dilution is necessary. A 5 mL aliquot of the dilution is taken for purging. All water samples are, by definition, low level.

7.3 Purging of Soil/Sediment and Nonaqueous Waste Samples

7.3.1 Low level

An inert gas is bubbled through a mixture of a 5 g sample (weighed to the nearest 0.1 g) and 10 mL reagent water contained in a specially designed purging chamber (Figure 2) at 40°C. The purgeables are transferred from the aqueous phase to the vapor phase, and the analysis is continued as in 7.2.

7.3.2 Medium level

A measured amount of solid (4 g ± 0.1 g) is slurried with 10 mL of methanol. An aliquot of the methanol supernatant is added to 5 mL of reagent water. An inert gas is bubbled through this solution in the water purging chamber (Figure 1) at ambient temperature. The purgeables are transferred from the aqueous phase to the vapor phase, and the analysis is continued as in 7.2.

7.3.3 Nonaqueous liquids

Nonaqueous liquids are diluted in methanol to an appropriate concentration. An aliquot of the methanol is added to 5 mL of water in the purge chamber and analyzed.

7.4 Interferences

7.4.1 Impurities in the purge gas, organic compounds out-gassing from the plumbing ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory reagent blanks. If methanol dilutions are to be analyzed, a methanol blank must also be analyzed. No samples can be analyzed until the system is demonstrated to be free of contamination.

7.4.2 Samples can be contaminated by diffusion of volatile organics (particularly fluorocarbons and methylene chloride) through the septum seal into the sample during storage and handling. A holding blank prepared from reagent water and carried through the holding period and the analysis protocol serves as a check for such contamination. One holding blank per week should be analyzed. Data are reviewed by the Technical and Quality Director.

7.4.3 Contamination by carry-over can occur whenever high level and low level samples are sequentially analyzed. To reduce carry-over, the purging device and sampling syringe must be rinsed with reagent water between sample analyses. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination. For samples containing large amounts of water-soluble materials, suspended solids, high boiling compounds or high purgeable levels, it may be necessary to wash out the purging device with a detergent solution, rinse it with distilled water, and then dry it in a 105°C oven between analyses. The trap and other parts of the system are also subject to contamination; therefore, frequent bakeout and purging of the entire system may be required.

The laboratory where volatile analysis is performed should be kept as free of solvents as possible.

7.5 Purge Device and GC/MS Operating Conditions

Assemble the purge and trap device and connect it to the injection port of the gas chromatograph. Condition the trap at 250°C in the purge mode with an inert gas flow of at least 40 mL/minute.

Gas chromatograph conditions are as follows:

Temperature program:	-10°C initial temperature. Hold for 3 minutes then ramp to 240°C at 8°C/minute.
Injection port temperature:	220°C
Purge flow:	40 mL/minute
Carrier gas:	Helium
Desorb (carrier) flow:	10 mL/minute
Interface oven temperature:	250°C

Mass spectrometer conditions are as follows:

Electron energy:	70 volts (nominal)
Mass range:	35-300
Scan time:	To give at least 5 scans per peak and not to exceed 1 second per scan

7.6 Calibration

7.6.1 Initial Calibration

7.6.1.1 Tune the GC/MS system to meet the tune criteria in Table 2, Section 9.0, by injecting BFB. Analyze each calibration standard, adding 5 uL of internal standard spiking solution directly into the syringe. Tabulate the area response of the characteristic ions against concentration for each compound and internal standard and calculate response factors (RF) for each compound using Equation 1.

Eq. 1

$$RF = \frac{A_x}{A_{is}} \quad X \quad \frac{C_{is}}{C_x}$$

Where:

A_x = Area of the characteristic ion for the compound to be measured

A_{is} = Area of the characteristic ion for the specific internal standard

C_{is} = Concentration of the internal standard

C_x = Concentration of the compound to be measured

7.6.1.2 The average response factor (RFi*) must be calculated for all compounds, including surrogates, using the 5 RF values calculated for each compound from the initial (5 point) calibration. The average response factor is calculated using Equation 2.

Eq. 2 $$RFi^* = \frac{\Sigma\ (RFi)\ \text{from 1 to 5}}{5}$$

Where,

RFi* = Average response factor for compound i
RFi = Initial response factor for compound i
Note: 5 is for the five different levels

A system performance check must be made before this calibration curve is used. Five system performance check compounds (SPCCs) are checked to ensure that a minimum response factor is achieved. These compounds are chloromethane, 1,1-dichloroethane, bromoform, 1,1,2,2-tetrachloroethane, and chlorobenzene. The minimum acceptable average response factor is 0.300 for all SPCCs except bromoform whose factor must be greater than 0.10. These compounds are used to check for both compound instability and for degradation caused by contamination in lines or actives sites in the system.

Examples of possible problem issues include the following:

> Bromoform is one of the compounds which is most likely to be purged very poorly if the purge flow is too slow. Cold spots and/or active sites in the transfer lines may adversely affect response. Response of the quantitation ion (m/z 173) is directly effected by the turning of BFB at ion m/z 174/176. Increasing the m/z 174/176 ratio to m/z 95 ratio may improve bromoform response.
>
> Chloromethane is the most likely compound to be lost if the purge flow is too fast.
>
> Tetrachloroethane and 1,1-dichloroethane are degraded by contaminated transfer lines in purge and trap systems and/or active sites in trapping materials.

7.6.1.3 Using the average response factors (RFi*) from the initial calibration, calculate and record the percent relative standard deviation (%RSD) for all compounds. Calculate the %RSD using Equation 3.

Eq. 3 $$\%RSD = SD/RFi^* \quad * 100$$

Where,

SD = Standard deviation of the average response factors for compound i
RFi* = Same as in 7.6.1.2

The %RSD for each individual calibration check compound (CCC) must be less than 30%. The CCCs are listed below.

1,1-Dichloroethene
Chloroform
1,2-Dichloropropane
Toluene
Ethylbenzene, and
Vinyl chloride.

If a %RSD greater than 30% is measured for any one CCC, then corrective action to eliminate a system leak and/or column reactive sites is required before reattempting calibration.

7.6.1.4 Linearity

7.6.1.4.1 If the %RSD of any compound is 15% or less, then the relative response factor is assumed to be constant over the calibration range, and the average response factor may be used for quantitation.

Or,

If the %RSD of any compound is 15% or less, you may construct a calibration curve using a first or second order regression fit of the five calibration points.

However,

7.6.1.4.2 If the %RSD of any compound is greater than 15%, construct a calibration curve using a first or higher order regression fit of the five calibration points for that compound. Select the lowest order regression which yields a coefficient of determination (r^2) of ≥ 0.99.

In practice, if the %RSD of any compound is greater than 15%, all compounds are quantitated from a regression fit curve.

7.6.2 Daily GC/MS Calibration

7.6.2.1 A check of the calibration curve must be performed once every 12 hours. The minimum response factors for the system performance check compounds must be 0.300 (0.10 for bromoform). If these criteria are met, the response factor of all compounds are calculated and reported.

7.6.2.2 Calculate the percent drift of the continuing calibration check compounds (CCCs) using Equation 4 listed below.

Eq. 4 % Drift (%D) $= \frac{C_I - C_C}{C_I} \text{ X } 100$

Where:

C_I - Calibration check compound standard concentration

C_C - Measured concentration

The maximum percent drift allowed for each CCC is 20%. If this criterion is not met (>20% percent drift) for any one CCC, corrective action must be taken. If no source of problem can be determined after corrective action has been taken, a new five point calibration must be generated. This criterion must be met before quantitative sample analysis begins.

NOTE: If no CCCs are required target analytes, then only the required analytes must meet the maximum 20% drift criterion.

Only after both the minimum response factors and %D criteria are met can sample analysis begin. Though the 20% maximum drift criterion does not always apply to all targets, if many targets have > 20% drift, this is a warning that system performance is deteriorating.

7.6.2.3 Internal standard responses and retention times in all standards must be evaluated during or immediately after data acquisition. If the retention time for any internal standard changes by more than 30 seconds from the latest daily (12 hours) calibration standard, the chromatographic system must be inspected for malfunctions, and corrections made as required. The extracted ion current profile (EICP) of the internal standards must be monitored and evaluated for each standard. If the EICP area for any internal standard changes by more than a factor of two (-50% to +100%) from the last daily calibration standard check, the mass spectrometer system must be inspected for malfunction and correction made as appropriate. When corrections are made, reanalysis of samples analyzed while the system was malfunctioning is necessary.

7.7 Sample Analysis

7.7.1 Water Samples

7.7.1.1 The holding time for water samples 14 days from sample collection, if preserved. All samples and standard solutions must be allowed to warm to ambient temperature before analysis.

7.7.1.2 Operating conditions for the gas chromatograph are listed in Section 7.5.

7.7.1.3 After achieving the key ion abundance criteria using BFB, calibrate the system with either the initial calibration procedure or continuing calibration procedure as appropriate.

7.7.1.4 Adjust the purge gas (helium) flow rate to 40 mL/minute. Variations from this flow rate may be necessary to achieve better purging and collection efficiencies for some compounds, particularly chloromethane and bromoform.

7.7.1.5 Remove a 5 mL syringe barrel from the oven and allow to cool to room temperature. Open the sample, which has been allowed to come to ambient temperature, and carefully pour the sample into the syringe barrel to just short of overflowing. Replace the syringe plunger and compress the sample. Open the syringe valve and vent any residual air while adjusting the sample volume to 5.0 mL. This process of taking an aliquot destroys the validity of the sample for future analysis so if there is only one VOA vial, the analyst should fill a second syringe at this time to protect against possible loss of sample integrity. This second sample is maintained only until such time as when the analyst has determined that the first sample has been analyzed properly. Filling one 20 mL syringe would allow the use of only one syringe. If a second analysis is needed from the 20 mL syringe, it must be analyzed within 24 hours. Care must also be taken to prevent air from leaking into the syringe.

7.7.1.6 Previous analyses, screening, or previous experience with a sample may indicate that a dilution is necessary. Select the volumetric flask that will allow for the necessary dilution. Intermediate dilutions may be necessary for extremely large dilutions.

Calculate the approximate volume of reagent water which will be added to the volumetric flask selected and add slightly less than this quantity of reagent water to the flask.

Inject the proper aliquot from the syringe into the volumetric flask. Dilute the flask to the mark with reagent water. Cap the flask, invert, and shake three times.

Fill a 5 mL syringe with the diluted sample.

If this is an intermediate dilution, use it and repeat the above procedure to achieve larger dilutions.

7.7.1.7 Add 5 uL of the surrogate spiking solution (Section 6.2.3) and 5 uL of the internal standard spiking solution (Section 6.2.4) through the valve bore of the syringe, then close the valve.

Attach the syringe-syringe valve assembly to the syringe valve on the purging device. Open the syringe valve and inject the sample into the purging chamber.

7.7.1.8 Close both valves and purge the sample for 11.0 ± 0.1 minutes at ambient temperature.

NOTE: Water samples may be analyzed using a heated (40°C) purge provided that data are on file demonstrating equivalent or superior performance and that standards, blanks, LCSs, and samples are analyzed using this method.

7.7.1.9 At the conclusion of the purge time, switch the device to the desorb mode, and begin the gas chromatograph temperature program. Concurrently, introduce the trapped materials to the gas chromatographic column by rapidly heating the trap to 240°C while backflushing the trap with helium at 10 mL/minute for two minutes.

7.7.1.10 While the trap is being desorbed into the gas chromatograph, empty the purging chamber of operating in manual mode. Wash the chamber with a minimum of two 5 mL flushes of reagent water to avoid carryover of pollutant compounds.

7.7.1.11 After desorbing the sample for two minutes, recondition the trap by returning the purge and trap device to the purge mode. Wait 15 seconds, then close the syringe valve on the purging device to begin gas flow through the trap. The trap temperature should be maintained at 250°C. After approximately ten minutes, turn off the trap heater open the syringe valve to stop the gas flow through the trap. When cool, the trap is ready for the next sample.

zzl 8/4/95 SEE SOP MED. F

~~7.7.1.12 If the initial analysis of a sample or a dilution of a sample has a concentration of target compounds that exceed the initial calibration range by more than 10%, the sample must be reanalyzed at a greater dilution.~~

7.7.1.13 All dilutions should keep the response of the major constituents (previously saturated peaks) in the upper half of the linear range of the calibration curve.

7.7.1.14 For water samples to be matrix spiked, add 5 uL of the matrix spike solution (Section 6.2.5) to the 5 mL of sample purged. Disregarding any dilutions, this is equivalent to a concentration of 50 ug/L of each matrix spike compound. Prepare MS/MSD pairs at the frequency described in Section 8.5.

7.7.1.15 At the conclusion of analysis, measure and record the pH of the sample to determine if it was properly preserved. <u>If a sample is found to be unpreserved, then flag data as being estimates</u>.

7.7.2 <u>Soil/Sediment/Nonaqueous Waste Samples</u>

7.7.2.1. Low Level Soil Method

The holding time for soil and other non-aqueous samples is 14 days. The low level soil method is based on purging a heated sediment/soil sample mixed with reagent water containing the surrogate and internal standards under the same conditions as the samples. A specially designed purge vessel is used for these analyses (See Figure 2). Screen the sample before analysis.

The GC/MS system should be set up as previously discussed. This should be done prior to the preparation of the sample to avoid loss of volatiles from standards and sample. A heated purge calibration curve must be prepared and used for the quantitation of all samples analyzed with the low level-method. Follow the initial and daily calibration instructions given, taking notice that a 40°C purge must be used.

To prepare the reagent water containing the surrogates and internal standards, remove the plunger from a 5 mL "Luerlock" type syringe equipped with a syringe valve and fill until overflowing with reagent water. Replace the plunger and compress the water to vent trapped air. Adjust the volume to 5 mL. Add 5 uL each of the surrogate spiking solution and the internal standard solution to the syringe through the valve. The addition of 5 uL of the surrogate spiking solution to 5 g of soil/sediment is equivalent to 50 ug/Kg of each surrogate standard.

The sample (for volatile organics) consists of the <u>entire</u> contents of the sample container (do not discard any supernatant liquids). Mix the contents of the sample container with a narrow metal spatula. Using a top loading balance, weigh an appropriate amount (0.5 - 5g) of sample into a tared purge device. Note and record the actual weight to the nearest 0.1 g.

Add 5 mL of reagent water to the purge vessel, cap, shake to disperse the sample, and attach it to the ALS-2016 unit. Spike a syringe containing 5 mL of reagent water with internal standards and surrogates, and inject through the valve into the sample. Attach the heating jacket to the purge vessel in order to bring the sample to 40°C ± 1°C, then purge the sample for 11.0 ± 0.1 minutes

Proceed with the analysis as for water samples. Use 10 mL of the sample reagent water for the reagent blank.

For matrix spikes of low level solids/sediments add 5 uL of the matrix spike solution to the 10 mL of water. The concentration for a 5 g sample would be equivalent to 50 ug/Kg of each matrix spike standard.

7.7.2.2. Medium Level Soil/Other Solids Method

The medium level method is based on extracting the sample with methanol. An aliquot of the methanol extract is added to the reagent water containing the surrogate and internal standards and purged at ambient temperature. All samples with a dilution factor greater than 10 (e.g., those which require an aliquot <0.5g) should be analyzed by the medium level method. If saturated peaks or concentrations exceeding the calibration range occurred or would occur when a 0.5 g sample was analyzed, the medium level method must be used.

The GC/MS system should be set up as previously discussed. This should be done prior to the addition of the methanol extract to reagent water. Initial and continuing calibrations are performed by adding standards in methanol to reagent water purging at ambient temperature.

NOTE: Samples may be analyzed using a heated (40°C) purge provided that data are on file demonstrating superior performance and that standards, blanks, LCSs, and samples are analyzed accordingly.

The sample (for volatile organics) consists of the entire contents of the sample container. Do not discard any supernatant liquids. Mix the contents of the sample container with a narrow metal spatula. Using a top loading balance, weigh 4 g (wet weight) of sample into a tared 15 mL vial. Note and record the actual weight to the nearest 0.1 g.

Quickly add 9.0 mL of methanol, then 1.0 mL of the surrogate spiking solution to the vial. Cap and shake for 2 minutes. Note: Perform rapidly to avoid loss of volatile organics. Perform in a laboratory free of solvent fumes.

Using a disposable pipette, transfer approximately 1 mL of extract into a GC vial for storage. The remainder may be disposed of. Transfer approximately 1 mL of the reagent methanol to a GC vial for use as the method blank for each case or set of 20 or fewer samples, whichever is more frequent. These extracts may be stored in the dark at 4°C (±2°C) prior to analysis.

The volume of methanol added to the 5 mL of water being purged should be kept constant. Therefore, add to the 5 mL syringe whatever volume of methanol is necessary to maintain a volume of 100 uL added to the syringe.

Dilute an aliquot of the methanol extract if necessary and then take 100 uL for analysis.

Remove the plunger from a 5 mL "Luerlock" type syringe equipped with a syringe valve and fill until overflowing with reagent water. Replace the plunger and compress the water to vent trapped air. Adjust the volume to 4.9 mL. Pull the plunger back to 5 mL to allow volume for the addition of sample and standards. Add 5 uL of the internal standard solution.

Attach the syringe-syringe valve assembly to the syringe valve on the purging device. Open the syringe valve and inject the water/methanol sample into the purging chamber. A water purge vessel is used for analysis of methanol dilutions (Figure 1).

Proceed with the analysis. Analyze all reagent blanks on the same instrument as the samples. The standards should also contain 100 uL of methanol to simulate the sample conditions.

For a matrix spike the medium level samples, add 8.0 mL of methanol, 1.0 mL of surrogate spike solution, and 1.0 mL of matrix spike solution. This results in a 6,200 ug/Kg concentration of each matrix spike standard when added to a 4 g sample. Add a 100 uL aliquot of this extract to 5 mL of water for purging.

7.8 Data Interpretation and Calculations

7.8.1 Qualitative Analysis

The compounds listed in the in Table 1 shall be identified by an analyst competent in the interpretation of mass spectra by comparison of the sample mass spectrum to the mass spectrum of a standard of the suspected compound. Two criteria must be satisfied to verify the identifications:

(1) Elution of the sample component at the same GC relative retention time as the standard component,

(2) Correspondence of the sample component and standard component mass spectra.

7.8.1.1 For establishing correspondence of the relative retention time (RRT), the sample component RRT must compare within ± 0.06 RRT units of the RRT of the standard component. For reference, the standard must be run on the same shift as the sample. If co-elution of interfering components prohibits accurate assignment of the sample component RRT from the total ion chromatogram, the RRT should be assigned by using extracted ion current profiles for ions unique to the component of interest.

7.8.1.2 For comparison of standard and sample component mass spectra, mass spectra obtained on the same GC/MS may be used for identification purposes, <u>only</u> if the GC/MS meets the daily tuning requirements for BFB. These standard spectra may be obtained from the run used to obtain reference RRTs.

7.8.1.3 The requirements for qualitative verification by comparison of mass spectra are as follows:

The qualitative identification of compounds determined by this method is based on retention time, and on comparison of the sample mass spectrum, after background correction, with characteristic ions in a reference mass spectrum. The reference mass spectrum must be generated by the laboratory using the conditions of this method. The characteristic ions from the reference mass spectrum are defined to be the three ions of greatest relative intensity, or any ions over 30% relative intensity if less than three such ions occur in the reference spectrum. Compounds should be identified as present when the criteria below are met.

The relative intensities of ions must agree within plus or minus 30 percentage points between the standard and sample spectra. (Example: For an ion with an abundance of 50% in the standard spectra, the corresponding sample abundance must be between 20 and 80 percent).

Ions greater than 10% in the <u>sample</u> spectrum but not present in the <u>standard</u> spectrum must be considered and accounted for by the analyst making the comparison. The verification process should favor false positives.

7.8.1.4 If a compound cannot be verified by all of the criteria above, but in the technical judgement of the mass spectral interpretation specialist, the identification is correct, then the analyst shall report that identification and proceed with quantification.

7.8.1.5 A library search is performed for non-target sample components for the purpose of tentative identification where requested. For this purpose, the 1990 release of the NIST Mass Spectral Library (or more recent release), containing approximately 50,000 spectra, is used. Computer generated library search routines must not use normalization routines that would misrepresent the library or unknown spectra when compared to each other.

Up to 20 non-surrogate, non-target organic compounds of greatest apparent concentration are tentatively identified via a forward search of the NIST mass spectral library. (Substances with responses less than 10% of the internal standard are not required to be searched in this fashion.) Only after visual comparison of sample spectra with the nearest library searches does the mass spectral interpretation specialist assign a tentative identification. Guidelines for making tentative identification are:

> Relative intensities of major ions in the reference spectrum (ions greater than 10% of the most abundant ion) should be present in the sample spectrum.
>
> The relative intensities of the major ions should agree within ±20 percentage points. (Example: For an ion with an abundance of 50 percent of the standard spectra, the corresponding sample ion abundance must be between 30 and 70 percent.)
>
> Molecular ions present in reference spectrum should be present in sample spectrum.
>
> Ions present in the sample spectrum but not in the reference spectrum should be reviewed for possible background contamination or presence of co-eluting compounds.
>
> Ions present in the reference but not in the sample spectrum should be reviewed for possible subtraction from the sample spectrum because of background contamination or co-eluting compounds. Data system library reduction programs can sometimes create these discrepancies.

If in the technical judgement of the mass spectral interpretation specialist, no valid tentative identification can be made, the compound should be reported as <u>unknown</u>. The mass spectral specialist should give additional classification of the unknown compound, if possible (e.g., unknown aromatic, unknown hydrocarbon, unknown acid type, unknown chlorinated compound). If probable molecular weights or carbon numbers can be distinguished, include them.

7.8.2 Quantitative Analysis

7.8.2.1 Target components identified shall be quantified by the internal standard method. The internal standards used are listed in Table 2. The EICP area of the characteristic ions of analytes listed in Tables 3 and 4 are used.

7.8.2.2 Internal standard responses and retention times in all standards must be evaluated during or immediately after data acquisition. If the retention time for any internal standard changes by more than 30 seconds from the latest daily (12 hour) calibration standard, the chromatographic system must be inspected for malfunctions, and corrections made as required. The extracted ion current profile (EICP) of the internal standards must be monitored and evaluated for each sample, blank, matrix spike and matrix spike duplicate. If the EICP area for any internal standard changes by more than a factor of two (-50% to +100%), the mass spectrometric system must be inspected for malfunction and correction made as appropriate. When corrections are made, reanalysis of sample analyzed while the system was malfunctioning is necessary.

If after reanalysis, the EICP area for all internal standards are inside the required limits (-50% to +100% of that internal standard in the mid low standard analyses for that day), then the problem with the first analysis is considered to have been within the control of the laboratory. Therefore, only submit data from the analysis with EICPs within the control limits.

If the reanalysis of the sample does not solve the problem, e.g., the EICP area are outside the control limits for both analyses report the initial analysis only and note the presence of matrix interferences.

7.8.2.3 Linearity is assumed for all targets which had ≤ 15% RSD in the initial calibration. For these targets, their average response factors may be used for quantitation (Section 7.8.3); otherwise, the calibration curve must be used (Section 7.8.4).

7.8.2.4 Xylenes (o,m, & p - isomers) are to be reported as xylenes (total). Since m- and p-xylene co-elute, the xylenes must be quantitated as m/p-xylene. The concentration of all xylene isomers must be added together to give the total.

1,2-dichloroethene (trans and cis stereoisomers) are usually reported as 1,2-dichloroethene (total). The concentrations of both isomers must be added together to give the total.

7.8.3 Calculations For Targets Whose %RSD ≤15%.

7.8.3.1 Water

Eq. 5 Concentration $\text{ug/L} = \dfrac{(A_x)(I_s)}{(A_{is})\,(RFi^*)\,(V_o)}$

Where:

A_X = Area of the characteristic ion for the compound to be measured.

A_{is} = Area of the characteristic ion of the specific internal standard from Table 4.

I_s = Amount of internal standard added in nanograms (ng).

V_o = Volume of water purged in milliliters (mL) (take into account any dilutions).

RFi* = Average response factor for the compound being measured.

7.8.3.2 Sediment/Soil Waste (medium level)

Eq 6. Concentration in ug/g (Dry weight basis)

$$= \frac{(A_X)(I_s)(V_t)}{(A_{is})(RFi^*)(V_i)(W_s)(D)}$$

Note: For analyses to be reported on an as-received basis, omit the division by "D".

Where:

A_X, I_S, A_{IS}, RFi* = Same as for water, above

V_t = Volume of total extract (uL) (use 10,000 uL or a factor of this when dilutions are made)

V_i = Volume of extract added (uL) for purging

D = $\frac{100 - \%\ \text{moisture}}{100}$

W_s = Weight of sample extracted (g) or purged

Note: For analyses to be reported on an as-received basis, omit the division by "D".

An estimated concentration for non-target components tentatively identified is calculated by the internal standard method. For quantitation, the nearest internal standard free of interference is used.

The formula for calculating non-target concentrations is the same as above. Total area counts (or peak heights) from the total ion chromatograms are to be used for both the compound to be measured and the internal standard. A average response factor (RFi*) of one is to be assumed. The value from this quantitation shall be qualified as estimated and this estimated concentration should be calculated for all tentatively identified compounds as well as those identified as unknowns.

Target analytes are usually reported to two significant figures if $\geq$ 10 ug/L or 10 ug/Kg. Targets present at <10 ug/L or ug/Kg, and tentatively identified compounds, are usually reported to one significant figure.

7.8.4 Quantitation For Targets Whose %RSD >15%

When a regression fit is used, the concentration is taken directly from the curve and multiplied by any dilution factor and divided by the percent solids.

8.0 QUALITY CONTROL

8.1 Tuning

8.1.1 The twelve (12) hour time period for GC/MS system tuning and standards calibration (initial or continuing calibration criteria) begins at the moment of injection of the BFB analysis that the laboratory submits as documentation of a compliant tune. The time period ends after twelve (12) hours has elapsed according to the system clock.

8.1.2 Tune to meet criteria as shown in Table 2.

Note: All instruments conditions must be identical to those used in sample analysis, except that a different temperature may be used. .

8.1.3 BFB criteria must be met before any standards, samples, or blanks are analyzed. Any samples analyzed when tuning criteria have not been met will require reanalysis.

8.2 Calibration

8.2.1 After tuning criteria have been met but prior to the analysis of samples and required blanks, the GC/MS system must be initially calibrated at a minimum of five concentrations to determine the linearity of response utilizing target compound standards. Once the system has been calibrated, the calibration must be verified each twelve (12) hour time period for each GC/MS system.

8.2.2 Initial calibration of volatile target compounds is required at a minimum of 5 concentration levels (normal concentration levels are 10, 20, 50, 100, and 200 ug/L). This will result in 50-1000 total ng analyzed. Surrogate and internal standards are used with each of the calibration standards. Analyze all method blanks and standards under the same conditions as the sample.

8.2.3 System Performance Check Compounds (SPCC)

8.2.3.1 The initial calibration is valid only after the minimum response factors for SPCCs have been met. Only after both these criteria are met can sample analysis begin.

8.2.3.2 A calibration standard(s) containing all volatile target compounds, including all required surrogates, must be analyzed each twelve hours during analysis. The SPCCs must meet the minimum response factor criteria.

8.2.4 Calibration Check Compounds

After the system performance check is met, the %Drift of the CCCs listed in the following table must be checked to ensure the validity of the initial calibration.

Calibration Check Compounds

1,1-Dichloroethene
Chloroform
1,2-Dichloropropane
Toluene
Ethylbenzene
Vinyl chloride

If the percent drift for each target compound is less than 20.0%, the initial calibration is assumed to be valid. If the criteria are not met (>20.0% drift), for any one calibration check compound, corrective action must be taken.

Problems similar to those listed under SPCC could affect these criteria. If no source of the problem can be determined after corrective action has been taken, a new initial five point calibration must be generated. These criteria must be met before sample analysis begins.

If no CCCs are required target analytes, then only the required analytes must meet the 20% drift criterion.

8.3 Method Blanks

A method blank is a volume of deionized, distilled laboratory water which is carried through the entire analytical scheme. The method blank volume must be approximately equal to the sample volumes or sample weights being processed.

8.3.1 For the analysis of volatile target compounds, a method blank analysis must be performed once for each 12 hour time period. A method blank must always follow any standard analysis.

8.3.2 A method blank for volatile analysis must contain less than five times (5X) the EQL of methylene chloride, acetone, and 2-butanone.

For all other target compounds, the method blank must contain less than the EQL of any single target analyte.

If a laboratory method blank exceeds these criteria, the analyst must consider the analytical system to be out of control. The source of the contamination must be investigated and appropriate corrective measures must be taken and documented before further sample analysis proceeds. All samples processed with a method blank that is out of control (e.g., contaminated) must be reextracted/repurged and reanalyzed. The result of blank analyses will be reported in text form.

All sample concentration data will be reported uncorrected for blanks.

8.4 Laboratory Control Sample (LCS)

8.4.1 A LCS is prepared by spiking a water blank with the spike solution described in Section 6.2.5.

8.4.2 A LCS will be analyzed at a frequency of once per tune.

8.4.3 LCSs must pass the acceptance criteria listed in Section 9.0, Table 6. If the LCS fails, perform corrective action and reanalyze.

8.5 Surrogates

Surrogate standard determinations are performed on all samples and blanks. All samples and blanks are fortified with surrogate spiking compounds before purging or extraction in order to monitor preparation and analysis of samples.

Eq. 7 $$\% \text{ Surrogate Recovery} = \frac{Q_d}{Q_a}$$

Where:

Q_d = Quantity determined by analysis
Q_a = Quantity added to sample

8.5.1 Surrogate Recovery Limits Are As Follows:

REQUIRED SURROGATE SPIKE RECOVERY LIMITS

Surrogate Compound	Water	Low/Medium Soil
Toluene-d_8	88-110	81-117
4-Bromofluorobenzene	86-115	74-121
1,2-Dichloroethane	76-114	70-121

Surrogate spike recovery limits for TCLP leachates, and wastes are determined statistically from actual laboratory data, and are subject to change quarterly.

8.5.2 Method Blank Surrogate Spike Recovery

The laboratory must take the actions listed below if the recovery of any surrogate compound in the volatiles fraction of the method blank is outside of the required surrogate spike recovery limits.

Check calculations to ensure that there are no errors; check internal standard and surrogate spiking solutions for degradation, contamination, etc.; also check instrument performance.

Reanalyze the blank or extract if steps above fail to reveal the cause of the noncompliant surrogate recoveries.

If the blank is a methanol extract for medium level soil samples, reextract and reanalyze the blank if reanalysis alone fails to reveal the cause of the noncompliant surrogate recoveries.

If all measures above fail to correct the problem, the analytical system must be considered out of control. The problem must be corrected before continuing. This may mean recalibrating the instrumentation but it may also mean more extensive action. The specific corrective action is left up to the GC/MS operator. When surrogate recovery(ies) in the blank is outside of the required windows, all samples associated with that blank must be reanalyzed.

8.5.3 Sample Surrogate Spike Recovery

The laboratory must take the action listed below if the recovery of any one surrogate compound in the volatiles fraction of the sample is outside of the control limits.

Check calculations to ensure that there are no errors; check internal standard and surrogate spiking solutions for degradation, contamination, etc.; also check instrument performance.

If the above steps fail to reveal a problem, then reanalyze the sample or extract. If reanalysis of the sample or extract solves the problem, then the problem was within the laboratory's control. Therefore, <u>only submit</u> data from analyses with surrogate spike recoveries <u>within</u> limits.

If the sample was a soil extracted with methanol and the steps above fail to solve the problem, then reextract and reanalyze the sample. If the reextraction and reanalysis solves the problem, then the problem was instrumental. <u>Only submit</u> data from the extraction and analysis with surrogate spike recoveries <u>within</u> the control windows.

If the reextraction and/or reanalysis of the samples does not solve the problem; e.g., surrogate recoveries are outside the control limits for both analyses, then report the initial analysis and describe the confirmation in text.

If the sample with surrogate recoveries outside the limits is the sample used for the matrix spike and matrix spike duplicate, and the surrogate recoveries of the matrix spike and matrix spike duplicate show the same pattern (e.g., outside the limits), then the sample, matrix spike, and matrix spike duplication do <u>not</u> require reanalysis. Document in the narrative the similarity in surrogate recoveries.

8.6 <u>Matrix Spike/Matrix Spike Duplicate Analyses (MS/MSD)</u>

8.6.1 Frequency of Analysis

Perform an MS/MSD analysis on at least every 20th sample of each matrix type (water, soil, and waste). One TCLP (ZHE) leachate of each waste type (as determined by the client) is spiked with all targets. No MS/MSD pairs are performed on TCLP leachates.

8.6.2 Matrix Spike % Recovery - Calculate the percent recovery for each spike target using the equation below.

Eq. 8 $$\text{Matrix Spike Percent Recovery} = \frac{SSR - SR}{SA} \times 100$$

Where:

SSR = Spike sample result
SR = Sample result
SA = Spike added for spiking mix

If the percent recovery is outside the range listed in Section 9.0, Table 6, flag the data noting that matrix interferences are present in these samples.

8.6.3 Relative Percent Difference (RPD) - Calculate the RPD for each spike target using the equation below.

Eq. 9 $$RPD = \frac{D_1 - D_2}{(D_1 + D_2)/2} \times 100$$

Where:

RPD = Relative Percent Difference
D_1 = First Sample Value
D_2 = Second Sample Value (duplicate)

If the RPD is greater than that listed in Section 9.0, Table 6, flag this in the narrative.

9.0 TABLES/FIGURES

Table 1

Normal Target Compounds
Estimated Quantitation Limits (EQLs)

Volatiles	CAS Number	Quantitation limits Water*, µg/L	Low soil/sediment*,** µg/Kg
Chloromethane	74-87-3	10	10
Bromomethane	74-83-9	10	10
Vinyl chloride	75-01-4	10	10
Chloroethane	75-00-3	10	10
Methylene chloride	75-09-2	5	5
Acetone	67-64-1	100	100
Carbon disulfide	75-15-0	5	5
1,1-Dichloroethene	75-35-4	5	5
1,1-Dichloroethane	75-34-3	5	5
1,2-Dichloroethene (total)	540-59-0	5	5
Chloroform	67-66-3	5	5
1,2-Dichloroethane	107-06-2	5	5
2-Butanone	78-93-3	100	100
1,1,1-Trichloroethane	71-55-6	5	5
Carbon tetrachloride	56-23-5	5	5
Vinyl acetate	108-05-4	50	50
Bromodichloromethane	75-27-4	5	5
1,2-Dichloropropane	78-87-5	5	5
cis-1,3-Dichloropropene	10061-01-5	5	5
Trichloroethene	79-01-6	5	5
Dibromochloromethane	124-48-1	5	5
1,1,2-Trichloroethane	79-00-5	5	5
Benzene	71-43-2	5	5
trans-1,3-Dichloropropene	10031-02-6	5	5
Bromoform	75-25-2	5	5
4-Methyl-2-pentanone	108-10-1	50	50
2-Hexanone	591-78-6	50	50
Tetrachloroethene	127-18-4	5	5
Toluene	108-88-3	5	5
1,1,2,2-Tetrachloroethane	79-34-5	5	5
Chlorobenzene	108-90-7	5	5
Ethyl benzene	100-41-4	5	5
Styrene	100-42-5	5	5
Xylenes (total)	1330-20-8	5	5

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediments are based on wet weights. The quantitation limits calculated on a dry weight basis will be higher than those listed.

Table 1 (Continued)

Additional Appendix IX Target Compounds
Estimated Quantitation Limits (EQLs)

Volatiles	CAS Number	Quantitation limits Water*, µg/L	Low soil/sediment*,** µg/Kg
Acetonitrile	75-05-8	10	10
Acrolein	107-02-8	20	20
Acrylonitrile	107-13-1	10	10
Ethyl methacrylate	97-83-2	5	5
Allyl chloride	107-05-1	5	5
Iodomethane	74-88-4	10	10
Methacrylonitrile	126-98-7	20	20
Methylene bromide	74-95-3	5	5
Methyl methacrylate	80-62-6	5	5
Propionitrile	107-12-0	20	20
1,1,1,2-Tetrachloroethane	630-20-6	5	5
Chloroprene	126-99-8	5	5
1,2-Dibromo-3-chloropropane	96-12-8	10	10
1,2-Dibromoethane	106-93-4	5	5
trans-1,4-Dichloro-2-butene	110-57-6	5	5
Dichlorodifluoromethane	75-71-8	10	10
Trichlorofluoromethane	75-69-4	5	5
1,2,3-Trichloropropane	96-18-4	5	5

* Specific quantitation limits are highly matrix dependent. The quantitation limits listed herein are provided for guidance and may not always be achievable.

** Quantitation limits listed for soil/sediments are based on wet weights. The quantitation limits calculated on a dry weight basis will be higher than those listed.

Table 2

BFB Key Ions and Abundance Criteria

Mass	Ion Abundance Criteria
50	15 - 40 percent of the base peak
75	30 - 60 percent of the base peak
95	Base peak, 100 percent relative abundance
96	5 - 9 percent of the base peak
173	Less than 2 percent of mass 174
174	Greater than 50 percent of the base peak
175	5 - 9 percent of mass 174
176	Greater than 95 percent but less than 101 percent of mass 174
177	5 - 9 percent of mass 176

Table 3

Characteristic Ions For Surrogate and Internal Standards For Volatile Organic Compounds

Parameter	Primary ion	Secondary ion(s)
<u>Surrogate standards</u>		
4-Bromofluorobenzene	95	174, 176
1,2-Dichloroethane	65	120
Toluene d-8	98	70, 100
<u>Internal standards</u>		
Bromochloromethane	128	49, 130, 51
1,4-Difluorobenzene	114	63, 88
Chlorobenzene d-5	117	82, 119

Table 4, Characteristic Ions for Volatile Compounds

Parameter	Primary ion*	Secondary ion(s)
Chloromethane	50	52
Bromomethane	94	96
Vinyl chloride	62	64
Chloroethane	64	66
Methylene chloride	84	49, 51, 86
Acetone	43	58
Carbon disulfide	76	78
1,1-Dichloroethane	96	61, 98
1,1-Dichloroethene	63	65, 83, 85, 998, 100
1,2-Dichloroethene	96	61, 98
Chloroform	83	85
1,2-Dichloroethane	62	64, 100, 98
2-Butanone	72	57
1,1,1-Trichloroethane	97	99, 117, 119
Carbon Tetrachloride	117	119, 121
Vinyl acetate	43	86
Bromodichloromethane	83	85
1,1,2,2-Tetrachloroethane	83	85, 131, 133, 166
1,2-Dichloropropane	63	65, 114
trans-1,3-Dichloropropene	75	77
Trichloroethene	130	95, 97, 132
Dibromochloromethane	129	208, 206
1,1,2-Trichloroethane	97	83, 85, 99, 132, 134
Benzene	78	-
cis-1,3-Dichloropropene	75	77
Bromoform	173	171, 175, 250, 252, 254, 256
2-hexanone	43	58, 57, 100
4-Methyl-2-pentanone	43	58, 100
Tetrachloroethene	164	129, 131, 166
Toluene	92	91
Chlorobenzene	112	114
Ethyl benzene	106	91
Styrene	104	78, 103
Total xylenes	106	91
Dichlorodifluoromethane	85	85, 87, 101, 103
Acetonitrile	41	41, 40, 39
Methyl iodide (iodomethane)	142	142, 127, 141
Trichlorofluoromethane	101	103, 66
Propionitrile	54	54, 52, 55, 40
Allyl chloride	76	76, 41, 39, 78
Methacrylonitrile	41	41, 67, 39, 52, 66
Dibromomethane	93	93, 174, 95, 172, 176

* The primary ion should be used unless interferences are present; in which case, a secondary ion may be used.

