REMEDIAL INVESTIGATION WORKPLAN

VOLUME III

APPENDIX C - SITE HEALTH AND SAFETY PLAN

APPENDIX D - LABORATORY QA/QC MANUALS

FMC CORPORATION
8787 ENTERPRISE DRIVE
NEWARK, CALIFORNIA

SEPTEMBER 1998

newarktmwk_cvr.cdr

FMC Corporation
8787 Enterprise Drive
Newark, California

APPENDIX C

SITE HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

CLIENT:	FMC Corporation
SITE NAME:	FMC Newark
PROJECT/NUMBER:	04.0603311.001.009
SITE ADDRESS:	8787 Enterprise Drive, Newark, Alameda County
DATE:	September 1998
PLAN EXPIRATION DATE:	September 1999

HASP APPROVALS:

PROJECT MANAGER	**Doug Beadle**		
	Name	**Signature**	**Date**
IH REVIEW	**Sonja Echeverria**		
	Name	**Signature**	**Date**
FIELD SUPERVISOR/ SITE SAFETY OFFICER	**Nathan King**		
	Name	**Signature**	**Date**
HEALTH AND SAFETY MANAGER	**David Durst**		
	Name	**Signature**	**Date**
SUBCONTRACTOR			
	Name	**Signature**	**Date**
SUBCONTRACTOR			
	Name	**Signature**	**Date**

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF TABLES

LIST OF ATTACHMENTS

PROJECT MANAGER HASP DOCUMENTATION TRACKING FORM

HASP JOB#: 04.0603311001.009	**HASP DATED: September 1998**
JOB NAME: FMC Newark	**FILE LOCATION: o:\clients\fmc\newark NewarkHASP.wpd**
CLIENT NAME: FMC Corporation	**OFFICE OF ORIGINATION: Alameda**
PROJECT MANAGER: Doug Beadle	**FIELD SUPERVISOR: Nathan King**

RETURN THE MISSING DOCUMENTS TO THE PROJECT MANAGER BY:

(✓) if Needed*	DOCUMENTS REQUIRED
	Signed Cover Page/Acknowledgment Sheet, *including contractor(s) signatures*
	Section 1.4; Additional Authorized Site Personnel: Training Verification, *including Project Manager/Field Supervisor Initials*
	Utility Clearance; Underground Service Alert, *including signatures & distribution*
	Utility Clearance; McLaren/Hart Utility Clearance Checklist, *including signatures & distribution*
	Direct Reading Report Form, *including signatures & distribution*
	Instrument Calibration Log, *including signatures & distribution*
	Tailgate Safety Meeting Form, *including signatures & distribution*
	PM/Field Supervisor Audit Form, *including signatures & distribution*
	Other:
	Other:

*** To be filled out by the Health & Safety Manager during completion and/or revision of the HASP**

EXECUTIVE SUMMARY

This document presents the Health and Safety Plan (HASP) for soil and groundwater boring installation at the FMC property at 8787 Enterprise Drive, Newark, Alameda County (the Site). This HASP addresses only the potential hazards of concern with respect to soil and groundwater boring installation, and soil and groundwater sampling at the Site. A description of the hazards associated with the performance of various tasks identified herein is presented in Section 3.0.

1.0 GENERAL INFORMATION

1.1 INTRODUCTION

This Health & Safety Plan (HASP) has been prepared by McLaren/Hart, Inc. (McLaren/Hart) to document the health and safety measures to be implemented to protect McLaren/Hart and subcontractor personnel during work at the FMC Newark site located at 8787 Enterprise Drive in Newark, California (the Site). The HASP will be implemented by the Site Safety Officer (SSO) during Site work. Compliance with this HASP is required of all persons and third parties who enter this site. Assistance in implementing this plan can be obtained from the Site Safety Officer and Project Manager, and/or the Health and Safety Manager (HSM). The content of this HASP may change or undergo revision based upon additional information made available to health and safety (H&S) personnel, monitoring results or changes in the scope of work. Any changes proposed must be reviewed by H&S staff and are subject to approval by the HSM and Project Manager.

This HASP addresses the health and safety requirements for field work at the Site. This plan supplements the Health and Safety training that each McLaren/Hart employee receives. The health and safety guidelines in this HASP were prepared specifically for this Site. Due to the potentially hazardous nature of the site covered by this HASP and the activity occurring on the site, it is not possible to discover, evaluate, and provide protection for all possible hazards which may be encountered. This plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if these conditions change.

This HASP is not intended to be used by any contractor or personnel of any such contractor with which McLaren/Hart does not have a written contract. This HASP may not address the specific health and safety needs or requirements of any other such contractor and its employees. Neither this HASP nor any part of it should be used on any other site.

This site specific HASP addresses applicable federal, state and local safety and health requirements, including:

- 29 CFR 1910 and 1926 (Occupational Safety & Health Administration General Industry & Construction Standards, respectively)
- 29 CFR 1910.120 Hazardous Waste Operations and Emergency Response

McLaren/Hart expressly disclaims any and all guarantees or warranties, express or implied, that the HASP cannot and does not assume any liability by the use or reuse of the HASP by any client, contractor or their employees or agents. Any reliance on the HASP will be at the sole risk and liability of such party.

1.2 KEY PERSONNEL

TABLE 1-1

PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS

TITLE/ NAME	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES	REQUIRED TRAINING AND MEDICAL SURVEILLANCE
Project Manager Doug Beadle	• Reports to upper-level management. • Has authority to direct response operations. • Assumes total control over site activities.	• Prepares and organizes the background review of the job at hand, the Work Plan, the Health and Safety Plan, and the field team. • Obtains permission for Site access and coordinates activities with appropriate officials. • Ensures that the work plan is completed and on schedule. • Briefs the field teams on their specific assignments. • Uses the Site Safety Officer to ensure that safety and health requirements are met. • Prepares the final report and support files on the response activities. • Serves as the liaison with public officials.	• 40-hr. Hazardous Waste Training including 8-hr. update (29 CFR 1910.120) • 8-hr. Manager/Supervisor Hazardous Waste Training (29 CFR 1910.120) • Respirator use training (if on-Site work) • Initial site specific (if on-Site) • Medical surveillance participant

TABLE 1-1

PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS

TITLE/ NAME	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES	REQUIRED TRAINING AND MEDICAL SURVEILLANCE
Site Safety Officer/ Alternate Site Safety Officer Nathan King/_____	• Advises the Field Supervisor on all aspects of health and safety on-site. • Recommends stopping work if any operations threaten worker or public health or safety.	• Coordinates safety and health program activities. • Conducts Tailgate Safety Meetings and completes all documentation forms required by the Health and Safety Plan. • Monitors site personnel for signs of stress, such as cold exposure, heat stress and fatigue. • Monitors on-site hazards and conditions. • Participates in preparation of and implements the Health and Safety Plan. • Ensures that protective clothing and equipment are properly stored and maintained. • Knows emergency procedures, evacuation routes, and the telephone numbers of the ambulance, local hospital, poison control center, fire and police department. • Notifies, when necessary, local public emergency officials. • Coordinates emergency medical care.	40-hr. Hazardous Waste Training including 8-hr. update (29 CFR 1910.120) • Respirator use training • Initial HASP review • Daily review of site conditions • Special • Medical surveillance participant

TABLE 1-1

PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS

TITLE/ NAME	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES	REQUIRED TRAINING AND MEDICAL SURVEILLANCE
Field Supervisor Nathan King	• Responsible for field team operations and safety. • Reports to Project Manager.	• Manages field operations. • Executes the Work Plan and schedule. • Enforces safety procedures • Coordinates with the Site Safety Officer in determining protection level. • Enforces site control. • Documents field activities and sample collection. • Serves as liaison with public officials.	• 40-hr. Hazardous Waste Training including 8-hr. update (29 CFR 1910.120) • 8-hr. Manager/Supervisor Hazardous Waste Training (29 CFR 1910.120) • Respirator use training. • Initial site specific • daily site specific "Tailgate" • Special • Medical surveillance participant

TABLE 1-1

PERSONNEL RESPONSIBILITIES AND QUALIFICATIONS

TITLE/ NAME	GENERAL DESCRIPTION	SPECIFIC RESPONSIBILITIES	REQUIRED TRAINING AND MEDICAL SURVEILLANCE
Team Members Matt Paulus Matt Holt Matt Moses Kerry Ettinger	• Reports to Field Supervisor. • Contains at least two people. • For drilling purposes, Team Members consist of a geologist, drilling foreman and helpers.	• Safely completes the on-site tasks required to fulfill the Work Plan. • Complies with Health and Safety Plan. • Notifies the Site Safety Officer or Field Supervisor of unsafe conditions	• 40-hr. Hazardous Waste Training including 8-hr. update (29 CFR 1910.120) • Respirator use training. • Initial site specific • Daily site specific "Tailgate" • Special • Medical surveillance participant

1.3 AUTHORIZED MCLAREN/HART SITE PERSONNEL

Personnel authorized to enter the Site while operations are being conducted must be approved by the HSM. Authorization requires confirmation of conformance with OSHA 29 CFR 1910.120 training and medical examination requirements and/or other applicable regulations and review/sign-off of this HASP. All personnel must utilize the buddy system, or trained escort, and check-in with the Field Supervisor.