Table 4, Characteristic Ions for Volatile Compounds (Continued)

Parameter	Primary ion*	Secondary ion(s)
Chloroprene	53	53, 88, 90, 51
1,2-Dibromoethane	107	107, 109, 93, 188
Methyl methacrylate	69	69, 41, 100, 39
1,1,1,2-Tetrachloroethane	131	131, 133, 117, 119, 95
1,2,3-Trichloropropane	110	75, 77, 112, 97
1,4-Dichloro-2-butene	75	75, 53, 77, 124, 89
Ethyl methacrylate	69	69, 41, 99, 86, 114
1,2-Dibromo-3-chloropropane	157	157, 75, 155, 77
Acrolein	56	55, 58
Acrylonitrile	53	52, 51

* The primary ion should be used unless interferences are present; in which case, a secondary ion may be used.

Table 5

Volatile Internal Standards With Corresponding Target Analytes Assigned For Quantitation

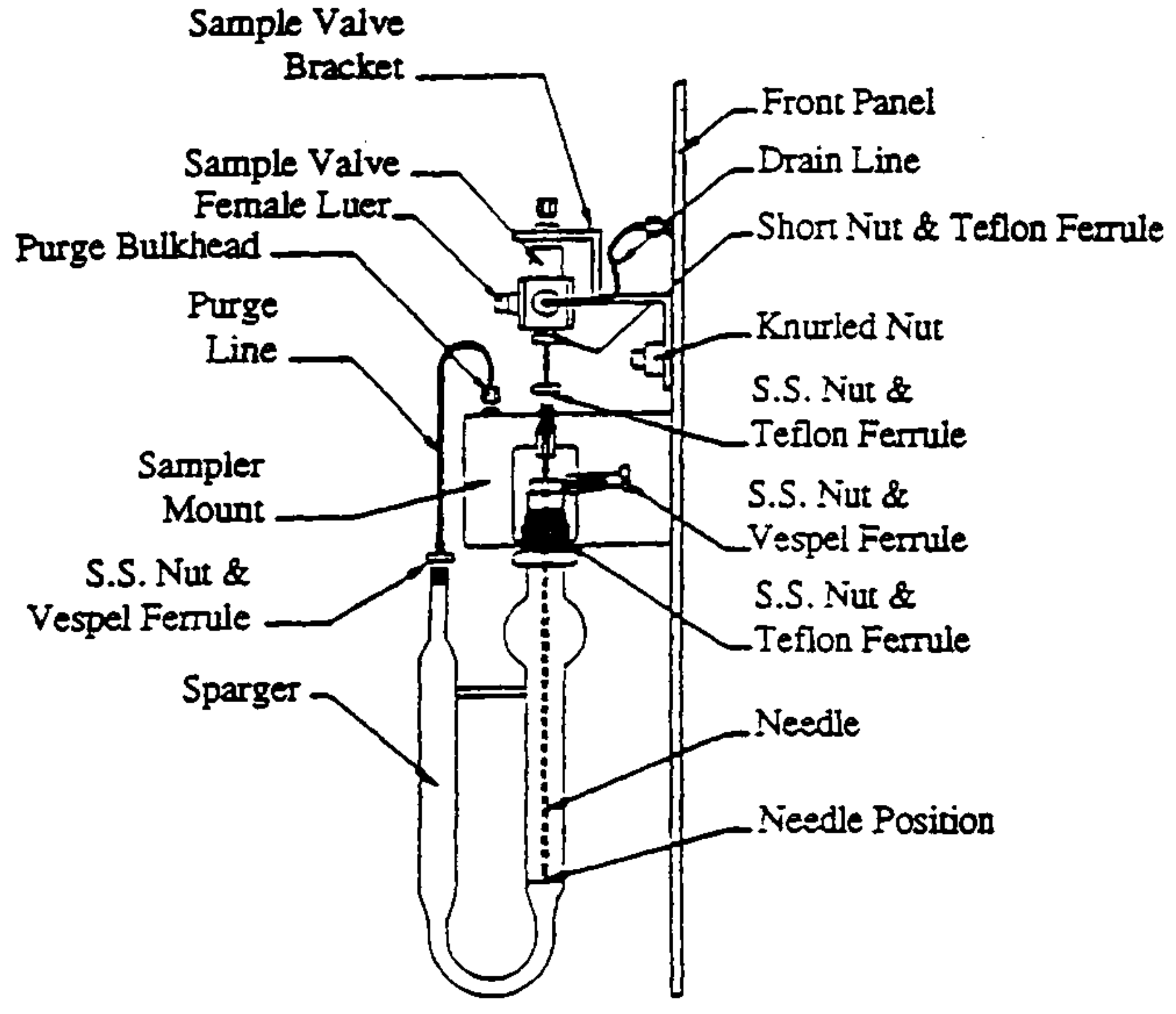
Bromochloromethane	1,4-Difluorobenzene	Chlorobenzene-d5
Chloromethane	2-Butanone	2-Hexanone
Bromomethane	1,1,1-Trichloroethene	4-Methyl-2-pentanone
Vinyl Chloride	Carbon tetrachloride	Tetrachloroethene
Chloroethane	Vinyl acetate	1,1,2,2-Tetrachloroethane
Methylene chloride	Bromodichloromethane	Toluene
Acetone	1,2-Dichloropropane	Chlorobenzene
Carbon Disulfide	trans-1,3-Dichloropropene	Ethylbenzene
1,1-Dichloroethene	Trichloroethene	Styrene
1,1-Dichloroethane	Dibromochloromethane	Xylene (total)
1,2-Dichloroethene (total)	1,1,2-Trichloroethane	Bromofluorobenzene (surrogate)
Chloroform	Benzene	Toluene-d$_8$ (surrogate)
1,2-Dichloroethane	cis-1,3-Dichloropropene	Ethyl methacrylate
1,2-Dichloroethane-d$_4$ (surrogate)	Bromoform	1,2,3-Trichloropropane
Acrolein	Methacrylonitrile	Methyl methacrylate
Acrylonitrile	1,2-Dibromoethane	1,1,2-Tetrachloroethane
Dichlorodifluoromethane	Chloroprene	1,2-Dibromo-3-chloropropane
Iodomethane	Dibromomethane	
Trichlorofluoromethane		
Acetonitrile		
Proprionitrile		
Allyl chloride		

Table 6

Matrix Spike/LCS Recovery Limits

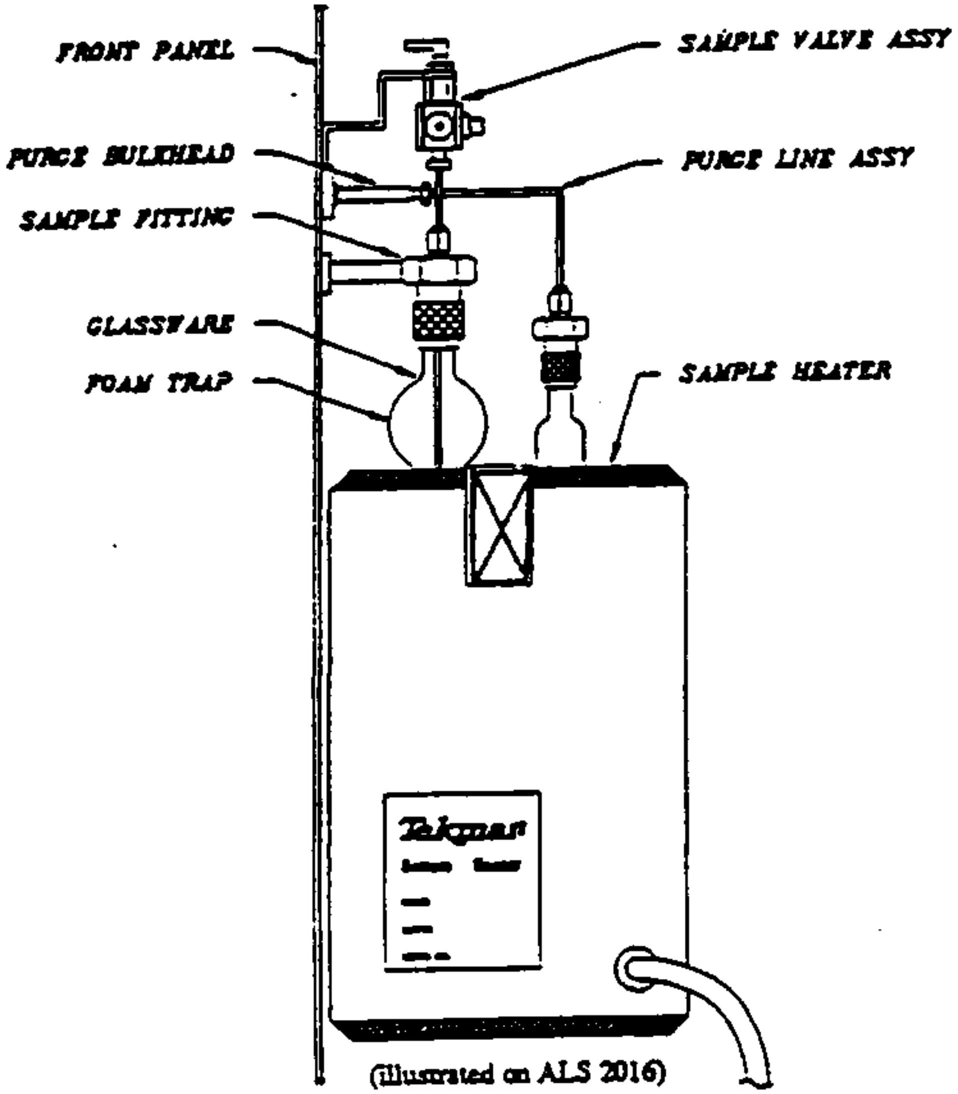
Matrix Spike Compound	Water/Soil	RPD
1,1-Dichloroethene	75.1-113	40
Trichloroethene	81.2-127	40
Chlorobenzene	80.6-115	40
Toluene	77.7-126	40
Benzene	77.5-117	40

Figure 1
Needle Sparger for LSC2000



Needle Sparger for the LSC 2000

Figure 2
Low Level Soils Impinger



(illustrated on ALS 2016)

Figure 3
Trap Specifications (VOCARB 3000 Multibed Purge Trap for Volatiles)

Recommended Conditions
Temp. (°C) / Time (min.)

Trap	Desorb	Bake	Precondition
A	180/4	180/7	180/30
B	180/4	180/7	180/30
C	180/4	180/7	180/30
D	180/4	180/7	180/30
E	180/4	180/7	180/30
F	180/4	180/7	180/30
G	180/4	180/7	180/30
H	230/6	250/5	260/60
I (VOCARB 4000)	250/10	260/4	270/60
J (BTEXTRAP)	250/6	260/4	270/60
K (VOCARB 3000)	250/6	260/4	270/60

Trademarks

Carbopack — Supelco, Inc.
Carbosieve — Supelco, Inc.
Carboxen — Supelco, Inc.
SP — Supelco, Inc.
Supeltex — Supelco, Inc.
Swagelok — Crawford Fitting Co.
Tekmar — Tekmar Co.
Tenax — Enka Research Institute Arnhem
VOCARB — Supelco, Inc.

*German Pat. No. 1935500. Patent holder — Badische Anilin-& Soda-Fabrik Aktiengesellschaft.

SAVE THIS DATA SHEET!
It Contains Important Information About This Product.

Tekmar® Purge Trap

This trap was designed for use with Tekmar LSC-1, LSC-2, LSC-3, LSC-2000 and LSC-4000 purge and trap instruments. The Swagelok® nut attached to the trap has been stamped with a letter designation for identification. Use the chart below for future identification of this trap as well as other purge traps available from Supelco. Custom traps can be obtained through our Order Processing Department.

Trap	Trap Contents	Cat. No.
A	Tenax®	2-1059
B	Tenax/silica gel	2-1060
C	Tenax/silica gel/charcoal	2-1061
D	Tenax/charcoal	2-1062
E	SP™-2100/Tenax/silica gel/charcoal	2-0294
F	SP-2100/Tenax/silica gel	2-0293
G	SP-2100/Tenax	2-0295
H	Carbopack™ B/Carbosieve™ S-III*	2-0321
I (VOCARB™ 4000)	Carbopack C & B/Carboxen™ 1000 & 1001	2-0308
J (BTEXTRAP™)	Carbopack C & B	2-1064
K (VOCARB 3000)	Carbopack B/Carboxen 1000 & 1001	2-1066
Z	custom order	———

Installation

See instrument users manual for proper trap installation instructions. Since it is necessary to periodically replace the trap, you must use a removable ferrule on the inlet (top) end of the trap. We recommend 1/8" flexible graphite ferrules (e.g., Supeltex™ M-4, Cat. No. 2-2491). Once you have installed the trap, check both fittings for leaks while operating in the purge mode and the desorb mode.

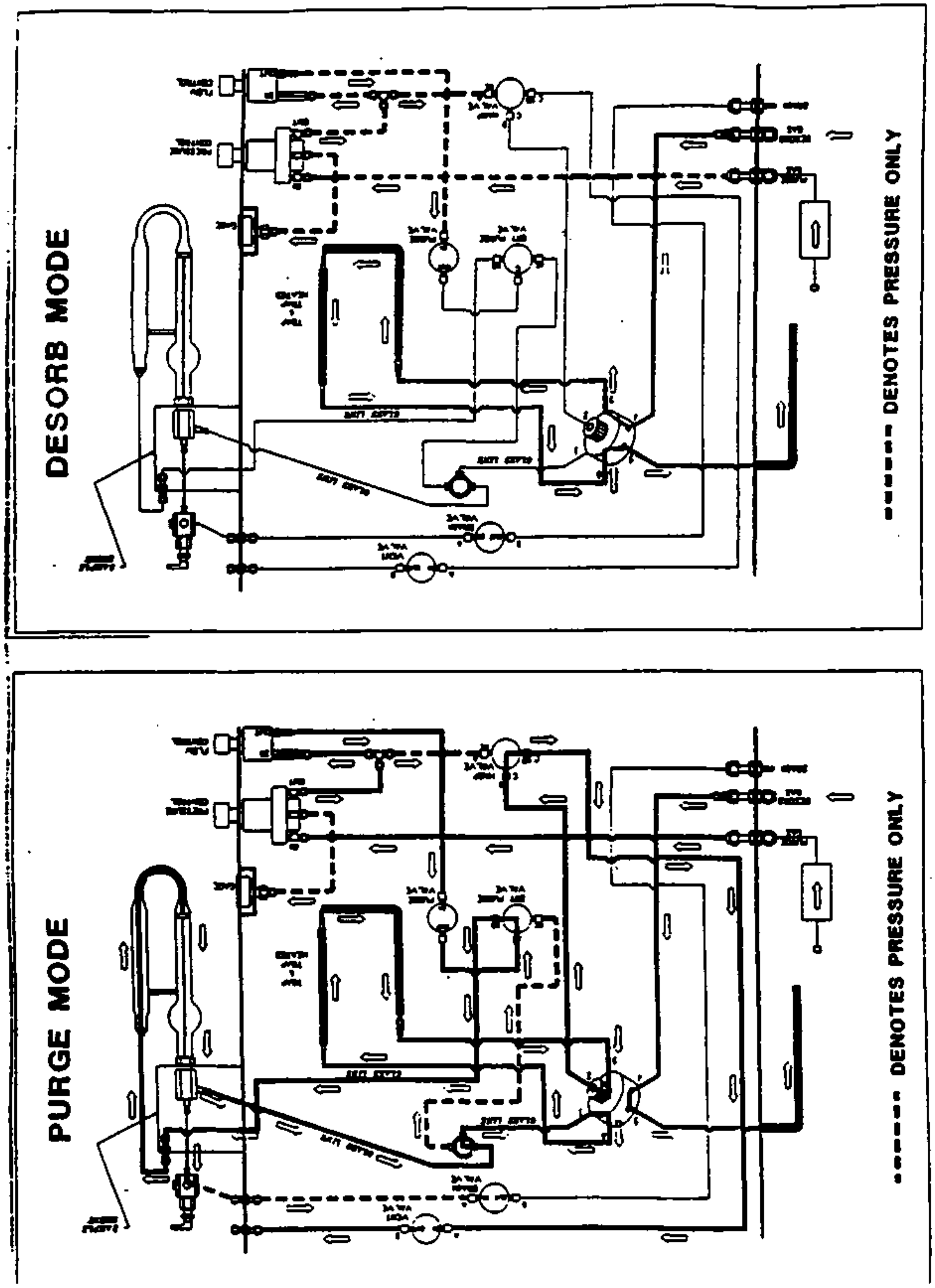
Operating Conditions

All traps must be preconditioned prior to use. This not only eliminates contamination, but also assures uniform performance during the lifetime of the trap. We recommend using conditions specified in the chart on the back of this form when setting time and temperature parameters. Purge times and sample volumes are dependent on compounds of interest and/or the specific method being followed.

[illegible]

SUPELCO
Bellefonte, PA

Figure 4
Purge Mode, Desorb Mode Illustration



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SOP MODIFICATION FORM

Use this form for minor modifications of SOPs. Reference the section to be changed and fully describe the change(s). If needed for maximum clarity, rewrite the whole section rather than listing several changes to it. If a single procedural change means changes in many sections of the SOP, it is best to amend and reissue the SOP. Otherwise, incorporate the changes into the body of the SOP at its annual review.

The original of this form is filed with the original version of the SOP. Copies are issued to every controlled copy book.

SOP Name: Determination of Volatile Organic Compounds by GC/MS by Methods 8240B and 8260A

SOP Number: MV-001-01

Date change implemented: 8/4/95

Change initiated by:

Operational approval:

QA Approval:

Section to be changed: 7.7.1.12

Change(s): Delete Section 7.7.1.12.

sopmod.doc
modmv001.doc

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SOP MODIFICATION FORM

Use this form for minor modifications of SOPs. Reference the section to be changed and fully describe the change(s). If needed for maximum clarity, rewrite the whole section rather than listing several changes to it. If a single procedural change means changes in many sections of the SOP, it is best to amend and reissue the SOP. Otherwise, incorporate the changes into the body of the SOP at its annual review.

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SOP Name: Determination of Volatile Organic Compounds by GC/MS by Methods 8240B and 8260A

SOP Number: MV-001-00

Date change implemented: 8/9/95

Change initiated by:

Operational approval:

QA Approval:

Section to be changed: 6.2.2

Change(s): Change: "Prepare calibration standards at five concentration levels in methanol for each target parameter and each surrogate. The concentration levels are 10, 20, 50, 100, and 200 ug/L."

Change to: "Prepare **daily** calibration standards **from the working calibration standards** at five concentration levels **or at the mid-level, if checking a continuing calibration,** in methanol for each target parameter and each surrogate. The concentration levels are 10, 20, 50 **(continuing calibration level)**,100, and 200 ug/L."

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ROSS

SOP

Standard Operating Procedure

SOP No: MV-003-0
Initial Date: 2/1/91
Page 1 of 10
Date Revised: ______

Title:

Preventive Maintenance in the Gas Chromatography/Mass Spectrometry Lab

Prepared by: Patrick Farrell

Approved by: CHCaldwell

Date: 5/7/91

QC Approval:

1.0 PURPOSE

This procedure is to be followed to prolong operation of the analytical instrumentation and to minimize and correct defects before they result in serious damage or failure.

2.0 APPLICATION

This procedure applies to the instruments used in the Gas Chromatography/Mass Spectrometry Lab.

3.0 REFERENCES

The manuals from the instrument's manufacturer are the source of the "How-to" details for performing preventive maintenance, routine maintenance, and repairs on all the instruments within the applicable laboratory. A library of instrument manuals is kept in the GC/MS lab.

4.0 ASSOCIATED SOPs

None

5.0 PROCEDURE

5.1 Gas Chromatographs

5.1.1 Once a month dust off instrument externally and internally or when repairs are made.

5.1.2 Replace septa with new septa as warranted, when the injection port liner is replaced, or after 50 septum punctures, whichever is soonest.

5.1.3 Replace Injection Port Liner, if applicable, as warranted when the column is "clipped".

5.3.2 Electronics

5.3.2.1 Dust off and reseat all printed circuit boards semi-annually or when any maintenance is performed on that sub-assembly, whichever is more often.

5.3.2.2 Reseat all cable connectors whenever any work is performed within the sub-assembly. Reseat all easily accessed cable connectors at least semi-annually.

5.3.2.3 Readjust RF resonance on the Finnigan MS after each source cleaning or whenever the front flange is removed from the manifold, whichever is more often.

5.3.3 Vacuum/Pneumatics System

5.3.3.1 Change the mechanical roughing pump oil semi-annually.

5.3.3.2 Check the oil level in the mechanical roughing pumps and the tubomolecular pumps monthly.

5.3.3.3 Purge the mechanical pumps monthly for about 15 minutes.

5.3.3.4 Check the condition of the manifold seals each time the flange is removed from the manifold.

5.3.3.5 Check the flexible tubing quarterly or when work is performed on the pumps, whichever is more often.

5.3.3.6 Check that the calibration gas valve and introduction system are functional weekly.

5.3.3.7 Leak check vacuum system if excessive pressures (> 0.025 TORR) are observed on the vacuum gauges or if excessive air is present in spectrum. When evaluating the air/water spectrum, a leak-tight system will have the N_2 peak (m/z 28) $\leq$ the water peak (m/z 18).

5.3.4 Data Systems

5.3.4.1 Clean heads on tape units quarterly.

5.3.4.2 Thoroughly clean printers including ribbon transport system semi-annually.

5.3.4.3 Replace printer ribbons as needed, to maintain enough contrast so that no special effort needs to be taken in reproducing copies of the output due to insufficient contrast.

5.3.4.4 Backup your system software at least quarterly, preferably monthly.

5.4 PURGE AND TRAP EQUIPMENT

5.4.1 Leak check all accessible fittings on the LSC-2000, ALS-2016, and their connections to the gas chromatograph, on a monthly basis.

5.4.2 Methanol flush the LSC-2000 and ALS-2016 quarterly or when needed as indicated by carryover contamination, plugged or restricted flow, or suspected adsorption problems.

5.4.3 Check flow rates when any line (other than the front panel connections) has been disconnected or connected.

5.5 THERMAL DESORPTION AND CRYOTRAPPING EQUIPMENT

5.5.1 Check temperatures of each zone monthly or more often if stability of the analysis is a problem.

6.0 DOCUMENTATION

6.1 Each analyst will keep records for the instrument or instruments assigned to him or her.

6.2 A checklist will be used to record the date and nature of the preventive maintenance performed. (See Figures 1-4).

6.3 Daily/weekly checklists will be stored in the Maintenance Log Book kept with each Mass Spectrometer. Monthly, quarterly, and semi-annually checklists will be stored in a notebook in the possession of the Technical Support Specialist.

6.4 Preventive maintenance documentation will be reviewed monthly by the Group Leader of the GC/MS Lab and at least quarterly by the Technical Director.

7.0 DEFINITION

7.1 When a preventive maintenance action is specified to be performed on a daily basis, it is intended to mean each day that the piece of analytical instrumentation is used, and is not required on the days that the instrument is not used.

Weekly and Daily Preventive Maintenance Checklist

Target Date : ____________________ Instrument : __________

Performed By : ____________________ Peripherals : __________

Week Beginning: ____________________

Preventiive Maintenance Action	Weekly	M	T	W	T	F	S	S
Gas Chromatograph								
Check zone temperatures via computer feedback								
Check supply gases for sufficient volume & pressure								
Autosampler								
Check or replace wash cup septa								
Check or dispose of waste solvent								
Visually check injection syringe for leakage								
Mass Spectrometer								
Check calibration gas valve & response level								

Record of routine or conditional preventive maintenance	M	T	W	T	F	S	S
Replacement of GC septa							
Replacement of GC injection port liner							
Clipped GC capillary column							
Replaced GC column							
Cleaned MS source & rods, dipped RF & EC							
Replaced desiccant in vent air drier							
MS manifold seals checked							
MS system leaked checked							
Printer ribbon replaced							
Purge & trap equipment flow rates checked							

Notes & Comments:

Monthly Preventive Maintenance Checklist

Target Date : ____________________

Instrument : ____________________

Performed By : ____________________

Peripherals : ____________________

Preventive Maintenance Action	Date Performed
Gas Chromatograph	
☐ Check the gas pressures and flow rates	____________
Autosampler	
☐ Perform Varian instrument test while watching autosampler for proper action	____________
Vacuum Pumps	
☐ Check the oil level in the mechanical pumps and in the turbomolecular pumps	____________
☐ Purge the mechanical pumps	____________
Purge & Trap Equipment	
☐ Leak check all accessible fittings	____________
Thermal Desorption and Cyrotrapping Equipment	
☐ Check temperatures of each zone	____________

Notes & Comments:

Quarterly Preventive Maintenance Checklist

Target Date : ____________ Instrument : ____________

Performed By : ____________ Peripherals : ____________

Preventive Maintenance Action	Date Performed
Gas Chromatograph	
☐ Dust off instrument internally & Externally	____________
Mass Spectrometers	
☐ Dust off instrument internally & Externally	____________
☐ Replace or clean the air filters	____________
☐ Check the cooling fans	____________
Vacuum Pumps	
☐ Check the integrity of the vacuum tubing	____________
Data Systems	
☐ Clean heads on tape units	____________
☐ Backup the operating software	____________
Purge & Trap Equipment	
☐ Methanol flush LSC & ALS	____________

Notes & Comments:

Semi-Annual Preventive Maintenance Checklist

Target Date : ____________________

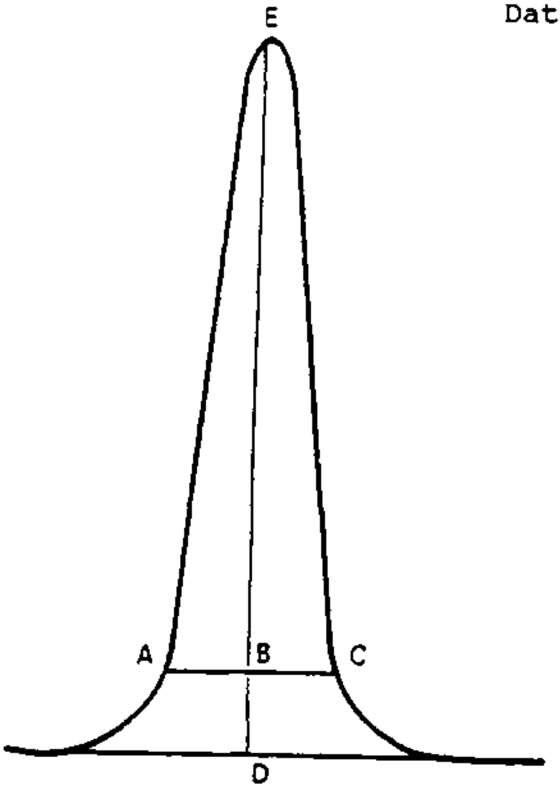
Instrument : ____________________

Performed By : ____________________

Peripherals : ____________________

Preventive Maintenance Action	Date Performed
Electronics	
☐ Dust off and reseat all printed circuit boards	____________
☐ Reseat all cable connectors	____________
☐ Check the operation of all solenoid valves	____________
Vacuum Pumps	
☐ Change the mechanical roughing pump oil	____________
Data Systems	
☐ Thoroughly clean printer	____________

Notes & Comments:



TAILING FACTOR= $\frac{BC}{AB}$

Example calculation: Peak Height = DE = 100 mm
10% Peak Height = BD = 10 mm
Peak Width at 10% Peak Height = AC = 23 mm
AB = 11 mm
BC = 12 mm

Therefore: Tailing Factor = $\frac{12}{11}$ = 1.1

Figure 5. Tailing factor calculation.

TO CALCULATE THE TAILING FACTOR YOU MUST FIRST DRAW TWO IMAGINARY LINES;
1) ONE THAT DIVIDS THE PEAK FROM APEX TO BASELINE (LINE DE).
2) ONE THAT GOES HORIZONTALLY ACROSS THE PEAK AT 10% OF IT'S HEIGHT. (LINE AC)
THE CALCULATION IS THEN SIMPLY MEASURING THE TWO LENGTHS AB AND BC.
N IS A REAL NUMBER THAT IS THE QUOTIENT (SEE EX. CALC)
THE VALVE FOR N SHOULD BE <3.

SOP MODIFICATION FORM

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SOP Name: PREVENTIVE MAINTENANCE IN THE GC/MS LAB

SOP Number: MV-003-00

Date change implemented : 10-15-91

Change initiated by: P Farell

Operational approval:

QA Approval:

Section to be changed: FIGURES 1-4

Change(s): THESE 4 FORMS WERE CONSOLIDATED INTO 1 MORE USABLE FORM. (ATTACHED)
THE SOP DOES NOT NEED TO BE RE-WRITTEN TO MAKE THIS CHANGE.

GC/MS PREVENTIVE MAINTENANCE CHECKLIST

INSTRUMENT:____________ ANALYST:____________ WEEK BEGINNING:___________

FREQUENCY PREFORMED

GAS CHROMATOGRAPH

D	W	M	Q	S	A		YES	NO
*						Check zone temperatures via computer feedback.		
	*					Check supply gases for sufficient volume & pressure.		
	*					Replace GC septa.		
					*	Replace injection port liner.		
					*	Clip GC column.		
					*	Replace GC column.		
		*				Run instrument self test.		

MASS SPECTROMETER

D	W	M	Q	S	A		YES	NO
	*					Calibrate with FC-43.		
*						Check zone temperatures via computer feedback.		
	*					Check system vacuum via computer feedback.		
					*	Clean mass spectrometer source & rods. Dip RF.		
		*				Check oil level in mechanical pumps.		
			*			Replace oil pads in turbo.		
				*		Replace filters on mechanical pumps.		
				*		Replace oil in mechanical pumps.		
		*				Clean air filters to electronics.		

TEKMAR PURGE & TRAP

D	W	M	Q	S	A		YES	NO
*						Flush sparge vessels with reagent water.		
					*	Change out sparge vessels.		
	*					Check purge flow rate.		
	*					Check temperature zones.		
			*			Leak-check all assessable fittings.		
					*	Solvent back-flush transfer lines.		

CTC AUTOSAMPLER

D	W	M	Q	S	A		YES	NO
	*					Replace wash vial septa.		
	*					Replenish wash solvent.		
	*					Dispose of waste solvent.		
*						Check injection syringe.		
*						Confirm correct operation of autosampler.		

PRINTER

D	W	M	Q	S	A		YES	NO
					*	Change printer ribbon.		
*						Check paper supply.		
*						Check paper alignment.		
		*				Clean printer (paper dust, etc.)		

D=Daily W=Weekly M=Monthly Q=Quarterly S=Semi Annually A=As Needed

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STANDARD OPERATING PROCEDURE

SOP No.: QC-001-02
Initial Date: 2/1/91
Page 1 of 4
Date Revised: 8/25/94

Title: Nonconformances and Corrective Action.

Prepared by: Approved by: Date: 8/25/94 QC Approval:

1.0 PURPOSE

The purpose of this SOP is to establish procedures for the identification, documentation and correction of nonconformances.

2.0 APPLICATION

A nonconformance is an uncorrected deviation from the requirements of a standard operating procedure or Quality Assurance Project Plan (QAPjP). SOP QC-001, then, applies to any occurrence or practice which does not follow an SOP or QAPjP.

Nonconformances always have the potential to affect data quality. Nonconformances must be communicated to the appropriate Group Leader and the Quality Assurance Manager or Director and corrective actions approved by them. Many nonconformances require that the client be notified and provide direction. A noncompliance memo is not permission to accept the error but an effort to prevent its reoccurrence.

3.0 REFERENCES

None

4.0 ASSOCIATED SOPs

None

5.0 PROCEDURE

5.1 The nonconformance must first be identified. Remember that a nonconformance is an <u>uncorrected</u> deviation from an SOP. An out-of-control event which is immediately corrected before samples are analyzed is not a nonconformance.

5.1.1 Examples of nonconformances include:

- A sample received in an improper container, with improper preservation, or past any holding time.
- An analysis holding time not met on a sample received within the holding time. This includes a late repreparation or reanalysis which does not confirm matrix interferences suspected from an initial analysis.
- A sample lost during preparation or analysis when reanalysis within holding is not possible or when insufficient sample remains for reanalysis.

- An out-of-control blank, surrogate, LCS, internal standard, etc., whose standard corrective action (usually reanalysis) is not performed.
- An out-of-control calibration whose standard corrective action is not performed.
- EQL's raised due to interferences or other factors not addressed in the SOP. This includes extracts which cannot be concentrated to their normal final volume.
- Analysis of a matrix for which the SOP does not provide standard conditions.
- An entire data set miscalculated which is discovered at any level of review.

5.1.2 Examples of occurrences which are not nonconformances are listed below. Many of these occurrences need to be recorded in a narrative form for inclusion in report comments.

- A sample received with missing or incomplete paperwork which is corrected in time to allow analysis within holding times.
- Use of a non-standard aliquot of a sample, even if adjustments are made to retain standard EQL's.
- An out-of-control blank whose associated samples are reanalyzed within holding time.
- An out-of-control surrogate which is repeated in a reanalysis and therefore confirms a matrix interference.
- A mechanical failure which is repaired before samples are analyzed or for which affected samples are reanalyzed within holding times.
- Random calculation errors found during data review.

5.2 The person identifying a nonconformance must immediately document it in a Nonconformance Memo (Figure 1). Describe the problem briefly but completely. Describe the actions taken to deal with the immediate occurrence. Describe the actions taken or which need to be taken to prevent a reoccurrence of the problem. Sign and date the memo on the "Corrective action initiated/performed by" line.

5.2.1 If you cannot perform the corrective action yourself (e.g. if a client needs to be notified and provide direction), pass the memo to the appropriate person for completion.

5.3 The person performing corrective actions must obtain the agreement of his or her Group Leader that the actions are sufficient. The Group Leader signs and dates the memo on the "Operations concurrence" line. In the absence of the Group Leader, the Operations Manager or Technical Director may substitute.

5.4 The person performing corrective actions must also obtain the agreement of the Quality Assurance Manager or Director that the actions are sufficient. This person signs and dates the memo on the "QA approval" line.

5.5 Corrective action must be designed to correct the problem and to minimize the probability of its recurrence. It is the ultimate responsibility of the Group Leader of the affected department to ensure that corrective actions (short and long term) are taken. A copy of the memo is given to the appropriate Group Leader as a reminder of needed corrective actions. A copy is also given to the Project Manager.

5.6 The Quality Assurance Manager maintains a log of all nonconformances and corrective actions. The QA Manager periodically reviews the log to determine if long-term corrective actions have been taken.

5.7 The Nonconformance Memo used in the RASI Laboratory is shown in Figure 1. Copies of the form, which is printed on pink paper, are available from the Quality Assurance Manager.

Figure 1 - Nonconformance Memo

NONCONFORMANCE MEMO

Client: ______________________ Work Order No.: ______________________ Filed by: __________ Date: __________

Sample(s) Affected: ______________________________________ Test(s) ______________________

Area: ___ SC ___ OP ___ IP ___ II ___ GC ___ GC/MS ___ MT ___ CW ___ RP ___ Other ______________________

Nonconformance

A nonconformance is an uncorrected deviation from an SOP or QAPjP. Examples include (1) holding times exceeded; (2) samples which are lost during extraction or analysis when no re-prep. is possible; (3) quality control (QC) data is outside of defined limits and standard corrective action was not taken; (4) when reported detection limits are higher than specified in contract, method, and/or project plan; and (5) sample received in a broken condition, without proper preservation, or in an improper container.

Describe all nonconformances briefly but completely in the space below. Describe the action taken to deal with the immediate occurrence. Describe the root cause of the nonconformance. Describe the actions taken or which need to be taken to prevent a reoccurrence of the problem.

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CORRECTIVE ACTION

__ Client informed orally by ____________ Comments: ______________________________ Date: ______________

__ Client informed in writing by (means) ______________ By whom: ______________ Date: ______________

__ Sample(s) processed "as is". Comments: ____

__ Sample(s) on hold until ______________ If released, notify: ______________________

Corrective action initiated/performed by: ______________ Date: __________

Operations concurrence: ______________________ Date. __________

QA Concurrence: ______________ Date: ________

CORRECTIVE ACTION VERIFICATION

__ Verified __ Cannot verify. Reason: ______________________________________

Verified by: ______________________ Date __________

ORIGINAL MUST BE RETAINED IN THE PROJECT FILE

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Ross Analytical Services, Inc.

STANDARD OPERATING PROCEDURE

SOP No.: QC-006-02
Initial Date: 2/1/91
Page 1 of 5
Date Revised: 6/9/95

Title: GC/MS Data Review and Verification

Prepared by: Approved by: Date: 6/8/95 QA Approval:

1.0 PURPOSE

To describe the procedure for the review and quality control checking of GC/MS data and verification of the analytical reports generated from the data at the RASI laboratory.

2.0 APPLICATION

These procedures are used to verify that volatile and semivolatile data, calculations, and analytical reports are free from errors. These procedures are used for all projects.

3.0 REFERENCES

None

4.0 ASSOCIATED SOPs

None

5.0 PROCEDURE

5.1 Data Generation

The instrument operator is responsible for verifying that his/her instrument is properly calibrated and is operating within the specifications outlined in the specified method before any analyses are begun. The operator should check the work order associated with the samples to verify the proper method before any analyses are begun. If any questions regarding method or quality control remain, he should see the laboratory supervisor or team leader before beginning.

As samples are analyzed, specially designed computer software is used to generate an initial report of quantitation of the compounds of interest in the sample. Software also generates lists of surrogate recoveries, internal standard areas, and retention times for the compounds which were spiked into the samples and checks for sample concentrations exceeding the range of the curve. The operator reviews these reports for problems such as false identifications; improperly quantitated peaks; targets which have been omitted; surrogate recoveries, or internal standard areas, or retention times outside acceptance windows, or target compound amounts which are above the calibration range.

As samples are analyzed, information pertaining to those samples must be recorded on the instrument run log summary sheet. That information is as follows: Ross Sample ID, Client Sample ID, Instrument Run Number, Volume/Amount of Sample Analyzed, Dilution Factor, Time of Analysis, Autosampler Position, and any special notes about the sample. This run log page will also contain in the header the following information: Instrument ID, Analyst Name or Initials, Tape Storage ID, Column Type, GC Temperature

Program, Date of Analysis, and Date of Initial Calibration. Any unused portion of this summary page must be Z'ed out and signed by the analyst. (See Section 6.0, Figure 1 for an example run log sheet).

5.2 Data Package Assembly

After the operator has determined that the analytical results are acceptable, he then prints spectra of all target compounds which were found by the computer software. These spectra are visually compared to spectra of standards with the same compounds which were generated on the same instrument. Spectral matches are checked and noted as good when criteria are met, while compounds are removed from the quantitation report to be searched. If tentative identification of non-target peaks is requested, library search results (spectra of 3 best matches) are printed for peaks with areas which are greater than 10 percent of the nearest internal standard (up to 20 for BNA, 10 for VOA; 30 for BNAs and VOAs for CLP). The completed data package is then forwarded to the laboratory supervisor or team leader for checking.

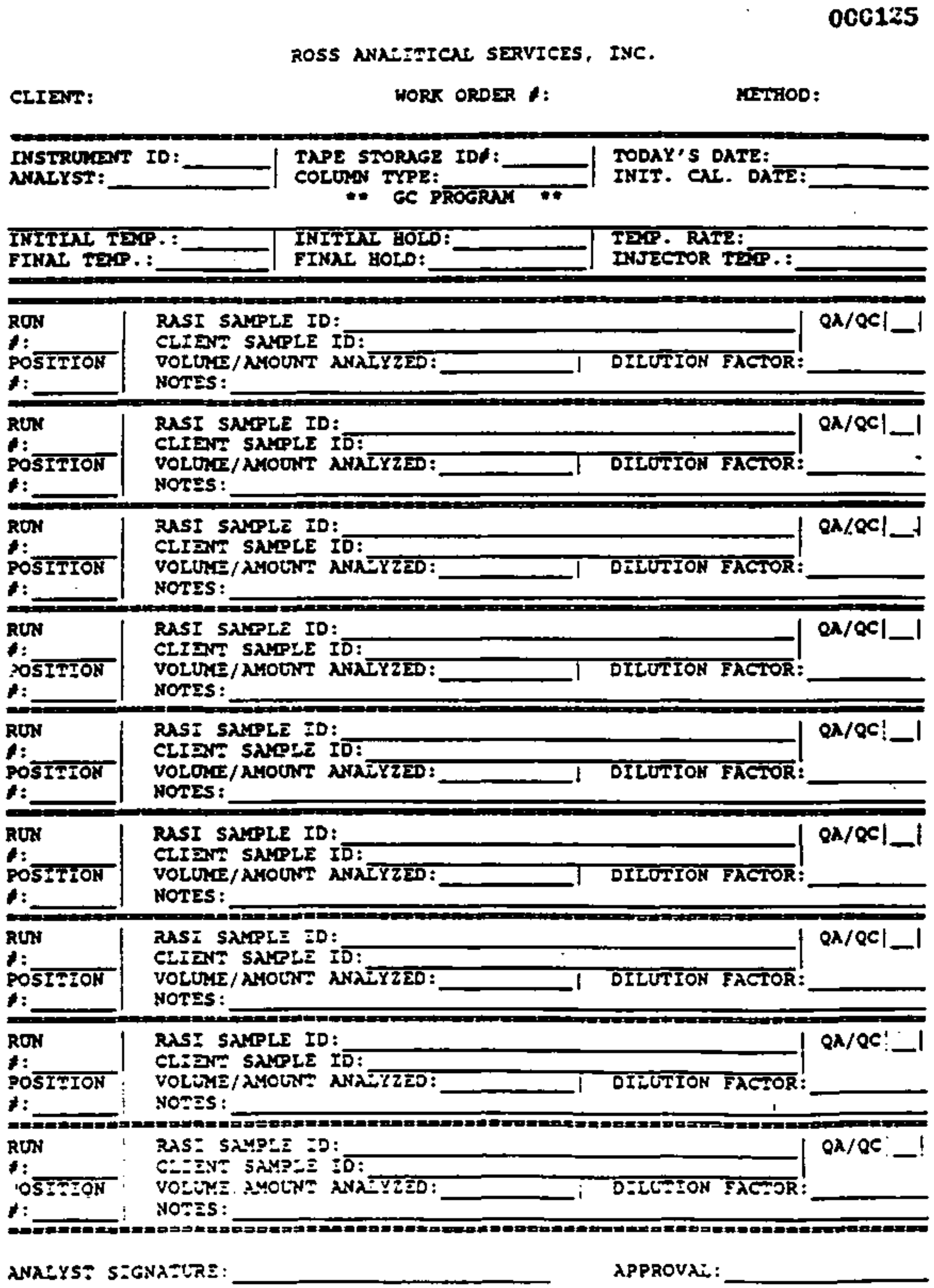
5.3 Data Review

The laboratory supervisor (or designate) reviews all tune and calibration data, reviews all confirmations, checks all dilution calculations, and reviews a minimum of 20 percent of non-target compound tentative identifications. The first page of each sample data package is initialed. The data package summary (Section 6.0, Figures 2, 3 are example data package summary sheets for BNAs and VOAs) is completed by the final reviewer. The reviewer then prepares a draft final report. CLP data are then taken into Envision for packaging. At any stage of the review, any corrections, alterations, additions or deletions are initialed and dated.

6.0 FIGURES

Figure 1

Example Run Log Sheet



000125

ROSS ANALYTICAL SERVICES, INC.

CLIENT: WORK ORDER #: METHOD:

INSTRUMENT ID: ____ | TAPE STORAGE ID#: ____ | TODAY'S DATE: ____
ANALYST: ____ | COLUMN TYPE: ____ | INIT. CAL. DATE: ____

** GC PROGRAM **

INITIAL TEMP.: ____ | INITIAL HOLD: ____ | TEMP. RATE: ____
FINAL TEMP.: ____ | FINAL HOLD: ____ | INJECTOR TEMP.: ____

RUN #: ____ | RASI SAMPLE ID: ____ | QA/QC ☐
CLIENT SAMPLE ID: ____
POSITION #: ____ | VOLUME/AMOUNT ANALYZED: ____ | DILUTION FACTOR: ____
NOTES: ____

RUN #: ____ | RASI SAMPLE ID: ____ | QA/QC ☐
CLIENT SAMPLE ID: ____
POSITION #: ____ | VOLUME/AMOUNT ANALYZED: ____ | DILUTION FACTOR: ____
NOTES: ____

RUN #: ____ | RASI SAMPLE ID: ____ | QA/QC ☐
CLIENT SAMPLE ID: ____
POSITION #: ____ | VOLUME/AMOUNT ANALYZED: ____ | DILUTION FACTOR: ____
NOTES: ____

RUN #: ____ | RASI SAMPLE ID: ____ | QA/QC ☐
CLIENT SAMPLE ID: ____
POSITION #: ____ | VOLUME/AMOUNT ANALYZED: ____ | DILUTION FACTOR: ____
NOTES: ____

RUN #: ____ | RASI SAMPLE ID: ____ | QA/QC ☐
CLIENT SAMPLE ID: ____
POSITION #: ____ | VOLUME/AMOUNT ANALYZED: ____ | DILUTION FACTOR: ____
NOTES: ____

RUN #: ____ | RASI SAMPLE ID: ____ | QA/QC ☐
CLIENT SAMPLE ID: ____
POSITION #: ____ | VOLUME/AMOUNT ANALYZED: ____ | DILUTION FACTOR: ____
NOTES: ____

RUN #: ____ | RASI SAMPLE ID: ____ | QA/QC ☐
CLIENT SAMPLE ID: ____
POSITION #: ____ | VOLUME/AMOUNT ANALYZED: ____ | DILUTION FACTOR: ____
NOTES: ____

RUN #: ____ | RASI SAMPLE ID: ____ | QA/QC ☐
CLIENT SAMPLE ID: ____
POSITION #: ____ | VOLUME/AMOUNT ANALYZED: ____ | DILUTION FACTOR: ____
NOTES: ____

RUN #: ____ | RASI SAMPLE ID: ____ | QA/QC ☐
CLIENT SAMPLE ID: ____
POSITION #: ____ | VOLUME/AMOUNT ANALYZED: ____ | DILUTION FACTOR: ____
NOTES: ____

ANALYST SIGNATURE: ____ APPROVAL: ____

Figure 2

Example BNA Data Package Summary Sheet

BNA's **7/93**

___ All necessary samples and MS/MSD's present and in alphanumeric order. Correct Case and SDG numbers are on the first sample (which will carry throughout batch).

___ Match Form V's with Form VI's (Initial calibrations) and Form VII's (Continuing calibrations). DFTPP must precede all other runs that day. All present and in order by date for each instrument.

___ Initial and continuing calibrations meet specifications (allowed 4 out > 25%). RIC's and quant lists have EPA names and instrument ID's. All standards have unique names. Raw data date/times match the Forms VI and VII.

___ Match DFTPP tunes with Form V's. Need one tune for each day standards or samples were run. Bars, quant lists, and RIC's labeled properly (page B-15, § b(3)). All present and in order by date for each instrument.

___ Match Blanks with Form IV's and Form V's. Need <u>one Blank per batch of extractions.</u> All present, have unique names, and are in order by date.

___ Each Blank Form I has proper matrix, weight or volume (30 g or 1000 mL for low level), level, GPC Y/N, pH, date extracted, and units.

___ Blanks' RIC's and spectra labeled properly.

___ Each Blank has the right number of triple plot and TIC spectra.

___ Form II present for each matrix and level, with all samples listed. Any samples with more than one acid and one base/neutral "*" must have a reanalysis with a "*" on at least some of the same surrogates. Record RE's and DL's for narrative.

___ Form III MS/MSD for each matrix and level present. Results on Form III and MS/MSD Form I's are the same.

___ Form IV's, with all samples, in order by date of analysis for each instrument.

___ Form V's DFTPP, with all samples, in order by date of analysis for each instrument.

___ Form VIII's, with all samples, present for each matrix and level. Any samples with "*" must have a reanalysis with a "*" on at least some of the same internal standards. Record RE's for narrative.

___ Each Sample Form I has proper matrix, weight or volume (~30 g or 1000 mL for low level, ~1 g for medium), level, moisture (soils only), decanted Y/N, GPC Y/N, pH, date received, date extracted, and units.

___ Each Sample's RIC and spectra labeled properly.

___ Each Sample has the right number of triple plot and TIC spectra. TIC's should not include hits from VOA fraction.

___ Each MS/MSD Form I has proper matrix, weight or volume, level, moisture, decanted Y/N, date received, date extracted, and units.

___ Section in proper order (Forms II, III, IV, V, VIII, Samples (Form 1 + raw data), Forms VI + raw initial cal data, Forms VII + raw continuing cal data, GPC calibration traces (soils only/copy from pesticides), DFTPP, Blanks, and MS/MSD's.

Figure 3

Example VOA Data Package Summary Sheet

CLP DATA PACKAGE REVIEW AND ASSEMBLY CHECKLIST

VOA'S 7/93

___ All necessary Samples and MS/MSD's present and in alphanumeric order. Correct Case and SDG numbers are on the first sample (which will carry throughout batch).

___ pH report for water samples.

___ Match Form V's BFB with Form VI's (Initial calibrations) and Form VII's (Continuing calibrations). BFB must precede all other runs that day. All present and in order by date for each instrument.

___ Initial and continuing calibrations meet specifications (allowed 2 >25%). RIC's and quant lists have EPA names and instrument ID's. All standards have unique names. Raw data date/times match the Forms VI and VII.

___ Match BFB tunes with Form V's. Need one tune for each day standards or samples were run. Bar, quant, and RIC labeled properly (page B-11, § b(3)). All present and in order by date for each instrument.

___ Match Blanks with Form IV's and Form V's. Need one blank for each day samples were run. All present, have unique names, and are in order by date.

___ Each Blank Form I has proper matrix, weight or volume (5 g or mL for low level), level, and units. (Look for hits).

___ Blanks' RIC's and spectra labeled properly. Should be <5 x PQL.

___ Each Blank has the right number of triple plot and TIC spectra.

___ Form II present for each matrix and level, with all samples listed. Any samples with "*" must have a reanalysis with a "*" on at least some of the same surrogates. Record RE's and DL's for Narrative.

___ Form III MS/MSD for each matrix and level present. Results on Form III and MS/MSD Form I's are the same.

___ Form IV's, with all samples, in order by date of analysis for each instrument.

___ Form V's, with all samples, in order by date of analysis for each instrument.

___ Form VIII's, with all samples, present for every day on which analyses performed. Any samples with "*" must have a reanalysis with a "*" on at least some of the same internal standards. Record RE's for narrative.

___ Each Sample Form I has proper matrix, weight or volume (almost always 5 g or mL), level, moisture (soils only), date received, and units.

___ Each Sample's RIC and spectra labeled properly (especially EPA name and instrument ID).

___ Each Sample has the right number of triple plot and TIC spectra.

___ Each MS/MSD Form I has proper matrix, weight or volume, level, moisture, date received, and units.

___ VOA section in proper order (Forms II, III, IV, V, VIII, samples (Form I + raw data, Forms VI + raw initial cal data, Forms VII + raw continuing cal data, BFB, Blanks, and MS/MSD's.

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Ross Analytical Services, Inc.

Standard Operating Procedure

SOP NO: QC-008-01
Initial Date 2/1/91
Page 1 of 3
Date Revised: 1/13/92

Title:

GC Data Validation

3/3/92

Prepared by:	Approved by:	Date:	QC Approval:
←	L. Anderson	2-10-92	

1.0 PURPOSE

This SOP provides a means of quickly determining the acceptability of GC analysis runs or parts thereof.

2.0 APPLICABILITY

This SOP applies to all non-CLP analyses in the GC Lab.

3.0 REFERENCES

3.1 Test Methods for Evaluating Solid Waste, SW-846.

3.2 Methods for Organic Chemical Analysis in Municipal and Industrial Wastewater, EPA-600/4-82-57.

4.0 ASSOCIATED SOP'S

None

5.0 PROCEDURE

5.1 Proceed through the checks in the order listed. If any check fails, perform the listed corrective action. Steps 5.2 and 5.3 should ideally be performed as soon as the calibration runs have been completed. If not possible, the entire check sequence must be performed at the beginning of the business day immediately following the analysis sequence.

5.2 Check the standard curve for linearity of all targets using a Lotus 1-2-3 spreadsheet which also calculates average RF's. Consult the appropriate RASI SOP for linearity requirements. If all targets are linear continue to 5.3.

Nonlinearity does not automatically disqualify a curve. However, if all targets are not linear, or if linearity varies widely among the targets, consult the Group Leader. Manual reintegration may correct outliers. If it does not, second or third order fitted curves may be used for calculations.

5.3 Using the average RF's determined above, or non-linear curves if directed by the Group Leader, determine the % recoveries of the compounds in the reference standard. If the reference standard meets limits, continue to 5.4.

If recoveries are not within limits consult the Group Leader. Again, reintegration may correct outliers. Examine the responses for the offending compounds. If one standard appears odd relative to the others, reanalyze it. If this does not correct the problem, prepare a fresh dilution of the reference standard and analyze it.

5.4 Similarly, check the values obtained for the continuing and end-of-run calibration standards. Continue to 5.5 if they are within limits.

If they are not, consult the Group Leader. Again, reintegration may correct outliers. If it does not, all blanks and samples from the last good standard to the next good standard must be reanalyzed.

5.5 For each blank and sample, check the chromatogram for the presence of a solvent peak. Check the surrogate peaks to see whether their areas are approximately in the acceptable range. Check all target peaks to see if their areas are below those of the highest standard. If all checks are acceptable, proceed to 5.6.

All blanks and samples without a solvent peak are presumed to have faulty injections. Reanalyze them.

If surrogate peaks appear out of the acceptable range, immediately calculate the recoveries. Those with recoveries outside the acceptable range must be reinjected. If recoveries are still out of range, the affected sample(s) must be reextracted.

Samples with target peaks above the top of the curve must be diluted and reinjected. Normally all unaffected peaks should be quantitated from the undiluted injection.

5.6 Proceed with the full data workup.

Any changes, corrections, additions or deletions are initialed and dated.

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Ross Analytical Services, Inc.
STANDARD OPERATING PROCEDURE

SOP No.: QC-010-02
Initial Date: 2/1/91
Page 1 of 3
Date Revised: 10/6/94

Title: Determining Method Detection Limits (MDLs), Estimated Quantitation Limits (EQLs), and Instrument Detection Limits (IDLs)			
Prepared by:	Approved by:	Date: 10/21/94	QA Approval:

1.0 PURPOSE

The purpose of this procedure is to ensure that a systematic method for performing detection limit studies is being used throughout the laboratory.

2.0 APPLICATION

This procedure is to be used when performing detection limit studies on water, soil, or sand matrices for both inorganic and organic analyses in the laboratory.

3.0 REFERENCES

3.1 Methods for the Chemical Analysis of Water and Wastes, EPA-600/4-79-020

3.2 Test Methods for Evaluating Solid Waste, SW-846

3.3 Methods for Organic Analysis of Municipal and Industrial Wastewater, EPA-600/4-82-57

3.4 U.S. EPA CLP Statement of Work for Inorganics Analysis, ILM02.0

3.5 U.S. EPA CLP Statement of Work for Organics Analysis, OLM03.0

3.6 Definition and Procedure for the Determination of the Method Detection Limit, 40 CFR Part 136, Appendix B

4.0 ASSOCIATED SOP's

None

5.0 PROCEDURE

Definitions

MDL	The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix type containing the analyte.
EQL	The lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the MDL. However, it

may be nominally chosen within these guidelines to simplify data reporting. For many analytes the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve. Sample EQLs are highly matrix-dependent.

With few exceptions, reports to clients will use EQLs rather than MDLs or IDLs. Likewise, results below the EQL, even if above the MDL or IDL, are normally expressed as <EQL.

IDL Instrument detection limits can be defined as a three nonconsecutive day MDL study. Its purpose is the same as the MDL study; however the criteria and necessity for performing an IDL study comes from the inorganic Contract Lab Program statement of work.

Instrument detection limit studies shall be determined for each instrument used for inorganic CLP work at least once each calendar quarter.

The quarterly determined IDL for an instrument shall always be used as the IDL for that instrument during that quarter. If the instrument is adjusted in any way that may affect the IDL, the IDL for that instrument shall be re-determined and the results used as the established IDL for that instrument for the remainder of the quarter.

5.1 MDL Procedure

5.1.1 Make an estimate of the MDL for the given matrix and particular analysis using one of the following criteria:

(a) Previous experience.

(b) The concentration value that corresponds to an instrument signal/noise in the range of 2.5 to 5.

(c) The region of the standard curve where there is a significant change in sensitivity, e.g., a break in the slope of the standard curve.

or, (d) Instrumental limitation.

5.1.2 If the MDL is to be determined in reagent (blank) water, prepare a laboratory standard (analyte in reagent water) at a concentration which is at least equal to or in the same concentration range as the estimated detection limit. (It is recommended to spike at a level of between 1 and 5 times the estimated detection limit or at the EQL.)

5.1.3 If the MDL is to be determined in another matrix which does not already contain the analyte to be spiked, spike at a level that is between one to five times the estimated detection limit of that particular analyte in *reagent water*. If the matrix does contain the analyte to be spiked at a level which exceeds 10 times the MDL of that particular analyte in reagent water, obtain another blank sample with a lower level of analyte.

If an MDL study has previously been conducted on this matrix, spike according to the previous study.

5.1.4 Prepare a minimum of seven aliquots of the sample and process each through the entire analytical method.

500 Series Methods require that these replicates be analyzed over a period of several days.

5.1.5 Calculate the standard deviation of the replicate measurements. Compute the MDL as follows:

MDL = (*t*) * (standard deviation)

t = (Student *t* value appropriate for a 99% confidence level and a standard deviation estimate with n-1 degrees for freedom.)

Student *t*-Distribution

Number of Samples	*t*-Statistic
6	3.36
7	3.14
8	3.00
9	2.90

5.1.6 If the calculated MDL is greater than the concentration used to determine it, repeat the MDL study using a higher concentration of analyte. If the calculated MDL is less than 10% of the concentration used to determine it, repeat the MDL study using a lower concentration of analyte.

500 Series Methods contain specific MDL acceptance criteria such as average percent recoveries, relative percent differences, and concentration levels which the MDL study must meet prior to being deemed ok by the SDWA.

5.2 IDL Procedure

5.2.1 Prepare a standard solution in acidified reagent water containing the analytes of interest at a concentration of 3x - 5x the instrument manufacturer's suggested IDL's or IDL's determined previously.

5.2.2 Analyze the standard solution 7 times on three nonconsecutive days according to the method. (Non consecutive means at least one day separates each pair of days on which analyses are done.)

5.2.3 Calculate the (n-1) standard deviation of0 each of the 7 replicates, then average the 3 days

5.2.4 Multiply by 3 the average of the standard deviations obtained. These will be your new IDL values.

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Standard Operating Procedure	SOP NO: QC-012-00 Initial Date 7/15/92 Page 1 of 1 Date Revised:

Title:

Internal Quality Assurance Audit Procedure

Prepared by:	Approved by:	Date:	QC Approval:
		7/16/92	

1.0 PURPOSE

The primary reason for this procedure is to describe the timing and content of the internal quality assurance audit function.

2.0 APPLICATION

This procedure applies to the quality assurance audits conducted within each of the individual group labs.

3.0 REFERENCES

None

4.0 ASSOCIATED SOPs

None

5.0 PROCEDURE

5.1 Each year an audit schedule will be set up describing the months in which audits will be conducted in each of the individual laboratories. The individual laboratories include Inorganic Preparation/Classical Wet, Organic Preparation, Inorganic Instrumentation/Metals, Gas Chromatography/Mass Spectroscopy, Gas Chromatography, and Sample Control. Each group will be audited twice a year.

5.2 During the month in which an audit is to be conducted, the QA Coordinator will contact the Group Leader of the laboratory and set up a mutually convenient time in which it can be performed.

5.3 The content of the audit is subject to change during a given year in order to remain current with the types of activities which are being conducted within each group. The current audit sheets are attached at the end of this operating procedure.

GC AUDIT CHECKLIST

ROSS ANALYTICAL SERVICES

Material Control

Are COA's and MSDS's sent to the QAC?
Yes No

Is standard preparation documented properly?
Yes No

Are all standards verified and approved before use?
Yes No

Are standards identified uniquely and traceable to their preparation?
Yes No

Are standard/reagent labels complete with standard/reagent number, concentration, dates of preparation and expiration, and name of analysts or numbered such that this information is readily accessible?
Yes No

Are standards/reagents stored properly?
Yes No

Are expired standards disposed of promptly?
Yes No

Logbooks

Are maintenance logs current and complete for each individual GC instrument?
Yes No

Are spare parts inventories available?
Yes No

Are refrigerator logs current and complete?
Yes No

Are standard preparation logs current and complete?
Yes No

Is standard traceability/comparison documentation current and complete?
Yes No

Are run logs current and complete (do they identify the lab and activity)?
Yes No

Does the supervisor periodically review and sign logbooks on a monthly basis?
Yes No

Laboratory Analysis

Are any major SOP's needed? If yes, list below.
Yes No

____

____

____

Are QC samples analyzed at the proper frequency?

Are method blanks run for every analysis?
Yes No

One MS/MSD pair for every 20 samples?
Yes No

Are detection limits determined every 6 months?
Yes No

Are nonconformances/deficiencies filed when necessary?
Yes No

Data Recording and Validation

Are data packages complete with supporting information and problems documented?
Yes No

Is data recorded in black ink?
Yes No

Are errors corrected by drawing a line through the error, writing in the correct entry, and initialing and dating the correction?
Yes No

Does supervisor periodically review and sign data sheets prior to transmittal?
Yes No

Is data recorded consistently?
Yes No

Does the analyst report data in a final form?
Yes No

Are out-of-control QC samples documented along with the corrective action?
Yes No

GC/MS AUDIT CHECKLIST

ROSS ANALYTICAL SERVICES

Material Control

Are COA's and MSDS's sent to the QAC?
Yes No

Are standards identified uniquely and traceable to their preparation?
Yes No

Is standard preparation documented properly?
Yes No

Are all standards verified and approved before use?
Yes No

Are standards labeled appropriately complete with standard, concentration, dates of preparation and expiration, and name of preparer?
Yes No

Are standards stored properly?
Yes No

Are expired standards disposed of promptly?
Yes No

Logbooks

Are maintenance logs current and complete for the following instruments, as described in SOP MV-003-00? (Check to see that the preventive maintenance checksheets are in use.)

Yes No GC/MS 1
Yes No GC/MS 2
Yes No GC/MS 3

Are spare parts inventories available?
Yes No

Are refrigerator logs current and complete?
Yes No

Are standard preparation logs current and complete?
Yes No

Is standard traceability/comparison documentation current and complete?
Yes No

Are run logs current and complete (do they identify the lab and activity)?
Yes No

Does the supervisor periodically review and sign logbooks on a monthly basis?
Yes No

Laboratory Analysis

Are any major SOPs needed? If yes, list below.
Yes No

____

____

____

Are QC samples analyzed at the proper frequency?

One MS/MSD pair for every 20 samples?
Yes No

Are method blanks run for every analysis?
Yes No

Are detection limits determined every 6 months?
Yes No

Are nonconformances/deficiencies filed when necessary?
Yes No

Data Recording and Validation

Are data packages complete with supporting information and problems documented?
Yes No

Are data recorded in black ink?
Yes No

Are errors corrected by drawing a line through the error, writing in the correct entry, and initialing and dating the correction?
Yes No

Is data recorded consistently?
Yes No

Does the analyst report data in a final form?
Yes No

Are out-of-control QC samples documented along with the corrective action?
Yes No

INORGANIC INSTRUMENT AUDIT CHECKLIST

ROSS ANALYTICAL SERVICES

Material Control

Is standard and reagent preparation documented properly? (Check logbooks.)
Yes No

Are standard/reagent labels complete with standard/reagent number, concentration, dates of preparation and expiration, and name of analysts?
Yes No

Are standards/reagents stored properly?
Yes No

Are expired standards/reagents disposed of promptly?
Yes No

Logbooks

Before an analyst begins to run an instrument, is the routine preventive maintenance check sheet filled out?
Yes No

Are spare parts inventories available for the instruments in the lab?
Yes No

Does the supervisor review the maintenance log on a monthly basis?
Yes No

Laboratory Analysis

Are any major SOPs needed? If yes, list below.

____

____

____

Are nonconformances/deficiencies filed when necessary?
Yes No

Data Recording and Validation

Are data sheets complete with test, method, analyst, date, client? (Check current data sheets.)
Yes No

Are data recorded in black ink?
Yes No

Are errors corrected by drawing a line through the error, writing in the correct entry, and initialing and dating the correction?
Yes No

Are data recorded consistently?
Yes No

Are out-of-control QC samples documented along with the corrective action?
Yes No

Are data validated 100% for correctness and accuracy prior to leaving the department.
Yes No

File name: IIAUD.DOC

INORGANIC PREPARATION/WET CHEMISTRY AUDIT CHECKLIST

ROSS ANALYTICAL SERVICES

Material Control

Are all materials logged through reagent control before use? (Check the chemical storage cabinet for proper labeling.)
Yes No

Are reagent number, date received, date opened, and expiration dates placed onto the labels for the purchased chemicals?
Yes No

Are standard and reagent labels complete with standard/reagent number, concentration, dates of preparation and expiration, and name of analyst?
Yes No

Are standards and reagents stored properly? (Check the chemicals in the chemical cabinet for correct storage according to the different hazard ratings.)
Yes No

Are expired standards and reagents disposed of promptly? (Check dates on standard and reagent labels.)
Yes No

How are standards, reagents, spent digestion and distillation wastes disposed?

Is this according to SOP # AD-008-00? (E.g., are acidic distillation wastes neutralized prior to disposal?)
Yes No

Logbooks

Are maintenance logs current and complete for the following instruments?
Yes No

UV/VIS spectrophotometer

A. Is the response of the UV/Vis using commercial solutions checked quarterly? (Review log.)
Yes No

B. Is the instrument wavelength checked with the internal wavelength scan quarterly? (Review log.)
Yes No

Does the lab have a spare parts inventories list? Is it complete and up to date?
Yes No

Are reagent/standard preparations documented properly? (Review log.)
Yes No

Does the supervisor periodically review and initial the logbooks?
Yes No

Check QA/QC Files and Current Working Data Sheets:

Are balance logs current and complete?
Yes No

Are oven/refrigerator logs current and complete?
Yes No

Is the water quality monitoring log current and complete according to SOP # QC-004-00?
Yes No

Are the quarterly calibrations for the autopipets current and complete?
Yes No

Are the balances checked to 95% of their capacity quarterly? Have they been certified yearly by an outside contractor?
Yes No

Are thermometers checked annually?
Yes No

Laboratory Analysis

Are QC samples analyzed at the proper frequency? (Review current data sheets.
Yes No

Data Recording and Validation

Are data sheets complete with test, method, analyst, date, client? (Check files.)
Yes No

Are data sheets checked? (Check files.)
Yes No

Does the supervisor periodically review and sign data sheets? (Check files.)
Yes No

Are data recorded in black ink? (Check files.)
Yes No

Are errors corrected by drawing a line through the error, writing in the correct entry, and initialing and dating the correction? (Check files.)
Yes No

Are data recorded in the same format consistently? (Check files.)
Yes No

ORGANIC PREPARATION AUDIT CHECKLIST

ROSS ANALYTICAL SERVICES

Material Control

Are all materials logged through reagent control before use? (Check solvent storage cabinets under the hoods for proper labeling.)
Yes No

Are containers with reagents/solvents in them labeled properly? (Check for reagent name, concentration, date of preparation, expiration date, ID number, and initials of preparer.)
Yes No

Are solvent lots checked for contamination, as required in SOP # OP-012, prior to use? (Check the hard copy of the solvent analysis, then check the lot number of the solvents in use to see that they have been analyzed.)
Yes No

SOP OP-006 states that for CLP Florisil cartridges must be tested using a 2,3,4,5-trichlorophenol solution and a pesticide/PCB standard mix in hexane. Is this done?
Yes No

Are blanks and matrix spikes for pesticides/PCB analytical batches put through Florisil cartridge cleanup before being sent to GC?
Yes No

Are standards/solvents stored properly? (Check refrigerator, hoods, and flammable cabinets.)
Yes No

Logbooks

Are maintenance logs current and complete for the following instruments and devices, as described in SOP # OP-015? Does the glassware and preparation apparatus appear to be in good shape?
Yes No

> Sonicators - (Remove residue from probe and polish tip after every 5 hours of use or as needed with an emery cloth.) Is this practiced and noted?
> Yes No
>
> GPC - (Reseat accessible cable connectors semiannually.) Is this practiced and noted?
> Yes No

Does the analyst report data in a final form with all calculations performed?
Yes No

Are out-of-control QC samples documented along with the corrective action or are all reworks included in the data packages?
Yes No

Are data and calculations checked on a 100% basis before being accepted?
Yes No

Other

Are any major SOPs needed? Yes No If yes, list below.

____

____

____

____

____

Are SOPs available for use in the lab?
Yes No

Has the IP/WC lab updated or modified any SOPs? If so, have the modifications been documented on the SOP Modification Form and sent to the QA/QC Coordinator?
Yes No

Has documentation for the training of analysts in current and new methods been completed, signed by the QA/QC Coordinator, and filed in the individual employee's files?
Yes No

Are the laboratory area and balance room weighing area clean?
Yes No

Comments ____

____

____

____

____

File Name: IPWCAUD.DOC

Are spare parts available for the instruments?
Yes No

Is the refrigerator log current and complete?
Yes No

Is the balance log current and complete?
Yes No

Is the GPC sample run log current and complete? (Check logbook.)
Yes No

Are periodic calibrations current and complete for the sonicators? (Check logbook.)
Yes No

Has documentation for the training of analysts in current and new methods been completed, signed by the QA/QC Coordinator, and filed in the individual employee's files? (Review employee files.)
Yes No

Laboratory Analysis

Are any major SOPs needed? Yes No

If yes, list below.

____
____
____
____
____
____

Have SOPs been updated or modified? Yes No

If so, have the modifications been documented on the SOP Modification Form and submitted to the QA/QC Coordinator?
Yes No

Have SOPs been reviewed/revised within the past year? (Check annually.)
Yes No

For CLP, is the GPC calibration verified with two check mixtures (one pesticide mixture and one Aroclor mixture) once every 7 days as required by SOP # OP-004?
Yes No

Are QC samples analyzed at the proper frequency? (Check the sample preparation logbook.)
Yes No

Method blanks? Yes No

One MS/MSD pair for every 20 samples, or more frequently?
Yes No

Blank spikes where appropriate? Yes No

Data Recording and Validation

Are extraction summary sheets and notebooks complete with test, method, analyst, date, client, solvent lot numbers? (Check extraction summary logbook.)
Yes No

Are extraction summary sheets and notebooks legible and complete?
Yes No

Are data recorded in black ink?
Yes No

Are errors corrected by drawing a line through the error, writing in the correct entry, and initialing and dating the correction? (Check data sheets and logbooks.)
Yes No

Are data and procedural technique recorded consistently?
Yes No

Are data reviewed per SOP QC-007? (Are extraction summaries reviewed on a 100 % basis, checked off, then initials placed after the entry?)
Yes No

SAMPLE CONTROL AUDIT CHECKLIST

	YES	NO
Refrigerators		
1. Are logs current and complete?	____	____
2. Are nonconformance sheets completed when an abnormality exists in temperature?	____	____
Chain-of-custody/Internal logs		
1. Are forms completed properly?	____	____
2. Are internal logs complete?	____	____
3. Is the sample log checked daily for accuracy?	____	____
3. Are internal logs legible?	____	____
4. Have any samples not been logged back into Sample Control?	____	____
Reagent Procurement		
Is the PC File updated and complete?	____	____
Sample Storage/Discards		
1. Is adequate space available?	____	____
2. Pick 3 random samples. Can they be located?	____	____
3. Are discards up to date?	____	____
Sample Receiving		
1. Are temperatures and pHs checked and documented? (on SAM and chain-of-custody, respectively)	____	____
2. Are samples labeled properly?	____	____
3. Are samples stored properly?	____	____

Comments ____

____

____

____

____

____

____

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Ross Analytical Services, Inc.
STANDARD OPERATING PROCEDURE

SOP No.: SC-001-02
Initial Date: 2/1/91
Page 1 of 5
Date Revised: 11/14/94

Title: Chain-of-Custody and Sample Security			
Prepared by:	Approved by:	Date: 12/7/94	QA Approval:

1.0 PURPOSE

This SOP defines the procedure for maintaining chain-of-custody for samples and related sampling materials. It will ensure the traceability of samples should their data be questioned.

2.0 APPLICATION

This procedure applies to all samples processed through the laboratory.

3.0 REFERENCES

None

4.0 ASSOCIATED SOPs

SOP No. SC-002, Sample Receipt, Log-in and Storage

5.0 PROCEDURE

5.1 Chain-of-Custody

5.1.1 The chain-of-custody on samples begins in the field. Chain-of-custody forms (Figure 1) may be obtained from Sample Control or clients may use their own forms.

5.1.2 The sample identification, time of sampling, date of sampling, sample descriptions, sampler's name, and company name. Note that if a chain-of-custody form is used from another company, information on these forms may vary from the RASI forms.

5.1.3 When the RASI lab receives the samples, the information is checked to be accurate. The chain-of-custody seals (Figure 2) ,if present, are inspected to ensure they are intact, legible, and dated correctly. If the sample arrives by a common carrier (e.g. Fed-Ex or UPS) the airbill is signed and the date and time of receipt is noted. The samples are inspected for information accuracy. The chain-of-custody forms are signed and dated by the recipient and the conditions of the chain-of-custody seals upon receipt is noted. Any problems are noted on the chain-of-custody form.

5.1.4 Once the samples are in Sample Control's custody, an internal chain-of-custody system is initiated. The samples are under the custody of the Sample Control Department. Anyone who removes a sample from the Sample Control area must log it out using the Internal Chain-of-Custody (Sample Control Record) (Figure 3). This is done by recording the RASI identification number, the test to be performed, the initials of the remover and the date and time of removal. Once a sample is signed out by remover, he/she is responsible for that sample until it is returned to Sample Control. The only exception to this general sample documentation are the CLP and similar programs, for which each SDG has its own internal chain-of-custody.

5.1.5. Samples must be returned to Sample Control at the end of each day, noting the date and time of return, and storage location in the logbook. Any analyst who wishes to transfer a sample to another analyst must first return to Sample Control and make the changes in the log book.

5.1.6 The log books are reviewed daily and initialed by a sample custodian. If a person has failed to abide by the established protocol, a mark is made to highlight the problem. If an individual repeatedly fails to follow the established protocol, a memo is sent to his/her supervisor.

5.1.7 The chain-of-custody forms received from the field are transferred from Sample Control to the Reporting Department once logging is complete. They are filed there until the data report is completed. The chain-of-custody documents are then filed with the report.