Table 1-2

Name	McLaren/Hart Staff Training Summary						
	40-hr. Haz-woper	8-hr. Haz-woper	8-hr. Super/ Mgr	CPR	First Aid	BBP	Other
1. Doug Beadle	1/27/89	11/19/97	5/31/91	11/1/91	11/1/91		
2. Nathan King	1/13/95	4/16/97	10/3/96	1/11/95	1/11/95		
3. Matt Moses	2/6/98			2/6/98	2/6/98		
4. Matt Paulus	9/26/97			9/25/97	9/25/97		
5. Matt Holt	8/8/97		12/22/97	8/1/97	8/1/97		
6. Kerry Ettinger	1/9/98		5/14/98	1/98	1/98		Confined spaces 4/16/98

1.4 AUTHORIZED SUBCONTRACTOR SITE PERSONNEL

Subcontractor personnel authorized to enter the Site while operations are being conducted must be approved by the Project Manager. Authorization will involve completion of appropriate training courses and medical examination requirements as required by OSHA 29 CFR 1910.120, 8 CCR 5192 and/or other applicable regulations and review of this HASP. All personnel must utilize the buddy system, or trained escort, and check-in with the Field Supervisor at the Command Post.

TABLE 1-3

Name	Subcontractor Training Summary						
	40-hr. Haz-woper	8-hr. Haz-woper	8-hr. Super/ Mgr.	CPR	First Aid	BBP	Other
1.							
2.							
3.							

1.5 SIGNATURE AND ACKNOWLEDGMENT SITE NAME: FMC NEWARK

All McLaren/Hart personnel, and their subcontractors, working at or visiting the Site (beyond the Support Zone) must acknowledge by signing below that the contents of this HASP have been reviewed. All personnel acknowledge that they participate in a medical surveillance program and have been trained in accordance with 29 CFR 1910.120 (e) and (f), [8CCR 5192], Hazardous Waste Operations and Emergency Response standard. Each person agrees that he/she has read and understands this HASP and agrees to comply with the provisions listed herein.

McLaren/Hart personnel have the authority to stop field activities at the Site if any activity is not performed in accordance with the requirements of this HASP.

All McLaren/Hart project personnel, subcontractors, and visitors are required to sign the Acknowledgment **prior** to conducting field work at this site.

	Name	Signature	Date	Company
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
13.				
14.				
15.				
16.				
17.				
18.				
19.				

1.6 MEDICAL SURVEILLANCE

McLaren/Hart personnel, and subcontractors, working at the Site will participate in a medical surveillance program which meets the requirements of 29 CFR 1910.120. McLaren/Hart's medical surveillance program is outlined in Health and Safety Policy HS 10, Medical Surveillance Program.

Employees working at the Site provided with pre-employment, annual and termination medical examinations to ensure that they are medically fit to perform work and wear personal protective

equipment. The scope of the medical exams includes a physical examination, audiometric testing, pulmonary function testing, visual testing, blood testing and urinalysis. The results of the examinations are confidential. Employees are provided with medical certificates and employees and their supervisors are informed of any restrictions or limitations.

Employees requesting access to their medical records should refer to Health and Safety Policy HS10 for the Authorization for Release of Medical Information.

2.0 PROJECT INFORMATION

2.1 SITE DESCRIPTION

The Site is located west of I-880 and east of salt evaporation ponds in an area with various industrial and commercial uses. Figure 1 shows the location of the Site, while Figure 2 presents a detailed Site map. The parcels formerly used for manufacturing at the Site (Parcels A, B, C, D, and I) comprise 39.3 acres and are located at the western end of Enterprise Drive in Newark, Alameda County, California. This portion of the Site is bounded by the Southern Pacific Railroad and portions of the Hetch-Hetchy Pipeline Right-of-Way to the north, Willow Street to the east, Enterprise Drive and undeveloped land owned by Cargill, Incorporated - Salt Division to the south, and undeveloped land including present or former salt evaporation ponds and one engineered barge canal connected to the Newark Slough to the west.

A discussion of specific areas is presented within the following subsections.

Parcel A (Former Phosphoric Acid Plant and Phosphate Plant Area)

Parcel A formerly contained the phosphoric acid plant and phosphate plant, the phossy pond and the 1707 catalyst plant. These areas are described below.

Former Phosphoric Acid Plant and Phosphate Plant

A phosphoric acid plant and phosphate plant were constructed on Parcel A in 1950. Phosphoric acid was manufactured by burning elemental phosphorus (P4), and phosphate products by processing phosphoric acid and sodium carbonate. The plant was subsequently retrofitted for purposes of manufacturing additional phosphate products using sodium and potassium hydroxide (Redeker, 7-27-98). Elemental phosphorus was originally stored in steel aboveground storage tanks (ASTs). In the 1960's, FMC constructed two below grade pits of steel reinforced concrete in Parcel A for storage of elemental phosphorous and the ASTs were taken out of service. The pits were taken out of service, decontaminated, and closed in place (i.e., the concrete floors and walls remain) by backfilling in 1993-1994. Sampling in the mid-1970's and 1996 has revealed the presence of elemental phosphorous in soil immediately outside the walls of the pits, suggesting that leaks or spills have occurred (Woodward-Clyde, April 1994). Sampling of the shallow zone groundwater beneath Parcel A has shown levels of arsenic above the State of California, Environmental Protection Agency (CAL EPA) Maximum Contaminant Levels (MCLs) (Woodward-Clyde, April 1994). All phosphate manufacturing concluded in 1994 and that plant was shutdown. FMC completed dismantling and removal of the equipment and structures for the plants by the end of 1996.

In the late 1960's, approximately 20,000 gallons of phosphoric acid, stored in lead lined redwood ASTs, either spilled or leaked in the area south of the former air compressors that were located outside the southern portion of the former warehouse (PES, April 10, 1998, Plate 3). The acid was thought to have flowed toward the west (Woodward-Clyde, 1994, p. 3-2). The ASTs were subsequently sealed with plastic liners (Delucchi, 7-27-98).

Former Phossy Pond

FMC operated a surface impoundment, known as the "phossy water pond", from early 1950 until the late 1970's for water that had come into contact with elemental phosphorous (e.g., water used to cover the elemental phosphorous during shipment in railcars or used to displace the elemental phosphorous during unloading) on the east side of Parcel A, north of the Hetch Hetchy Right of Way (FMC Letter to DHS, June 26, 1984, p. 2). The pond was approximately 140 feet wide, 180 feet long, and 4 feet deep (FMC Letter to DHS, May 3, 1985). Water was kept in the pond at all times. Discarded pipes, valves, etc. that had contained P4 were occasionally discarded into the ponds to prevent ignition. The pond was unlined and there was no drainage from the pond. The phossy pond was closed in 1985 in accordance with the California Department of Health Services (DHS) (now the Department of Toxic Substances Control, or DTSC) (Woodward-Clyde, 1994). The DHS acknowledged the completion of the phossy water pond closure in a letter dated January 29, 1987 (DHS, 1987).

Former 1707 Catalyst Plant

The "1707" catalyst plant was located on the western half of Parcel A and operated from 1942-1944 to produce a catalyst used in the production of synthetic rubber for the United States Government during World War II. The catalyst contained magnesia, potassium chloride, copper sulfate, and iron sulfate (Woodward-Clyde, 1994, p. 3-2, ESI, January 1988, Chang, 7-15-98, and Redeker, 7-16-98).

Parcels B & I (Former EDB Plant and DBS Property Area)

Parcels B and I formerly contained the EDB plant and bromine towers, the "Petro-Tex" pilot plant, the 1707 catalyst pilot plant, the research pilot plant, the soda ash transloading area, an effluent pond (E-1 pond), the quality control laboratory, and stores buildings. Additionally, Parcel B still contains the aboveground storage tank area, the hazardous waste storage area, the hydrogen peroxide distribution facility, the paint shed and garage, and the groundwater treatment system. These areas are described below.

Former EDB and Bromine Plants

The bromine towers and adjoining EDB plant were constructed in 1929 (Redeker, 7-16-98, Westvaco Digest January 1953) on Parcels B and I (ESI, January 1988, and Chang, 7-15-98). Bromine was extracted from seawater bittern and then was reacted with ethylene gas to produce EDB (Chang, 7-15-98). EDB was manufactured primarily for agricultural use as a soil fumigant. Over the years of operations, it is likely that there were minor leaks and spills in the course of routine manufacturing and handling. The only known significant spill occurred in 1967 when a steel tank used to store EDB ruptured, spilling approximately 6,000 gallons of product onto the ground. Other than flushing with water, there is no record of specific cleanup actions taken at the time (Woodward-Clyde, 1994, p. 3-5).

The EDB area also contained an underground diesel tank that overflowed and leaked in the 1960's. The tank was removed. Additionally, a small underground gasoline storage tank was removed from the area in 1986 in accordance with the City of Newark Fire Department requirements and oversight. The adjacent soil was impacted with total petroleum hydrocarbons, yet was excavated, treated, and placed back into the pit (Woodward-Clyde, 1994, p. 3-5).