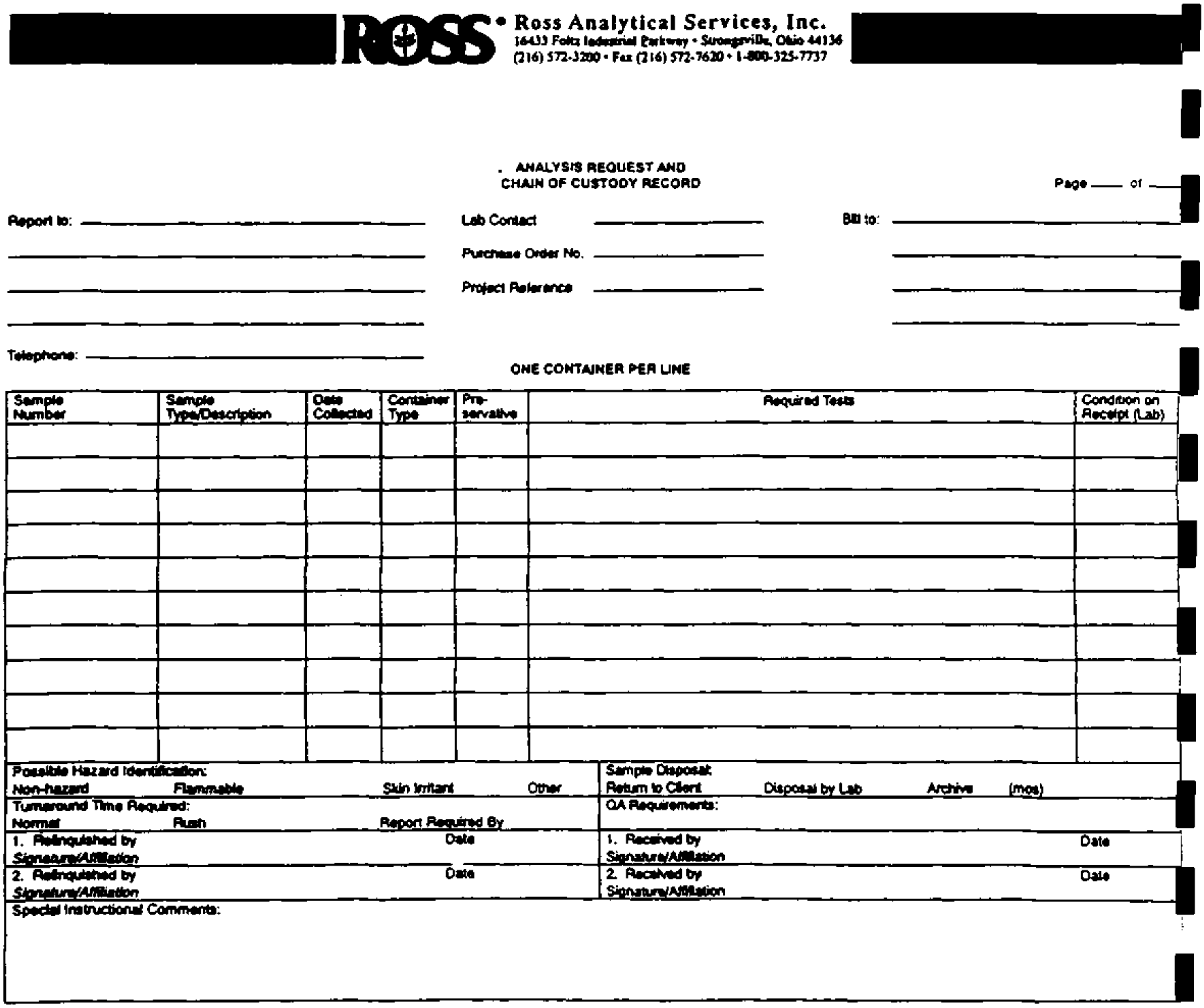
5.1.8 If a sample is returned to the client for a reason other than routine disposal, the chain-of-custody is signed and a copy is put in the file for that project. The original is sent on with the samples.

5.1.9 If a portion of a sample is sent to a subcontractor, a chain-of-custody form is generated by Sample Control to accompany the samples. A copy is placed in the files and the original is sent back to RASI with the written report.

5.2 Sample Security

5.2.1 The door to the Sample Control room is kept locked unless occupied. Only Sample Control personnel have keys to the sample control areas. All samples must be returned to Sample Control each night. During times which sample control personnel are unavailable, such as after normal business hours, one laboratory person will be the designated "sample custodian". If there is a time when only one individual is working in the laboratory, he or she will be the designated "sample custodian". On these occasions samples will be returned to Sample Control, signed in and placed on a cart inside the walk-in cooler. The next morning sample control personnel will make sure that all samples on the cart are signed in. Sample Control personnel will then put samples away.

Figure 1
Chain-of-Custody Form



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(216) 572-3200 • Fax (216) 572-7620 • 1-800-325-7737

. ANALYSIS REQUEST AND
CHAIN OF CUSTODY RECORD

Page ___ of ___

Report to: ______________________
____
____
____

Lab Contact ______________________
Purchase Order No. ______________________
Project Reference ______________________

Bill to: ______________________
____
____
____

Telephone: ______________________

ONE CONTAINER PER LINE

Sample Number	Sample Type/Description	Date Collected	Container Type	Pre-servative	Required Tests	Condition on Receipt (Lab)

Possible Hazard Identification: Non-hazard Flammable Skin Irritant Other	Sample Disposal: Return to Client Disposal by Lab Archive (mos)
Turnaround Time Required: Normal Rush Report Required By	QA Requirements:
1. Relinquished by Date *Signature/Affiliation*	1. Received by Date Signature/Affiliation
2. Relinquished by Date *Signature/Affiliation*	2. Received by Date Signature/Affiliation

Special Instructional Comments:

CUSTODY SEAL
ROSS ANALYTICAL SERVICES, INC.
16433 FOLTZ PARKWAY · STRONGSVILLE, OH 44136

SITE:______________________
SAMPLE NO.:________________
DATE:______________________

SIGNATURE:______________________ PRINTED NAME:______________________

CUSTODY SEAL
ROSS ANALYTICAL SERVICES, INC.
16433 FOLTZ PARKWAY · STRONGSVILLE, OH 44136

SITE:______________________
SAMPLE NO.:________________
DATE:______________________

SIGNATURE:______________________ PRINTED NAME:______________________

Figure 2
Chain-of-Custody Seals

ROSS ANALYTICAL SERVICES, INC.

INTERNAL CHAIN OF CUSTODY (SAMPLE CONTROL RECORD)

Sample(s) Taken	Test(s)	Taken by	Date and Time Out	Date and Time In	Storage Site

Figure 3
Internal Chain-of-Custody

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ROSS	SOP Standard Operating Procedure	SOP No: SC-002-00 Initial Date: 2/1/91 Page 1 of 8 Date Revised:

Title:

Sample Receipt, Log-in and Storage for Non-CLP Samples

Prepared by:	Approved by:	Date:	QC Approval:
		5/10/91	

1.0 PURPOSE

This procedure defines the actions taken to properly log and store samples received at the RASI Laboratory.

2.0 APPLICATION

This procedure applies to all samples sent through the Laboratory for analysis or other processing, other than those received through the US EPA Contract Lab Program.

3.0 REFERENCES

None

4.0 ASSOCIATED SOPs

SOP No. SC-001-00, Chain of Custody and Sample Security
SOP No. SC-003-00, Monitoring Sample Control Refrigerator Temperature

5.0 PROCEDURE

5.1 Sample Receipt

5.1.1 If there is paperwork on the outside of the container used for transporting the samples, read to see if it notes any hazards associated with the samples.

5.1.2 If the samples are in a cooler or if they are suspected of being hazardous, open the transportation container in the Sample Control hood. The appropriate protection should be used by the person handling the samples. Normally this means gloves and protective glasses. In some cases a face mask may be needed.

5.13 Remove the samples from the transportation container. Line the samples up in the most logical order. (This may be by sample date, numeric, alphabetic, or according to the paperwork if there is no other logical order.)

5.2 Sample Inspection

5.2.1 Check the sample against the paperwork to verify the paperwork is accurate. Note any discrepancies on the chain of custody, if applicable, and also on a nonconformance memo.

5.2.2 The condition of these specific samples should be checked as follows. All discrepancies between the sample condition and the desired condition as mapped out in the following paragraphs will be noted on the chain of custody if applicable and on (Figure 1).

Figure 1

NONCONFORMANCE MEMO

Client: ____________________ Work Order No.: ____________________ Filed by: ______ Date: ______

Sample(s) Affected: ____

Area: __ SC __ OP __ IP __ II __ GC __ GC/MS __ MT __ Other ____________________

Nonconformance

Please explain nonconformances (issues which affect data quality) in the space below for reasons such as (1) holding times exceeded; (2) samples which are lost during extraction or analysis, especially when no re-prep. is possible; (3) quality control (QC) data is outside of defined limits; (4) when reported detection limits are higher than specified in contract, method, and/or project plan; (5) sample received in a broken condition, without proper preservation, or in an improper container; (6) or, any other problem issues which may arise in the course of sample receipt, preparation, or analysis.

(Note that nonconformance memos are to be used to provide accurate and concise information regarding problems associated with our client's samples.)

CORRECTIVE ACTION

__ Client informed verbally on ____________________ by ____________________

__ Client informed in writing on ____________________ by ____________________

__ Sample(s) processed "as is". Comments: ____________________

__ Sample(s) on hold until ____________________ If released, notify: ____________________

Corrective action initiated/performed by: ____________________ Date ____________

Operations concurrence: ____________________ Date ____________

QA Concurrence: ____________________ Date: ____________

CORRECTIVE ACTION VERIFICATION

__ Verified __ Cannot verify. Reason: ____________________

Verified by: ____________________ Date ____________

ORIGINAL MUST BE RETAINED IN THE PROJECT FILE

5.2.2.1 Hivol filters for TSP analysis

5.2.2.1.1 Remove filters from envelopes and sleeves and inspect for holes, tears, and excess particulate matter. If necessary, void the sample and fill out a Nonconformance Memo. Leave voided filters in the envelope.

NOTE: Wear gloves when handling filters.

5.2.2.1.2 Place filters in a rack as they are logged. (No numbers are placed on the filters; the lab number is placed in the envelope.)

5.2.2.2 Method 5 Stack Testing Samples

Check each sample for accuracy against the recovery sheets. Note any discrepancies on the recovery sheets and a Nonconformance Memo. Check the container numbers, filters, and liquid levels carefully.

5.2.3 (Figure 2) describes the necessary requirements for the more common sample types received. The aqueous fractions that should be preserved are checked with pH paper. The temperature of one sample of a shipment is taken with a calibrated thermometer and recorded on the work order. Problems are documented as nonconformances.

5.3 Sample Log in

5.3.1 Each sample submitted to the lab is assigned a unique identity. Logging in is performed on a computerized system called Sample and Analysis Management (SAM), developed by Radian Corp. The following information common to all samples in a batch is entered:

Client code and project number
The person within RASI requesting the work
Date of receipt
Date the report is due
Date samples can be discarded and the method of discarding

A work identification (such as case number)
Text comments applying to all samples
The following information specific to each sample is entered:

Sample matrix and the client's identification of the sample
Date of sample collection
Storage location in the laboratory
Test(s) to be performed
Text comments applying to individual samples

5.3.2 SAM assigns a hyphenated number to each sample and fraction within a sample. This number is written on the sample bottle in indelible marker. A fraction is usually a separate container appropriate for a specific set of tests; for instance, a sample being analyzed for cyanide, metals, and extractable organics would have three fractions. Sample Number 91-02-040-03B is interpreted as follows:

91 - Sample batch received in 1991
02 - Sample batch received in January (the first month)
040 - Sample batch is the 40th received in January
03 - Sample is the third in the batch
B - Fraction is the second on the sample

5.3.3 For SAM, the laboratory is divided into departments such as organic preparation, GC/MS, classical wet tests, and AA/ICP. Each test is assigned to one department. The system prints a master work order listing all samples and their tests and a work order for each department represented in the order. Each department work sheet lists only those samples which will be prepared or analyzed in the department. The system also prints a label for each sample container. Copies of the master work order are distributed to the Technical Director and to the appropriate Supervisors. The original is kept in a three-ring notebook in sample control. Copies of the department work orders are distributed to the appropriate departments supervisors'. (A copy of the master work order is filed with the raw data and report.) Dates of completion, reporting, and invoicing are later entered into SAM. The work order is archived (removed from the active database) about 3 months after it is invoiced.

5.3.4 The samples remain in Sample Control until removed for analysis. The temperatures of the refrigerators in the sample storage are monitored to ensure that proper storage temperature is maintained (See SOP No. SC-003-00). Transfer is documented on a Sample Control Record which is maintained by the sample custodian. The Sample Control Record documents all custody changes that occur in the laboratory and each procedure performed on the sample (See SOP No. SC-001-00).

5.4 Sample Storage

5.4.1 Hivol filters for TSP Analysis

5.4.1.1 Store in the balance room.

5.4.1.2 Place a Kimwipe over the rack.

5.4.2 Method 5 stack testing sample

5.4.2.1 Store on the metal shelves in sample control.

5.4.2.2 If it is a modified Method 5, contact the project manager, QA Coordinator, or Technical Director on how to store the samples.

5.4.3 Store highly concentrated samples in coolers in the cold box.

5.4.4 Extracts

5.4.4.1 Store extract samples on shelves (for metals) RT 1A-F or (for all others) CB 12A-F

NOTE: The refrigerator is separated into areas for Base-Neutrals, PCB, Acids, and Pesticides. These areas are clearly marked.

5.4.5 Use the chart (Figure 2) to determine where to store other common types of samples.

5.4.6 Non-routine samples will be stored according to the project manager, QA Coordinator or Technical Director instructions.

	Preserved to pH =	Bottle Type	Temperature	Storage Location
<u>Water Samples</u>				
Metals	2	any	room	RT
Hardness	2	any	room	RT
Oil & Grease	2	glass*	4 C	CB
Phenolics	2	glass	4 C	CB
COD	2	any	4 C	CB
TKN	2	any	4 C	CB
NH3	2	any	4 C	CB
NO3	2	any	4 C	CB
Phosphorus	2	any	4 C	CB
TOC	2	any	4 C	CB
Cyanide	10	any	4 C	CB
Sulfide	10	any	4 C	CB
pH	none	any	4 C	CB
Other Inorganics	none	any	4 C	CB
624	**	glass*	4 C	VOA Ref.
8240	**	glass*	4 C	VOA Ref.
SELVA	**	glass*	4 C	VOA Ref.
625	none	glass	4 C	VOA Ref.
8270	none	glass	4 C	VOA Ref.
Pesticides	none	glass	4 C	VOA Ref.
PCB	none	glass	4 C	VOA Ref.
Other Extractables	none	glass	4 C	VOA Ref.
<u>Soil Samples</u>				
Metals	none	any	room	RT
Other Inorganic	none	any	4 C	CB
624	none	glass*	4 C	VOA Ref.
8240	none	glass*	4 C	VOA Ref.
Other Volatiles	none	glass*	4 C	VOA Ref.
625	none	glass	4 C	VOA Ref.
8270	none	glass	4 C	VOA Ref.
Pesticides	none	glass	4 C	VOA Ref.
PCB's	none	glass	4 C	VOA Ref.
Other Extractables	none	glass	4 C	VOA Ref.

* Must have at least 2 bottles per sample
** Do not open bottles to take pH or temperature.

Figure 2

	Preserved to pH =	Bottle Type	Temperature	Storage Location
<u>Other Samples Types</u>				
Oil for PCB's	none	glass	room	RT
Other Oils	none	any	4 C	CB
Sludges	none	any	4 C	CB
VOST Tubes	none	glass	4 C	VOA Freezer
XAD-2 Resin	none	any	4 C	
Canisters	none	any	room	RT
PUF Filters	none	any	4 C	CB
Filters for Metals		any	room	RT
Coal	none	any	room	RT
QC Ampules	none	glass	room	RT
Charcoal Tubes	none	glass	4 C	VOA Freezer

"Any" means plastic or glass

Figure 2
(Continued)

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Ross Analytical Services, Inc.

STANDARD OPERATING PROCEDURE

SOP No.: SC-003-02
Initial Date: 2/1/91
Page 1 of 4
Date Revised: 6/7/95

Title: Sample Control Refrigerator Temperature Monitoring

Prepared by: Approved by: Date: 6/8/95 QA Approval:

1.0 PURPOSE

To describe the procedure for monitoring and controlling the temperatures of refrigerators used for sample storage.

2.0 SCOPE

Most samples are maintained under refrigeration to preserve integrity. As a control measure, the temperatures of all sample storage refrigerators must be checked routinely. If readings are beyond acceptable limits, corrective action must be taken.

3.0 REFERENCES

None

4.0 ASSOCIATED SOPs

SOP AD-005, Calibration of Thermometers

5.0 EQUIPMENT

5.1 Glass mercury thermometers which have been calibrated against an NBS-traceable thermometer within the past year

5.2 Mineral oil

5.3 Vials, 40 mL

6.0 PROCEDURE

6.1 Thermometer Preparation

6.1.1 Immerse the end of the thermometer in a 40 mL vial containing approximately 20 mL mineral oil. Seal the top to prevent spillage.

6.1.2 Place the thermometer vial near the center of the refrigerator.

6.2 Temperature Monitoring

6.2.1 Refrigerators are uniquely identified. The temperature of each refrigerator must be checked twice daily. The first temperature check must be done before 10:00 a.m., and the second in the mid-to-late afternoon. The reading is recorded along with the date, time, and initials of the person taking the reading on a Refrigerator Temperature Record sheet (Section 7.0, Figure 1). Log sheets are kept in a folder with a magnetic clip, and are attached to a cabinet next to the cold box in Sample Control until completed. They are checked periodically and signed by a person from Quality Assurance. Completed pages will be filed in the QA Department.

6.2.2 The acceptable range for the refrigerator temperature is 4°C ± 2°C (or 39.2°F ± 3.6°F). The acceptance range for the organics extract freezer is -10 to -20 °C.

6.2.3 If a reading is found to be unacceptable, corrective action must be taken. A Refrigerator Nonconformance Memo (Section 7.0, Figure 2) which documents the actions taken must be filed.

6.2.4 Below are the recommended procedures to be followed when an unacceptable reading is obtained. Remember that each case may be unique and that good judgement will be necessary to decide on specific actions.

6.2.4.1 If the temperature is below 2°C:

1. Open door to warm the refrigerator

2. If problem cannot be corrected immediately, consult the Technical Director or QA Manager for actions to be taken (See Section 6.2.5)

6.2.4.2 If the temperature is above 6°C:

1. Check to see that the refrigerator is getting power.

2. Assume excess activity and recheck temperature after two hours.

3. Consult Technical Director or QA Manager for immediate actions to be taken. (See Section 6.2.5)

6..2.5 For cases where a serviceman is required, it may be necessary to take immediate actions to preserve the integrity of samples. The Technical Director or QA Manager must decide what these actions will be. They may include:

1. Do nothing until repairman comes.

2. Put ice or blue ice in malfunctioning refrigerator.

3. Move samples to another refrigerator.

6.2.6 If moved, samples may be returned to a refrigerator when two consecutive readings two hours apart are within acceptance limits.

7.0 FIGURES

Figure 1
Example Refrigerator Temperature Record

ROSS ANALYTICAL SERVICES
Refrigerator Temperature Record

Temperature, degree Celcius

	Date	Checker	SC 1	Cold Box	Time	Comments/Corrective Actions
1						
2						
1						
2						
1						
2						
1						
2						
1						
2						
1						
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2						
1						
2						
1						
2						

Acceptable Range = 4 +/− 2 degrees Celcius
If you have any problems or questions, contact the QA Department.

Figure 2
Example Refrigerator Nonconformance Memo

ROSS ANALYTICAL SERVICES

Refrigerator Nonconformance Memo

Date Reported __________ Refrigerator __________

Reported by __________ Refrigerator Contents __________

Acceptable Range: 2–6°C

1) Record temperatures when outside of acceptable range
2) Note the following corrective action(s) taken

   - A. Checked to see if refrigerator is on and has power
   - B. Opened door to raise temperature
   - C. Adjusted thermostat
   - D. Assumed heavy activity -- rechecked after 2 hours
   - E. Put ice or refrigerant in refrigerator
   - F. Called repair service
   - G. Moved samples to another refrigerator
   - H. Other ______________________________

TIME	TEMP in °C	CORRECTIVE ACTION TAKEN (document all actions taken with the reference letter or a statement)

APPENDIX B

ROSS ANALYTICAL SERVICES, INC.
QUALITY ASSURANCE MANUAL

QUALITY ASSURANCE MANUAL

ROSS ANALYTICAL SERVICES, INC.

VERSION 3.0

APRIL, 1995

Approved for Issue by:

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STATEMENT OF PRINCIPLES

Ross Analytical Services, Inc. (RASI), is committed to providing high quality environmental testing services. We intend to meet the needs of our clients, to comply with all regulatory requirements, and to protect the health and safety of our own employees.

Analytical test results are our product. Their accuracy and precision are therefore necessary, and significant, components of quality service. Other components of our service are equally important and include such things as timeliness, flexibility, guidance on methods, and the appearance of our written reports.

To aid in providing the highest quality service possible, this Quality Assurance Manual defines the structure of the Laboratory's Quality Assurance (QA) program. Every member of the laboratory is responsible for following these practices. Every level of laboratory management has the commitment, duty, and authority to see that this responsibility is met.

The laboratory Quality Assurance Department is charged with the QA Program's oversight, but every employee of Ross Analytical Services has the authority and duty to stop work whenever it is necessary to satisfy the requirements of each program.

Wayne P. Zeman, President
Ross Analytical Services, Inc.

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1.0 INTRODUCTION

The principal function of Ross Analytical Services is the analysis of environmental samples. Our data must be of sufficiently high quality and completeness to meet the objectives of the program for which they are produced. Our responsibility is to assure that reported data are accurate, precise, complete, representative, comparable, legally defensible, and on time.

Ross Analytical Services, Inc., must provide its clients with high data and services. Toward this end, Ross Analytical has implemented a company-wide Quality Assurance program. This Quality Assurance Manual describes the program.

Ross Analytical's Quality Assurance program is modeled after the International Standards Organization (ISO) Guide 25, "General Requirements for the Competence of Calibration and Testing Laboratories".

2.0 LABORATORY ORGANIZATION

2.1 Introduction

Ross Analytical Services is staffed and organized for efficient production of high quality data. All supervisors and most analysts have degrees in chemistry or another science, and undergo additional formal training in their specialties when available. The Quality Assurance Director reports directly to the President in parallel with the Operations Manager. While the QA Department sets policy and audits compliance, each analyst is expected to maintain control during day-to-day operations. The intention is that quality be "built in" rather than "inspected in".

2.2 Organization Chart

Figure 2-1 is a generalized organization chart for Ross Analytical. Five analytical departments (Sample Preparation, Wet Chemistry, Metals, Air Analyses, and Chromatography) and three support departments (Sample Control, Reporting, and Information Systems) report to the Operations Manager. The Air and Chromatography departments each include Gas Chromatography and Gas Chromatography/Mass Spectrometry. The five analytical departments have the direct responsibility for data quality.

The Technical and Quality Assurance Director, with the President, sets overall QA policy. The QA Department defines procedures to achieve corporate QA goals and oversees their implementation.

2.3 Facilities

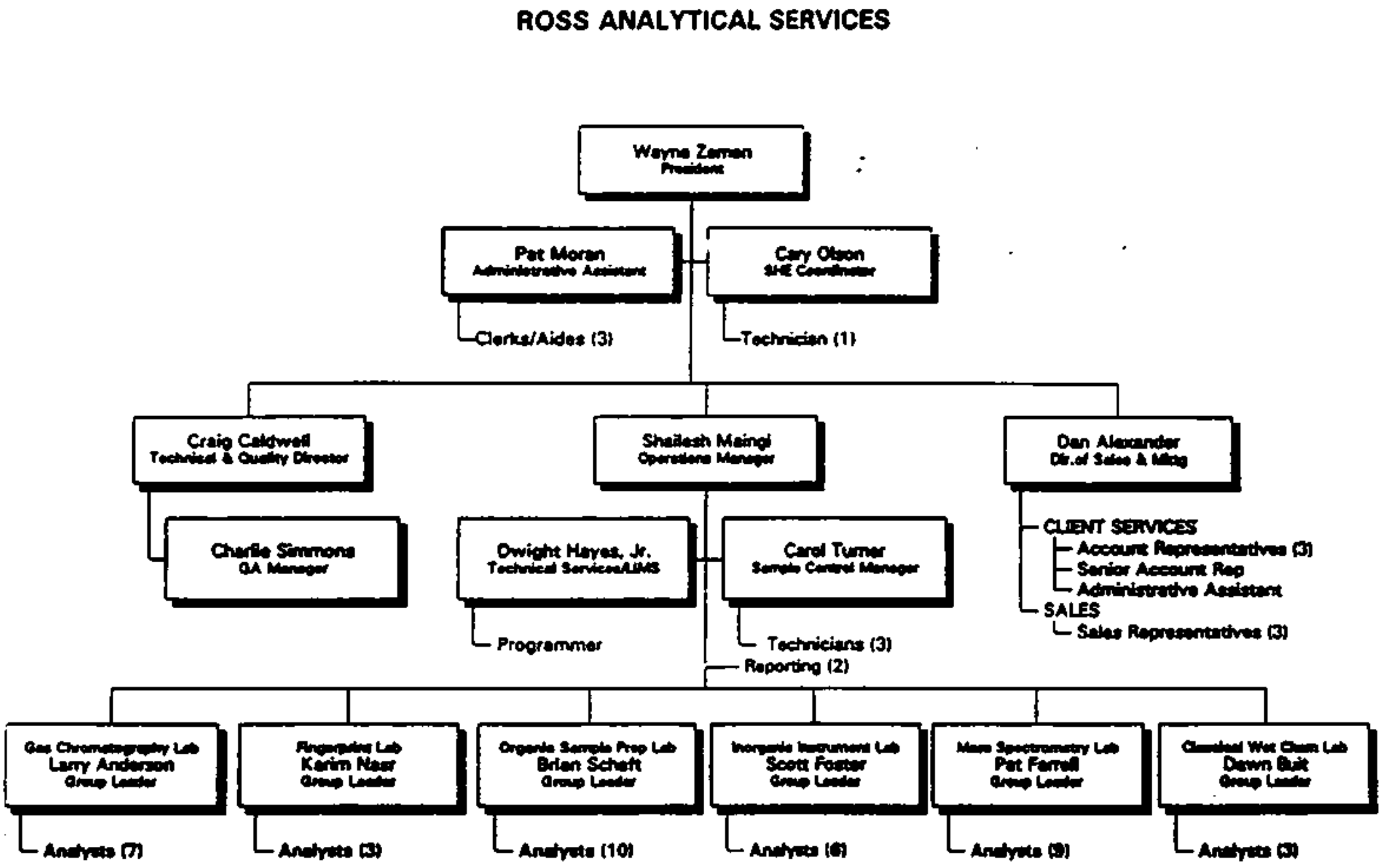
Figure 2-2 is a floor plan of the Ross Analytical Services facility. The Laboratory spaces were designed to allow orderly flow of samples while maintaining isolation where needed. The total area is 19,000 ft^2, of which approximately 11,000 ft^2 is laboratory, including sample storage. Laboratory and sample storage areas are separated by locked doors from the office and public areas.

2.4 Equipment

Table 2-1 is a list of major analytical instruments used by Ross Analytical. These instruments include eight gas chromatograph/mass spectrometers, eleven gas chromatographs, two inductively coupled plasma emission spectrometers, two atomic absorption spectrophotometers, and one each liquid chromatograph, mercury analyzer, ion chromatograph, total organic carbon analyzer, total organic halogen analyzer, infrared spectrometer, UV/visible spectrometer, and wet chemistry analyzer.

Figure 2-1

Laboratory Organization Chart



Total Number of Employees : 69

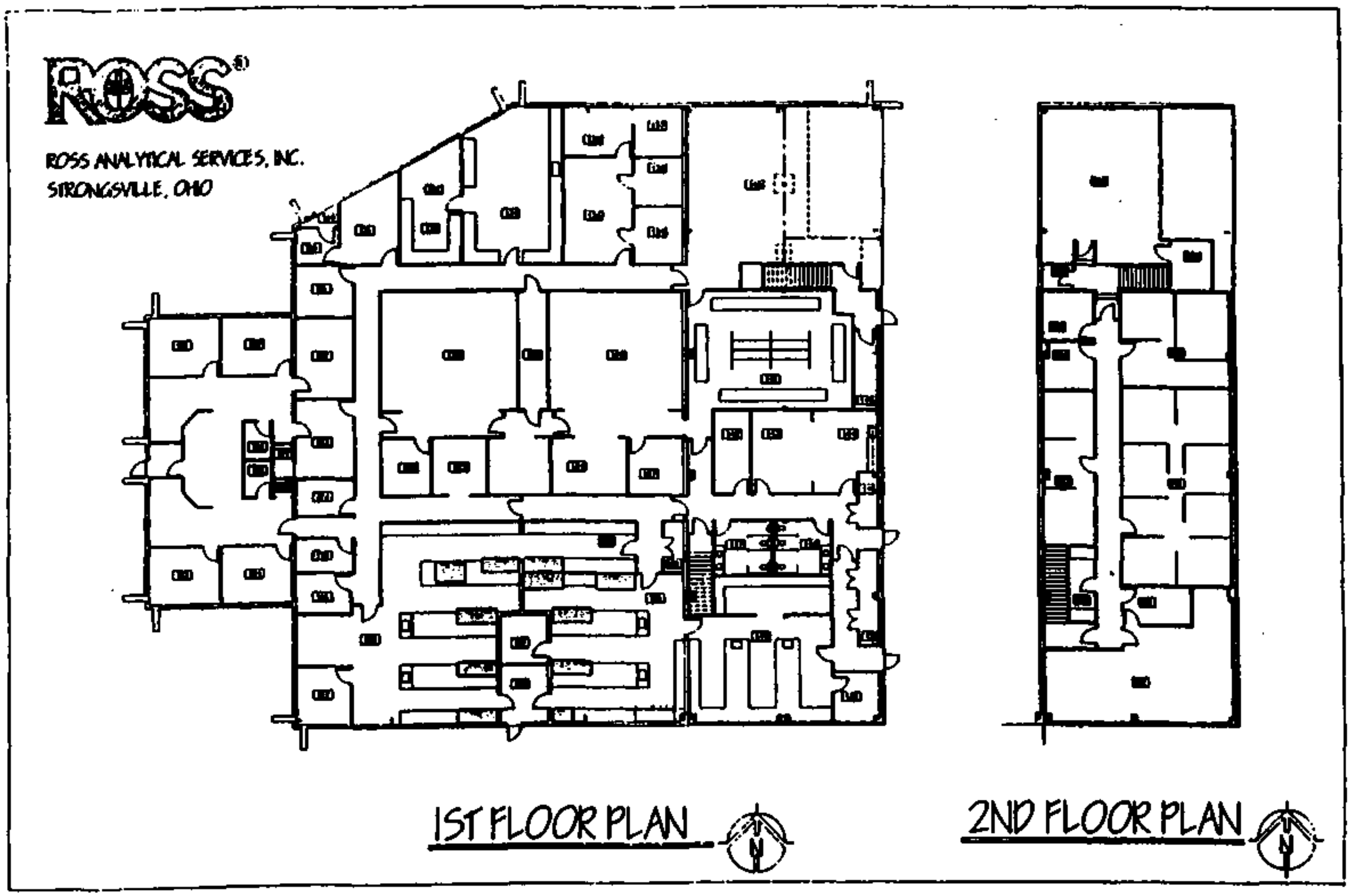


Figure 2-2
Laboratory Floor Plan

Table 2-1

Major Instruments, Equipment, and Data Systems

Mass Spectrometry

Finnigan MAT INCOS 500 Mass Spectrometer/Varian 3400 Gas Chromatograph with Tekmar LSC 2000 concentrator and ALS2016 autosampler (2)

Finnigan MAT INCOS 500 Mass Spectrometer/Varian 3400 Gas Chromatograph with Entec Model 2000 Sample Concentrator and Model 2010 16-Canister Manifold Autosampler or Nutech 8533 Concentrator as needed

Finnigan MAT XL Mass Spectrometer/Varian 3400 Gas Chromatograph with CTC A200S Autosampler (2)

Hewlett Packard 5972A Mass Spectrometer/5890 Series II Plus Gas Chromatograph with NUTECH 3550A Cryogenic Concentrator System

Hewlett Packard 5972A Mass Spectrometer/5890 Series II Plus Gas Chromatograph with CTC A200S Autosampler

Hewlett Packard 5972A Mass Spectrometer/5890 Series II Plus Gas Chromatograph with OI 4551 Purge & Trap Autosampler

Tekmar 600 Thermal tube desorber/concentrator

NUTECH 8553 automated concentrator

Gas and Liquid Chromatography

Varian 3400 Gas Chromatograph with Photoionization and Hall Electrolytic Detectors and Dynatech Dynasoils Sample Concentrator and Autosampler

Varian 3400 Gas Chromatograph with dual Electron Capture Detectors and CTC A200S Autosampler (4)

Varian 3400 Gas Chromatograph with dual Flame Ionization Detectors and CTC A200S Autosampler (2)

Varian 3400 Gas Chromatograph with dual Nitrogen/Phosphorous Detectors and CTC A200S Autosampler

Hewlett Packard 5890 Series II Plus Gas Chromatograph with dual Electron Capture Detectors and CTC A200S

MTI M200 Gas Chromatograph with dual Thermal Conductivity Detectors

Hewlett Packard 1050 High Performance Liquid Chromatography with Programmable Fluorescence Detector and Diode Array Detector

Table 2-1, Continued

Major Instruments, Equipment, and Data Systems

Metals

Thermo Jarrell Ash Inductively Coupled Argon Plasma Emission Spectrometer 61E Trace Analyzer with TGA 300 Autosampler

Thermo Jarrell Ash Enviro 36 Inductively Coupled Plasma Emission Spectrometer with TGA 300 Autosampler

Varian Spectraa 20 Atomic Absorption Spectrometer/Flame/Cold Vapor/Graphite Furnace with Deuterium Background Correction and Autosampler

Varian Spectraa 400 Atomic Absorption Spectrometer/Graphite Furnace with Zeeman Background Correction and Autosampler

Leeman Labs PS200 Automated Mercury Analyzer

Leeman Labs AP200 Automated Mercury Preparation System

Inorganics and Wet Chemistry

Perkin-Elmer 1310 Infrared Spectrophotometer

Dohrmann DC-80 Total Organic Carbon Analyzer with Autosampler and Sludge/Solids Sampler

Dohrmann DX-20 Total Organic Halide Analyzer

Lachat Instruments QuikChem AE Flow Injection Analyzer

Hitachi U-2000 UV/Visible Spectrophotometer

Leeman Labs AP1214 Automated Cyanide Preparation System

Dionex DX-100 Ion Chromatograph

Mettler AE100 and AE200 Analytical Balances

CEM MDS-810 Microwave Digestion Oven

Hach Chemical Oxygen Demand Reactor

YSI Model 35 Conductance Meter

Orion pH/ Selective Ion Meters (2)

Table 2-1, Continued

Major Instruments, Equipment, and Data Systems

Organic Preparation

- ABC AP1000 Gel Permeation Chromatograph
- ABC 1002B Gel Permeation Chromatograph
- Organomation N-Evap Nitrogen Blow Down Unit
- Heat Systems XL Ultrasonic Disrupters (3)
- Mistral 3000e Centrifuge

Data Systems

- ChemWare Horizon Laboratory Management Information System (LIMS)
- ChromPerfect chromatography data acquisition system
- Target chromatography data processing system
- Envision chromatography data deliverables system

3.0 QUALITY ASSURANCE OBJECTIVES

This section discusses the Quality Assurance (QA) objectives for each major measurement system. QA objectives, when met, assure that all measurements are representative of the media and conditions being measured, and assure the precision, accuracy and completeness of all reported analytical results. The Quality Control (QC) samples described below help to assure that media and conditions are taken into account. The QA objectives also assure that the reported analytical results are comparable to results obtained from different sampling events with the same matrix.

3.1 Samples Used to Determine Data Precision and Accuracy

Below are listed the various Quality Control samples and their purposes in determining precision, accuracy, and completeness. Table 3-1 contains a summary of the QC samples used in the laboratory, their frequency of use, and their acceptance criteria.

3.1.1 Instrument Blank

An instrument blank is prepared from either deionized water or solvent and is analyzed throughout an analytical sequence. It is not carried through the preparation steps of a method.

An instrument blank is used to evaluate the cleanliness of an instrument. This blank provides analysts a diagnostic tool by allowing them to easily check for sample carryover. Sample carryover will affect the precision and accuracy of sample analytical results. As contamination builds up in the system, the likelihood that the system is able to consistently generate the same values for one sample analyzed consecutively is reduced. Essentially, precision will decrease as contamination increases. The same scenario is true for sample accuracy. As system contaminants increase, recoveries for surrogates and matrix spikes will either increase or decrease dramatically depending on the effect the contaminant has on the sample matrix. Instrument blanks are applicable for all instrumentation.

3.1.2 Method Blank

A method blank is prepared from a pure example of the matrix being analyzed, for instance deionized water, clean soil, clean sand, or an unused sorbent trap. It may also be a substitute such as sodium sulfate. The blank is carried through the entire preparation and analytical steps of a given method exactly as a sample would be. All reagents are added in the same proportions as used in the preparation of the samples. Every batch of samples prepared (or analyzed, if the method has no preparation step) includes a method blank.

A method blank is used to evaluate the cleanliness of the whole analytical process. All reagents, glassware, and process steps such as extraction or digestion are evaluated through the use of this blank. In general, if a contaminant is found at levels greater than the EQL, then the process must be repeated with fresh sample and clean glassware. Exceptions are made for universal laboratory contaminants such as methylene chloride, which may be present at up to 5 times the EQL, and for metals if present in the samples at levels at least 20 times that in the blank. Contaminants in the method blank, even at levels below the EQL, may reduce the usefulness or invalidate sample results. Analytical SOPs discuss the specific blank acceptance criteria for each method.

3.1.3 Equipment Blank (Rinsate)

An equipment blank is a sample of analyte-free media, usually water, which has been used to rinse sampling equipment. It is collected after completion of decontamination and prior to sampling.

This blank is useful in documenting adequate decontamination of sampling equipment. Sampling personnel are responsible for providing equipment blanks.

3.1.4 Field Blank

A field blank is a sample of analyte-free media, usually water, which is transferred from bulk storage to sample collection containers. A field blank for air sampling is the medium, such as a filter or sorbent cartridge, which has been connected to the sampling device but has not had air pulled through it.

Field blanks are used to detect contamination from the sample containers or air sampling device.

3.1.5 Trip Blank

A trip blank is a VOC-free water sample provided by the Laboratory and shipped both to and from the sampling site. It is returned to the laboratory unopened.

Analytical results from a trip blank indicate if contamination has occurred during the shipping. Contamination in the trip blank may provide insight into whether values found in samples are accurate or biased.

3.1.6 VOC Refrigerator Blank

A refrigerator blank is VOC-free water in a VOC vial placed into the volatile sample storage refrigerators.

Analytical results from this sample are used to evaluate the potential for cross-contamination during sample storage. If contamination is found, the analytical results for samples stored in the refrigerator during the same time period as the blank are checked for the contaminants and the data qualified if necessary.

3.1.7 Field Duplicate

Field duplicates are independent samples collected as closely as possible at the same point in space and time. They are taken from the same source, stored in separate containers, and analyzed independently.

These samples are useful in documenting the precision of the sampling process.

3.1.8 Laboratory Control Sample (LCS)

An LCS is either prepared by spiking a clean water with targets of interest or purchasing a quality control sample which contains analytical targets at known concentrations. The LCS is carried through all preparation and analytical steps. Every batch of samples prepared (or analyzed, if the method has no preparation step) includes an LCS.

This sample is used to evaluate the accuracy of the method performed. If the percent recovery for an analyte is out of range, the accuracy is considered inadequate and the system out of control. Corrective actions include repreparing and reanalyzing the samples contained in the batch.

3.1.9 Analysis Duplicate (Split Sample)

Analysis duplicates are two aliquots of a sample carried in parallel through the entire analytical process. They are normally performed for tests which matrix spikes are not possible, such as pH and moisture. Analysis duplicates are performed on at least 5% of samples submitted for these tests.

Analysis duplicates are used to evaluate the precision of the data generated at the laboratory. A large percent difference indicates that the precision is poor between the two analyses. This does not necessarily mean that there are problems in the analytical process, but may be indicative of a nonhomogeneous sample matrix such as some soils and wastes.

3.1.10 Matrix Spike

A matrix spike sample is an aliquot of sample spiked with known concentrations of target analyte(s). Most methods call for a pair of spikes, yielding a matrix spike/matrix spike duplicate (MS/MSD) pair. Sample aliquots are spiked before sample preparation and analysis. MS/MSD pair analyses are performed on at least 5% of samples submitted for the applicable tests.

Matrix spikes are used to determine the presence of bias due to matrix interferences. MS/MSD pairs are also used to evaluate the precision of a analytical process. For example, if a target has low recovery from the sample matrix both in the MS and MSD, and had good recovery from the accompanying LCS, then a low bias is probable in the reported results. Data are qualified for samples whose matrix spike results indicate bias.

3.2 Evaluation of Precision and Accuracy

Precision and accuracy data are compared, at the bench or instrument level, to method criteria. If laboratory data do not fall within acceptance limits, then the system is considered out of control. Problems with the system are evaluated and corrected prior to any further analysis being performed.

Data from all QC sample analyses are stored in our LIMS database. These data include blank results; surrogate, LCS, and MS recoveries; and results for laboratory duplicate analyses. Control charts are automatically updated and are available for examination at any time. This enables detection of trends in QC data. Printed charts are generated at least quarterly, for the periodic updates of control limits, or more frequently as needed for special purposes.

3.3 Data Completeness

In order for data to be complete, correct, and on time, many up-front steps must be taken to ensure that the correct information is gathered from the client, and then effectively communicated to the analysts.

Below are listed the major questions to be answered by the client prior to sample arrival. The Project Manager is responsible for obtaining this information and communicating it to the operating groups. The means of communication may be as simple as notes appended to the samples in the LIMS or as detailed as a point-by-point briefing conference. The Project Manager is responsible for updates as needed so the operating departments can efficiently schedule the work. Project-specific QC is entered into the system at time of quotation or at sample login.

What methods and targets are desired?
What are the required detection or quantitation limits?
Is there a QAPjP associated with the samples?
What QC analyses must be performed on or with the samples?
Does the requested QC or another item deviate from our SOP?
What is the turn-around time?
How many samples should be expected?
Are any unusual safety precautions associated with the samples?
What are the reporting requirements?

Analysts are responsible for performing all sample and QC analyses required for the project and providing the documentation necessary to enable report assembly.

Ross Analytical's goal is 100% data completeness. This means that all requested analyses are performed, that all quality control analyses are within limits, and that reporting requirements are met. Occurrences of <100% completeness are recorded and reported to the client.

Table 3-1 Methods, Associated QC Analyses, and Acceptance Criteria

PARAMETER/METHOD(S)(1)	Ross Analytical QC SAMPLE(S)	ACCEPTANCE CRITERIA
Wet Chemistry		
Conventional Parameters as listed in Table 7-1. This includes all wet chemistry parameters.	1. Method blank per batch	1. The method blank must be <EQL.
	2. LCS per batch	2. LCS recovery ranges are as follows: CN (distilled) 75-125% Reactive CN 10-110% Reactive sulfide 10-110% Lachat analysis 90-110% Ion chromatography 90-110% Manual WC except BOD, TKN 90-110% BOD 75-125% TKN 85-115%.
	3. MS/MSD pair at 5% minimum (where possible)	3. MS/MSD recovery ranges of 75-125 %.
	4. Duplicate at 5% minimum (where MS/MSD impossible)	4. 20% RPD
Inorganic Instrumentation		
Total Organic Carbon/415.1, 415.2, 9060	1. Method blank per batch	1. The method blank must be <EQL.
	2. LCS per batch	2. LCS recovery range of 90-110 %
	3. MS/MSD pair at 5% minimum	3. MS/MSD recovery range of 80-120 %
Total Organic Carbon/Lloyd Kahn	1. Quadruplicate - 1 sample per batch	1. If the SD of the quadruplicate is outside the established limits, reanalyze the batch.
Total Organic Halogen/9020	1. Method blank per batch	1. The method blank must be <EQL.
	2. LCS per batch	2. LCS recovery range of 80-120 %
	3. MS/MSD at 5% minimum	3. MS/MSD recovery range of 80-120 %
Metals		
Metals by ICP /200.7, 6010 Methods	1. Method blank per batch	1. The method blank must be <EQL.(2)
	2. LCS per batch (aqueous samples)	2. LCS recovery range of 80-120 %.
	3. LCS per batch (non-aqueous samples)	3. LCS recovery within supplier's 95% confidence interval.
	4. MS/MSD at 5% minimum	4. MS/MSD recovery range of 80-120 %.
Metals by GFAA/All 200 and 7000 series GFAA Methods	1. Method blank per batch	1. The method blank must be <EQL.(2)
	2. LCS per batch (aqueous samples)	2. LCS recovery range of 80-120 %.
	3. LCS per batch (non-aqueous samples)	3. LCS recovery within supplier's 95% confidence interval.
	4. MS/MSD at 5% minimum	4. MS/MSD recovery range of 80-120 %.
	4a. If MS/MSD range is exceeded, do post-digestion spike.	4a. Spike recovery is 85-115 %, or use MSA.
Metals by GFAA/ Method 200.9	1. Method blank per batch	1. The method blank must be <EQL.(2)
	2. LCS per batch (aqueous samples)	2. LCS recovery range of 80-120 %.
	3. LCS per batch (non-aqueous samples)	3. LCS recovery within supplier's 95% confidence interval.
	4. MS/MSD at 5% minimum	4. MS/MSD recovery range of 80-120 % if spike concentration is >10% of sample concentration, or use MSA. No limits if spike is <10% of sample.

Table 3-1 (continued)

PARAMETER/METHOD(S)(1)	Ross Analytical QC SAMPLE(S)	ACCEPTANCE CRITERIA
Metals (continued)		
Mercury by CVAA/7470, 7471, and 245.2	1. Method blank per batch	1. The method blank must be <EQL.(2)
	2. LCS per batch (aqueous samples)	2. LCS recovery range of 80-120 %.
	3. LCS per batch (non-aqueous samples)	3. LCS recovery within supplier's 95% confidence interval.
	4. MS/MSD at 5% minimum	4. MS/MSD recovery range of 80-120 %.
Gas Chromatography		
Purgeable Halocarbons/601	1. Method blank per batch	1. The method blank must be <EQL.(3)
	2. LCS per batch	2. LCS recoveries must be within the QC acceptance limits listed in Table 2 of the method for any compound which fails the criteria in this table for the MS/MSD pair. If both fail, check for cause and reanalyze.
	3. MS at 5% minimum	3. If MS recoveries are outside of the QC acceptance limits contained in Table 2 of the method, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.
Purgeable Halocarbons/8010	1. Method blank per batch	1. The method blank must be <EQL.(3)
	2. LCS per batch	2. LCS recoveries must be within the QC acceptance limits listed in Table 3 of the method for any compound which fails the criteria in this table for the MS/MSD pair. If both fail, check for cause and reanalyze.
	3. MS/MSD at 5% minimum	3. If MS/MSD recoveries are outside of the QC acceptance limits contained in Table 3 of the method, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.
Purgeable Aromatics/602	1. Method blank per batch	1. The method blank must be <EQL.
	2. LCS per batch	2. LCS recoveries must be within the QC acceptance limits listed in Table 2 of the method for any compound which fails the criteria in this table for the MS/MSD pair. If both fail, check for cause and reanalyze.
	3. MS at 5% minimum	3. If MS recoveries are outside of the QC acceptance limits contained in Table 2 of the method, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.

Table 3-1 (continued)

PARAMETER/METHOD(S)(1)	Ross Analytical QC SAMPLE(S)	ACCEPTANCE CRITERIA
Purgeable Aromatics/8020	1. Method blank per batch 2. LCS per batch 3. MS/MSD at 5% minimum	1. The method blank must be <EQL. 2. LCS recoveries must be within the QC acceptance limits listed in Table 3 of the method for any compound which fails the criteria in this table for the MS/MSD pair. If both fail, check for cause and reanalyze. 3. If MS/MSD recoveries are outside of the QC acceptance limits contained in Table 3 of the method, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.
Purgeable Halocarbons and Aromatics in Series/601 & 602, or, 8021	1. Method blank per batch 2. LCS per batch 3. MS or MS/MSD at 5% minimum	Utilize the acceptance criteria of the individual Purgeable Halocarbon and Purgeable Aromatic methods listed above.
Organochlorine Pesticides, PCBs/608	1. Method blank per batch 2. LCS per batch 3. MS at 5% minimum	1. The method blank must be <EQL. 2. LCS recoveries must be within the QC acceptance limits listed in Table 3 of the method for any compound which fails the criteria in this table for the MS/MSD pair. If both fail, check for cause. If none is found, samples which are associated with this LCS must be reprepared and reanalyzed. 3. If MS recoveries are outside of the QC acceptance limits contained in Table 3 of the method, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.
Organochlorine Pesticides, PCBs/8080, 8081	1. Method blank per batch 2. LCS per batch 3. MS/MSD at 5% minimum	1. The method blank must be <EQL. 2. LCS recoveries must be within the QC acceptance limits of Table 3, Method 8080 for any compound which fails the criteria in this table for the MS/MSD pair. If both fail, check for cause. If none is found, samples which are associated with this LCS must be reprepared and reanalyzed. 3. If MS/MSD recoveries are outside of the QC acceptance limits contained in Table 3, Method 8080, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.
PCBs in Air/TO-4	1. Method blank per batch 2. Check standard 3. MS/MSD if client provides three PUFs	1. None. Note contaminants on report. 2. None. Note low recoveries on nonconformance. 3. None. Note on report any odd occurrences.

Table 3-1 (continued)

PARAMETER/METHOD(S)(1)	Ross Analytical QC SAMPLE(S)	ACCEPTANCE CRITERIA
Polynuclear Aromatic Hydrocarbons/610	1. Method blank per batch	1. The method blank must be <EQL.
	2. LCS per batch	2. LCS recoveries must be within the QC acceptance limits listed in Table 3 of the method for any compound which fails the criteria in this table for the MS/MSD pair. If both fail, check for cause. *If none is found, samples associated with this LCS* must be reprepared and reanalyzed.
	3. MS at 5% minimum	3. If MS recoveries are outside of the QC acceptance limits contained in Table 3 of the method, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.
Polynuclear Aromatic Hydrocarbons/8100	1. Method blank per batch	1. The method blank must be <EQL.
	2. LCS per batch	2. LCS recoveries must be within the QC acceptance limits listed in Table 2 of the method for any compound which fails the criteria in this table for the MS/MSD pair. If both fail, check for cause. If none is found, samples associated with this LCS must be reprepared and reanalyzed.
	3. MS/MSD at 5% minimum	3. If MS/MSD recoveries are outside of the QC acceptance limits contained in Table 2 of the method, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.
Organophosphorus Pesticides/8140, 8141	1. Method blank per batch	1. The method blank must be <EQL.
	2. LCS per batch	2. LCS recoveries must be within the ranges listed in Method 8140, for any compounds contained in the list which fail these criteria for the MS/MSD pair. If both fail, check for cause. If none is found, samples which are associated with this LCS must be reprepared and reanalyzed.
	3. MS/MSD at 5% minimum	3. If MS/MSD recoveries are outside of the lab-generated QC acceptance limits, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.

Table 3-1 (continued)

PARAMETER/METHOD(S)(1)	Ross Analytical QC SAMPLE(S)	ACCEPTANCE CRITERIA
hlorinated Herbicides/8150, 8151	1. Method blank per batch	1. The method blank must be <EQL.
	2. LCS per batch	2. LCS recoveries must be within the mean ± 3 standard deviations of the recoveries listed in Table 4, Method 8151, for any compound which fails the criteria in this table for the MS/MSD pair. If both fail, check for cause. If none is found, samples which are associated with this LCS must be reprepared and reanalyzed.
	3. MS/MSD at 5% minimum	3. If MS/MSD recoveries are outside of the QC acceptance limits contained in Table 3 of the method, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.
Total Petroleum Hydrocarbons/8015 (Modified)	1. Method blank per batch	1. The method blank must be <EQL.
	2. LCS per batch	2. Recovery should be between 80-120% of true.
	3. MS/MSD at 5% minimum	3. None. Note on report any odd occurrences.
Alcohols/8015	1. Method blank per batch	1. The method blank must be <EQL.
	2. LCS per batch	2. Recovery should be between 80-120% of true.
	3. MS/MSD at 5% minimum	3. None. Note on report any odd occurrences.
olvents on Solid Sorbents (NIOSH/OSHA)	1. Six-sample desorption efficiency study. Spike three levels with two spikes per each level.	1. Adjust values according to DEs.
as Chromatography/Mass Spectrometry		
olatile Organics/524.2	1. Method blank per batch	1. The method blank should be below the MDL.
	2. LCS per batch	2. Recoveries should be between 70-130 % of true.
	3. Quarterly, analyze an external quality control sample.	3. Recoveries must be within manufacturer limits. If not, check the system to find where problems are occurring, fix, then reanalyze the sample.
olatile Organics/624	1. System blank per batch	1. The method blank must be <EQL.(3)
	2. LCS per batch	2. LCS recoveries must be within the QC acceptance limits listed in Table 5 of the method for any compound which fails the criteria in this table for the MS. If both fail, check for cause and reanalyze.
	3. MS at 5% minimum	3. If MS recoveries are outside of the QC acceptance limits contained in Table 5 of the method, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.

Table 3-1 (continued)

PARAMETER/METHOD(S)(1)	Ross Analytical QC SAMPLE(S)	ACCEPTANCE CRITERIA
Volatile Organics/8240 (with capillary column) & 8260	1. System blank per batch 2. LCS per batch 3. MS/MSD at 5% minimum	1. The method blank must be <EQL.(3) 2. LCS recoveries must be within ±30 percentage points of the mean recovery listed in either Table 6 or 7 (depending on column used) of Method 8260. 3. If MS/MSD recoveries are outside ±30 percentage points of the mean recovery in either Table 6 or 7 (depending on column used) of Method 8260, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.
Semivolatile Organics/625	1. Method blank per batch 2. LCS per batch 3. MS at 5% minimum	1. The method blank must be <EQL.(4) 2. LCS recoveries must be within the QC acceptance limits listed in Table 6 of the method for any compound which fails the criteria in this table for the MS. If both fail, check for cause, have samples reprepared and reanalyzed. 3. If MS recoveries are outside of the QC acceptance limits contained in Table 6 of the method, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.
Semivolatile Organics/8270	1. Method blank per batch 2. LCS per batch 3. MS/MSD at 5% minimum	1. The method blank must be <EQL.(4) 2. LCS recoveries must be within the QC acceptance limits listed in Table 6 of the method for any compound which fails the criteria in this table for the MS/MSD pair. If both fail, check for cause, have the samples reprepared and reanalyzed. 3. If MS/MSD recoveries are outside of the QC acceptance limits contained in Table 6 of the method, check to make sure that the recoveries for the unacceptable compounds are within limits for the LCS.
Organics in Air/TO-14	1. System (method) blank per batch 2. LCS per client request	1. The method blank must be <EQL. 2. Acceptance criteria which client requests.

(1) Methods noted are the most current versions available. For example, Method 6010 listed above is the latest version, 6010A, unless the A has been superseded.
(2) or <5% of the concentration in all samples.
(3) except methylene chloride and acetone, which are allowed at ≤ 5X EQL.
(4) except for common phthalates, which are allowed at ≤ 5X EQL.

4.0 SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

4.1 Introduction

No amount of analytical skill and care can generate good data if the samples are not properly collected and preserved. Generally, Ross Analytical provides sample containers, preservatives, and instructions for their use. Ross Analytical does not provide sampling services. The information listed here is derived from "Methods for Chemical Analysis of Water and Wastes" (EPA 600/4-79-020) and "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods" (SW-846).

4.2 Sample Containers

Containers for collection of water, soil/sediment, and waste are purchased precleaned and certified. Certificates of cleanliness are filed in the Sample Control Department. SUMMA canisters and solid sorbents for air sample collection (other than those which are sealed by the manufacturer) are cleaned and blank checked according to applicable SOPs. Other sample collection and storage media such as impinger solutions, and high volume and source emission filters with folders and Petri dishes, respectively, are also provided.

Tables 4-1 and 4-2 list the allowable containers for analyses routinely performed by Ross Analytical, with the minimum amount needed for each test. At least double the minimum amount is normally collected to allow for reanalyses and QC analyses. If the client intends to specify particular samples for QC analyses, four to six times the minimum amount of those samples is collected.

For analytes which allow storage in either glass or plastic, plastic is normally used. Plastic is high density polyethylene (HDPE). Glass containers have solid Teflon-lined caps unless otherwise specified (such as septum caps for VOCs).

Multiple tests can be performed from most containers based on compatible preservation techniques. Allowed combinations are listed in Table 4-3.

4.3 Sample Preservation and Holding Time

Proper sample preservation and adherence to holding times are essential to quality results and data defensibility. Tables 4-1 and 4-2 list the preservatives and holding times for the tests routinely performed by Ross Analytical. For many analyses, samples must be delivered within one day of collection to allow their holding times to be met without scheduling conflicts. A few tests, for example residual chlorine, can almost never be performed within their holding times because the times are so short.

Samples which are received without proper preservation cause initiation of a Nonconformance Memo. These include samples for dissolved metals for which the client requests filtration at the laboratory. Samples received after their holding times or with insufficient time to perform the analysis before expiration also cause initiation of a Nonconformance Memo. Such nonconformances are noted in the report.

Ross Analytical discourages the pre-preservation of sample containers. This is because most chemical preservation is to a specific pH rather than using a specified volume, and the proper amount of preservative cannot be predicted.

TABLE 4-1

Sample Containers, Amounts, Preservatives, and Holding Times for Routine Analyses of Water Samples

Test	Container	Min. mL	Preservative	Hold time
Acidity	Plastic or glass	50	4° C	14 days
Alkalinity	Plastic or glass	50	4° C	14 days
Biochemical oxygen demand	Plastic or glass	1000	4° C	48 hrs.
Bromide	Plastic or glass	100	None required	28 days
Chemical oxygen demand	Plastic or glass	50	4° C; H_2SO_4 to pH<2	28 days
Chloride	Plastic or glass	50	None required	28 days
Chlorine, residual	Plastic or glass	200	None required	Immediate
Conductivity	Plastic or glass	100	4° C	28 days
Cyanide, total	Plastic or glass	500	4° C; NaOH to pH>12 (1)	14 days
Cyanide, amen. to chlorination	Plastic or glass	500	4° C; NaOH to pH>12 (1)	14 days
Fluoride	Plastic only	100	4° C	28 days
Hardness	Plastic or glass	100	HNO_3 to pH<2	6 mos.
Iodide	Plastic or glass	100	4° C	24 hrs.
MBAS (Surfactants)	Plastic or glass	500	4° C	48 hrs.
Nitrogen, ammonia	Plastic or glass	100	4° C; H_2SO_4 to pH<2	28 days
Nitrogen, total Kjeldahl	Plastic or glass	100	4° C; H_2SO_4 to pH<2	28 days
Nitrogen, nitrate + nitrite	Plastic or glass	100	4° C; H_2SO_4 to pH<2	28 days
Nitrogen, nitrate	Plastic or glass	50	4° C; H_2SO_4 to pH<2	28 days
Nitrogen, nitrite	Plastic or glass	50	4° C	24 hrs.
Oil and grease	Glass only	1000	4° C; H_2SO_4 to pH<2	28 days
Petroleum hydrocarbons	Glass only	1000	4° C; H_2SO_4 to pH<2	28 days
pH	Plastic or glass	25	4° C	24 hrs.
Phenolics	Glass only	100	4° C; H_2SO_4 to pH<2	28 days
Phosphorus, ortho	Plastic or glass	50	4° C	48 hrs.
Phosphorus, total	Plastic or glass	50	4° C; H_2SO_4 to pH<2	28 days
Residue, filterable (TDS)	Plastic or glass	100	4° C	7 days
Residue, non-filterable (TSS)	Plastic or glass	100	4° C	7 days
Residue, total (TS)	Plastic or glass	100	4° C	7 days
Residue, volatile (TVS)	Plastic or glass	100	4° C	7 days
Turbidity	Plastic or glass	100	4° C	48 hrs.
Silica	Plastic only	50	4° C	28 days.
Sulfate	Plastic or glass	50	4° C	28 days.
Sulfide	Glass BOD bottle (2)	300	4° C; ZnOAc; NaOH to pH>9	28 days.
Sulfite	Plastic or glass	50	None required	Immediate
Total organic carbon (TOC)	Plastic or glass	25	4° C; H_2SO_4 to pH<2	28 days
Total organic halogen (TOX)	Glass septum cap bottle	100	4° C (3)	28 days
Chromium, hexavalent	Plastic or glass	100	4° C	24 hrs.
Mercury, dissolved	Plastic or glass	100	Filter on site; HNO_3 to pH<2	28 days
Other metals, dissolved	Plastic or glass	100	Filter on site; HNO_3 to pH<2	6 mos.
Mercury, total	Plastic or glass	100	HNO_3 to pH<2	28 days
Other metals, total	Plastic or glass	100	HNO_3 to pH<2	6 mos.
Purgeable organics (VOCs)	Septum cap glass vial	40	4° C; HCl (4)	14 days (5)
Semivolatile organics (BNAs)	Amber glass only	1000	4° C (4)	7 days (6)
Organochlorine pesticides/PCBs	Amber glass only	1000	4° C (4)	7 days (6)
Organophosphate pesticides	Amber glass only	1000	4° C (4)	7 days (6)
Phenoxy acid herbicides	Amber glass only	1000	4° C (4)	7 days (6)
TCLP for VOCs (ZHE)	Septum cap glass	100	4° C	14 days (7)
TCLP for metals	Plastic or glass	200	None needed	28 days (7)
TCLP for extr. organics	Glass only	1000	4° C	14 days (7)

Notes:

1. If the sample is known or suspected to contain oxidants such as residual chlorine, also add 0.6 g ascorbic acid.
2. A 250 mL septum cap bottle may be substituted.
3. If the sample is known or suspected to contain oxidants such as residual chlorine, add a *few grains of* $NaSO_3$.
4. *If the sample is known or suspected to contain oxidants such as residual chlorine, add a few grains of* $Na_2S_2O_3$ *before the HCL*
5. It is a common belief that VOC analyses have a 7 day holding time if not preserved. This is not supported by the EPA methods.
6. Time to extraction is 7 days. The extract must be analyzed within 40 days of extraction.
7. This time is for starting the TCLP leaching. Normal analytical holding times begin with completion of the TCLP leaching.

TABLE 4-2

Sample Containers, Amounts, Preservatives, and Holding Times for Routine Analyses of Soil, Sediment, and Waste Samples

Test	Container	Min. g	Preservative	Hold time
Cyanide, total	Glass only	20	4° C	14 days
Cyanide, amen. to chlorination	Glass only	20	4° C	14 days
Moisture/solids	Glass only	10	4° C	7 days
Oil and grease	Glass only	50	4° C	28 days
Petroleum hydrocarbons	Glass only	50	4° C	28 days
pH	Glass only	25	4° C	24 hrs.
Phenolics	Glass only	10	4° C	28 days
Total organic carbon (TOC)	Glass only	10	4° C	28 days
Total organic halogen (TOX)	Glass only	10	4° C	28 days
Mercury	Glass only	10	4° C	28 days
Other metals	Glass only	10	4° C	6 mos.
Purgeable organics (VOCs)	Glass only	5	4° C	14 days
Semivolatile organics (BNAs)	Glass only	30	4° C	14 days (1)
Organochlorine pesticides/PCBs	Glass only	30	4° C	14 days (1)
Organophosphate pesticides	Glass only	30	4° C	14 days (1)
Phenoxy acid herbicides	Glass only	30	4° C	14 days (1)
TCLP for VOCs (ZHE)	Glass only	40	4° C	14 days (2)
TCLP for metals	Glass only	150	None needed	28 days (2)
TCLP for extractable organics	Glass only	150	4° C	14 days (2)

Notes:

1. Time to extraction is 14 days. The extract must be analyzed within 40 days of extraction.
2. This time is for starting the TCLP leaching. Normal analytical holding times begin with completion of the TCLP leaching.

TABLE 4-3

Allowable Combinations of Tests from Each Container Type

Container and Preservative Combination	Allowed Tests
Plastic or glass, preserved at 4° C	Acidity
	Alkalinity
	Biochemical oxygen demand
	Bromide
	Chloride
	Chlorine, residual
	Chromium, hexavalent
	Conductivity
	Fluoride (only if bottle is plastic)
	Iodide
	MBAS (surfactants)
	Nitrogen, nitrite
	pH
	Phosphorus, ortho
	Residue, filterable (TDS)
	Residue, non-filterable (TSS)
	Residue, total (TS)
	Residue, volatile (TVS)
	Turbidity
	Silica (only if bottle is plastic)
	Sulfate
	Sulfite
Plastic or glass, preserved at 4° C with H_2SO_4 to pH<2	Chemical oxygen demand
	Nitrogen, total Kjeldahl
	Nitrogen, nitrate + nitrite
	Nitrogen, nitrate
	Phenolics (only if bottle is glass)
	Phosphorus, total
	Total organic carbon (TOC)
Plastic or glass, preserved with HNO_3 to pH<2	Hardness
	Metals (all)
Plastic or glass, preserved with NaOH to pH>12	Cyanide, total
	Cyanide, amenable to chlorination
Amber glass, preserved at 4° C	Semivolatile organics (BNAs)
	Organochlorine pesticides /PCBs
	Organophosphate pesticides
	Phenoxy acid herbicides
	TCLP for extractable organics
	TCLP for metals
Glass, preserved at 4° C (non-aqueous samples)	All tests except VOCs (total or TCLP)

Note: Aqueous samples for oil and grease, petroleum hydrocarbons, sulfide, and total organic halide (TOX) require individual bottles for each test despite having in some cases common preservation requirements.

5.0 SAMPLE RECEIPT, LOGIN, AND CUSTODY

5.1 Introduction

Proper sample handling at receipt is a necessary step for successful completion of a project. Sample integrity must be ensured, the proper tests must be assigned, the samples must be stored appropriately, and Chain-of-Custody must be maintained.

5.2 Sample Receipt

5.2.1 Samples are received through hand delivery by clients or commercial carriers such as Federal Express. Most are delivered at the loading dock; some are delivered at the reception desk. During normal working hours, samples are formally accepted only by Sample Control personnel. The individual receiving the shipment signs for it, either on the commercial carrier's waybill or on the Chain-of-Custody Form for hand-delivered samples.

5.2.2 Shipping containers are inspected for physical damage and opened in the Sample Control area. They are opened in a hood if there is any reason to suspect an inhalation hazard from the contents, e.g. the samples are known to be volatile wastes. Otherwise they are opened on a table. Shipments from U.S. DOE or nuclear industry sites are screened for radioactivity before and after opening the outer container. The date and time of receipt are recorded on the Chain-of-Custody.

5.2.3 Samples are unpacked from the shipping container. Damaged sample containers are isolated and their presence recorded on the Chain-of-Custody; an undamaged shipment is recorded as "intact". The temperature of the temperature blank (if provided) or of a representative sample container is determined with an infrared thermometer and recorded on the Chain-of-Custody. (The temperature of samples which do not require refrigeration, e.g. filters, is not determined.)

5.2.4 The containers received are cross-checked against the Chain-of-Custody or other accompanying documents and any discrepancies are recorded on the Chain-of-Custody. Items checked include:

- Were all listed items received?
- Are all received items listed?
- Are the client, client address, etc. unambiguous?
- Are unambiguous sample IDs used?
- Are the desired tests and target lists unambiguous?
- Are the samples properly bottled and preserved for the desired tests?
- Is there sufficient sample volume for the desired tests?

5.2.5 The pH of at least 10% of the containers for each class of analysis, except VOCs, is checked with test paper and the presence or absence of proper preservation is recorded on the Chain-of-Custody. Samples lacking proper pH adjustment are acidified or basified as needed.

5.2.6 Discrepancies and deficiencies are recorded on the Chain-of-Custody and on a Nonconformance Memo. The Project Manager is notified so he or she can contact the client for resolution.

5.3 Sample Login

Samples are logged into the Laboratory Information Management System (LIMS) after all discrepancies are resolved. For each sample, the following minimum information is entered:

- Sample identification
- Sample matrix
- Date and time of collection
- Tests to be performed, including target lists for chromatographic analyses
- Storage location of each container
- Date of receipt
- Date results are due
- Comments, hazard warnings, etc. specific to each sample

The LIMS assigns a unique number to each sample entered. Samples to be reported together are assigned to a Sample Delivery Group (SDG), which may be a single sample or many samples received over several days. The SDG is labeled with a text description such as "Quarterly groundwaters". Each SDG is linked to the appropriate client or client/project file, which includes all addresses and telephone numbers for client contact, reporting, and invoicing. The file also describes the desired report format for that client or project. Additional comments applicable to individual samples or the SDG as a whole can also be recorded. These include caution statements for samples with known hazards or information about concentrations of targets or interferences.

5.4 Sample Storage

Samples are stored in a manner designed to preserve their physical and chemical characteristics, prevent cross-contamination, and maintain laboratory safety and health. The four categories of storage are described below. Sample locations are described by room or refrigerator number, shelf number, and bin number. Samples are normally stored for a minimum of 30 days following the date of the report. Certain contracts or projects require longer storage.

5.4.1 Room temperature, open shelves. Used for samples which are not flammable and do not require refrigeration. Examples are filters, multimetals train components, Tedlar bags, canisters, and some water and soil samples for metals analysis.

5.4.2 Room temperature, safety cabinets. Used for samples known or suspected to be flammable and for wastes suspected to contain high concentrations of volatile organics. This storage is used for such samples even if they are being tested for targets which would otherwise require refrigeration.

5.4.3 Refrigerator temperature (2-6° C). Used for most water, soil, and waste samples to be tested for organics and non-metallic inorganics. U.S. EPA CLP and other clients' volatile analysis fractions are each stored in separate stand-alone refrigerators. Organic extracts are stored in another separate stand-alone refrigerator. General refrigerated storage is in one of two walk-in cold boxes.

5.4.4 Freezer temperature (≤10° C). Used for solid sorbents to be analyzed for volatiles (e.g. charcoal and VOST tubes) and for most biological samples.

5.5 External Chain-of-Custody

Ross Analytical provides Chain-of-Custody forms for clients who do not provide their own. Figure 5-1 is an example of the form. A form is filled out at the time of receipt for hand-delivered samples which do not already have one. When samples are received by common carrier without a Chain-of-Custody, this fact is recorded in the LIMS and included in the report. Samples or sample aliquots shipped to subcontractors are accompanied by Ross Analytical Chain-of-Custody forms. Upon receipt of the subcontractor's report, that Chain-of-Custody becomes part of the data file.

5.6 Internal Chain-of-Custody

Samples are obtained from their sample location and signed out on an internal Chain-of-Custody by the analyst. Upon return, the analyst signs in the samples to Sample Control and either reshelves them or places them onto a designated cart for a member of Sample.Control to reshelve. Some projects require individual internal Chain-of-Custody forms while most transactions are recorded in the general logbook.

Extracts, leachates, distillates, digestates, and other subsamples derived from original samples are separately tracked within the LIMS and Chain-of-Custody system.

Samples or sample aliquots shipped to subcontractors are accompanied by Ross Analytical Chain-of-Custody forms. Upon receipt of the subcontractor's report, that Chain-of-Custody becomes part of the data file.

5.7 Sample Disposal

Periodically, a list is generated of the samples which have passed their minimum storage time. Some samples are removed from storage and returned under Chain-of-Custody to the client. The remaining samples are removed from storage and custody is transferred to the Safety, Health, and Environment (SHE) department.

The SHE department segregates the samples based on their matrix and known characteristics (PCB-containing, characteristic ("D") waste, or no known hazard) and arranges for appropriate disposal. Most samples are incinerated at a RCRA TSDF.

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ANALYSIS REQUEST AND CHAIN OF CUSTODY RECORD

Page ____ of ____

Report to ____________________

Lab Contact ____________________

Purchase Order No. ____________________

Project Reference ____________________

Bill to: ____________________

Telephone ____________________

ONE CONTAINER PER LINE

Sample *Number*	Sample *Type/Description*	Date Collected	Container *Type*	Pre-*servative*	Required Tests	Condition on *Receipt (Lab)*

Possible Hazard Identification:
Non-hazard *Flammable* *Skin Irritant* *Other*

Sample Disposal:
Return to Client *Disposal by Lab* *Archive* *(mos)*

Turnaround Time Required:
Normal *Rush* *Report Required By*

QA Requirements:

1. Relinquished by *Signature/Affiliation* Date

1. Received by *Signature/Affiliation* Date

2. Relinquished by *Signature/Affiliation* Date

2. Received by *Signature/Affiliation* Date

Special Instructional Comments:

Figure 5-1

Analyst Request and Chain-of-Custody Record

6.0 CALIBRATION PROCEDURES

6.1 Introduction

A formal calibration program is essential for verifying that instruments and equipment are working properly and capable of producing quality data. This section discusses Ross Analytical's calibration practices for major analytical instruments and supporting apparatus.

The two basic types of calibration are operational and periodic. Periodic calibration usually applies to apparatus such as thermometers, balances, ovens, and pipettes which do not directly produce an analytical result. Periodic calibrations are performed on a specific time schedule regardless of the frequency of use of the apparatus. Operational calibration applies to analytical instruments and manual analyses. Operational calibrations precede each use of the instrument and are performed during use at frequencies defined in the test method.

Periodic calibration records are stored in the QA Department. Operational calibration records become part of the data file for each SDG.

Analysts are responsible for ensuring that their analyses are performed under valid calibrations.

6.2 Periodic Calibrations

6.2.1 Balances

A National Institute of Standards and Technology (NIST)-certified technician examines and calibrates analytical and top-loader balances annually. The QA Department also calibrates them quarterly to 95% of full capacity. An assigned analyst checks the balances with class S weights at the beginning of each working day.

6.2.2 Refrigerators and Freezers

A member of the Sample Control group checks the temperatures of refrigerators and freezers used for storing samples and extracts twice each working day. An assigned analyst checks those used for storing standards and reagents daily.

6.2.3 Ovens

An assigned analyst checks the temperatures of ovens used for sample analysis each working day.

6.2.4 Thermometers

The QA department checks thermometers upon receipt and annually thereafter against a NIST-traceable thermometer over the range at which they are to be used. Those differing more than 2° C from true are returned (if new) or discarded.

6.2.5 Micropipettes

Micropipettes are used for preparing dilutions of calibration solutions and samples and for adding reagents and spiking solutions during analysis. An assigned analyst calibrates them upon receipt, quarterly thereafter, and after maintenance. The pipette is repaired or discarded if delivery volume is not within ±5% of true.

6.3 Operational Calibrations

Operational calibration procedures for many instruments vary with the method, especially for metals and chromatographic analyses. This section is not intended to provide the details of calibration for each method but only an overview. Details for each method are found in the applicable Standard Operating Procedure. The term "sample" as used here includes method blanks, LCSs, MS/MSDs, and duplicates.

6.3.1 Titrants used for titrimetric analyses are standardized at least weekly, with the exception of those for which a commercial supplier gives a shelf life..

6.3.2 pH meters are calibrated before each use with commercial buffers. At least two buffers, 3 pH units apart, that bracket the sample value are used for calibration.

6.3.3 The conductivity meter is calibrated before each use. The constant used to calculate sample conductance is determined with 0.01 M KCl solution. Calibration is verified with an independent standard reference solution.

6.3.4 The coulometric detector of the total organic halogen (TOX) analyzer is checked before use each day by injecting a NaCl standard into the titrating cell. An organic halogen standard, 2,4,6-trichlorophenol, is adsorbed onto charcoal and combusted with each sample set to show proper functioning of the total system.

6.3.5 The total organic carbon (TOC) analyzer is calibrated before use each day with a single potassium hydrogen phthalate (KHP) standard. The concentration of the standard used (10, 400, or 2,000 ppm) depends on the TOC concentrations of the samples being analyzed. For most methods, two injections are made, and the average value is used to calibrate the instrument. Calibration is verified by using an independent reference solution: Continuing calibration verifications are performed after every tenth sample or as otherwise required by the method in use. For some methods, a calibration curve is constructed from multiple standard levels.