Former Petro-Tex Catalyst Plant

A "Petro-Tex" catalyst plant operated at the location of the current warehouse on Parcel B beginning in the mid 1960s. The plant was owned 50% by FMC and used iron and zinc oxide, barium carbonate, and poly vinyl alcohol for purposes of manufacturing a proprietary catalyst. The plant operated through 1976 (ESI, 1988, Chang, 7-15-98, Redeker, 7-16-98, Delucchi, 7-27-98).

Former 1707 Catalyst Pilot Plant and Manufacturing Plant

Parcel I also contained a 1707 catalyst pilot plant that operated for a few months prior to the operation of the 1707 catalyst plant on Parcel A during World War II. The pilot plant's purpose was to conduct research necessary for the development of the 1707 catalyst plant (Redeker, 7-16-98). During the Korean War, between 1955 and 1959 full scale manufacturing of 1707 catalyst was conducted on Parcel I at the location of the former pilot plant (Delucchi, 7-27-98).

Former Research Pilot Plant

A small magnesia research pilot plant existed at the location of the current training center during the 1950s and early 1960s. The pilot plant's purpose was to conduct research necessary for the development of magnesia products (Redeker, 7-16-98).

Former Soda Ash Transloading Area

A soda ash transloading area was also present on Parcel B, northwest of the EDB area. Soda ash was transferred from railcars to trucks, and some soda ash spilled onto the ground and railroad tracks. The area was paved in 1992. This area is equipped with a below-grade screw conveyor, a product elevator, and a dust collector. This area was also used for transferring sodium phosphates as well, through 1980 (Woodward-Clyde, 1994, p. 3-6).

Former Effluent (E-1) Pond

Parcel B contained a clay lined pond (E-1 Pond) which was operated from the mid-1970's to 1995 as part of the plant's effluent management and treatment system under a National Pollutant and Discharge Elimination System (NPDES) permit. Effluent from the plant, consisting primarily of cooling tower blowdown, boiler blowdown, softener regeneration brines, and stormwater runoff, was collected in this pond and adjusted for pH prior to discharge (Woodward-Clyde, 1994). The effluent pond was taken out of service and backfilled with clean fill in mid-1996 (Woodward-Clyde, April 1996).

Former Laboratory

A laboratory operated on Parcel B from approximately 1941 through 1994 as a product quality control lab for the magnesia and phosphate produced on Parcels C and A, respectively. All sample material was recycled with the exception of gypsum and magnesia which was transferred to the magnesia pile (Delucchi, 7/27/98).

Former Stores and Former Engineer Stores Buildings

The former stores building located on Parcel B was used as a parts warehouse for storage of pumps, motors, valves, etc.. The former engineer stores located on the same Parcel was used for office space for maintenance personnel and later for storage of files (Chang, 7-15-98).

Aboveground Storage Tank Area

Diesel and solvents were stored in ASTs in this area beginning in the 1950s (Redeker, 7-16-98). These ASTs will be closed under the authority of the City of Newark Fire Department (NFD). Additionally, a 500-gallon aboveground gasoline storage tank is located near this area. The gasoline tank is currently used by the hydrogen Peroxide Transloading facility. This tank is permitted by the NFD and Bay Area Air Quality Management District (BAAQMD).

Hazardous Waste Storage Area

The hazardous waste storage area was operated under DHS 90-day Generator Permit Status beginning in January 1987 until July 1997 when the NFD Certified Unified Program Administrator (CUPA) Program assumed authority. Hazardous waste stored at the facility is limited to spent filters and carbon generated by the Site's groundwater treatment system.

Existing Hydrogen Peroxide Distribution Facility

A hydrogen peroxide transloading and chemical warehousing distribution facility was constructed on Parcel B in 1976. FMC has ceased warehousing and distribution of chemical products, but continues to operate the hydrogen peroxide transloading facility.

Existing Paint Shed and Garage

A paint shed and garage is located on the northern portion of Parcel B. These facilities have been utilized as storage areas for paints and vehicles, respectively since the 1950s (Chang, July 1998, and Redeker, July 1998).

Existing Groundwater Treatment System

Following the adoption of Order No. 85-113, FMC implemented a remedial measures program based on the EDB concentrations detected in the Newark aquifer. The Newark aquifer remediation

program was initiated in January and February 1986 and currently consists of extracting groundwater from Well DW-2, filtering to remove suspended solids, and treating by granular activated carbon (GAC) to remove VOCs prior to discharge. Following the adoption of Order No. 87-49 and based on the results of site investigations, FMC commenced operation of a shallow zone extraction system in August 1989. The shallow zone system was comprised on 26 extraction wells (W-7, W-20, W-29, W-33, and W-37 through W-58) from which groundwater was pumped under negative pressure. In September 1989, Wells W-7 and W-52 through W-58 were isolated from the extraction system to minimize the possibility of accelerating the migration of 1,1-dichloroethane (1,1-DCA) and other compounds to the Site from upgradient sources. With the concurrence of the RWQCB, methods for discharging treated groundwater have been reinjection into the Newark aquifer, discharge to surface waters, and with the commencement of the shallow zone extraction system discharge to the USD sanitary sewer system (Geosystem, July 1998).

Former DBS Property

Parcel I was leased by FMC from Leslie Salt Company (or its predecessor companies) from 1929 through 1969. In 1969 the property was purchased by DBS. DBS used the area for customizing mobile buildings, and portions of the property were leased to a number of small businesses which included, a pallet repair business (north side), truck repair station (south side), trailer remodeling business (south side), junk car dealer (south side) and equipment storage yard (south side). FMC purchased land owned by DBS on Parcel I in 1988.

Parcel C (Former Magnesia Plant Area)

Parcel C formerly contained the magnesia plant, as described below

Former Magnesia Plant

Between 1929 and 1937 a kiln was operated on Parcel C which roasted oyster shells for the production of quick lime. The magnesia plant was constructed in 1937 on approximately 15 acres adjacent to an engineered barge canal connected to the Newark Slough. Prior to its construction, a pilot plant performed research on the magnesia process (Redeker, July 7-16-98 and 7-28-98). Upon the magnesia plant's completion, barges with clams and oyster shells (used as a source of calcium) were brought from the San Francisco Bay into the Newark Slough and barge canal and unloaded at the magnesia plant. Magnesia compounds were produced and gypsum was a coproduct. Additionally, seawater bittern was used as a raw material and during World War II dolomite replaced the oyster shells as the source of calcium and magnesite (Redeker, 7-27-98). The magnesia compounds were used in refactory brick, pulp, and paper. The gypsum was primarily used in wallboard manufacture and as a soil amendment. The manufacturing equipment, which consisted of five kilns, crushers, burners, and fuel oil storage, was removed with the closure of the plant in 1968. Two Bunker C fuel oil storage tanks were located at the plant. The tanks were overfilled occasionally (Redeker, 7-27-98).

Parcel D (Former Maintenance and Parking Area)

Parcel D formerly contained the stormwater pond, tetrapotassium pyrophosphate (TKPP) pond, and filter aid pit. These areas are described below.

Former Stormwater Pond

Stormwater runoff from the phosphate plant and other manufacturing areas was collected and contained in an earthen impoundment near the southeastern corner of the Site. The pond, constructed in 1978-1979, was approximately 3-4 feet deep, had a capacity of approximately 300,000 gallons, and was lined with native clay soil. Samples of sludge and underlying soil were collected from the pond in 1985-1986 and the pond was subsequently closed in 1987 by excavation and off-site disposal, with the excavated soils manifested as a hazardous waste due to arsenic (toxicity characteristic). The area was subsequently backfilled (Woodward-Clyde, 1994). After closure of the pond stormwater runoff was collected in a 200,000 gallon AST located near the former pond. The 200,000-gallon AST was closed in 1995 under the authority of the NFD.

Former TKPP Pond

Activated carbon filter used in the production of tetrapotassium pyrophosphate (TKPP) was disposed of in an earthen impoundment, known as the "TKPP Pond", located immediately south of the Hetch-Hetchy right-of-way. The unlined and undrained pond was constructed in 1972 and measured approximately 22 feet wide, 52 feet long, and 3 feet deep. The pond was utilized through 1980 (PES, April 1998). It was closed pursuant to notifications to the State of California Regional Water Quality Control Board, San Francisco Bay Region (RWQCB) and the DHS in 1983 by excavation and off-site disposal, and the area backfilled (FMC Letters to USEPA, September 1983 and May 1985). The DHS approved the closure of the TKPP Pond in a letter dated April 12, 1984 (DHS, 1984).

Former Filter Aid Pit

Prior to about 1972, the effluent ditch E-1 began in the middle of Parcel D, with a pit located at the head of the ditch used for disposal of filter cake. The filter cake contained dicalite (diatomaceous earth) and arsenic sulfide, generated during the production of food grade phosphoric acid. Along with 700-800 feet of ditch, the pit was closed by excavation and off-site disposal in 1972, and the area backfilled with clean fill and graded (Woodward-Clyde, 1994).