6.3.6 The Lachat automated analyzer is calibrated before each use with a blank and at least four standards. The number and concentrations of the standards are specified in each method. An independent reference solution is used to verify calibration. Continuing calibration verifications are performed after every tenth sample.

6.3.7 The ultraviolet/visible spectrophotometer, used for colorimetric analyses, is calibrated before each use with a blank and at least four standards. The number and concentrations of standards are specified in each method. An independent reference solution is used to verify calibration. Continuing calibration verifications are performed after every tenth sample.

6.3.8 Atomic absorption spectrophotometers are calibrated before use for each metal analyzed. At least three points and a blank establish a curve. An independent check sample is used to verify initial and continuing calibrations. Continuing calibration verifications are performed after every tenth sample.

6.3.9 The mercury analyzer is calibrated before each use with a blank and four to six standards which are carried through the entire preparation procedure. Calibration verification standards are included with each batch. Continuing calibration verifications are performed after every tenth or fifteenth sample, depending on the method.

6.3.10 The inductively coupled plasma (ICP) spectrophotometer is calibrated before use for each element analyzed. Calibrations use a blank and one standard. Calibration is initially verified by using an independent check sample or samples, and is verified again after every 10 samples.

6.3.11 The infrared (IR) spectrophotometer is used in the determination of petroleum hydrocarbons. General instrument operation is checked with polystyrene prior to its use. A minimum three point curve is determined using a mixture of n-hexadecane, isooctane, and chlorobenzene.

6.3.12 The ion chromatograph (IC) is initially calibrated with a blank and up to five standards, depending on the method being performed. An independent check sample is used to verify initial and continuing calibrations. Continuing calibration verifications are performed after every tenth sample.

6.3.13 Gas chromatograph calibrations are variable depending on the method being used. The CLP protocol requires a three point initial calibration for most pesticides and a single point for multiple-peak targets like PCBs, with continuing calibrations every 12 hours. EPA 500 series methods require a three to five point initial calibration and continuing calibration every eight hours. EPA 600 series methods require a three point initial calibration and continuing calibration verifications every 24 hours. SW-846 methods (8000 series) require a five point initial calibration and continuing calibration verifications after every 10 samples.

6.3.14 Gas chromatograph/mass spectrometer initial and continuing calibrations are preceded by instrument tunes to confirm proper mass spectra can be obtained. CLP protocol requires five point initial calibrations and continuing calibrations every twelve hours. EPA 500 and 600 series GC/MS methods have the same calibration timing as do the GC methods of the same series. EPA 8000 series require a five point initial calibration and continuing calibration verifications every twelve hours.

7.0 ANALYTICAL METHODS

7.1 Analytical Methods

Ross Analytical normally uses published methods, e.g., Federal Register methods for Environmental Protection Agency (EPA) compliance analyses, and various other regularly accepted analytical methods such as those of the ASTM.

The methods Ross Analytical routinely uses for analysis are selected from these publications. Table 7-1 lists these methods and the analytes or analyte classes to which they pertain.

It is our policy to use the most recent versions of EPA methods which have been promulgated. Most EPA methods retain their same number at each update, but may have a revision number appended. For SW-846 methods, letters are appended to the base method number. For instance, Method 8270B, promulgated January 13, 1995, replaced Method 8270A, which had replaced Method 8270. In all tables of methods in this document, only the base method number is used.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. U.S. EPA SW-846, 3rd Ed. Update II, January, 1995.

Methods for Chemical Analysis of Water and Wastes. U.S. EPA, Cincinnati, Ohio, Publication No. EPA-600/4-79-020, Revised March 1983.

Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater. U.S. EPA, Cincinnati, Ohio, Publication No. EPA-600/4-82-055, December 1982.

Standard Methods for the Examination of Water and Wastewater. 18th Ed., 1992, American Public Health Assn., Washington DC. 20005.

Guidelines Establishing Test Procedures for the Analysis of Pollutants. Federal Register, December 3, 1979, Vol. 44, No. 233, Part 3, pp. 69464-69575.

Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air. U.S. EPA, RTP, NC, Publication No. EPA/600/4-87/006, September, 1986.

Annual Book of ASTM Standards, Volumes 11.01 and 11.02, Water. American Society for Testing and Materials. Philadelphia, Pennsylvania.

Annual Book of ASTM Standards, Volume 11.03, Atmospheric Analyses; Occupational Health and Safety. American Society for Testing and Materials. Philadelphia, Pennsylvania.

Annual Book of ASTM Standards, Volume 11.04, Pesticides; Resource Recovery; hazardous Substances and Oil Spill Responses; Waste Disposal; Biological Effects. American Society for Testing and Materials. Philadelphia, Pennsylvania.

Annual Book of ASTM Standards, Volume 05.01, Petroleum Products and Lubricants. American Society for Testing and Materials. Philadelphia, Pennsylvania.

Annual Book of ASTM Standards, Volume 05.05, Gaseous Fuels; Coal and Coke. American Society for Testing and Materials. Philadelphia, Pennsylvania.

Methods of Air Sampling and Analysis. 2nd Ed., APHA Intersociety Committee, 1977.

Sampling and Analysis Methods for Hazardous Waste Combustion, 1st Ed., prepared for U.S. EPA under Contract No. 68-02-3111 Technical Directive 124.

Statement of Work for Organic Analysis, U.S. EPA., Contract Laboratory Program, "Low Level Concentration Water for Organic Analysis, 10/92".

Statement of Work for Organic Analysis, U.S. EPA., Contract Laboratory Program, "Organic Analysis, Multi-Media, Low-Medium Concentration", OLM01.0 through OLMO1.9 and its successors.

Statement of Work for Inorganic Analysis, U.S. EPA., Contract Laboratory Program, "Inorganic Analysis, Multi-Media, Multi-Concentration", ILM0.3.0 and its successors.

NIOSH Manual of Analytical Methods, 4th Ed., U.S. Department of Health and Human Services, August, 1994.

OSHA Analytical Methods Manual, Second Edition, January, 1990. U.S. Department of Labor, Occupational Safety and Health Administration.

Official Methods of Analysis, 15th Edition, 1990. Association of Official Analytical Chemist (AOAC).

Quality Assurance Handbook for Air Pollution Measurement Systems, Volumes I, II, III, U.S. EPA-600/9-76-005, EPA-600/4-77-027a, and US EPA-600/4-77-027b.

7.2 Standard Operating Procedures

Ross Analytical normally uses standard operating procedures (SOPs) derived from the published methods. The SOPs document how a particular reference method is performed in the Ross Analytical Laboratory. The purpose of SOPs and their underlying methods are to ensure that data are legally defensible and that analyses are performed uniformly within the Laboratory.

New or non-routine analyses usually do not have an SOP. SOPs for new analyses are initiated after Ross Analytical decides to routinely provide the method. An SOP is written after the published method is reviewed; the proper equipment is installed, debugged, and is working properly; and analyst(s) has (have) been appropriately trained in the method and equipment. In most instances an SOP is completed prior to performing sample analyses. However, sometimes the analytical processes have not been fully optimized prior to receiving samples for the new analysis, or a new analysis may be a one-time project.

Ross Analytical's SOPs contain the following sections (when applicable):

Purpose
Application
References
Associated SOPs
Equipment
Standards and Solutions
Procedure
QC
Interferences
Troubleshooting

SOPs are reviewed annually and revised as necessary. SOPs may contain modifications to the underlying published method. If the modifications are not explicitly allowed within the scope of the method, this is noted in the SOP. The Quality Assurance Manager keeps the master set of originals, and working copies are kept in a central location in each laboratory. Table 7-1 includes the SOPs pertaining to each method.

7.3 Detection Limits

According to SW-846, the estimated quantitation limit (EQL) is

> "the lowest concentration [of an analyte] that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The EQL is generally 5 to 10 times the MDL [method detection limit]. However, it may be nominally chosen within these guidelines to simplify data reporting. For many analytes the EQL analyte concentration is selected as the lowest non-zero standard in the calibration curve."

Method Detection Limit (MDL) studies are performed in water, soil, and selected other matrices according to 40 CFR, Part 136, Appendix B. A minimum of seven aliquots of a given sample matrix are spiked and processed through the entire analytical method. The standard deviation is calculated. The MDL is computed by multiplying the standard deviation, with n-1 degrees of freedom, by the appropriate Students t value representing a 99% confidence level.

EQLs derived as multiples of MDLs are subject to change on a periodic basis as MDL studies are conducted. Current water and soil EQLs for metals and selected organic target lists are found in Appendix B-1. However, EQLs are highly matrix dependent and in practice may be different than those listed in Appendix B-1.

Ross Analytical considers EQLs to be reporting limits (RLs). Another term for the same concept is Practical Quantitation Limit (PQL).

Table 7-1 Parameters, Methods, and SOPs

Parameter	Method(s)(1)	Matrix	Ross Analytical SOP(6)
Conventional Parameters			
Acidity	EPA 305.1	Water	CW-033, Acidity
Alkalinity, Total	EPA 310.1	Water	CW-001, Total Alkalinity
Ammonia, as Nitrogen	EPA 350.1 or 350.2	Water	CW-015, Ammonia-Nitrogen
Ash Content	ASTM D-482	Waste	FP-008, Determination of Ash Content
Biochemical Oxygen Demand (BOD)	EPA 405.1	Water	CW-032, Biochemical Oxygen Demand
Bromide	EPA 320.1	Water	CW-034, Bromide
Btu	ASTM D-240	Waste	FP-006, Btu Analysis
Chemical Oxygen Demand (COD)	EPA 410.4	Water	CW-014, Chemical Oxygen Demand
Cation Exchange Capacity	SW 9080	Soil	CW-024, Ammonium Acetate Cation Exchange Capacity
Chloride	EPA 325.3, SW 9252	Water	CW-002, Chloride by Mercuric Nitrate Titration
Chlorine, Residual	EPA 330.3	Water	CW-062, Residual Chlorine
Color	EPA 110.2	Water	CW-049, Color
Cyanide (CN), Total	EPA 335.2, SW 9010	Water	CW-004, Total Cyanide
Cyanide, Amenable	EPA 335.1, SW 9010	Water	CW-005, Cyanides Amenable to Chlorination
Cyanide, Free	SM 4500-CNI	Water	CW-051, Free Cyanide
Cyanide, Reactive	SW Chapter 7, Section 7.3	Waste	CW-029, Reactive Cyanide
Dissolved Oxygen	SM 4500-OG, EPA 360.1	Water	CW-052, Dissolved Oxygen
Fluoride, Soluble	EPA 340.2	Water	CW-010, Fluoride
Fluoride, Total	EPA 340.2	Water	CW-010, Fluoride
Hardness	EPA 130.2	Water	CW-003, Hardness
Halide, Total (TOX)	ASTM D-808	Waste	FP-007, Total Halogen Content
Hexavalent Chromium (colorimetric)	SW 7196	Water	CW-008, Hexavalent Chromium

Table 7-1 Parameters, Methods, and SOPs (Continued)

Parameter	Method(s)(1)	Matrix	Ross Analytical SOP(6)
Inorganic Ions in Water by IC	EPA 300.0	Water	CW-053, Inorganic Ions in Water by IC Using Method 300.0
% Moisture	EPA 160.3	Soil	OP-040, % Moisture Determination
Nitrate (colorimetric)	EPA 352.1, SW 9200	Water	CW-037, Nitrate
Nitrite	EPA 354.1	Water	CW-054, Nitrite
Nitrate-Nitrite	EPA 353.2	Water	CW-038, Automated Nitrate/Nitrite Analysis
Nitrogen, Kjeldahl (TKN)	EPA 351.3	Water	CW-016, Total Kjeldahl Nitrogen
Odor	EPA 140.1	Water	CW-050, Odor
Oil and Grease	EPA 413.1, SW 9070	Water	CW-009, Oil and Grease
Oil and Grease	SW 9071	Soil	OP-046, Oil and Grease in Solids by 9071
pH	EPA 150.1, SW 9040 SW 9045	Water/Soil Waste	CW-022, pH
Paint Filter Liquids Test	SW 9095	Waste	CW-048, PFLT
Phenolics	EPA 420.1, SW 9065	Water	CW-007, Total Phenolics
Phosphorus, Total	EPA 365.2	Water	CW-017, Total and Ortho Phosphorus
Phosphorus, Ortho	EPA 365.2	Water	CW-017, Total and Ortho Phosphorus
Residue (Solids):			
Filterable, Total Dissolved (TDS)	EPA 160.1	Water	CW-011, Total Dissolved Solids (TDS)
Non-Filterable, Total Suspended (TSS)	EPA 160.2	Water	CW-012, Total Suspended Solids (TSS)
Total Solids (TS)	EPA 160.3	Water	CW-013, Total Solids (TS)
Volatile	EPA 160.4	Water	CW-055, Total Volatile Solids
Settleable	EPA 160.5	Water	CW-056, Settleable Solids
Specific Conductance	EPA 120.1	Water	CW-057, Specific Conductance
Specific Gravity		Liquid/Solid	FP-004, Specific Gravity
Sulfate	EPA 375.4, SW 9038	Water	CW-059, Sulfate

Table 7-1 Parameters, Methods, and SOPs (Continued)

Parameter	Method(s)(1)	Matrix	Ross Analytical SOP (6)
Sulfide, Reactive	SW, Chapter 7, Section 7.3	Waste	CW-030, Reactive Sulfide
Sulfide, Total	EPA 376.1, SW 9030	Water	CW-018, Total Sulfide
Surfactants (MBAS)	EPA 425.1	Water	CW-060, Surfactants (MBAS)
Total Organic Carbon (TOC)	EPA 415.1, 415.2, SW 9060	Water	II-006, Nonpurgable Organic Carbon (NPOC) in Waters
	or "Lloyd Kahn" (2)	Soil	II-007, Organic Carbon in Soils, Domestic and Industrial Wastes, Oils, and Sediments
Total Organic Halogen (TOX)	SW 9020	Water	II-004, Total Organic Halides in Waters
Total Organic Nitrogen	EPA 351.1	Water/Soil	CW-061, Total Organic Nitrogen
Total Recoverable Petroleum Hydrocarbons	EPA 418.1	Water	OP-036, Extraction and Analysis of Total Petroleum Hydrocarbons in Water Using Method 418.1 (IR)
Total Recoverable Petroleum Hydrocarbons	SW 9071/EPA 418.1	Soil, waste	OP-020, Extraction and Analysis of Total Petroleum Hydrocarbons in Soils
Toxicity Characteristic Leaching Procedure	SW 1311	Waste	IP-006, TCLP
Turbidity	EPA 180.1	Water	CW-047, Turbidity
Metals			
Metals by ICP	SW 6010	Water/Soil/Waste	MT-001, Calibration and Operation of the TJA Enviro 36
	SW 6010	Water/Soil/Waste	MT-002, Quality Control Procedures for the TJA Enviro 36 ICP Using Method 6010A
	Inorganic CLP SOW	Water/Soil	MT-006, Quality Control Procedures for the TJA Enviro 36 Using the CLP Statement of Work
	EPA 200.7	Water	MT-001, Calibration and Operation of the TJA Enviro 36
	EPA 200.7	Water	MT-003, Quality Control Procedures for the TJA Enviro 36 ICP Using Method 200.7
Metals by GFAA (3)	EPA 2xxx.x, SW 7xxx	Water/Soil	MT-008, General Calibration and Operation of the Varian Spectraa 400Z
Mercury by CVAA	EPA 245.x, SW 7470, 7471	Water/Soil/ Waste	MT-004, Mercury Analysis by CVAA

Table 7-1 Parameters, Methods, and SOPs (Continued)

Parameter	Method(s)(1)	Matrix	Ross Analytical SOP (6)
Metals Digestion Procedures			
Mercury	EPA 245.1, SW 7470	Water	IP-001, Digestion Procedure for Mercury in Aqueous Samples
Mercury	EPA 245.5, SW 7470, 7471	Soil/Waste	IP-002, Digestion Procedure for Mercury in Solids and Non-Aqueous Wastes Using SW-846, Methods 7470 and 7471
Metals by ICP and GFAA	SW 3010, 3020	Water	IP-003, Digestion Procedure for Metals in Aqueous Samples Using SW-846, Methods 3010A, 3020A
Metals by ICP and GFAA	SW 3050	Soil/Waste	IP-004, Digestion Procedure for Metals in Solids and Non-Aqueous Wastes Using SW-846, Methods 3050A
Arsenic and selenium by GFAA	SW 7060, 7740	Water	IP-005, Digestion Procedure for Arsenic and Selenium in Aqueous Samples Using SW-846, Methods 7060A, and 7740
Metals by CLP protocol	CLP SOW ILM02.0	Water	IP-007, CLP Digestion Procedure for Metals in Aqueous Samples
Multimetals train (source emissions)	40 CFR 266 Appendix IX, EPA 29 (4)	Multi-Metals	IP-008, Digestion Procedure for Metals in Stack Emissions from Hazardous Waste Incinerators and Similar Combustion Processes
Metals in workplace air	NIOSH 7300, 7082	Filter	IP-009, Digestion Procedure Industrial Hygiene Air Filters
Gas Chromatography			
Purgeable Halocarbons and Aromatics	SW 8021	Water/Soil	GV-005, Analysis of Purgeable Halocarbons and Aromatics in Series by Method 8021
	EPA 601, 602	Water	GV-008, Analysis of Purgeable Halocarbons and Aromatics in Series by 601, 602

Table 7-1 Parameters, Methods, and SOPs (Continued)

Parameter	Method(s)(1)	Matrix	Ross Analytical SOP (6)
Organochlorine Pesticides/PCBs	SW 8080, 8081	Water/Soil	GP-004, Analysis of Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs) - Method 8081
	EPA 608	Water	GP-007, Analysis of Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs) by Method 608
	CLP SOW OLM01.9	Water/Soil	GP-005, CLP Pesticide/PCB Analysis
Polynuclear Aromatic Hydrocarbons	EPA 610, SW 8100	Water/Soil	GX-008, Analysis of Polynuclear Aromatic Hydrocarbons by Method 610
			GX-009, Analysis of Polynuclear Aromatic Hydrocarbons by Method 8100
Organophosphorus Pesticides	SW 8141	Water/Soil	GP-002, GC/TSD Analysis for Organophosphorus Pesticides
Chlorinated Herbicides	SW 8150	Water/Soil	GX-005, Chlorinated Herbicide Analysis (EPA SW-846, Method 8150)
Total Petroleum Hydrocarbons	SW 8015 (Modified)	Water/Soil	GX-007, Analysis of Total Petroleum Hydrocarbons by GC/FID
Alcohols	SW 8015	Water/Soil	GV-001, Analysis of Alcohols by Direct Injection
			GV-004, Analysis of Microdistilled Alcohols by GC/FID Using Modified Method 8015
Solvents on Charcoal Tubes	NIOSH and OSHA Methods	Tube	GA-001, Analyzing Charcoal Tubes for Solvents
Permanent Gases	EPA 3C	Tedlar bag	GA-002, Analysis of Permanent Gases
Preparation Methods for GC			
Organochlorine Pesticides and PCBs	EPA 608	Waters	OP-034, Pesticide/PCB Water Extraction Using EPA Method 608
	SW 3510, 3520	Water/Soil	OP-002, Pesticide and PCB Extraction Using SW-846, Methods 3510A, 3520A
			OP-024, PCB Solid Waste Extraction
			OP-026, PUF Sample Extraction
			OP-032, Extraction of PCBs from Wipes or Swabs
	CLP SOW OLM01.9	Water/Soil	OP-008, CLP Pesticides/PCB Extraction

Table 7-1 Parameters, Methods, and SOPs (Continued)

Parameter	Method(s)(1)	Matrix	Ross Analytical SOP(6)
Organophosphorus Pesticides	SW 8141	Water/Soil	OP-018, Extraction of Organophosphorus Pesticides from Water Samples by Continuous Extraction
			OP-019, Extraction of Organophosphorus Pesticides from Soil Samples
Chlorinated Herbicides	SW 8150	Water/Soil	OP-013, Extraction of Acid Herbicides from Water Samples
			OP-009, Extraction of Acid Herbicides from Solid Samples
Total Petroleum Hydrocarbons		Water	OP-021, Extraction of Water Samples for Petroleum Hydrocarbons, Analysis by GC
Alcohols	SW 8015 (Modified)	Water/Soil	OP-031, Microdistillation of Alcohols from Solid and Liquid Samples
Gas Chromatography/Mass Spectrometry			
Volatile Organics	EPA 624, SW 8240, 8260	Water/Soil	MV-001, Determination of Volatile Organic Compounds by GC/MS by Methods 8240B, 8260A
			MV-006, Analysis of Low Level Purgeable Organic Compounds by GC/MS Using Method 8260A
	EPA 524.2	Water	MV-007, Analysis of Volatile Compounds by GC/MS Using Method 524.2
	CLP SOW OLM01.9	Water/Soil	MV-005, Analysis of Volatile Compounds by GC/MS for CLP
Semivolatile Organics	EPA 625, SW 8270	Water/Soil	MX-003, Analysis of Aqueous Samples for Semivolatile Organics Using Method 625
			MX-002, Analysis of Semivolatile Compounds by GC/MS for RCRA/CERCLA by Method 8270B
	CLP SOW OLM01.9	Water/Soil	MX-001, Analysis of Semivolatile Compounds by GC/MS for CLP
Organics in Air		Tenax/Charcoal	MA-001, Tenax and Tenax/Charcoal Sorbent Trap Analysis
	TO-14 (5)	Canister	MA-006, Analysis of SUMMA Polished Canisters by GC/MS for Non-CLP
			MA-007, Analysis of SUMMA Polished Canisters by GC/MS for Non-CLP, Low Level Curve

Table 7-1 Parameters, Methods, and SOPs (Continued)

Parameter	Method(s)(1)	Matrix	Ross Analytical SOP(6)
Organics in Air, continued	CLP draft SOW	Tenax	MA-003, Tenax Sorbent Trap Analysis for CLP
		Canister	MA-005, Analysis of SUMMA Polished Canisters by GC/MS for CLP
Preparation Methods for GC/MS			
Base/Neutrals and Acids	SW 3510, 3520	Water	OP-001, B/N/A Extraction of Water Samples Using SW-846 Methods 3510A, 3520A
	SW 3550	Soil/Waste	OP-011, Ultrasonic Extraction of BNAs from Low Level Soils, Solid Wastes, and Sludges
	SW 3580	Waste	OP-025, BNA Liquid Waste Dilution
	SW 3540	Waste	OP-038, B/N/A Soxhlet Extraction for Wastes by Method 3540A
	EPA 625	Water	OP-033, Extraction of Base/Neutral and Acid Compounds from Aqueous Samples Using Method 625
Organics in Air	TO-4, TO-13 (5)	Air	OP-026, PUF Sample Extraction
	SW 0010	Air	OP-030, MM5 Sample Extraction

(1) Methods noted are the most current versions available. For example, Method 8240 listed above may be the latest version (e.g., 8240B unless the B has been superseded). Sources are as follows, except as noted otherwise.

EPA: Methods for chemical Analysis of Waters and Wastes (inorganics), Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater (organics)
SW: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods
ASTM: American Society for Testing and Materials, Annual Book of Standards
SM: Standard Methods for the Examination of Water and Wastewater
NIOSH: NIOSH Manual of Analytical Methods
OSHA: OSHA Analytical Methods Manual

(2) Determination of Total Organic Carbon in Sediment, Lloyd Kahn

(3) Metals are antimony, arsenic, beryllium, cadmium, chromium, copper, lead, selenium, silver, and thallium.

(4) From 40 CFR 60, Appendix A

(5) Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air

(6) SOPs are subject to revisions. Check your SOP notebooks for the most current SOP available.

8.0 DATA REDUCTION, VERIFICATION, AND REPORTING

8.1 Data Reduction

Data reduction is the calculation of final results from raw data. Most data reduction at Ross Analytical is automated to reduce errors and speed the process. However, manual calculations predominate for wet tests such as titrations and gravimetric analyses. Some data reduction occurs at the instrument level, while other data sets are reduced within the LIMS or with stand-alone software. Data transfer is electronic wherever possible, again to reduce errors and increase speed.

8.2 Data Verification

Data verification (data review) is a multistep process designed to detect and correct errors as early as possible. The data verification system is designed so data are released to the Reporting Department fully calculated and in their appropriate final units. A representative number of data sets are reviewed by the QA department, but the responsibility for verification lies within each analytical department.

The data items reviewed vary with the analysis and include applicable items from this list:

- Initial and continuing calibrations (proper levels and frequency, acceptable linearity and drift)
- Instrument blanks (proper frequency, results within limits)
- Method blanks (proper frequency, results within limits)
- Quality Control samples (proper frequency, results within limits)
- Manual data entry (correct weights, volumes, and moistures)
- Manual calculations (same result when repeated)
- Surrogate recoveries (within limits, or out for legitimate reason)
- Completeness (necessary forms and raw data present)

8.2.1 Analyst Review

The analyst, or data reducer if he or she is not the analyst, performs the first review of all of the applicable items above. Items failing review are examined to find the source of the error. Corrections are made as needed; these may be as simple as replacing a wrong result with the right one or as complex as initiating repreparation of an entire batch. Corrective actions are documented. Upon successful analyst review, the data are passed to the next level.

8.2.2 Supervisor Review

The Group Leader or a senior analyst other than the original data reducer perform a second review. Selected items from the above list are checked. Manual calculations undergo up to a 100% check, depending on complexity. Upon successful supervisor review, the data are flagged in the LIMS as available for reporting. The physical data package is examined for completeness and passed to the Reporting Department.

8.2.3 Final Review

Final review is performed by the Reporting Department with input from the Project Manager as needed. The QA Department may also review selected data sets at this stage. Final review examines elements which would not be apparent to a single department, such as relationships between wet chemistry and metals results or comparison with historical data. A unifying narrative is written at this stage if needed.

8.4 Data Reporting

8.4.1 Acquisition of Computer Readable Data

Data from computer based data systems are electronically transferred to the LIMS with analyst verification of the proper linkage and transfer. Data output by dedicated microprocessor data systems are captured; the analyst tags the data with the proper identification information and electronically transfers them into the LIMS. Non-computer generated data are entered into the LIMS manually.

8.4.2 Updating Computer Readable Data

Data entered into the LIMS follow a standardized flow chart with a review at each step along the path. Data in the active step are available for data entry or editing. When that step has been verified, the data are locked and prevented from any further modification without intervention by a supervisor or the Information Systems (IS) Department. The LIMS maintains an audit trail of all changes to the data.

8.4.3 Correcting Computer Readable Data

Any changes to data that have previously been reviewed and verified require intervention by the QA Manager, a Group Leader, the Operations Manager, the Technical Director, or a member of the IS Department. This individual "unlocks" the data file to allow changes to be made. The change itself may be performed by a member of the originating department. The reason for the change and the person making it are entered into the LIMS audit trail.

8.4.4 Storage and security of computer readable data

The LIMS software and data reside on a UNIX platform computer located in the IS Department office. Access to this area is limited to members of the IS Department, the President, the Operations Manager, the Technical Director, and the Safety Officer. Each Ross Analytical employee has a pair of unique login name/password combinations which set his or her security access at the appropriate level of need. The first pair allows access to the UNIX system and the second to the LIMS itself.

The LIMS software and database are backed up during the night following every business day. A weekly backup is also made and stored in secure off-site storage. Data are archived as needed, duplicated, and stored locally in the IS Department office and in secure off-site storage.

The LIMS provides an audit trail of all accesses and changes to the LIMS system and documents all transactions.

8.5.5 Report Preparation

At completion of the final review by the Reporting Department, data are flagged in the LIMS as available for printing. Printing is initiated as needed, the cover page of the Certificate of Analysis is signed, and the report is assembled for sending. Reports for analyses performed by U.S. EPA *Contract Laboratory Program (CLP) protocol are assembled according to the relevant Statement of* Work (SOW). For non-CLP analyses, one of three levels of reports is prepared:

8.5.5.1 Ross Analytical Report Level III

This is the simplest report, a Certificate of Analysis. It includes a cover page, report comments (narrative) if necessary, descriptions of test methodologies, analytical results, and the Chain-of-Custody.

8.5.5.2 Ross Analytical Report Level II

The Level II report is a Level III report with a Quality Control Summary section. The contents of the summary vary with the client's needs and expectations. It may include blank results, LCS recoveries, MS/MSD results, duplicate analysis results, and other, similar, data.

8.5.5.3 Ross Analytical Report Level I

The Level I report is a "CLP-style" data package for analyses performed by other than CLP protocols. Its structure follows, as closely as possible, the basic inorganic and organic SOWs. It is essentially a Level II report containing summaries of all blanks and QC analyses, with the addition of analytical sequence lists, calibration summaries, and raw data for all calibrations, samples, blanks, and QC analyses.

8.5.6 Post-Reporting Changes

Occasionally an error is found after a report is sent, or a client requests revision of a report. Such changes require the same steps as changes at any other stage of the process. Data are made accessible as in 8.4.3 above, the change is made, and the reason for the change and the person performing it are recorded in the LIMS audit trail. The report is then reissued, with a description of the change included in the narrative.

8.5 Project Files

Project files contain the record of the analyses performed on the samples. Files normally contain a copy of the report (including Chain-of-Custody) and copies or originals of the work order, any nonconformance memos, and most raw data for the samples. Raw data (instrument output) for ICP, AA, TOC, and TOX results are kept in a master file in the Metals Department because those runs usually include results from many work orders. Run summaries are included in the project file to allow recovery of the raw data if needed. Raw data are copied as needed for submission or inclusion in individual SDG files. Raw data for GC and GC/MS initial calibrations are also kept in master files, and summaries (equivalent to CLP Form VI) are in the project file. Raw data and summaries for GC and GC/MS continuing calibrations are in the project file. Master files are maintained in the department of their origin for one year and then moved to long-term storage. Purely business-related records, such as quotations and invoices, are not part of the project file. Project files and related master files are retained for a minimum of three years from submission of the report.

8.6 Quality Assurance/Quality Control Files

The Quality Assurance Department maintains files of QA and QC records which are not directly linked to individual sample sets. These files include the following:

- Method Detection Limit (MDL) studies
- Site visit (audit) reports and responses
- Performance Evaluation (PE) sample results
- Quality Assurance Project Plans (QAPjPs)
- QC analyses tabulations and control charts
- Refrigerator and freezer temperature records
- Balance calibration and daily check records
- Reagent water check records
- Nonconformance log
- Masters of current and out-of-date SOPs

9.0 INTERNAL QUALITY CONTROL

The quality of reagents, supplies, water, and other materials used in the laboratory directly affects the quality of analytical results. Purchased materials must be controlled to verify that reagent requirements, whether lab-specific or method-specific, are met. Each laboratory has one or more persons responsible for purchasing laboratory materials and controlling them. The quality of reagent water produced by Laboratory deionizing systems is also critical to data quality.

9.1 Reagents and Standards

Most chemicals (reagents, as distinguished from analytical standards) used in the Laboratory are of ACS Reagent quality or better. Solvent purity is specified in each SOP and is normally chromatographic grade or better. Reagents for some analyses have special purity requirements; an example is those used for mercury analysis, which are specified mercury-free. Analytical standards are traceable to NIST when possible or are otherwise certified by their manufacturer. Certificates of Analysis for standards are stored in the office of the Quality Assurance Manager.

Reagents and standards are logged into a database upon receipt and assigned an inventory number and expiration date. Regents and standards which are subject to chemical changes have expiration dates assigned by the manufacturer. Other reagents, such as sodium chloride, have no physical "expiration" and so are assigned a three year life. Reagents are stored in a manner which best maintains their quality and integrity and the safety of Laboratory personnel.

Solutions made from stock reagents are logged and are traceable to the specific bottle used in preparation. If a contamination problem is found, the affected stock is identified and immediately removed from use. Each lot of high volume solvents such as methylene chloride is checked for impurities before use. If found, the lot is rejected and a new lot issued.

Group Leaders are responsible for purchasing reagents and standards of the quality appropriate for their use. They are also responsible for removing expired materials from their labs and transferring them to the SHE Department for proper disposal.

9.2 Laboratory Pure Water

Laboratory pure water (reagent water) is prepared with one of two deionizer systems. Standard purity water is passed through beds of activated charcoal and mixed ion exchange resins. This water is available at taps throughout the Laboratory and is used for wet chemical analyses and final rinses of washed labware. High purity water is standard purity water passed through a LabConCo polishing system to remove the last traces of organic and inorganic contamination. This water is available at taps in the Wet Chemistry, Sample Preparation, Organic Standards Preparation, and Metals Laboratories and is used for organic blanks and for metals analyses.

The conductivity of both the standard and high purity water is checked daily. The volatile organic content of the high purity water from the Organic Preparation Lab and the Standards Preparation Room taps is monitored monthly. A sample drawn from each location is analyzed by SW-846, Method 8021. Acceptance criteria for both sets of tests are listed in Table 9-1.

9.3 Compressed Gases

High purity nitrogen and argon are piped throughout the Laboratory from bulk liquid cryotanks. Other gases, such as hydrogen and helium, are purchased in individual cylinders. As with reagents, Group Leaders are responsible for purchasing compressed gases of the appropriate purity for their use.

Standard gas mixtures for calibration are also purchased. Their certificates of analysis are stored in the Quality Assurance Manager's office.

9.4 Laboratory Glassware

Laboratory glassware and plasticware are kept stocked by the individual departments which use them. Volumetric ware, such as pipettes and volumetric flasks, are Class A. Permanent glassware installations, such as cyanide stills and banks of condensers, are maintained wherever practical. Labware is cleaned according to its intended use as described below. The standard operating procedure for glassware cleaning is posted in the Glassware Cleaning Room.

9.4.1 Glassware for Wet Chemistry and Metals Analyses

Following glassware use, the glassware is rinsed with hot tap water to remove residues. The glassware is then soaked in a Alco-Nox solution and is scrubbed to remove all surface residues. It is then rinsed well with tap water to remove all traces of detergent, followed by several rinses with deionized water. If glassware still contains stubborn deposits, special cleaning steps described in the SOP are used. Glassware are dried in an oven overnight. Prior to metals analyses, glassware is soaked in 1:1 nitric acid:water and thoroughly rinsed.

9.4.2 Glassware for Organics Analyses

Organic glassware cleaning follows the same procedure as above up to the drying step. Before oven drying, the glassware is rinsed with methanol. It is then is either air dried or oven dried before storage. Immediately before use, the glassware is rinsed with the solvent to be used in the method.

Table 9-1

Inorganic and Organic Laboratory Water Checks

Analysis	Acceptance Criteria	Corrective Action
Conductivity/Inorganic Check	Deionized Water - < 1.0 umhos/cm	Check cartridges and filters; replace if necessary.
	LabConco Water - < 0.2 umhos/cm	Check cartridges and filters; replace if necessary.
8021/Organics Check	All compounds except methylene chloride must be < EQL.	Retest water the next day. If it is still out, notify the QA Manager.

10.0 PERFORMANCE AND SYSTEM AUDITS

The Ross Analytical Laboratory is subject to several types of audits each year, both internally and by outside parties. These include performance audits, system audits, and data quality audits. These audits are performed for the following reasons:

To determine that contractual and regulatory obligations are being fulfilled.

To determine that Ross Analytical procedures and standards are being followed.

To establish that quality assurance objectives are being met.

To identify potential or existing deficiencies.

To determine that proper records are being maintained.

10.1 Proficiency Testing Programs - Performance Audits

Ross Analytical participates in many proficiency testing programs administered by government and private agencies. Many of them are part of accreditation or certification programs. They include:

The U.S. EPA Water Pollution (WP) Performance Evaluation Studies for trace metals, minerals, nutrients, demand, PCBs, pesticides, volatiles, and miscellaneous wet chemistry parameters;

The U.S. EPA/Ohio Department of Health Water Supply (WS) Performance Evaluation Studies for trace metals, trihalomethanes, and other volatile organics;

The State of New York Department of Health Performance Evaluation Studies: Non-Potable Water series for demand, nutrient, minerals, miscellaneous wet chemistry parameters, metals, volatiles, semivolatiles, pesticides, PCBs, and herbicides; Solid and Hazardous Waste series for metals, hazardous properties, volatiles, semivolatiles, pesticides, and PCBs; and Air series for particulate, volatiles, and PCBs..

The U.S. EPA Contract Laboratory Program (CLP) Quarterly Blind Performance Evaluation Studies for volatiles, semivolatiles, and pesticides/PCBs.

The Proficiency in Analytical Testing (PAT) program sponsored by the National Institute of Safety and Health (NIOSH), for metals and organic solvents;

10.2 System Audits

System audits are performed by the Quality Assurance Manager and agencies such as the U.S. EPA, private laboratory accreditation programs, and clients. Their purpose is to determine if the laboratory's quality assurance program is adequate and if the procedures described by it are being followed.

10.2.1 Audits by External Agencies

Examples of agencies performing these audits are the U.S. EPA Contract Laboratory Program (CLP), the Ohio EPA, the New York State Department of Health, the American Association for Laboratory Accreditation, and the American Industrial Hygiene Association.

The audits by these agencies generally examine the laboratory's QA Plan, its sample receipt and log-in procedures, calibration and analytical practices, and record keeping. Schedules vary, but normally at least one system audit is conducted each year by each program.

Reports from external auditors are reviewed by the Quality Assurance Manager, Technical and Quality Director, Operations Manager, and other individuals as necessary. Corrective actions are decided among all affected parties. A corrective action reply is prepared by the Quality Assurance Manager for the auditing client or agency. Corrective actions are performed by the necessary Group Leader or staff departmental area supervisor. A follow-up internal audit is made after the implementation deadline to ensure that corrective actions have been taken.

10.2.2 Internal Audits

Internal audits of each operating department are conducted by the QA Department twice per year. The process is detailed in SOP QC-012, Internal Quality Assurance Audit Procedure. A report is generated which includes Findings, Corrective Actions, and Corrective Actions Needed From Previous Audits. Findings are items which are deemed deficient and need attention. Corrective Actions are a list of items which specify how the findings are to be corrected. The last category lists any deficiencies which were not adequately addressed since the previous audit or items which were corrected but reoccurred since the last audit.

This report is distributed to the Group Leader in charge of the department, the President, and the Operations Manager. It is the responsibility of the Group Leader to make all appropriate changes listed in the report. Follow-up will occur following the implementation deadline to ensure that corrective actions have been taken.