Parcels E, F, and G (Undeveloped Parcels)

There are three undeveloped parcels (E, F, and G), owned by FMC, that are located to the southeast, northeast, and east of Willow Street, respectively. These properties comprise 7.9 acres, have not been used for manufacturing activities, and have remained undeveloped. However, groundwater beneath these parcels have been polluted with volatile organic compounds (VOCs) from off-site source areas located on neighboring sites.

Hetch-Hetchy Right-of-Way

The City of San Francisco Water Department owns a right of way at the Site for the Hetch Hetchy water pipeline that bisects the eastern portion of the Site from the southeast to the northwest and borders the western portion to the north. FMC has a Land Use Permit with the San Francisco Water Department for access to this property (San Francisco Water Department, September 1987).

Neighboring Sites

Four neighboring sites are currently conducting groundwater cleanup under RWQCB Orders, including: Ashland Chemical Company, Romic Environmental Technologies (Romic), Jones-Hamilton Chemical Company, and the Baron-Blakeslee Solvent processing facility. Three of these sites are located immediately up-gradient of the Site. Ashland is up- to cross-gradient of the Site and is in the process of implementing soil and groundwater remediation. Pollutants from the sites have commingled to some extent in the shallow groundwater zone. A discussion of each facility is presented below.

The Ashland Chemical Company is located directly southeast of the Site (8610 Enterprise Drive) and is operating under Site Cleanup Requirements Order No. 89-109 to cleanup released VOCs in the shallow zone groundwater. A groundwater extraction and treatment system has been installed. Groundwater flow within the shallow zone at the site is variable, with flows observed toward the southwest, west, and northwest. VOCs are generally confined to the Ashland property, with the exception of 1,2-dichloroethane (1,2-DCA). Vinyl chloride, TCE, 1,1-DCE, 1,1-DCA, and cis-1,2-DCE have consistently been detected above MCLs in downgradient monitoring well W-22, located on FMC's site. 1,1-DCA, cis-1,2-DCE, and 1,2-DCA have all been detected in FMC monitoring well W-26, at a concentrations above their respective MCLs (Fluor Daniel GTI, February 1998).

Romic is located to the west of Willow Street (37445 Willow Street), southeast of the Ashland Chemical Company. The Board issued a Consent Order (No. 89-111) to Romic to investigate and remediate soil and groundwater contamination at the site. 1,2-DCA is the primary contaminant of concern, although other VOCs have been detected. 1,2-DCA has impacted shallow groundwater at this site at concentrations up to 22,000 ppb. Romic has performed a soil investigation, installed groundwater monitoring wells, and installed a groundwater extraction and treatment system for the shallow zone (Harza, April 1998).

Jones-Hamilton Company is located at 8400 Enterprise Drive, southwest of the intersection of Willow Street and Enterprise Drive. The Site and is operating under Site Cleanup Requirements Order No. 89-111 to undertake measures to address chemicals in shallow zone groundwater beneath the site. Contaminants of concern include pentachlorophenol (PCP), tetrachlorophenol (TCP), 1,2-DCA, and gasoline. A slurry wall, and groundwater extraction and treatment system have been installed at the site. Some chemicals appear to have migrated from the site (Emcon, April 1998).

Baron-Blakeslee (a Division of Allied-Signal) operated a solvent processing facility for a number of years at 8333 Enterprise Drive, located approximately 0.4 miles east of the Site. The facility was shutdown in 1994, yet is currently being leased to another solvent distributor. The Board issued Site Cleanup Requirements Order No. 95-132 to cleanup released contaminants (VOCs) to soil and groundwater. The area of impact is widespread. VOCs [including TCE, tetrachloroethene (PCE), 1,1-DCE, 1,1,1,-trichloroethane (1,1,1-TCA), and trichloroflouromethane (TCFM)] have migrated offsite to a significant distance in the westerly direction. First quarter 1998 monitoring data from this site showed high levels (>10,000 parts per billion [ppb]) of VOCs present in monitoring wells on or near FMC Parcels F and G, with lesser concentrations (approximately 1,000 ppb) present on FMC Parcel A (Radian, April 1998).

Groundwater Contamination

VOCs detected in groundwater at the Site include; 1,1,1-TCA, 1,1-DCA, 1,2-DCA, 1,2-dichloropropane, bromoform, chlorobenzene, chloroethane, chloroform, dibromochloromethane, EDB, methylene chloride, TCE, trichloroethene, and vinyl chloride. Maximum concentrations detected at the Site from January 1997 to April 1998 are presented in Table 3-2.

Soil Contamination

Metals detected in soil at the Site include; arsenic, barium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, phosphorous (including orthophosphate), silver, vanadium, and zinc. VOCs and semi-VOCs detected in soil at the Site include; acetone, bromoform, EDB, and toluene. Petroleum hydrocarbons detected at the Site include; diesel, kerosene and motor oil. Maximum concentrations of metals, semi-VOCS, VOCs and petroleum hydrocarbons are presented in Table 3-2.

2.2 BACKGROUND INFORMATION

FMC and predecessor companies have manufactured chemicals at this Site from 1929 through 1995. At present, FMC only operates a facility for storage and distribution of hydrogen peroxide on the Site.

Sierra Magnesite Company first began chemical production at the Site in 1929. Quick lime was manufactured from oyster shells (Parcel C) and bromine and ethylene dibromide (EDB) were made from seawater bittern (Parcels B and I). Sierra Magnesite became California Chemical Company in 1934. California Chemical Company merged into Westvaco Chlorine Products Corporation in 1937. A magnesia plant was constructed at that time on Parcel C. In 1942, a pilot plant for a copper-based catalyst was built on Parcel I, which was leased from Leslie Salt Company, and a plant for the full production of the catalyst was constructed on Parcel A. These catalyst plants were closed in 1944. Westvaco Chlorine Products Corporation merged with Food Machinery Corporation in 1948. A phosphoric acid and phosphate plant were constructed on Parcel A in 1950. During the Korean War, between 1955 - 1959, full scale manufacturing of the 1707 Catalyst was performed at the location of the former pilot plant on Parcel I. The magnesia plant, bromine towers, and EDB

plant were shutdown and the manufacturing facilities were removed in 1968. In the mid 1960s, a small catalyst plant was constructed on Parcel B for manufacture of a proprietary catalyst; this facility was shutdown in 1976. During that same year, a hydrogen peroxide (and other chemical) distribution area was constructed on Parcel B. FMC acquired the adjacent site (Parcel I where the former EDB plant was located, at least in part) from Designed Building Systems, Inc. (DBS) on August 16, 1988. The phosphate plant and phosphoric acid plant were shutdown in 1994 and 1995, respectively. All former manufacturing facilities were removed by the end of 1996 (Redeker, 7/27/98, Delucchi, 7/27/98, Woodward-Clyde, April 1994, p. A-1 & ESI, January 1988, Table 2.1). The City of San Francisco maintains a right of way for the Hetch-Hetchy water pipeline that bisects the eastern portion of the Site from the southeast to the northwest and borders the western portion to the north (San Francisco Water Department, September 30, 1987).

2.3 PURPOSE OF SITE WORK

The purpose of the Site work will be to install soil and groundwater borings and to collect soil and groundwater samples. The location of these samples will be used to confirm previous field investigations performed at the Site, and to define areas and depths of known contamination.

2.4 JOB TASK IN ORDER OF EXECUTION

Task 1. Conduct Site visit, mark soil/groundwater boring locations;

Task 2. Mobilize to Site;

Task 3. Perform underground utility clearance;

Task 4. Install soil and groundwater borings, collect samples;

Task 5. Prepare and send soil and groundwater samples to laboratory;

Task 6. Decontaminate equipment; and

Task 7. Demobilization from Site.

2.5 SCHEDULED DATES OF SITE WORK

Site work will begin upon approval of work plan, and will be completed within two months (approximately).

2.6 AGENCY OVERSIGHT (STATE OF CALIFORNIA):

Regional Water Quality Control Board, San Francisco Bay Region

3.0 HEALTH AND SAFETY RISK ANALYSIS

3.1 HAZARD ANALYSIS AND MITIGATION MEASURES

This section discusses possible chemical and physical hazards, and mitigation associated with the potential health and safety risks associated with the Site. Hazard specific training must be completed by field personnel prior to initiating work activities. Precautions must be taken to prevent injuries and exposures to the following potential hazards. For additional information, refer to McLaren/Hart's Health and Safety Policies and Procedures, procedures provided in the Attachment section or consult your Site Safety Officer.

Hazard Analysis and Measure

Back Injury Prevention
▸ Use a mechanical lifting device or a lifting aid where appropriate. ▸ If you must lift, plan the lift before doing it and seek help if object is heavy or awkward. ▸ Check your route to assure it is clear. ▸ Bend at the knees and use leg muscles when lifting. ▸ Do not twist or jerk your body while lifting.
Biological Hazards
▸ Tuck pants into socks and wear long sleeves. ▸ Use insect repellent. ▸ Avoid contact by always looking ahead to where walking, standing, and sitting. ▸ Use buddy system and check for signs of insect/spider bites, such as redness, swelling. ▸ Tick bites should be reported via accident report form. Multiple tick bites (2-3) sustained at one time should be treated by the nearest medical facility to prevent the onset of Lyme disease. ▸ Do not enter areas infested with poisonous plants. ▸ Immediately wash any skin areas that come into contact with poisonous plants. ▸ Protect exposed skin areas with gloves and protective clothing. ▸ Contact with poisonous plants can result in the oils being carried on boots, clothing, and equipment. Remember to wash hands and face after field work. ▸ If you have known of suspected allergies, see the SSO prior to the start of work. ▸ Always look ahead to where walking for signs of snakes and avoid walking in areas where snakes may hide, also when moving objects. ▸ Never reach into areas where you cannot see. ▸ Wear leather chaps if working in tall grass or bushes.