Method audits are conducted on a periodic basis. Results from the audits are used to evaluate the effectiveness and correctness of standard operating procedures. Additionally, analyst performance is evaluated by how well the analyst complies with the standard operating procedures. Written reports are prepared for the Operations Manager, the Technical and Quality Director, and the Group Leader of the department.

10.2.3 Subcontractor Approval Process

Ross Analytical has a formal process for approving subcontractors laboratories. The approval process is outlined in SOP QC-014, Subcontractor Approval Process. The process includes, at a minimum, an examination of the proposed subcontractor's Quality Assurance Program Plan or Manual and applicable SOPs. Results of third-part performance evaluation samples for the analyses in question are also examined, if available. The approval process can also include the submission of single-or double-blind PE samples. Subcontractor data are clearly identified in reports. Client-designated subcontractors are not necessarily put through the approval process and might not become approved subcontractors of Ross Analytical.

10.3 Certifications, Accreditations, Approvals, and Licenses

Ross Analytical is approved to perform under many government programs. These approvals are variously called certifications, accreditations, approvals, or licenses. Brief descriptions of each follow.

10.3.1 Federal Programs

U.S. EPA Contract Laboratory Program (CLP); Regular Analytical Services (RAS). Contract holder since January, 1992.

U.S. EPA Contract Laboratory Program (CLP), Special Analytical Services (SAS). Approved since August, 1992.

U.S. EPA Region V, RCRA. Approved June, 1992, to perform Appendix IX analyses on RCRA Corrective Action project in Region V.

U.S. Department of Agriculture. Permitted since to receive soils from outside the continental U.S. and from quarantined areas within the U.S..

Nuclear Regulatory Commission Licensing. Licensed to receive environmental media from regulated sites.

10.3.2 State Programs

Ohio EPA, Division of Emergency and Remedial Response. Certified since January, 1995, to perform analyses in support of Voluntary Action Program cleanup projects in Ohio.

Ohio EPA, Division of Drinking Water. Certification for metals and volatiles initiated.

State of New York Department of Health. Approved since January, 1992, for PCBs in non-potable water; March, 1992, for PCBs in non-potable water; April, 1993 for aromatic and halogenated volatiles and particulate in air and emissions; April, 1993 for volatiles, semivolatiles, pesticides, PCBs, herbicides, metals, total organic carbon, and wet tests in non-potable water; and April, 1993, for characteristic testing, volatiles, semivolatiles, pesticides, PCBs, and metals in solid and hazardous waste.

State of California Department of Health. Approved since March, 1994, for inorganic and organic analyses of hazardous waste and organic analyses of wastewater.

10.3.3 Private Programs

American Industrial Hygiene Association (AIHA). Application for accreditation pending.

11.0 PREVENTIVE MAINTENANCE

Preventive maintenance is an organized program to maintain proper instrument and equipment performance. The frequency of maintenance is based on the manufacturer's recommendations and on previous experience with the instrument. A maintenance schedule is prepared for each instrument in the program and kept in a maintenance logbook. Maintenance is documented in the logbook. Group Leaders are responsible for following the preventive maintenance schedules. The QA Department audits maintenance logbooks as part of the semiannual internal system audits.

A major part of the preventive maintenance program is a an adequate spare parts inventory. To minimize downtime, consumables and parts including reagents, columns, filaments, electron multipliers, and computer boards are kept on hand for most instruments. Used parts are immediately replaced to maintain necessary backups.

Table 11-1 summarizes the Ross Analytical preventive maintenance program. It includes instrument identification, items to be checked or serviced, and the frequency at which each operation is performed.

Table 11-1
Preventive Maintenance Summary

Instrument	Item Checked/Serviced	Frequency
Balances	External service calibration	Annually
Deionized water	Conductivity checked	Daily
	Cartridges changed	As needed
Refrigerators	Temperature checked and logged	Daily
pH meter	Electrode cleaned	Monthly or as needed
UV/Vis spectrophotometer	Instrument response checked with commercially purchased solutions	Quarterly
	Outside of instrument wiped down	Weekly
Conductivity meter	Conductivity cell cleaned	As needed
	Replatinization	As needed
TOX	Adjust furnace temperature	As needed
	Empty waste acid containers	Daily
	Inlet and outlet tubes checked for residue buildup	Daily
	Inlet and outlet tubes cleaned or replaced	As needed
	Cell electrodes checked for residue buildup	Daily
	Cell electrodes cleaned or replaced	As needed
	Electrolyte replenished	As needed
	Outside of instrument wiped down	Weekly
TOC	Septa replaced	As needed
	Reagent in reaction vessel replenished	Daily
	Tin and copper scrubbers repacked	As needed
	Pump tubing replaced	As needed
	Lithium hydroxide scrubber repacked	As needed
	Cupric oxide furnace tube repacked	As needed
	Outside of instrument wiped down	Weekly

Table 11-1
(Continued)

Instrument	Item Checked/Serviced	Frequency
AA Spectrophotometer	Burner head checked	As needed
	Burner head cleaned	As needed
	Flow chamber checked and rinsed	As needed
	Flow chamber cleaned	As needed
	Nebulizer checked and rinsed	Daily
	Nebulizer cleaned	As needed
	Drain bottle checked and emptied	As needed
	D_2 lamp changed	As needed
	Gas supply and pressure checked	Daily
Furnace	Graphite tube checked	Daily
	Contract rings checked	Daily
	Contract rings cleaned or replaced	As needed
	Quartz windows checked	Daily
	Quartz windows cleaned or replaced	As needed
ICP spectrophotometer	Pump tubing replaced	Daily
	Capillary tubing checked	Daily
	Capillary tubing replaced	As needed
	Torch quartz tube checked	Daily
	Torch quartz tube cleaned or replaced	As needed
	Torch injector tube checked	As needed
	Torch injector tube cleaned or replaced	As needed
	Nebulizer insert cleaned or replaced	As needed
	Drain bottle emptied	As needed
	Nebulizer insert checked	As needed
	Pump oil changed	Semiannually

Table 11-1
(Continued)

Instrument	Item Checked/Serviced	Frequency
GC	Column maintenance	As needed
	Clean purge and trap	Daily
	Clean injector port	As needed
	Column packing replaced	Determined by analyst so that the calibration is within specifications.
	Detector cleaned	As above
	Glass wool plug changed	As above
	Insert cleaned	As above
	EC (Ni-63) wipe test	Semiannually or NRC requirements
	Replace septa	After each production sequence
GC/MS	Replace septa	Daily
	Liner cleaned	Daily
	Column maintenance	Daily or as needed
	Clean purge and trap	Daily
	Clean injector port	As needed
	Clean ion source	As needed
	Replace Filament	As needed
	Clean quadruple rod	As needed
	Replace resistor or election multiplier	As needed
	Replace o-ring on magnet well flange or front cover port	As needed
	Check air filter for obstruction	As needed
	Change air filter	Quarterly
	Check cooling fans	Monthly
	Clean cooling fans	Quarterly
	Inspect all PCBA's, interior of module	Quarterly
	Thoroughly clean the interior module of each PCBA	Annually

Table 11-1
(Continued)

Instrument	Item Checked/Serviced	Frequency
GC/MS (continued)	Clean turbometer pump fan	Semiannually or as needed
	Change rotary vane vacuum pump oil	Quarterly
	Regenerate air filter/drier desiccant	Quarterly
	Replace ferrules (interface oven and transfer line)	Quarterly
	Clean disk drive cooling fan	Quarterly
	Clean power-supply cooling fan	Quarterly
	Clean magnetic tape drive	Quarterly
	Clean and lubricate auto sampler	Change semiannually

12.0 ASSESSING DATA PRECISION, ACCURACY, AND COMPLETENESS

12.1 Accuracy

Accuracy is defined as the degree of difference between measured or calculated values and the true value. Method accuracy is evaluated as the percent recovery of a known laboratory control sample.

$$\% \text{ recovery} = \frac{\text{Value obtained}}{\text{True value}} \times 100$$

The average percent recovery of at least 20 measurements for a particular analysis is determined and three standard deviations about the mean are calculated. The mean ± three standard deviations about the mean are considered the control limits. In cases where lab generated control limits are set, the analyst compare their percent recoveries with these limits. If the recoveries are within limits, then the system is considered in control. In cases where method limits are used, the analyst compare their recoveries with the method limits. If the recoveries are within limits, then the system is considered in control. In either case, if an analyst's recoveries fall outside the limits established, then the system is considered out of control and corrective action must take place. This corrective action usually includes reanalysis and/or sample repreparation followed by reanalysis.

12.2 Precision

Precision is defined as the reproducibility, or degree of agreement, between duplicate measurements of the same quantity. Precision is evaluated as the relative percent difference (RPD) between the analyses. These analyses are usually performed on matrix spike/matrix spike duplicate pairs (see below for definition). The RPD is defined as the difference between the analyses, divided by their mean (average value), times 100. For duplicate results, D1 and D2, the RPD is formed as follows:

$$\text{RPD, \%} = \frac{(D1-D2) \times 100}{\frac{(D1+D2)}{2}}$$

If precision is calculated using three or more replicates, the relative standard deviation is used. The formula for calculating the RSD according to SW-846, Chapter One-27, is listed below.

$$\text{RSD} = (S/X) \times 100$$

where S = Variance and X = the arithmetic mean of the measurements.

Precision is dependent on the sample matrix. Precision may be assessed for laboratory operations with laboratory duplicates and for field and laboratory operations with field duplicates.

12.3 Accuracy and Precision

Matrix spike/matrix spike duplicate (MS/MSD) pairs provide a means for measuring both accuracy and precision of a measurement on the same sample. Two separate aliquots of sample are spiked with the compound(s) of interest. If the percent recoveries and RPD fall within the control limits generated in the same manner as for LCS data listed above, then the batch is considered good. If the percent recoveries fall outside the control limits generated as above, then, in most instances, the method specifies corrective actions which must be taken before continuation of analysis.

In some instances, the method does not specify control limits nor corrective actions to take if recoveries or RPDs are out of control limits. In these cases the MS/MSD pairs are used to provide additional QC information in cases where none would exist otherwise.

12.4 Completeness

Completeness is expressed as the percentage of valid data obtained from a measurement system. This is measured by using the following equation where A is defined as the number of valid results and B is defined as the total number of possible results:

$$\% \text{ Completeness} = A/B * 100$$

Sometimes it is necessary to report questionable results, because of matrix effects or uncorrectable laboratory error. Such results are qualified in the report. In these situations, completeness cannot be calculated because the usefulness of the data are not known.

12.5 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a parameter dependent on the proper design of each sampling program and of proper laboratory protocol. Laboratory representativeness can be ensured by analysts collecting an aliquot of sample which accurately represents the sample itself.

12.6 Comparability

Comparability is a qualitative parameter that expresses the confidence with which one data set can be compared with another. The extent to which existing and planned analytical data are comparable depends both the similarity of sampling and of analytical methods.

13.0 NONCONFORMANCE AND CORRECTIVE ACTION

13.1 Definition

A nonconformance is an uncorrected deviation from the requirements of a standard operating procedure (SOP) or Quality Assurance Project Plan (QAPjP).

Nonconformances always have the potential to affect data quality. Nonconformances must be communicated to the appropriate Group Leader and the Quality Assurance Manager or Director and corrective actions approved by them. Many nonconformances require that the client be notified and provide direction. A nonconformance memo is not permission to accept the error but an effort to prevent its reoccurrence.

SOP QC-001 details the nonconformance memo procedure. The nonconformance memo (Figure 13-1) is printed on pink paper for visibility in a data package.

13.1.1 Examples of Nonconformances

Because a nonconformance is an uncorrected deviation from an SOP, an out-of-control event which is immediately corrected before samples are analyzed is not a nonconformance. Examples of nonconformances include:

- A sample received in an improper container, with improper preservation, or past any holding time.
- An analysis holding time not met on a sample received within the holding time. This includes a late repreparation or reanalysis which does not confirm matrix interferences suspected from an initial analysis.
- A sample lost during preparation or analysis when reanalysis within holding is not possible or when insufficient sample remains for reanalysis.
- An out-of-control blank, surrogate, LCS, internal standard, etc., whose standard corrective action (usually reanalysis) is not performed.
- An out-of-control calibration whose standard corrective action is not performed.
- EQLs raised due to interferences or other factors not addressed in the SOP. This includes extracts which cannot be concentrated to their normal final volume.
- Analysis of a matrix for which the SOP does not provide standard conditions.
- An entire data set miscalculated which is discovered at any level of review.

13.1.2 Examples of Other Events

Examples of occurrences which are not nonconformances are listed below. Many of these occurrences need to be recorded in a narrative form for inclusion in report comments.

- A sample received with missing or incomplete paperwork which is corrected in time to allow analysis within holding times.
- Use of a non-standard aliquot of a sample, if adjustments are made to retain standard EQLs.
- An out-of-control blank whose associated samples are reanalyzed within holding time.
- An out-of-control surrogate which is repeated in a reanalysis and therefore confirms a matrix interference.
- A mechanical failure which is repaired before samples are analyzed or for which affected samples are reanalyzed within holding times.
- Random calculation errors found during data review.

13.2 Focus of the Nonconformance System

The focus of the nonconformance system is to identify problems, correct them, and minimize the probability of their recurrence. Corrective actions may be short term (e.g., immediately reanalyze an affected sample) or long term (e.g., provide additional training to an errant analyst). It is the ultimate responsibility of the Group Leader of the affected department to ensure that corrective actions (short and long term) are taken. A copy of the memo is given to the appropriate Group Leader as a reminder of needed corrective actions. A copy is also given to the Project Manager.

The person identifying a nonconformance immediately documents it in a Nonconformance Memo, proposes or performs corrective action, and signs and dates the memo on the "Corrective action initiated/performed by" line. The person performing corrective actions obtains the agreement of his or her Group Leader that the actions are sufficient. The Group Leader signs and dates the memo on the "Operations concurrence" line. In the absence of the Group Leader, the Operations Manager or Technical Director may substitute.

The person performing corrective actions also obtains the agreement of the Quality Assurance Manager or Director that the actions are sufficient. Additional corrective action may be proposed or required. This person signs and dates the memo on the "QA approval" line.

13.3 Document Control

The Quality Assurance Manager maintains a log of all nonconformances and corrective actions. The QA Manager periodically reviews the log to determine if long-term corrective actions have been taken.

Figure 13-1 Nonconformance Memo

NONCONFORMANCE MEMO

Client: ______________________ Work Order No.: ___________________ Filed by: ________ Date: _____

Sample(s) Affected: ______________________________ Test(s) ______________________________

Area: __ SC __ OP __ IP __ II __ GC __ GC/MS __ MT __ CW __ RP __ Other ________________

Nonconformance

A nonconformance is an uncorrected deviation from an SOP or QAPjP. Examples include (1) holding times exceeded; (2) samples which are lost during extraction or analysis when no re-prep. is possible; (3) quality control (QC) data is outside of defined limits and standard corrective action was not taken; (4) when reported detection limits are higher than specified in contract, method, and/or project plan; and (5) sample received in a broken condition, without proper preservation, or in an improper container.

Describe all nonconformances briefly but completely in the space below. Describe the action taken to deal with the immediate occurrence. Describe the root cause of the nonconformance. Describe the actions taken or which need to be taken to prevent a reoccurrence of the problem.

CORRECTIVE ACTION

__ Client informed orally by _________ Comments: ______________________________ Date: _________

__ Client informed in writing by (means) ____________ By whom: __________________ Date: _________

__ Sample(s) processed "as is". Comments: ____

__ Sample(s) on hold until _______________ If released, notify: ____________________________

Corrective action initiated/performed by: __________________ Date: __________

Operations concurrence: ____________________________ Date: __________

QA Concurrence: ____________________ Date: _________

CORRECTIVE ACTION VERIFICATION

__ Verified __ Cannot verify. Reason: ____

Verified by: ______________________________ Date __________

ORIGINAL MUST BE RETAINED IN THE PROJECT FILE

NONCONF.DOC

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

A Monthly Quality Assurance Department reports are prepared for the President and Operations Manager during the first ten days of the following month. Additional reports covering the findings of internal laboratory audits are prepared within two weeks following audit completion.

Monthly reports include at a minimum the following information:

Summary of findings of internal audits completed in the month;
Corrective actions which were not taken in response to an internal audit;
The number of nonconformances by category, including holding time violations, in the month;
The number of data errors by category in the month;
Scores of performance evaluation studies received in the month;
Status changes in certification programs during the month;-
Summary of QA/QC training completed in the month;
Copies of external audit reports and their responses for the month.

The intent of this information is to provide input to management from the Quality Department in order that they may take appropriate actions necessary to maintain and improve quality.

15.0 TRAINING

Adequate training of analysts, supervisors, and support personnel is vital for high quality and efficient operation, and the personal and professional growth of employees. Ross Analytical provides internal and external training as needed to fulfill these goals.

15.1 Job Descriptions

Job descriptions have been developed which list the duties and responsibilities of each position. They also describe the minimum qualifications in terms of education, experience, knowledge, and skills necessary to perform the job.

15.2 Formal Short Courses and Training Seminars

Project managers and professional employees are kept informed of schedules for short courses and training seminars that are appropriate for maintaining and increasing technical and managerial skills. These courses include those offered by the U.S. EPA, instrument manufacturers, major academic institutions, research and professional organizations, and contractors. Examples of subject matter of courses completed by laboratory staff members include:

Air pollution microscopy

Atomic absorption: Applications technology in water quality laboratories

ICP analysis

Finnigan MAT series/OWA GC/MS operation

Modern techniques of chromatography

Laboratory management

Quality Circle operation

Lachat analyzer operation

Department of Transportation regulations

Hazardous waste disposal procedures

15.3 On-Site Training

In addition to off-site training, Ross Analytical has had on-site training by external consultants and companies. Examples include the following:

Management and supervisory training

Performance appraisal training

LIMS training

Target and Envision™ training

Instrumental training on the ICP, AA, GC/MS, GC, and HPLC systems

15.4 On-The-Job Training

All new employees in the laboratory receive on-the-job training by senior-level personnel with experience in EPA analytical methods and specialized methods performed by Ross Analytical. Major emphasis is placed on detailed study of the Standard Operating Procedures (SOPs) that the new employee will be using. As evidence that this training has been effective, new analysts must pass analyst proficiency testing studies once the supervisor of the department decides that the analyst has had sufficient training and hand-on experience. The decision as to when an analyst is ready to perform sample analysis without direct supervision is left to the departmental supervisor.

When new techniques are needed, the Technical Director or other senior-level person is assigned the responsibility for their development and implementation. After these systems have been developed, tested, and are operational, all personnel that will use the new methodology will train under the on-the-job training program with guidance from the senior-level person assigned to the project.

15.5 Quality Assurance Training

Training for all staff on revisions of the Quality Assurance Manual is provided the month proceeding handing out of the manual. Staff read and review the document prior to the training session. The training session highlights various topics in the manual with emphasis on group participation. Upon completion of the training session, an examination is given. The examination covers quality concepts as well as details of the QA Manual. If an analyst does not obtain a score of 75% or more, individual training and make-up examination are provided.

New employees are trained and examined within one month of their starting date.

Throughout the year training is provided on specific quality issues such as nonconformances and corrective action, and evaluation of control charts.

15.6 Quality Assurance Staff Training

All Quality Assurance Department staff receive training so they are proficient in the requirements of the Ross Analytical Quality Assurance Program and its application. Training emphasizes the performance of audits and required reporting. This training includes audit fundamentals, objectives, characteristics, organizations, performance, and results of quality auditing, reporting, follow-up actions involved in conducting audits. Related training includes statistical quality control, the writing of Standard Operating Procedures (SOPs), and the review of analytical data and QA Project Plans by using standardized guidelines. Quality Assurance Staff must be capable of effective written and oral communications with all levels of the organization. Additional training in topics such as public speaking and how to run meetings is provided as needed.

15.7 Safety Training

Safety training is provided to all employees so they are adequately informed of the risks and potential hazards present in the laboratory in which they work. The SHE Officer is responsible for safety and health training and the maintaining of training documentation.

This training includes emergency and personal protection equipment, the OSHA Laboratory Standard, OSHA permissible exposure limits, the Ross Analytical Chemical Hygiene Program, and RCRA and TSCA topics. It addresses general and specific laboratory hazards posed by equipment, reagents, and samples. It also addresses laboratory waste disposal. All new employees and temporary employees are included in any on-going training which is provided.

15.8 Training Records

The training records which Ross Analytical maintains on each of its employees and the areas in which they are stored are listed in the chart below.

Training Record	Storage Location
Personal Resumes	Department of Human Resources
Copies of Diplomas	Department of Human Resources
Copies of Internal and External Training Certificates	Department of Human Resources
Professional Certificates	Department of Human Resources
Analyst Proficiency Test Results	Quality Assurance Department
Quality Assurance Examinations	Quality Assurance Department

16.0 SOFTWARE QUALITY CONTROL

16.1 Lifecycle Procedures Applied to Computer Software Systems

Software is usually available on-line until superseded by a newer version. At that time, the old version is removed and replaced by the new version. Documentation and originals of the version which was removed are stored in the Information Services (IS) Department. Software is reviewed periodically and if found to be of little or no value is removed from the system, with the original documentation and software stored in the IS department.

16.2 Testing Requirements for Laboratory Computer Systems

The majority of the instrument-specific data systems are part of the instrument purchase and are accepted without further testing since the manufacturer of the instrument will be the source of support for those systems. When original, instrument vendor-supplied hardware is replaced (usually to upgrade computing power), backups are made of the old system and the new system is tested to verify that it works as expected. Stand-alone (non-instrument) computer systems are also accepted from the manufacturer without further testing. Third-party software is tested on these systems before use and problems are resolved by the technical support services of the software and hardware vendors.

16.3 Acceptance Requirements for Laboratory Computer Systems

Consistency in quality in a PC at a reasonable cost has been accomplished by standardization on a single manufacturer. Gateway 2000 is the primary source of PCs, parts, technical support, and related services.

16.4 Software version control

Major software packages (Horizon LIMS and the Target/Envision Data System) are kept up to the current revision as much as practical by having maintenance contracts with the vendors of major software packages. Smaller commercial products (e.g. Lotus 1-2-3 and Microsoft Word) are not necessarily updated to the most recent version. Selected updates are purchased as needed. A software inventory lists the current and past versions of software used for further tracking and monitoring.

16.5 Computer System Maintenance

The computer systems are maintained by the IS Department. Replacement parts are normally modular replacements that have been obtained usually through the manufacturer, or a computer vendor if it is a generic module. Printer repair is usually performed by an outside vendor.

16.6 Software/Hardware System Documentation Requirements

Originals of all hardware and software documentation are kept in the IS Department for reference by the IS staff and by the lab staff. Selected copies are also kept by the system users. Training material and video tapes will be used in developing an in-house training schedule and to start a reference library for the lab staff.

16.7 System Security

Each employee has a login name and password to each of the networking servers as well as to the LIMS software, to best use the security features of those software packages. The servers are in the IS Department, which has an uniquely keyed door lock so that only the IS staff, President, Safety Officer, Operations Manager, and Technical Director have access. A backup key is stored in a sealed envelope with the Administrative Assistant. Each server is powered through an Uninterrupted Power Supply which has communication backup with the server to shut it down properly and maintain data integrity if building power fails for an extended period of time.

16.8 System Backup

The Novell File Server, the Target/Envision UNIX computer, and the Horizon LIMS UNIX computer are backed up on a daily basis using Grandfather-Father-Son scheme. Backup tapes are stored in a locked cabinet in the IS Department, with a monthly copy of the system stored off-site in a safe at the IS Manager's home.

16.9 System Archiving

The SAM LIMS database, which is being phased out of use, is purged into an Archive database approximately every two months. The Archive database is available on-line for querying, but is set to read-only access. The Archive database file is also backed up onto tape and stored. Other non-LIMS software is archived as needed by backing up to tape.

Appendix A

Table of Analytes for Selected Regulatory Target Lists

ANALYTE	CAS NO.	App IX	HSL	CLP	PPL
		(1)	(2)	(3)	(4)
Classical Wet Chemistry Parameters					
Cyanide	57-12-5	X	X	X	
Phenolics, total					X
Sulfide	18496-25-8	X			

ANALYTE	CAS NO.	App IX	HSL	CLP	PPL
		(1)	(2)	(3)	(4)
Metals					
Aluminum	7429-90-5		X	X	
Antimony	7440-36-0	X	X	X	X
Arsenic	7440-38-2	X	X	X	X
Barium	7440-39-3	X	X	X	
Beryllium	7440-41-7	X	X	X	X
Cadmium	7440-43-9	X	X	X	X
Calcium	7440-70-2		X	X	
Chromium	7440-47-3	X	X	X	X
Cobalt	7440-48-4	X	X	X	
Copper	7440-50-8	X	X	X	X
Iron	7439-89-6		X	X	
Lead	7439-92-1	X	X	X	X
Magnesium	7439-95-4		X	X	
Manganese	7439-96-5		X	X	
Mercury	7439-97-6	X	X	X	X
Nickel	7440-02-0	X	X	X	X
Potassium	7440-09-7		X	X	
Selenium	7782-49-2	X	X	X	X
Silver	7440-22-4	X	X	X	X
Sodium	7440-23-5		X	X	
Thallium	7440-28-0	X	X	X	X
Tin	7440-31-5	X			
Vanadium	7440-62-2	X	X	X	
Zinc	7440-66-6	X	X	X	X

Appendix A

Table of Analytes for Selected Regulatory Target Lists, continued

ANALYTE	CAS NO.	App IX	HSL	CLP	PPL
		(1)	(2)	(3)	(4)
Purgeable Volatiles					
Acetone	67-64-1	X	X	X	
Acetonitrile	75-05-8	X			
Acrolein	107-02-8	X			X
Acrylonitrile	107-13-1	X			X
Benzene	71-43-2	X	X	X	X
Bis(chloromethyl) ether	542-88-1				X
Bromodichloromethane (Dichlorobromomethane)	75-27-4	X	X	X	X
Bromoform (Tribromomethane)	75-25-2	X	X	X	X
Bromomethane (Methyl bromide)	74-83-9	X	X	X	X
2-Butanone (Methyl ethyl ketone)	78-93-3	X	X	X	
Carbon disulfide	75-15-0	X	X	X	
Carbon tetrachloride	56-23-5	X	X	X	X
Chlorobenzene	108-90-7	X	X	X	X
2-Chloro-1,3-butadiene (Chloroprene)	126-99-8	X			
Chloroethane	75-00-3	X	X	X	X
2-Chloroethyl vinyl ether	110-75-8		X		X
Chloroform (Trichloromethane)	67-66-3	X	X	X	X
Chloromethane (Methyl chloride)	74-87-3	X	X	X	X
3-Chloropropene (Allyl chloride)	107-05-1	X			
Dibromochloromethane (Chlorodibromomethane)	124-48-1	X	X	X	X
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	X			
1,2-Dibromoethane	106-93-4	X			
trans-1,4-Dichloro-2-butene	110-57-6	X			
Dichlorodifluoromethane (Freon 12)	75-71-8	X			X
1,1-Dichloroethane	75-34-3	X	X	X	X
1,2-Dichloroethane	107-06-2	X	X	X	X
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	X	X	X	X
trans-1,2-Dichloroethene (trans-1,2-Dichloroethylene)	156-60-5	X			X
1,2-Dichloroethene, total (1,2-Dichloroethylene, total)	540-59-0		X	X	
1,2-Dichloropropane	78-87-5	X	X	X	X
cis-1,3-Dichloropropene	10061-01-5	X	X	X	
trans-1,3-Dichloropropene	10061-02-6	X	X	X	
1,3-Dichloropropene, total	542-75-6				X
Ethylbenzene	100-41-4	X	X	X	X
Ethyl methacrylate	97-63-2	X			
2-Hexanone	591-78-6	X	X	X	

Appendix A

Table of Analytes for Selected Regulatory Target Lists, continued

ANALYTE	CAS NO.	App IX	HSL	CLP	PPL
		(1)	(2)	(3)	(4)
Purgeable Volatiles, continued					
Iodomethane (Methyl iodide)	74-88-4	X			
Methacrylonitrile	126-98-7	X			
Methylene bromide (Dibromomethane)	74-95-3	X			
Methylene *chloride* (Dichloromethane)	75-09-2	X	X	X	X
Methyl methacrylate	80-62-2	X			
2-Methyl-4-pentanone (Methyl isobutyl ketone)	108-10-1	X	X	X	
Propionitrile (Ethyl cyanide)	107-12-0	X			
Styrene	100-42-5	X	X	X	
1,1,1,2-Tetrachloroethane	630-20-6	X			
1,1,2,2-Tetrachloroethane	79-34-5	X	X	X	X
Tetrachloroethene (Tetrachloroethylene)	127-18-4	X	X	X	X
Toluene	108-88-3	X	X	X	X
1,1,1-Trichloroethane	71-55-6	X	X	X	X
1,1,2-Trichloroethane	79-00-5	X	X	X	X
Trichloroethene (Trichloroethylene)	79-01-6	X	X	X	X
Trichlorofluoromethane (Freon 11)	75-69-4	X			X
1,2,3-Trichloropropane	96-18-4	X			
Vinyl acetate	108-05-4	X	X		
Vinyl chloride	75-01-4	X	X	X	X
Xylenes	1330-20-7	X	X	X	

ANALYTE	CAS NO.	App IX	HSL	CLP	PPL
		(1)	(2)	(3)	(4)
Non-purgeable Volatiles					
1,4-Dioxane	123-91-1	X			
Isobutanol	78-83-1	X			

Appendix A

Table of Analytes for Selected Regulatory Target Lists, continued

ANALYTE	CAS NO.	App IX (1)	HSL (2)	CLP (3)	PPL (4)
Semivolatiles					
Acenaphthene	83-32-9	X	X	X	X
Acenaphthylene	208-96-8	X	X	X	X
Acetophenone	98-86-2	X			
2-Acetylaminofluorene	53-96-3	X			
4-Aminobiphenyl	92-67-1	X			
Aniline	62-53-3	X			
Anthracene	120-12-7	X	X	X	X
Aramite	140-57-8	X			
Benzidine	92-87-5				X
Benzoic acid	65-85-0		X		
Benzo[a]anthracene	56-55-3	X	X	X	X
Benzo[b]fluoranthene	205-99-2	X	X	X	X
Benzo[k]fluoranthene	207-08-9	X	X	X	X
Benzo[ghi]perylene	191-24-2	X	X	X	X
Benzo[a]pyrene	50-32-8	X	X	X	X
Benzyl alcohol	100-51-6	X	X		
Bis(2-chloroethoxy)methane	111-91-1	X	X	X	X
Bis(2-chloroethyl)ether	111-44-4	X	X	X	X
Bis(2-chloroisopropyl)ether (2,2'-oxybis(1-Chloropropane)	108-60-1	X	X	X	X
Bis(2-ethylhexyl)phthalate	117-81-7	X	X	X	X
4-Bromophenyl phenyl ether	101-55-3	X	X	X	X
Butyl benzyl phthalate	85-68-7	X	X	X	X
Carbazole	86-74-8			X	
4-Chloroaniline (p-Chloroaniline)	106-47-8	X	X	X	
Chlorobenzilate	510-15-6	X			
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7	X	X	X	X
2-Chloronaphthalene	91-58-7	X	X	X	X
2-Chlorophenol	95-57-8	X	X	X	X
4-Chlorophenyl phenyl ether	7005-72-3	X	X	X	X
Chrysene	218-01-9	X	X	X	X
Diallate	2303-16-4	X			
Dibenz[a,h]anthracene	53-70-3	X	X	X	X
Dibenzofuran	132-64-9	X	X	X	
Di-n-butyl phthalate	84-74-2	X	X	X	X
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	X	X	X	X
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	X	X	X	X

Appendix A

Table of Analytes for Selected Regulatory Target Lists, continued

ANALYTE	CAS NO.	App IX (1)	HSL (2)	CLP (3)	PPL (4)
Semivolatiles, continued					
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	X	X	X	X
3,3'-Dichlorobenzidine	91-94-1	X	X	X	X
2,4-Dichlorophenol	120-83-2	X	X	X	X
2,6-Dichlorophenol	87-65-0	X			
Diethyl phthalate	84-66-2	X	X	X	X
Dimethoate	60-51-5	X			
p-(Dimethylamino)azobenzene	60-11-7	X			
7,12-Dimethylbenz[a]anthracene	57-97-6	X			
3,3'-Dimethylbenzidine	119-93-7	X			
alpha,alpha-Dimethylphenethylamine	122-09-8	X			
2,4-Dimethylphenol	105-67-9	X	X	X	X
Dimethyl phthalate	131-11-3	X	X	X	X
1,3-Dinitrobenzene	99-65-0	X			
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1	X	X	X	X
2,4-Dinitrophenol	51-28-5	X	X	X	X
2,4-Dinitrotoluene	121-14-2	X	X	X	X
2,6-Dinitrotoluene	606-20-2	X	X	X	X
Dinoseb	88-85-7	X			
Di-n-octyl phthalate	117-84-0	X	X	X	X
Diphenylamine	122-39-4	X			
1,2-Diphenylhydrazine	122-66-7				X
Ethyl methanesulfonate	62-50-0	X			
Fluoranthene	206-44-0	X	X	X	X
Fluorene	86-73-7	X	X	X	X
Hexachlorobenzene	118-74-1	X	X	X	X
Hexachlorobutadiene	87-68-3	X	X	X	X
Hexachlorocyclopentadiene	77-47-4	X	X	X	X
Hexachloroethane	67-72-1	X	X	X	X
Hexachlorophene	70-30-4	X			
Hexachloropropene	1888-71-7	X			
Indeno(1,2,3-cd)pyrene	193-39-5	X	X	X	X
Isophorone	78-59-1	X	X	X	X
Isosafrole	120-58-1	X			
Methapyrilene	91-80-5	X			
3-Methylcholanthrene	56-49-5	X			
Methyl methanesulfonate	66-27-3	X			

Appendix A

Table of Analytes for Selected Regulatory Target Lists, continued

ANALYTE	CAS NO.	App IX	HSL	CLP	PPL
		(1)	(2)	(3)	(4)
Semivolatiles, continued					
2-Methylnaphthalene	91-57-6	X	X	X	
2-Methylphenol (o-Cresol)	95-48-7	X	X	X	
3-Methylphenol (m-Cresol)	108-39-4	X	X		
4-Methylphenol (p-Cresol)	106-44-5	X	X	X	
Naphthalene	91-20-3	X	X	X	X
1,4-Naphthoquinone	130-15-4	X			
1-Naphthylamine	134-32-7	X			
2-Naphthylamine	91-59-8	X			
2-Nitroaniline	88-74-4	X	X	X	
3-Nitroaniline	99-09-2	X	X	X	
4-Nitroaniline	100-01-6	X	X	X	
Nitrobenzene	98-95-3	X	X	X	X
2-Nitrophenol	88-75-5	X	X	X	X
4-Nitrophenol	100-02-7	X	X	X	X
4-Nitroquinoline 1-oxide	56-57-5	X			
N-Nitrosodi-n-butylamine	924-16-3	X			
N-Nitrosodiethylamine	55-18-5	X			
N-Nitrosodimethylamine	62-75-9	X			X
N-Nitrosodiphenylamine	86-30-6	X	X	X	X
N-Nitrosodi-n-propylamine	621-64-7	X	X	X	X
N-Nitrosomethylethylamine	10595-95-6	X			
N-Nitrosomorpholine	59-89-2	X			
N-Nitrosopiperidine	100-75-4	X			
N-Nitrosopyrrolidine	930-55-2	X			
5-Nitro-o-toluidine	99-55-8	X			
Pentachlorobenzene	608-93-5	X			
Pentachloroethane	76-01-7	X			
Pentachloronitrobenzene	82-68-8	X			
Pentachlorophenol	87-86-5	X	X	X	X
Phenacetin	62-44-2	X			
Phenanthrene	85-01-8	X	X	X	X
Phenol	108-95-2	X	X	X	X
p-Phenylenediamine	106-50-3	X			
2-Picoline	109-09-8	X			
Pronamide	23950-58-5	X			
Pyrene	129-00-0	X	X	X	X

Appendix A

Table of Analytes for Selected Regulatory Target Lists, continued

ANALYTE	CAS NO.	App IX (1)	HSL (2)	CLP (3)	PPL (4)
Semivolatiles, continued					
Pyridine	110-86-1	X			
Safrole	94-59-7	X			
1,2,4,5-Tetrachlorobenzene	95-94-3	X			
2,3,4,6-Tetrachlorophenol	58-90-2	X			
o-Toluidine	95-53-4	X			
1,2,4-Trichlorobenzene	120-82-1	X	X	X	X
2,4,5-Trichlorophenol	95-95-4	X	X	X	
2,4,6-Trichlorophenol	88-06-2	X	X	X	X
1,3,5-Trinitrobenzene (sym-Trinitrobenzene)	99-35-4	X			

Appendix A

Table of Analytes for Selected Regulatory Target Lists, continued

ANALYTE	CAS NO.	App IX	HSL	CLP	PPL
		(1)	(2)	(3)	(4)
Pesticides and PCBs					
Aldrin	309-00-2	X	X	X	X
alpha-BHC	319-84-6	X	X	X	X
beta-BHC	319-85-7	X	X	X	X
delta-BHC	319-86-8	X	X	X	X
gamma-BHC (Lindane)	58-89-9	X	X	X	X
Chlordane, technical	57-74-9	X	X		X
alpha-Chlordane	5103-71-9			X	
gamma-Chlordane	5103-74-2			X	
4,4'-DDD	75-54-8	X	X	X	X
4,4'-DDE	72-55-9	X	X	X	X
4,4'-DDT	50-29-3	X	X	X	X
Dieldrin	60-57-1	X	X	X	X
Endosulfan I	959-98-8	X	X	X	X
Endosulfan II	33213-65-9	X	X	X	X
Endosulfan sulfate	1031-07-8	X	X	X	X
Endrin	72-20-8	X	X	X	X
Endrin aldehyde	7421-93-4	X	X	X	X
Endrin ketone	53494-70-5			X	
Heptachlor	76-44	X	X	X	X
Heptachlor epoxide	1024-57-3	X	X	X	X
Isodrin	465-73-6	X			
Kepone	143-50-0	X			
Methoxychlor	72-73-5	X	X	X	
Toxaphene	8001-35-2	X	X	X	X
Arochlor 1016	12674-11-2	X	X	X	X
Arochlor 1221	11104-28-2	X	X	X	X
Arochlor 1232	11141-16-5	X	X	X	X
Arochlor 1242	11096-82-5	X	X	X	X
Arochlor 1248	12672-29-6	X	X	X	X
Arochlor 1254	11097-69-1	X	X	X	X
Arochlor 1260	11096-82-5	X	X	X	X

Appendix A

Table of Analytes for Selected Regulatory Target Lists, continued

ANALYTE	CAS NO.	App IX (1)	HSL (2)	CLP (3)	PPL (4)
Organophosphate Pesticides					
Disulfoton	298-04-4	X			
Famphur	52-85-7	X			
Methyl parathion	298-00-0	X			
Parathion	56-38-2	X			
Phorate	298-02-2	X			
Sulfotepp (Tetraethyl dithiopyrophosphate)	3689-24-5	X			
Thionazin (O,O-Diethyl O-2-pyrazinyl phosphorothioate)	297-97-2	X			
O,O,O-Triethyl phosphorothioate	126-68-1	X			

ANALYTE	CAS NO.	App IX (1)	HSL (2)	CLP (3)	PPL (4)
Chlorophenoxy Acid Herbicides					
2,4-D	94-75-7	X			
2,4,5-T	93-76-5	X			
2,4,5- TP (Silvex)	93-72-1	X			

ANALYTE	CAS NO.	App IX (1)	HSL (2)	CLP (3)	PPL (4)
Dioxins and Furans					
Hexachlorodibenzo-p-dioxins, total		X			
Hexachlorodibenzofurans, total		X			
Pentachlorodibenzo-p-dioxins, total		X			
Pentachlorodibenzofurans, total		X			
2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)	1746-01-6	X			X
Tetrachlorodibenzo-p-dioxins, total		X			
Tetrachlorodibenzofurans, total		X			

(1) 40 CFR 264, Appendix IX - Ground-water Monitoring List
(2) "Hazardous Substances List"; the original U.S. EPA Contract Laboratory Program target list
(3) U.S. EPA Contract Laboratory Program target lists from Statements of Work ILM04.0 and OLM03.1
(4) Priority Pollutant List; 40 CFR 125 Form 2C.