Hazard Analysis and Measure

Chemical Exposures
▸ Stay upwind of chemical vapor releases whenever possible. ▸ Minimize direct contact and contact time with contaminated media to prevent exposure. ▸ Avoid walking through stained areas, puddles, or contacting anything that is likely to be contaminated, unless wearing the appropriate PPE. ▸ Do not eat, drink, smoke and/or apply cosmetics in the hot or warm zones. ▸ Wear the PPE specified in Table F-4-1 and KNOW the limitations of the PPE used. ▸ Level D PPE must be worn at a minimum when on project sites. ▸ Refer to Table F- 4-2 for Air Monitoring Protocols and Chemical Contaminant Action Levels. ▸ Elemental phosphorus (in pit/pond areas) will ignite upon contact with air. Avoid contact. Conduct fire watch to be aware of any phosphorus or sediment that could ignite. Smother phosphorus with dirt, and/or sand, and water. ▸ If unknown materials are encountered, call the Field Supervisor or HSO.
Cold Stress
▸ Take breaks in heated shelters when working in extremely cold temperatures. ▸ Remove the outer layer of clothing and loosen other layers to promote evaporation of perspiration, upon entering the shelter. ▸ Know the symptoms of cold stress which include shivering, numbness in the extremities, and sluggishness. ▸ Plan for a change of work clothes should your clothing become damp or wet. ▸ Drink warm sweet liquids to reduce the susceptibility to cold stress. ▸ Reference Attachment F-7 for Cold Stress recognition and prevention procedures.
Decontamination
▸ Wear appropriate PPE to avoid contact with decon solutions. ▸ Stand upwind to minimize spray back and wear a respirator to minimize any potential inhalation exposure. ▸ Contain decon solutions and dispose of properly. ▸ Appropriate disposition of reusable PPE. Appropriate disposal of disposable PPE.

Hazard Analysis and Measure

Drilling Safety
▸ Driller and helper must be present during all active operations. ▸ Drill rig emergency shut off switch shall be tested prior to the start of work and a rig safety inspection shall be performed by the Field Supervisor. ▸ Loose fitting clothing and/or PPE, loose jewelry will be removed or secured. ▸ Unauthorized personnel must be kept clear of drilling rig and work area by barrier. ▸ When drilling in an enclosed area or building, additional ventilation may be necessary. ▸ Pipe, casing, augers, and other tools should be orderly stacked on racks to prevent, rolling, or sliding. ▸ Work areas, platforms, and walkways should be kept free of materials, debris, and obstructions such as ice, grease, or oil that could cause a preventable fall hazard. ▸ Clean mud and grease from your boots before mounting a drill platform. ▸ Drill rig shut down for repairs or adjustments or lubrication shall involve the release of all pressure on the hydraulic systems, the drilling fluid system, and the air pressure systems of the drill rig prior to performing maintenance. ▸ Do not drive the drill rig from hole to hole with the mast in the raised position. Before raising the mast, check for overhead obstructions. ▸ Should the rope "grab" the cathead it could become tangled in the drum. Release the rope and provide warning for all personnel to rapidly back away and stay clear. ▸ Always maintain a minimum clearance of 18 inches between the operating hand and the cathead drum. ▸ If a lighting or power utility strike occurs, all personnel should jump clear from the rig. ▸ Refer to McLaren/Hart H&S Policy HS 16, Drilling Safety, for additional information.
Dust Control
▸ Stand upwind whenever intrusive activities occur and generate visible signs of airborne dust. ▸ Monitor air for airborne soil dust where required by the HASP with portable aerosol dust-direct reading instrument. ▸ >2.0 mg/M^3 in breathing zone requires use of respirator.

Hazard Analysis and Measure

Electrical Safety
▸ Maintain appropriate distance from overhead utilities; 20-foot minimum clearance from power lines required. ▸ Use ground-fault circuit interrupters as required. ▸ Perform LO/TO procedures as specified in HS 25, Attachment F-19. ▸ Use three-pronged plugs & extension cords & remove damaged cords from service. ▸ Contact your local underground utility-locating service in advance of evasive work. ▸ Contact HSO if electrical installations must be installed in hazardous locations.
Elevated Work Platforms
▸ While working from elevated levels greater than 6 feet, all employees will use fall protection with full body harnesses and guardrails. ▸ Wear leather gloves to protect against pinching injuries. ▸ Pre-operational inspections of aerial lifts shall be performed to include: tire air pressure, hydraulic fuel level and pressure check, make sure pivot pins are secured, check for worn or damaged hoses, check for physical damage to the lift, ensure the safety limit switch is operational, ensure guardrail system is installed on the platform, check both ground and platform control functions, raise the lower each boom system. ▸ Ensure the lift operators have been trained and the training is documented. ▸ When moving materials with a crane, use a non-conductive tag line to direct and position the load. ▸ Never climb a raised platform or stand on the mid-rail or top-rail. ▸ Tools should be placed in an area where they cannot fall out of bucket or off platform. ▸ Do not stand under loads.
Fire Safety
▸ Smoke only in designated areas. ▸ Secure Hot Work Safety Permits for all welding, cutting, brazing, etc. ▸ Keep flammable liquids in closed FM approved containers. ▸ Remove debris accumulation and clear vegetation for around fueling stations. ▸ Ensure the appropriate size and type of extinguisher are available and that staff are trained in their use. Ensure fire safety equipment is inspected and maintained.

Hazard Analysis and Measure

General Site Safety
▸ Wear hard hats and safety glasses when on site. ▸ Maintain visual contact with the equipment operator and wear orange safety vest when heavy equipment or vehicular traffic. ▸ Prevent slips, trips, and falls; keep work area uncluttered. ▸ Keep your hands away from moving parts and pinch points (i.e., augers). ▸ Be aware of your surroundings at all times and look out for your co-worker. ▸ Use the buddy system.
Hazard Communication
▸ Chemicals brought on site by McLaren/Hart personnel or subcontractors, such as adhesives, fuels, solvents, reagents, decontamination solutions, or any other OSHA defined hazardous material must contain warning labels and the MSDSs available on site. ▸ MSDS brought on site can be attached as an Appendix F-26. ▸ Chemical specific hazard awareness training on OSHA defined hazardous materials must be completed and documented. Reference McLaren/Hart's Hazard Communication policy, HS 19 for training requirements. Use the Tailgate Safety Meeting form to record training attendance. ▸ Flammable materials shall be stored in NFPA-approved cabinets or containers and secured in an area at least 50 feet from any potential splash/flame producing operation.
Hearing Conservation Program
▸ Wear hearing protection if you need to raise your voice above normal conversational levels due to noise. ▸ Wear hearing protection when equipment such as a drill rig, cut-off saw, or other heavy equipment is operating. ▸ Hearing protection is required when sound level measurements exceed 85 dBA. ▸ Noise monitoring of suspected high noise operations shall be monitored at the beginning of operations or new processes to determine if hearing protection is necessary.

Hazard Analysis and Measure

Heat Stress
▸ Increase water intake while working and rest in cool shaded places. ▸ Avoid alcohol intake the night before working in heat stress situations. ▸ Increase number of rest breaks and/or rotate workers in shorter work shifts; take breaks in shaded areas. ▸ Watch for signs and symptoms of heat exhaustion and fatigue. ▸ Plan work for early morning or evening to avoid hot part of day. ▸ Use ice vests or vortex cooling devices when necessary. ▸ In the event of a heat related disorder, provide a cool area and seek first aid. ▸ Reference Attachment F-7 for Heat Stress recognition and prevention procedure.
Inclement Weather
▸ Stop outdoor work during electrical storms and other extreme weather conditions such as extreme heat or cold temperatures. ▸ Take cover indoors or in a vehicle. ▸ Listen to local forecasts or the National Weather Service for warnings about specific weather hazards.
Utility Clearance
▸ Contact Underground Service Alert (USA) Safe Dig or equivalent agency to have utility lines marked prior to excavation/trenching. ▸ Refer to site drawings or customer interviews if on private property for utility locations and screen area with utility locating instrumentation. ▸ Hand dig 3 to 5 feet down and 5 feet each side of utility marker to avoid breaking utility lines. ▸ Refer to McLaren/Hart's policy (HS 34) for additional information.
Vehicular Safety
▸ Wear traffic safety vest when vehicle and/or heavy equipment hazard exists. ▸ Obtain necessary agency permits, or plans for roadway work. ▸ Use vehicle to protect workers from vehicle exposure hazards on roadways. ▸ Define work area by use of cones, barricades, or caution tape.

The overall hazard is:

_____ Low
_____ Moderate
__X__ High

3.2 SITE CONTAMINANT SOURCE(S) AND DATA

See Table 3-2 for list of known/probable contaminants..

3.3 CHEMICAL HAZARD SUMMARY

Elemental phosphorous (P_4) is present in soil in Parcel A. At the Site, the work to be performed will involve the installation of soil and groundwater borings which may disturb or unearth elemental phosphorous, or sediments containing P_4. In the presence of air, P_4 oxidizes creating a fire and potential burn hazard as well as giving off phosphorous pentoxide (P_2O_5). To minimize the potential exposure to the hazards of P_4, special safety precautions will be taken, personal protective equipment/clothing will be used, and good personal hygiene practices will be required.

Metals present in soil and groundwater at the Site include; arsenic, barium, cadmium, chromium, lead, mercury, nickel, silver, vanadium, and zinc. Precautions will be taken to limit the amount of dust and airborne particles produce in the work areas.

The potential for phosphine gas (PH_3) exists at the Site in Parcel A where phosphoric acid was manufactured. PH_3 can be produced if an acid reacts with a metal (aluminum or magnesium) producing hydrogen gas (H_2). The hydrogen gas can then react with P_4, producing PH_3. PH_3 is a very toxic gas which effects the central nervous system and lungs. Inhalation can cause coma and convulsions leading to death. Strict monitoring protocol will be followed to ensure the detection of any PH_3 prior to exposure of workers.

Ethylene dibromide (EDB) is present in soil and groundwater in Parcels B and I, in addition to other volatile organic compounds (bromoform, 1,2-dichloroethane, toluene, 1,1,1-trichloroethene, 1,1-dichloroethane, 1,2-dichloropropane, chlorobenzene, chloroethane, chloroform, dibromochloromethane, methylene chloride, tetrachloroethene, trichloroethene, and vinyl chloride). Monitoring of the breathing space shall be conducted by the SSO using the appropriate Draeger tubes and organic vapor monitoring equipment.

<u>P_4 and Phosphorous Pentoxide (P_2O_5)</u>

P_4 is considered a poison and is acutely and chronically toxic if inhaled or ingested orally. Skin, eye, and other mucous membrane exposure to the pure phosphorous should be avoided due to irritating and burning effects on the skin. Inhalation; skin, eye and soft mucous membrane contact; and ingestion of fumes from ignited phosphorous are all hazardous due to the irritating effects of the phosphorous oxides generated by combustion.

Symptoms of acute exposure to phosphorous and phosphorous oxides include vomiting and generalized weakness, retinal hemorrhage, and other associated visual disorders.

Symptoms of chronic exposure to phosphorous and phosphorous oxides include general weakness, anemia, and skeletal system degeneration (especially a condition known as "phossy jaw", whereby

necrosis of the jaw occurs). Any employees with dental work that opens pathways to the jaw (such as tooth extractions) will not be allowed onto the Site.

Oxidation of P_4 produces P_2O_5 aerosols that may be encountered during drilling activities at the Site. P_2O_5 reacts with water in the air and on mucous membrane surfaces of the eyes, nose, throat, or lungs to form phosphoric acid, which can irritate those mucous membranes. Appropriate respirators will be worn anytime that workers encounter visible amounts of P_2O_5 (usually visible as white "smoke"), or any time that workers exhibit any symptoms of exposure, including scratchy throat, coughing or sneezing, or other evidence of irritated mucous membranes.

Permissible exposure limits, routes of entry, irritant classification, and potential effects from exposure to these two compounds are indicated in Table 3-3.

Phosphine Gas (PH_3)

Phosphine is a colorless gas with a foul odor of decaying fish. High concentrations can be pyrophoric (oxidizing to P_2O_5 in the presence of atmospheric oxygen). Lower concentrations can be toxic by inhalation. Acute poisoning by inhalation of high concentrations can cause convulsions and coma, leading to death within 48 hours. Acute toxic effects due to inhalation at lower concentrations are central nervous system depression, lung irritation leading to pulmonary edema, dilatation of the heart, and hyperemia of the visceral organs.

Chronic poisoning, characterized by anemia, bronchitis, gastro-intestinal disturbances, and visual, speech, and motor disturbances, may result from continued exposure to low concentrations. Work area and worker breathing zone phosphine levels will be carefully monitored. At levels approaching the permissible exposure limit (PEL), the job may be temporarily closed to allow dissipation, or level B respiratory protection will be used.

Ethylene Dibromide (EDB)

EDB is present in soil and groundwater beneath Parcels B and I. Acute health effects by inhalation can cause respiratory irritation and central nervous system depression. Chronic health effects may include liver and kidney damage and dermatitis. EDB is also known as a reproductive toxicant (sterilant) and is carcinogenic. At levels approaching the OSHA Ceiling Limit (0.13 ppm), the job may be temporarily closed to allow dissipation, or Level B respiratory protection will be used.

TABLE 3-2

KNOWN AND/OR PROBABLE CHEMICAL CONTAMINANTS

Contaminant	Suspected Source of Contamination	Sample Location (Parcel)	Sample Type Air/Soil Groundwater	Maximum Concentration
Acetone	Manufacturing	E,F,G	Soil	19 ppm
Arsenic	Manufacturing	A,D,E,F,G	Soil	24 ppm
Barium	Manufacturing	B,E	Soil	300 ppm
Bromoform	Manufacturing	E,F,G	Soil	419 ppm
Cadmium	Manufacturing	E,F,G	Soil	1.4 ppm
Chromium	Manufacturing	E,F,G	Soil	72 ppm
Cobalt	Manufacturing	E,F,G	Soil	12 ppm
Copper	Manufacturing	E,F,G	Soil	2,400 ppm
1,2-Dichloroethane	Manufacturing	E,F,G	Soil	34.7 ppm
Ethylene Dibromide	Manufacturing	B,E,F,G	Soil	12,000 ppm
Lead	Manufacturing	E,F,G	Soil	330 ppm
Mercury	Manufacturing	E,F,G	Soil	0.41 ppm
Nickel	Manufacturing	E,F,G	Soil	80 ppm
Orthophosphates	Manufacturing	A	Soil	13,000 ppm
Phosphorous	Manufacturing	A	Soil	ignited
Silver	Manufacturing	E,F,G	Soil	5.2 ppm

TABLE 3-2

KNOWN AND/OR PROBABLE CHEMICAL CONTAMINANTS

Contaminant	Suspected Source of Contamination	Sample Location (Parcel)	Sample Type Air/Soil Groundwater	Maximum Concentration
Toluene	Manufacturing	E,F,G	Soil	6.2 ppm
Diesel	Manufacturing	B,E,F,G,I	Soil	49 ppm
Kerosene	Manufacturing	E,F,G	Soil	21 ppm
Motor Oil	Manufacturing	C	Soil	1,200 ppm
Vanadium	Manufacturing	E,F,G	Soil	36 ppm
Zinc	Manufacturing	E,F,G	Soil	140 ppm
Phosphine Gas	Manufacturing	A	NA	Unknown
Arsenic	Manufacturing	A,D,E,F,G	Grab Groundwater Sample	0.36 ppm
Copper	Manufacturing	A	Grab Groundwater Sample	0.01 ppm
Lead	Manufacturing	E,F,G	Grab Groundwater Sample	3.2 ppm
Orthophosphates	Manufacturing	A	Grab Groundwater Sample	9.8 ppm
Diesel	Manufacturing	B,E,F,G,I	Grab Groundwater Sample	0.51 ppm
Kerosene	Manufacturing	E,F,G	Grab Groundwater Sample	0.51 ppm
Motor Oil	Manufacturing	C	Grab Groundwater Sample	0.55 ppm
1,1,1-Trichloroethene	Manufacturing	E,F,G	Groundwater Monitoring (recent)	0.027 ppm
1,1-Dichloroethane	Manufacturing	E,F,G	Groundwater Monitoring (recent)	0.012 ppm

TABLE 3-2

KNOWN AND/OR PROBABLE CHEMICAL CONTAMINANTS

Contaminant	Suspected Source of Contamination	Sample Location (Parcel)	Sample Type Air/Soil Groundwater	Maximum Concentration
1,2-Dichloroethane	Manufacturing	E,F,G	Groundwater Monitoring (recent)	21 ppm
1,2-Dichloropropane	Manufacturing	E,F,G	Groundwater Monitoring (recent)	0.16 ppm
Bromoform	Manufacturing	E,F,G	Groundwater Monitoring (recent)	190 ppm
Chlorobenzene	Manufacturing	E,F,G	Groundwater Monitoring (recent)	0.011 ppm
Chloroethane	Manufacturing	E,F,G	Groundwater Monitoring (recent)	0.0013 ppm
Chloroform	Manufacturing	E,F,G	Groundwater Monitoring (recent)	0.6 ppm
Dibromochloromethane	Manufacturing	E,F,G	Groundwater Monitoring (recent)	19 ppm
Ethylene Dibromide	Manufacturing	B,I	Groundwater Monitoring (recent)	13 ppm
Methylene Chloride	Manufacturing	E,F,G	Groundwater Monitoring (recent)	0.13
Tetrachloroethene	Manufacturing	E,F,G	Groundwater Monitoring (recent)	0.086
Trichloroethene	Manufacturing	E,F,G	Groundwater Monitoring (recent)	1.4 ppm
Vinyl Chloride	Manufacturing	E,F,G	Groundwater Monitoring (recent)	0.039 ppm