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Appendix IX Analytes and EQLs

ANALYTE	CAS No.	Water EQL, mg/L	Soil EQL, mg/Kg
Classical Wet Chemistry Parameters			
Cyanide	57-12-5	0.010	1.0
Sulfide	18496-25-8	1.5	30

ANALYTE	CAS No.	Water EQL, mg/L	Soil EQL, mg/Kg
Metals			
Antimony	7440-36-0	0.10	10
Arsenic	7440-38-2	0.10	10
Barium	7440-39-3	0.0040	0.40
Beryllium	7440-41-7	0.0020	0.20
Cadmium	7440-43-9	0.0050	0.50
Chromium	7440-47-3	0.010	1.0
Cobalt	7440-48-4	0.010	1.0
Copper	7440-50-8	0.020	2.0
Lead	7439-92-1	0.050	5.0
Mercury	7439-97-6	0.0002	0.08
Nickel	7440-02-0	0.020	2.0
Selenium	7782-49-2	0.10	10
Silver	7440-22-4	0.10	10
Thallium	7440-28-0	0.20	20
Tin	7440-31-5	0.10	10
Vanadium	7440-62-2	0.010	1.0
Zinc	7440-66-6	0.020	2.0

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Appendix IX Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Purgeable Volatiles			
Acetone	67-64-1	10	10
Acetonitrile	75-05-8	50	50
Acrolein	107-02-8	10	10
Acrylonitrile	107-13-1	10	10
Benzene	71-43-2	5	5
Bromodichloromethane (Dichlorobromomethane)	75-27-4	5	5
Bromoform (Tribromomethane)	75-25-2	5	5
Bromomethane (Methyl bromide)	74-83-9	10	10
2-Butanone (Methyl ethyl ketone)	78-93-3	10	10
Carbon disulfide	75-15-0	5	5
Carbon tetrachloride	56-23-5	5	5
Chlorobenzene	108-90-7	5	5
2-Chloro-1,3-butadiene (Chloroprene)	126-99-8	5	5
Chloroethane	75-00-3	10	10
Chloroform (Trichloromethane)	67-66-3	5	5
Chloromethane (Methyl chloride)	74-87-3	10	10
3-Chloropropene (Allyl chloride)	107-05-1	5	5
Dibromochloromethane (Chlorodibromomethane)	124-48-1	5	5
1,2-Dibromo-3-chloropropane (DBCP)	96-12-8	5	5
1,2-Dibromoethane	106-93-4	5	5
trans-1,4-Dichloro-2-butene	110-57-6	5	5
Dichlorodifluoromethane (Freon 12)	75-71-8	10	10
1,1-Dichloroethane	75-34-3	5	5
1,2-Dichloroethane	107-06-2	5	5
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	5	5
trans-1,2-Dichloroethene (trans-1,2-Dichloroethylene)	156-60-5	5	5
1,2-Dichloropropane	78-87-5	5	5
cis-1,3-Dichloropropene	10061-01-5	5	5
trans-1,3-Dichloropropene	10061-02-6	5	5
Ethylbenzene	100-41-4	5	5
Ethyl methacrylate	97-63-2	5	5
2-Hexanone	591-78-6	10	10
Iodomethane (Methyl iodide)	74-88-4	5	5
Methacrylonitrile	126-98-7	5	5
Methylene bromide (Dibromomethane)	74-95-3	5	5

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Appendix IX Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Purgeable Volatiles, continued			
Methylene chloride (Dichloromethane)	75-09-2	5	5
Methyl methacrylate	80-62-2	5	5
2-Methyl-4-pentanone (Methyl isobutyl ketone)	108-10-1	10	10
Propionitrile (Ethyl cyanide)	107-12-0	20	20
Styrene	100-42-5	5	5
1,1,1,2-Tetrachloroethane	630-20-6	5	5
1,1,2,2-Tetrachloroethane	79-34-5	5	5
Tetrachloroethene (Tetrachloroethylene)	127-18-4	5	5
Toluene	108-88-3	5	5
1,1,1-Trichloroethane	71-55-6	5	5
1,1,2-Trichloroethane	79-00-5	5	5
Trichloroethene (Trichloroethylene)	79-01-6	5	5
Trichlorofluoromethane (Freon 11)	75-69-4	5	5
1,2,3-Trichloropropane	96-18-4	5	5
Vinyl acetate	108-05-4	10	10
Vinyl chloride	75-01-4	10	10
Xylenes	1330-20-7	10	10

ANALYTE	CAS No.	Water EQL, mg/L	Soil EQL, mg/Kg
Non-purgeable Volatiles			
1,4-Dioxane	123-91-1	400	400
Isobutanol	78-83-1	400	400

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Appendix IX Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Semivolatiles			
Acenaphthene	83-32-9	10	330
Acenaphthylene	208-96-8	10	330
Acetophenone	98-86-2	10	330
2-Acetylaminofluorene	53-96-3	10	330
4-Aminobiphenyl	92-67-1	10	330
Aniline	62-53-3	10	330
Anthracene	120-12-7	10	330
Aramite (1)	140-57-8	10	330
Benzo[a]anthracene	56-55-3	10	330
Benzo[b]fluoranthene	205-99-2	10	330
Benzo[k]fluoranthene	207-08-9	10	330
Benzo[ghi]perylene	191-24-2	10	330
Benzo[a]pyrene	50-32-8	10	330
Benzyl alcohol	100-51-6	20	670
Bis(2-chloroethoxy)methane	111-91-1	10	330
Bis(2-chloroethyl)ether	111-44-4	10	330
Bis(2-chloroisopropyl)ether (2,2'-oxybis(1-Chloropropane)	108-60-1	10	330
Bis(2-ethylhexyl)phthalate	117-81-7	10	330
4-Bromophenyl phenyl ether	101-55-3	10	330
Butyl benzyl phthalate	85-68-7	10	330
4-Chloroaniline (p-Chloroaniline)	106-47-8	10	330
Chlorobenzilate	510-15-6	10	330
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7	10	330
2-Chloronaphthalene	91-58-7	10	330
2-Chlorophenol	95-57-8	10	330
4-Chlorophenyl phenyl ether	7005-72-3	10	330
Chrysene	218-01-9	10	330
Diallate	2303-16-4	10	330
Dibenz[a,h]anthracene	53-70-3	10	330
Dibenzofuran	132-64-9	10	330
Di-n-butyl phthalate	84-74-2	10	330
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	10	330
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	10	330
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	10	330
3,3'-Dichlorobenzidine	91-94-1	20	670

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Appendix IX Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Semivolatiles, continued			
2,4-Dichlorophenol	120-83-2	10	330
2,6-Dichlorophenol	87-65-0	10	330
Diethyl phthalate	84-66-2	10	330
p-(Dimethylamino)azobenzene	60-11-7	10	330
7,12-Dimethylbenz[a]anthracene	57-97-6	10	330
3,3'-Dimethylbenzidine (1)	119-93-7	10	330
alpha,alpha-Dimethylphenethylamine (1)	122-09-8	10	330
2,4-Dimethylphenol	105-67-9	10	330
Dimethyl phthalate	131-11-3	10	330
1,3-Dinitrobenzene	99-65-0	10	330
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1	50	1700
2,4-Dinitrophenol	51-28-5	50	1700
2,4-Dinitrotoluene	121-14-2	10	330
2,6-Dinitrotoluene	606-20-2	10	330
Dinoseb	88-85-7	10	330
Di-n-octyl phthalate	117-84-0	10	330
Diphenylamine	122-39-4	10	330
Ethyl methanesulfonate	62-50-0	10	330
Fluoranthene	206-44-0	10	330
Fluorene	86-73-7	10	330
Hexachlorobenzene	118-74-1	10	330
Hexachlorobutadiene	87-68-3	10	330
Hexachlorocyclopentadiene	77-47-4	10	330
Hexachloroethane	67-72-1	10	330
Hexachlorophene (1)	70-30-4	10	330
Hexachloropropene	1888-71-7	10	330
Indeno(1,2,3-cd)pyrene	193-39-5	10	330
Isophorone	78-59-1	10	330
Isosafrole	120-58-1	10	330
Methapyrilene (1)	91-80-5	10	330
3-Methylcholanthrene	56-49-5	10	330
Methyl methanesulfonate	66-27-3	10	330
2-Methylnaphthalene	91-57-6	10	330
2-Methylphenol (o-Cresol)	95-48-7	10	330
3-Methylphenol (m-Cresol)	108-39-4	10	330

Appendix B-1

Appendix IX Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Semivolatiles, continued			
4-Methylphenol (p-Cresol)	106-44-5	10	330
Naphthalene	91-20-3	10	330
1,4-Naphthoquinone	130-15-4	200	6700
1-Naphthylamine (1)	134-32-7	10	330
2-Naphthylamine	91-59-8	10	330
2-Nitroaniline	88-74-4	50	1700
3-Nitroaniline	99-09-2	50	1700
4-Nitroaniline	100-01-6	50	1700
Nitrobenzene	98-95-3	10	330
2-Nitrophenol	88-75-5	10	330
4-Nitrophenol	100-02-7	10	330
4-Nitroquinoline 1-oxide	56-57-5	20	670
N-Nitrosodi-n-butylamine	924-16-3	10	330
N-Nitrosodiethylamine	55-18-5	10	330
N-Nitrosodimethylamine	62-75-9	10	330
N-Nitrosodiphenylamine (2)	86-30-6	10	330
N-Nitrosodi-n-propylamine	621-64-7	10	330
N-Nitrosomethylethylamine	10595-95-6	10	330
N-Nitrosomorpholine	59-89-2	10	330
N-Nitrosopiperidine	100-75-4	10	330
N-Nitrosopyrrolidine	930-55-2	10	330
5-Nitro-o-toluidine	99-55-8	10	330
Pentachlorobenzene	608-93-5	10	330
Pentachloroethane	76-01-7	10	330
Pentachloronitrobenzene	82-68-8	10	330
Pentachlorophenol	87-86-5	50	1700
Phenacetin	62-44-2	10	330
Phenanthrene	85-01-8	10	330
Phenol	108-95-2	10	330
p-Phenylenediamine (1)	106-50-3	10	330
2-Picoline (1)	109-09-8	10	330
Pronamide	23950-58-5	10	330
Pyrene	129-00-0	10	330
Pyridine	110-86-1	10	330
Safrole	94-59-7	10	330

Appendix B-1

Appendix IX Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Semivolatiles, continued			
1,2,4,5-Tetrachlorobenzene	95-94-3	10	330
2,3,4,6-Tetrachlorophenol	58-90-2	10	330
o-Toluidine (1)	95-53-4	10	330
1,2,4-Trichlorobenzene	120-82-1	10	330
2,4,5-Trichlorophenol	95-95-4	10	330
2,4,6-Trichlorophenol	88-06-2	10	330
1,3,5-Trinitrobenzene (sym-Trinitrobenzene)	99-35-4	10	330

(1) These compounds exhibit poor recovery from some matrices and may not be reportable.
(2) N-Nitrosodiphenylamine cannot be distinguished from diphenylamine.

Appendix B-1

Appendix IX Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Pesticides and PCBs			
Aldrin	309-00-2	0.050	1.7
alpha-BHC	319-84-6	0.050	1.7
beta-BHC	319-85-7	0.050	1.7
delta-BHC	319-86-8	0.050	1.7
gamma-BHC (Lindane)	58-89-9	0.050	1.7
Chlordane, technical	57-74-9	0.10	3.3
4,4'-DDD	75-54-8	0.10	3.3
4,4'-DDE	72-55-9	0.10	3.3
4,4'-DDT	50-29-3	0.10	3.3
Dieldrin	60-57-1	0.10	3.3
Endosulfan I	959-98-8	0.050	1.7
Endosulfan II	33213-65-9	0.10	3.3
Endosulfan sulfate	1031-07-8	0.10	3.3
Endrin	72-20-8	0.10	3.3
Endrin aldehyde	7421-93-4	0.10	3.3
Heptachlor	76-44	0.050	1.7
Heptachlor epoxide	1024-57-3	0.050	1.7
Isodrin	465-73-6	0.10	3.3
Kepone	143-50-0	0.50	17
Methoxychlor	72-73-5	0.50	17
Toxaphene	8001-35-2	2.0	67
Arochlor 1016	12674-11-2	1.0	33
Arochlor 1221	11104-28-2	2.0	67
Arochlor 1232	11141-16-5	1.0	33
Arochlor 1242	11096-82-5	1.0	33
Arochlor 1248	12672-29-6	1.0	33
Arochlor 1254	11097-69-1	1.0	33
Arochlor 1260	11096-82-5	1.0	33

Appendix B-1

Appendix IX Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Organophosphate Pesticides			
Dimethoate	60-51-5	0.25	83
Disulfoton	298-04-4	0.25	83
Famphur	52-85-7	0.25	83
Methyl parathion	298-00-0	0.25	83
Parathion	56-38-2	0.25	83
Phorate	298-02-2	0.25	83
Sulfotepp (Tetraethyl dithiopyrophosphate)	3689-24-5	0.25	83
Thionazin (O,O-Diethyl O-2-pyrazinyl phosphorothioate)	297-97-2	0.25	83
O,O,O-Triethyl phosphorothioate	126-68-1	0.25	83

ANALYTE	CAS No.	Water EQL, mg/L	Soil EQL, mg/Kg
Chlorophenoxy Acid Herbicides			
2,4-D	94-75-7	2.0	40
2,4,5-T	93-76-5	2.0	40
2,4,5- TP (Silvex)	93-72-1	2.0	40

ANALYTE	CAS No.	Water EQL, mg/L	Soil EQL, mg/Kg
Dioxins and Furans			
Hexachlorodibenzo-p-dioxins, total		0.0001	0.0033
Hexachlorodibenzofurans, total		0.0001	0.0033
Pentachlorodibenzo-p-dioxins, total		0.0001	0.0033
Pentachlorodibenzofurans, total		0.0001	0.0033
2,3,7,8-Tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD)	1746-01-6	0.0001	0.0033
Tetrachlorodibenzo-p-dioxins, total		0.0001	0.0033
Tetrachlorodibenzofurans, total		0.0001	0.0033

Appendix B-2

"Hazardous Substances List" Analytes and EQLs

ANALYTE	CAS No.	Water EQL, mg/L	Soil EQL, mg/Kg
Classical Wet Chemistry Parameters			
Cyanide	57-12-5	0.010	1.0

ANALYTE	CAS No.	Water EQL, mg/L	Soil EQL, mg/Kg
Metals			
Aluminum	7429-90-5	0.10	10
Antimony	7440-36-0	0.10	10
Arsenic	7440-38-2	0.10	10
Barium	7440-39-3	0.0040	0.40
Beryllium	7440-41-7	0.0020	0.20
Cadmium	7440-43-9	0.0050	0.50
Calcium	7440-70-2	0.20	20
Chromium	7440-47-3	0.010	1.0
Cobalt	7440-48-4	0.010	1.0
Copper	7440-50-8	0.020	2.0
Iron	7439-89-6	0.050	5.0
Lead	7439-92-1	0.050	5.0
Magnesium	7439-95-4	0.10	10
Manganese	7439-96-5	0.0050	0.50
Mercury	7439-97-6	0.0002	0.08
Nickel	7440-02-0	0.020	2.0
Potassium	7440-09-7	0.20	20
Selenium	7782-49-2	0.10	10
Silver	7440-22-4	0.10	10
Sodium	7440-23-5	0.50	50
Thallium	7440-28-0	0.20	20
Vanadium	7440-62-2	0.010	1.0
Zinc	7440-66-6	0.020	2.0

Appendix B-2

"Hazardous Substances List" Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Purgeable Volatiles			
Acetone	67-64-1	10	10
Benzene	71-43-2	5	5
Bromodichloromethane (Dichlorobromomethane)	75-27-4	5	5
Bromoform (Tribromomethane)	75-25-2	5	5
Bromomethane (Methyl bromide)	74-83-9	10	10
2-Butanone (methyl ethyl ketone)	78-93-3	10	10
Carbon disulfide	75-15-0	5	5
Carbon tetrachloride	56-23-5	5	5
Chlorobenzene	108-90-7	5	5
Chloroethane	75-00-3	10	10
2-Chloroethyl vinyl ether	110-75-8	200	200
Chloroform (Trichloromethane)	67-66-3	5	5
Chloromethane (Methyl chloride)	74-87-3	10	10
Dibromochloromethane (Chlorodibromomethane)	124-48-1	5	5
1,1-Dichloroethane	75-34-3	5	5
1,2-Dichloroethane	107-06-2	5	5
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	5	5
1,2-Dichloroethene, total (1,2-Dichloroethylene, total)	540-59-0	5	5
1,2-Dichloropropane	78-87-5	5	5
cis-1,3-Dichloropropene	10061-01-5	5	5
trans-1,3-Dichloropropene	10061-02-6	5	5
Ethylbenzene	100-41-4	5	5
2-Hexanone	591-78-6	10	10
Methylene chloride (Dichloromethane)	75-09-2	5	5
2-Methyl-4-pentanone (Methyl isobutyl ketone)	108-10-1	10	10
Styrene	100-42-5	5	5
1,1,2,2-Tetrachloroethane	79-34-5	5	5
Tetrachloroethene (Tetrachloroethylene)	127-18-4	5	5
Toluene	108-88-3	5	5
1,1,1-Trichloroethane	71-55-6	5	5
1,1,2-Trichloroethane	79-00-5	5	5
Trichloroethene (Trichloroethylene)	79-01-6	5	5
Vinyl acetate	108-05-4	10	10
Vinyl chloride	75-01-4	10	10
Xylenes	1330-20-7	10	10

Appendix B-2

"Hazardous Substances List" Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Semivolatiles			
Acenaphthene	83-32-9	10	330
Acenaphthylene	208-96-8	10	330
Anthracene	120-12-7	10	330
Benzoic acid	65-85-0	50	1700
Benzo[a]anthracene	56-55-3	10	330
Benzo[b]fluoranthene	205-99-2	10	330
Benzo[k]fluoranthene	207-08-9	10	330
Benzo[ghi]perylene	191-24-2	10	330
Benzo[a]pyrene	50-32-8	10	330
Benzyl alcohol	100-51-6	20	670
Bis(2-chloroethoxy)methane	111-91-1	10	330
Bis(2-chloroethyl)ether	111-44-4	10	330
Bis(2-chloroisopropyl)ether (2,2'-oxybis(1-Chloropropane)	108-60-1	10	330
Bis(2-ethylhexyl)phthalate	117-81-7	10	330
4-Bromophenyl phenyl ether	101-55-3	10	330
Butyl benzyl phthalate	85-68-7	10	330
4-Chloroaniline (p-Chloroaniline)	106-47-8	10	330
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7	10	330
2-Chloronaphthalene	91-58-7	10	330
2-Chlorophenol	95-57-8	10	330
4-Chlorophenyl phenyl ether	7005-72-3	10	330
Chrysene	218-01-9	10	330
Dibenz[a,h]anthracene	53-70-3	10	330
Dibenzofuran	132-64-9	10	330
Di-n-butyl phthalate	84-74-2	10	330
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	10	330
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	10	330
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	10	330
3,3'-Dichlorobenzidine	91-94-1	20	670
2,4-Dichlorophenol	120-83-2	10	330
Diethyl phthalate	84-66-2	10	330
2,4-Dimethylphenol	105-67-9	10	330
Dimethyl phthalate	131-11-3	10	330
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1	50	1700
2,4-Dinitrophenol	51-28-5	50	1700

Appendix B-2

"Hazardous Substances List" Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Semivolatiles, continued			
2,4-Dinitrotoluene	121-14-2	10	330
2,6-Dinitrotoluene	606-20-2	10	330
Di-n-octyl phthalate	117-84-0	10	330
Fluoranthene	206-44-0	10	330
Fluorene	86-73-7	10	330
Hexachlorobenzene	118-74-1	10	330
Hexachlorobutadiene	87-68-3	10	330
Hexachlorocyclopentadiene	77-47-4	10	330
Hexachloroethane	67-72-1	10	330
Indeno(1,2,3-cd)pyrene	193-39-5	10	330
Isophorone	78-59-1	10	330
2-Methylnaphthalene	91-57-6	10	330
2-Methylphenol (o-Cresol)	95-48-7	10	330
3-Methylphenol (m-Cresol)	108-39-4	10	330
4-Methylphenol (p-Cresol)	106-44-5	10	330
Naphthalene	91-20-3	10	330
2-Nitroaniline	88-74-4	50	1700
3-Nitroaniline	99-09-2	50	1700
4-Nitroaniline	100-01-6	50	1700
Nitrobenzene	98-95-3	10	330
2-Nitrophenol	88-75-5	10	330
4-Nitrophenol	100-02-7	10	330
N-Nitrosodiphenylamine (1)	86-30-6	10	330
N-Nitrosodi-n-propylamine	621-64-7	10	330
Pentachlorophenol	87-86-5	50	1700
Phenanthrene	85-01-8	10	330
Phenol	108-95-2	10	330
1,2,4-Trichlorobenzene	120-82-1	10	330
2,4,5-Trichlorophenol	95-95-4	10	330
2,4,6-Trichlorophenol	88-06-2	10	330

(1) N-Nitrosodiphenylamine cannot be distinguished from diphenylamine.

Appendix B-2

"Hazardous Substances List" Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Pesticides and PCBs			
Aldrin	309-00-2	0.050	1.7
alpha-BHC	319-84-6	0.050	1.7
beta-BHC	319-85-7	0.050	1.7
delta-BHC	319-86-8	0.050	1.7
gamma-BHC (Lindane)	58-89-9	0.050	1.7
Chlordane, technical	57-74-9	0.10	3.3
4,4'-DDD	75-54-8	0.10	3.3
4,4'-DDE	72-55-9	0.10	3.3
4,4'-DDT	50-29-3	0.10	3.3
Dieldrin	60-57-1	0.10	3.3
Endosulfan I	959-98-8	0.050	1.7
Endosulfan II	33213-65-9	0.10	3.3
Endosulfan sulfate	1031-07-8	0.10	3.3
Endrin	72-20-8	0.10	3.3
Endrin aldehyde	7421-93-4	0.10	3.3
Heptachlor	76-44	0.050	1.7
Heptachlor epoxide	1024-57-3	0.050	1.7
Methoxychlor	72-73-5	0.50	17
Toxaphene	8001-35-2	2.0	67
Arochlor 1016	12674-11-2	1.0	33
Arochlor 1221	11104-28-2	2.0	67
Arochlor 1232	11141-16-5	1.0	33
Arochlor 1242	11096-82-5	1.0	33
Arochlor 1248	12672-29-6	1.0	33
Arochlor 1254	11097-69-1	1.0	33
Arochlor 1260	11096-82-5	1.0	33

Appendix B-3

Contract Laboratory Program Analytes and CRDLs/CRQLs

ANALYTE	CAS No.	CRDL, µg/L
Classical Wet Chemistry Parameters		
Cyanide	57-12-5	10

ANALYTE	CAS No.	CRDL, µg/L
Metals		
Aluminum	7429-90-5	200
Antimony	7440-36-0	60
Arsenic	7440-38-2	10
Barium	7440-39-3	200
Beryllium	7440-41-7	5
Cadmium	7440-43-9	5
Calcium	7440-70-2	5000
Chromium	7440-47-3	10
Cobalt	7440-48-4	50
Copper	7440-50-8	25
Iron	7439-89-6	100
Lead	7439-92-1	3
Magnesium	7439-95-4	5000
Manganese	7439-96-5	15
Mercury	7439-97-6	0.2
Nickel	7440-02-0	40
Potassium	7440-09-7	5000
Selenium	7782-49-2	5
Silver	7440-22-4	10
Sodium	7440-23-5	5000
Thallium	7440-28-0	10
Vanadium	7440-62-2	50
Zinc	7440-66-6	20

Appendix B-3

Contract Laboratory Program Analytes and CRDLs/CRQLs

ANALYTE	CAS No.	Water CRQL, µg/L	Soil CRQL, µg/Kg
Purgeable Volatiles			
Acetone	67-64-1	10	10
Benzene	71-43-2	10	10
Bromodichloromethane (Dichlorobromomethane)	75-27-4	10	10
Bromoform (Tribromomethane)	75-25-2	10	10
Bromomethane (Methyl bromide)	74-83-9	10	10
2-Butanone (Methyl ethyl ketone)	78-93-3	10	10
Carbon disulfide	75-15-0	10	10
Carbon tetrachloride	56-23-5	10	10
Chlorobenzene	108-90-7	10	10
Chloroethane	75-00-3	10	10
Chloroform (Trichloromethane)	67-66-3	10	10
Chloromethane (Methyl chloride)	74-87-3	10	10
Dibromochloromethane (Chlorodibromomethane)	124-48-1	10	10
1,1-Dichloroethane	75-34-3	10	10
1,2-Dichloroethane	107-06-2	10	10
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	10	10
1,2-Dichloroethene, total (1,2-Dichloroethylene, total)	540-59-0	10	10
1,2-Dichloropropane	78-87-5	10	10
cis-1,3-Dichloropropene	10061-01-5	10	10
trans-1,3-Dichloropropene	10061-02-6	10	10
Ethylbenzene	100-41-4	10	10
2-Hexanone	591-78-6	10	10
Methylene chloride (Dichloromethane)	75-09-2	10	10
2-Methyl-4-pentanone (Methyl isobutyl ketone)	108-10-1	10	10
Styrene	100-42-5	10	10
1,1,2,2-Tetrachloroethane	79-34-5	10	10
Tetrachloroethene (Tetrachloroethylene)	127-18-4	10	10
Toluene	108-88-3	10	10
1,1,1-Trichloroethane	71-55-6	10	10
1,1,2-Trichloroethane	79-00-5	10	10
Trichloroethene (Trichloroethylene)	79-01-6	10	10
Vinyl chloride	75-01-4	10	10
Xylenes	1330-20-7	10	10

Appendix B-3

Contract Laboratory Program Analytes and CRDLs/CRQLs

ANALYTE	CAS No.	Water CRQL, µg/L	Soil CRQL, µg/Kg
Semivolatiles			
Acenaphthene	83-32-9	10	330
Acenaphthylene	208-96-8	10	330
Anthracene	120-12-7	10	330
Benzo[a]anthracene	56-55-3	10	330
Benzo[b]fluoranthene	205-99-2	10	330
Benzo[k]fluoranthene	207-08-9	10	330
Benzo[ghi]perylene	191-24-2	10	330
Benzo[a]pyrene	50-32-8	10	330
Bis(2-chloroethoxy)methane	111-91-1	10	330
Bis(2-chloroethyl)ether	111-44-4	10	330
Bis(2-chloroisopropyl)ether (2,2'-oxybis(1-Chloropropane))	108-60-1	10	330
Bis(2-ethylhexyl)phthalate	117-81-7	10	330
4-Bromophenyl phenyl ether	101-55-3	10	330
Butyl benzyl phthalate	85-68-7	10	330
Carbazole	86-74-8	10	330
4-Chloroaniline (p-Chloroaniline)	106-47-8	10	330
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7	10	330
2-Chloronaphthalene	91-58-7	10	330
2-Chlorophenol	95-57-8	10	330
4-Chlorophenyl phenyl ether	7005-72-3	10	330
Chrysene	218-01-9	10	330
Dibenz[a,h]anthracene	53-70-3	10	330
Dibenzofuran	132-64-9	10	330
Di-n-butyl phthalate	84-74-2	10	330
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	10	330
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	10	330
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	10	330
3,3'-Dichlorobenzidine	91-94-1	10	330
2,4-Dichlorophenol	120-83-2	10	330
Diethyl phthalate	84-66-2	10	330
2,4-Dimethylphenol	105-67-9	10	330
Dimethyl phthalate	131-11-3	10	330
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1	25	830
2,4-Dinitrophenol	51-28-5	25	830
2,4-Dinitrotoluene	121-14-2	10	330
2,6-Dinitrotoluene	606-20-2	10	330

Appendix B-3

Contract Laboratory Program Analytes and CRDLs/CRQLs

ANALYTE	CAS No.	Water CRQL, µg/L	Soil CRQL, µg/Kg
Di-n-octyl phthalate	117-84-0	10	330
Fluoranthene	206-44-0	10	330
Fluorene	86-73-7	10	330
Hexachlorobenzene	118-74-1	10	330
Hexachlorobutadiene	87-68-3	10	330
Hexachlorocyclopentadiene	77-47-4	10	330
Hexachloroethane	67-72-1	10	330
Indeno(1,2,3-cd)pyrene	193-39-5	10	330
Isophorone	78-59-1	10	330
2-Methylnaphthalene	91-57-6	10	330
2-Methylphenol (o-Cresol)	95-48-7	10	330
4-Methylphenol (p-Cresol)	106-44-5	10	330
Naphthalene	91-20-3	10	330
2-Nitroaniline	88-74-4	25	830
3-Nitroaniline	99-09-2	25	830
4-Nitroaniline	100-01-6	25	830
Nitrobenzene	98-95-3	10	330
2-Nitrophenol	88-75-5	10	330
4-Nitrophenol	100-02-7	25	830
N-Nitrosodiphenylamine (1)	86-30-6	10	330
N-Nitrosodi-n-propylamine	621-64-7	10	330
Pentachlorophenol	87-86-5	25	830
Phenanthrene	85-01-8	10	330
Phenol	108-95-2	10	330
Pyrene	129-00-0	10	330
1,2,4-Trichlorobenzene	120-82-1	10	330
2,4,5-Trichlorophenol	95-95-4	25	830
2,4,6-Trichlorophenol	88-06-2	10	330

(1) N-Nitrosodiphenylamine cannot be distinguished from diphenylamine.

Appendix B-3

Contract Laboratory Program Analytes and CRDLs/CRQLs

ANALYTE	CAS No.	Water CRQL, μg/L	Soil CRQL, μg/Kg
Pesticides and PCBs			
Aldrin	309-00-2	0.050	1.7
alpha-BHC	319-84-6	0.050	1.7
beta-BHC	319-85-7	0.050	1.7
delta-BHC	319-86-8	0.050	1.7
gamma-BHC (Lindane)	58-89-9	0.050	1.7
alpha-Chlordane	5103-71-9	0.050	1.7
gamma-Chlordane	5103-74-2	0.050	1.7
4,4'-DDD	75-54-8	0.10	3.3
4,4'-DDE	72-55-9	0.10	3.3
4,4'-DDT	50-29-3	0.10	3.3
Dieldrin	60-57-1	0.10	3.3
Endosulfan I	959-98-8	0.050	1.7
Endosulfan II	33213-65-9	0.10	3.3
Endosulfan sulfate	1031-07-8	0.10	3.3
Endrin	72-20-8	0.10	3.3
Endrin aldehyde	7421-93-4	0.10	3.3
Endrin ketone	53494-70-5	0.10	3.3
Heptachlor	76-44	0.050	1.7
Heptachlor epoxide	1024-57-3	0.050	1.7
Methoxychlor	72-73-5	0.50	17
Toxaphene	8001-35-2	5.0	170
Arochlor 1016	12674-11-2	1.0	33
Arochlor 1221	11104-28-2	2.0	67
Arochlor 1232	11141-16-5	1.0	33
Arochlor 1242	11096-82-5	1.0	33
Arochlor 1248	12672-29-6	1.0	33
Arochlor 1254	11097-69-1	1.0	33
Arochlor 1260	11096-82-5	1.0	33

Appendix B-4

Priority Pollutant List Analytes and EQLs

ANALYTE	CAS No.	Water EQL, mg/L	Soil EQL, mg/Kg
Classical Wet Chemistry Parameters			
Cyanide	57-12-5	0.010	1.0
Phenolics, total		0.10	2.0

ANALYTE	CAS No.	Water EQL, mg/L	Soil EQL, mg/Kg
Metals			
Antimony	7440-36-0	0.10	10
Arsenic	7440-38-2	0.10	10
Beryllium	7440-41-7	0.0020	0.20
Cadmium	7440-43-9	0.0050	0.50
Chromium	7440-47-3	0.010	1.0
Copper	7440-50-8	0.020	2.0
Lead	7439-92-1	0.050	5.0
Mercury	7439-97-6	0.0002	0.08
Nickel	7440-02-0	0.020	2.0
Selenium	7782-49-2	0.10	10
Silver	7440-22-4	0.10	10
Thallium	7440-28-0	0.20	20
Zinc	7440-66-6	0.020	2.0

Appendix B-4

Priority Pollutant List Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Purgeable Volatiles			
Acrolein	107-02-8	10	10
Acrylonitrile	107-13-1	10	10
Benzene	71-43-2	5	5
Bis(chloromethyl) ether	542-88-1	5	5
Bromodichloromethane (Dichlorobromomethane)	75-27-4	5	5
Bromoform (Tribromomethane)	75-25-2	5	5
Bromomethane (Methyl bromide)	74-83-9	10	10
Carbon tetrachloride	56-23-5	5	5
Chlorobenzene	108-90-7	5	5
Chloroethane	75-00-3	10	10
2-Chloroethyl vinyl ether	110-75-8	200	200
Chloroform (Trichloromethane)	67-66-3	5	5
Chloromethane (Methyl chloride)	74-87-3	10	10
Dibromochloromethane (Chlorodibromomethane)	124-48-1	5	5
Dichlorodifluoromethane (Freon 12)	75-71-8	10	10
1,1-Dichloroethane	75-34-3	5	5
1,2-Dichloroethane	107-06-2	5	5
1,1-Dichloroethene (1,1-Dichloroethylene)	75-35-4	5	5
trans-1,2-Dichloroethene (trans-1,2-Dichloroethylene)	156-60-5	5	5
1,2-Dichloropropane	78-87-5	5	5
1,3-Dichloropropene, total	542-75-6	5	5
Ethylbenzene	100-41-4	5	5
Methylene chloride (Dichloromethane)	75-09-2	5	5
1,1,2,2-Tetrachloroethane	79-34-5	5	5
Tetrachloroethene (Tetrachloroethylene)	127-18-4	5	5
Toluene	108-88-3	5	5
1,1,1-Trichloroethane	71-55-6	5	5
1,1,2-Trichloroethane	79-00-5	5	5
Trichloroethene (Trichloroethylene)	79-01-6	5	5
Trichlorofluoromethane (Freon 11)	75-69-4	10	10
Vinyl chloride	75-01-4	10	10

Appendix B-4

Priority Pollutant List Analytes and EQLs

ANALYTE	CAS No.	Water EQL, µg/L	Soil EQL, µg/Kg
Semivolatiles			
Acenaphthene	83-32-9	10	330
Acenaphthylene	208-96-8	10	330
Anthracene	120-12-7	10	330
Benzidine	92-87-5	20	670
Benzo[a]anthracene	56-55-3	10	330
Benzo[b]fluoranthene	205-99-2	10	330
Benzo[k]fluoranthene	207-08-9	10	330
Benzo[ghi]perylene	191-24-2	10	330
Benzo[a]pyrene	50-32-8	10	330
Bis(2-chloroethoxy)methane	111-91-1	10	330
Bis(2-chloroethyl)ether	111-44-4	10	330
Bis(2-chloroisopropyl)ether (2,2'-oxybis(1-Chloropropane))	108-60-1	10	330
Bis(2-ethylhexyl)phthalate	117-81-7	10	330
4-Bromophenyl phenyl ether	101-55-3	10	330
Butyl benzyl phthalate	85-68-7	10	330
4-Chloro-3-methylphenol (p-Chloro-m-cresol)	59-50-7	10	330
2-Chloronaphthalene	91-58-7	10	330
2-Chlorophenol	95-57-8	10	330
4-Chlorophenyl phenyl ether	7005-72-3	10	330
Chrysene	218-01-9	10	330
Dibenz[a,h]anthracene	53-70-3	10	330
Di-n-butyl phthalate	84-74-2	10	330
1,2-Dichlorobenzene (o-Dichlorobenzene)	95-50-1	10	330
1,3-Dichlorobenzene (m-Dichlorobenzene)	541-73-1	10	330
1,4-Dichlorobenzene (p-Dichlorobenzene)	106-46-7	10	330
3,3'-Dichlorobenzidine	91-94-1	20	670
2,4-Dichlorophenol	120-83-2	10	330
Diethyl phthalate	84-66-2	10	330
2,4-Dimethylphenol	105-67-9	10	330
Dimethyl phthalate	131-11-3	10	330
4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)	534-52-1	50	1700
2,4-Dinitrophenol	51-28-5	50	1700
2,4-Dinitrotoluene	121-14-2	10	330
2,6-Dinitrotoluene	606-20-2	10	330
Di-n-octyl phthalate	117-84-0	10	330