TABLE 3-3

ASSESSMENT OF CHEMICAL HAZARDS

Task No.(s)	Chemical Name (or class)	PEL/TLV	Other Pertinent Limitsa (Specify)	Potential Exposure Pathways	Acute Health Effects	Chronic Health Effects
4,5,6	Acetone	750/750 ppm	STEL = 1000 ppm C = 3000 ppm	Inhalation; Ingestion; Dermal	Eye, skin & respiratory irritation; CNS depression	Dermatitis
4,5,6	Arsenic	0.01/0.2 mg/m^3	None cited	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation	Lung, skin & lymphatic cancer; GI & skin disorders; peripheral neuropathy
4,5,6	Cadmium (metal dust & soluble salts)	0.05/0.05 mg/m^3 (0.01 mg/m^3 total dust; 0.002 mg/m^3 respirable dust)	C = 0.6 mg/m^3	Inhalation; dermal; ingestion	Skin & respiratory irritation; pulmonary edema; CNS effects; nasal perforation	Emphysema; kidney damage; anemia; human carcinogen
4,5,6	Chlorobenzene	75/10 ppm	None cited	Inhalation; dermal; ingestion	Eye skin & respiratory irritation; CNS depression; skin burns	Possible liver, kidney & lung damage; dermatitis
4,5,6	Chromium (hexavalent compounds)	0.05/0.05 mg/m^3	C = 0.1 mg/m^3	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation; skin & nasal ulcerations	Possible liver & kidney damage; dermatitis; suspected human carcinogen
4,5,6	Crude oil	None cited	None cited	Inhalation; dermal	Possible CNS depression	Possible dermatitis

TABLE 3-3

ASSESSMENT OF CHEMICAL HAZARDS

Task No.(s)	Chemical Name (or class)	PEL/TLV	Other Pertinent Limitsa (Specify)	Potential Exposure Pathways	Acute Health Effects	Chronic Health Effects
4,5,6	1,1-Dichloroethane (DCA)	100/200 (100) ppm	TLV-STEL = 250 ppm	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation; CNS depression	Possible liver & kidney damage; skin burns
4,5,6	1,2-Dichloroethane (ethylene dichloride)	1/10 ppm	STEL = 2 ppm C = 200 ppm	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation; CNS depression	Liver & kidney damage; dermatitis; suspected human carcinogen
4,5,6	Ethylene dibromide (EDB)	20 ppm (OSHA)	C = 0.13 ppm REL = 0.045 IDLH = 100 ppm	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation; CNS depression	Liver & kidney damage; sterilant; suspected human carcinogen; dermatitis
4	Phosphine gas (PH3)	0.3 ppm 8 hr TWA	1 ppm STEL IDLH = 50 ppm	Inhalation	Nausea, vomiting, abdominal pain, diarrhea, chest pressure, muscle pain	Anemia, bronchitis, gastrointestinal disturbances
4,5,6	Phosphoric acid	1 mg/m3 TWA	3 mg/m3 STEL	Inhalation, ingestion, dermal	Irritation of upper respiratory tract, eyes, burns skin	Dermatitis

TABLE 3-3

ASSESSMENT OF CHEMICAL HAZARDS

Task No.(s)	Chemical Name (or class)	PEL/TLV	Other Pertinent Limitsa (Specify)	Potential Exposure Pathways	Acute Health Effects	Chronic Health Effects
4	Phosphorous - elemental (P4)	0.1 mg/m3		Inhalation, ingestion, dermal	Irritation of eyes and respiratory tract, burns skin and eyes, abdominal pain, dental and jaw pain, excess salivation, nausea, jaundice	General Debilitation
4,5,6	Phosphorous pentoxide	Not published	Not published	Inhalation, dermal	Irritation of eyes, mucous membranes, skin	Stomach hemorrhages, calcium metabolismdisturbance
4,5,6	Lead	0.05/0.15 mg/m^3	None cited	Inhalation; dermal; ingestion	GI disturbances; anemia; neuromuscular dysfunction; encephalopathy	GI disturbances; anemia; neuromuscular dysfunction; encephalopathy; nephropathy; human carcinogen
4,5,6	Mercury	0.05/0.05 mg/m^3	C = 0.1 mg/m^3	Inhalation; ingestion; dermal	Eye, skin, GI & respiratory irritation; tremors; pneumonitis	Neuromuscular & psychic disturbances; liver & kidney damage; sensitization dermatitis

TABLE 3-3

ASSESSMENT OF CHEMICAL HAZARDS

Task No.(s)	Chemical Name (or class)	PEL/TLV	Other Pertinent Limitsa (Specify)	Potential Exposure Pathways	Acute Health Effects	Chronic Health Effects
4,5,6	Methylene chloride	100/50 ppm	STEL = 1000 ppm	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation; CNS depression	Possible liver & kidney damage; dermatitis; suspected human carcinogen
4,5,6	Nickel, metal	0.1/0.1 (0.05) mg/m^3	None cited	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation; pneumonitis	Sensitization dermatitis ("nickel itch"); human carcinogen
4,5,6	Perchloroethylene (tetrachloroethylene; tetrachloroethene; or PCE)	25/50 ppm	C = 300 ppm TLV-STEL = 200 ppm	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation; CNS depression; skin burns	Liver damage; peripheral neuropathy; suspected human carcinogen
4,5,6	Silver (metal)	0.01/0.1 mg/m^3	None cited	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation; argyria of eyes, skin & mucous membrane	Argyria of eyes, skin & mucous membranes
4,5,6	Toluene	100/100 (50) ppm	STEL = 150 ppm C = 500 ppm	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation; CNS depression	Possible liver & kidney damage; dermatitis
4,5,6	1,1,1-Trichloroethane (methyl chloroform; or TCA)	350/350 ppm	STEL = 450 ppm C = 800 ppm	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation; CNS depression	Possible liver damage, dermatitis

TABLE 3-3

ASSESSMENT OF CHEMICAL HAZARDS

Task No.(s)	Chemical Name (or class)	PEL/TLV	Other Pertinent Limitsa (Specify)	Potential Exposure Pathways	Acute Health Effects	Chronic Health Effects
4,5,6	Trichloroethylene (TCE)	25/50 ppm	STEL = 200 ppm C = 300 ppm	Inhalation; dermal; ingestion	Eye, skin & respiratory irritation; CNS depression	Possible liver, kidney, cardiovascular & GI injury; suspected human carcinogen
4,5,6	Vinyl chloride	1/5 ppm	None cited	Inhalation; dermal; ingestion	CNS depression	Liver cancer; Reynauds syndrome; vascular disturbances

PEL = OSHA Permissible Exposure Limit; represents the maximum allowable 8-hr. time weighted average (TWA) exposure concentration.
TLV = ACGIH Threshold Limit Value; represents the maximum recommended 8-hr. TWA exposure concentration.
STEL = OSHA Short-term Exposure Limit; represents the maximum allowable 15 minute TWA exposure concentration.
TLV-STEL = ACGIH Short-term Exposure Limit; represents the maximum recommended 15 minute TWA exposure concentration.
C = OSHA Ceiling Limit; represents the maximum exposure concentration above which an employee shall not be exposed during any period without respiratory protection.
IDLH = Immediately Dangerous to Life and Health; represents the concentration at which one could be exposed for 30 minutes without experiencing escape-impairing or irreversible health effects.
TPH = Total Petroleum Hydrocarbons
VOC = Volatile Organic Compounds
( ) = ACGIH TLV Intended Change

4.0 HEALTH AND SAFETY FIELD IMPLEMENTATION

4.1 PERSONAL PROTECTIVE EQUIPMENT (PPE) REQUIREMENTS

As discussed in Section 5.4, fire and smoke are serious hazards caused by the presence of P_4 igniting upon contact with air. The following PPE will be worn where the potential exists for contact with elemental phosphorous:

- Flame resistant "Nomex" suits, including head coverings and gloves will be worn, and donned before the person enters the work area, to be removed in the decontamination area.
- The SSO will determine whether the flame resistant PPE and head coverings are sufficient protection.
- Face shields will be worn at all times.

A 10% copper sulfate solution in spray bottles will be present within the exclusion zone to saturate any P_4 that might come in contact with the workers. This copper solution will coat the P_4 and prevent combustion.

PPE may be upgraded or downgraded by the site industrial hygienist, HSM, or qualified Site Safety Officer based upon site conditions and air monitoring results. Reference to required PPE will be by Level of Protection (A-D). A summarized description of PPE by level of protection is indicated below:

LEVEL A: Should be worn when the highest level of respiratory, skin and eye protection is needed.

LEVEL B: Should be worn when the highest level of respiratory protection is needed, but a lesser level of skin protection. Level B is the primary level of choice when encountering unknown environments.

LEVEL C: Should be worn when the criteria for using air-purifying respirators are met and a lesser level of skin protection is needed.

LEVEL D: Should be worn only as a work uniform and not in any area with respiratory or skin hazards. It provides minimal protection against chemical hazards.

See Table 4-1 for specific PPE requirements.

4.2 MONITORING EQUIPMENT REQUIREMENTS

When elemental phosphorous ignites, a white smoke is produced containing phosphorous pentoxide particles. Workers should immediately move upwind and avoid inhaling the smoke.

Monitoring is conducted by the Site Safety Officer or designee. Conduct contaminant source monitoring initially. Complete breathing zone monitoring if source concentrations are near or above contaminant action level concentrations. Log direct reading monitoring and record results on Direct Reading Report form. Calibrate monitoring instruments daily or in accordance with manufacturers' specifications. Record calibration data on the Instrument Calibration Log.

Results shall be interpreted by the Site Safety Officer. At a minimum, exposures to suspected chemicals of contamination, as defined in this HASP, should be monitored prior to and during intrusive field activities. Additional characterization monitoring shall begin immediately if the operation destabilizes, the environment changes, or the potential for exposure is otherwise affected. Monitoring should continue on a continuous basis until the operation is stable and the SSO or HSM feels that the monitoring is sufficient to adequately assess and characterize exposure during that operation.

See Table 4-2 for monitoring protocols and contaminant action levels.

See Attachment 3 for Direct Reading Report and Instrument Calibration Log.

TABLE 4-1

PERSONAL PROTECTIVE EQUIPMENT (PPE) REQUIREMENTS

Job Task	Level of Protection	PPE[a] Suit	PPE[a] Gloves	PPE[a] Feet	PPE[a] Head	PPE[a] Eye	PPE[a] Ear	PPE[a] Respirator	Level if Upgrade	Additional PPE[a] for Upgrade
1.	D	Std	Work	Steel	HH	Glass	None	None	None	None
2.	D	Std	Work	Steel	HH	Glass	None	None	None	None
3.	D	Std	Work	Steel	HH	Glass	None	None	None	None
4.	D	Std	Work	Steel	HH	Glass	Plugs	None	APR	APR
4.(Parcels A and D)	D,B	Nomex	Nomex	Steel/Nomex	HH/ Nomex	Shield	Plugs	None	SCBA/ SAR	SCBA/ SAR
4.(Parcels B and I)	D,B	Std	Work	Steel	HH	Glass	Plugs	None	SCBA/ SAR	SCBA/ SAR
5.	D,B	Std	L	Steel	HH	Glass	Plugs	None	SCBA/ SAR	SCBA/ SAR
6.	D	Std	L	Steel	HH	Glass	Plugs	None	APR	APR
7.	D	Std	Work	Steel	None	Glass	None	None	None	None

a Personal Protective Equipment (PPE):	a Personal Protective Equipment (PPE):	a Personal Protective Equipment (PPE):
SUIT: Std = Standard work clothes Tyvek = Uncoated Tyvek disposable coverall PE Tyvek = Polyethylene-coated Tyvek Chemrel = Chemrel coverall with hood Saranex = Saranex-laminated Tyvek Lt PVC = Light wt. PVC raingear Med PVC = Medium wt. PVC suit Hvy PVC = Heavy wt. PVC coverall with hood Road = Roadwork vest GLOVES: Work = Work gloves (canvas, leather) Neo = Neoprene gloves PVC = PVC gloves N = Nitrile gloves V = Vinyl gloves L = Latex gloves	FEET: Steel = Steel-toe boots Steel+ = Steel-toe PVC boots Booties = PVC booties HEAD: HH = Hardhat EYE: Glass = Safety glasses Goggle = Goggles Shield = Face shield EAR: Plugs = Earplugs Muff = Ear muff	RESPIRATOR: APR = Air purifying respirator Full APR = Full face APR Half APR = Half face APR PAPR = Powered Air Purifying Respirator SAR = Airline supplied air respirator SCBA = Self contained breathing apparatus Escape = Escape SCBA OV = Organic Vapor cartridge AG = Acid gas cartridge OV/AG = Organic vapor/Acid gas cartridge AM = Ammonia cartridge D/M = Dust/mist pre-filter and cover for cartridge HEPA = High efficiency particulate air filter cartridge OTHER: * = Use if contact with wet soil or water ** = Optional use except if specific hazard present

COMMENTS:

TABLE 4-2

AIR MONITORING PROTOCOLS AND CHEMICAL CONTAMINANT ACTION LEVELS

				Breathing Zone Action Level Concentrations*	
Job Task	**Contaminant**	**Monitoring Equipment**	**Monitoring Protocol/Frequency**	**Monitored Level for Mandatory Respirator Use**	**Monitored Level for Mandatory Work Stoppages****
4,5,6	phosphorous pentoxide	Visual (white smoke)	NA	If white smoke is observed	Consult SSO
4,5,6	phosphine	Draegar Tube CH 31101	see comments	any detection	25 ppm in breathing space
4,5,6	EDB	Draegar Tube CH 24401	see comments	any detection	50 ppm in breathing space
4,5,6	VOCs	PID	Periodic (every 15 min.)	10 ppm	50 ppm

COMMENTS:

Monitoring during sediment sample collection shall be conducted as follows in Parcels A, D, B and I:

1) Sediment sampling equipment will be advanced to desired depth
2) Prior to sample retrieval, monitoring for phosphine gas/EDB will be conducted by the SSO (or designee) wearing SAR PPE -first monitor breathing zone at sampling location, then monitor boring
3) If phosphine gas/EDB is detected in breathing space, all work will stop until phosphine gas/EDB has dissipated (no detection)
4) If phosphine gas is present in borehole, all handling of samples and sediment cores will be conducted in SAR
5) Monitoring for other VOCs using PID will occur during monitoring for phosphine/EDB (leave PID running while using Draegar Tubes)

Monitoring for well installation shall be conducted as follows:

1) All workers within exclusion zone (100 feet from drilling location) shall wear SCBA/SAR PPE during drilling activities
2) Monitoring for EDB/phosphorus (dependent on location, determined by SSO) shall be conducted at regular intervals (every 15 min.)
3) SSO will allow removal of SCBA/SAR if conditions allow after total depth of boring is attained

4.3 SITE ZONES/DELINEATION

Exclusion Zone:

__X__ Areas within barricades, cones and/or caution tape
__X__ Within 100-ft radius of drill rig operations
____ Within 40-ft radius of heavy equipment operations
____ Within 10-ft radius of hand auguring location
____ Within 10-ft radius of groundwater monitoring well locations
____ Other (describe):

Contamination Reduction Zone: At perimeter of Exclusion Zone.

Support Zone: Outside of Contamination Reduction Zone.

4.4 SITE COMMUNICATION

__X__ By two way radio
__X__ By telephone
__X__ By pager
____ By other means (describe):

4.5 SITE SECURITY

__X__ Restricted access
__X__ Fenced
__X__ Security guard
____ Other means (describe):

5.0 SITE OPERATING PROCEDURES

5.1 INITIAL SITE ENTRY PROCEDURES

- Review Initial Health and Safety Mobilization Checklist (Attachment 4).
- Locate nearest available telephone. Indicate location on Site Map.
- Determine wind direction, establish hotline, and set up decontamination facilities. Note wind direction and location of decontamination facilities on site map.
- Post Emergency Information Confirm/post emergency phone numbers and hospital route.
- Designate at least one vehicle for emergency use.
- If toilet facilities are not located within a 5-minute walk from the decontamination facilities, either provide a chemical toilet and hand washing facilities or have a vehicle available (not the emergency vehicle) for transport to nearby facilities.
- Prior to working on-site, conduct an inspection for physical and chemical hazards.
- Conduct or review utility clearance prior to start of work, if appropriate.
- Note any specialized protocols particular to work tasks associated with the project.

5.2 DAILY OPERATING PROCEDURES

- Hold daily Tailgate Safety Meetings prior to work start.

  See Attachment 5 for Tailgate Safety Meeting Form.

- Use monitoring instruments and follow designated protocol and contaminant action levels.
- Use personal protective equipment (PPE) as specified.
- Remain upwind of operations and airborne contaminants, if possible.
- Establish a work/rest regime when ambient temperatures and protective clothing create a potential heat stress hazard.
- Do not carry cigarettes, gum, etc. into contaminated areas.
- Refer to Site Safety Officer for specific concerns for each individual site task.

- **USE BUDDY SYSTEM WHERE APPROPRIATE.**
- Be alert to your own physical condition. Watch buddy for signs of fatigue, exposure, etc.
- All accidents, no matter how minor, must be reported immediately to the SSO.
- A work/rest regimen must be initiated when ambient temperature and protective clothing create a potential heat stress situation.
- Contain liquids and cuttings generated during drilling.
- Limit contaminants contact with clean equipment.
- Practice contamination avoidance, on- and off-site. Activities should be planned ahead of time.
- Apply immediate first aid to any and all cuts, scratches, abrasions, etc.
- Be alerted to your own physical condition. Watch your buddy for signs of fatigue, exposure, etc.

5.3 UTILITY CLEARANCE

Date to be performed: To be determined.

Will be performed by following personnel: Site Safety Officer

Method that will be utilized: Underground utility clearing devices, as built drawings.

Follow utility clearance requirements specified in Attachment 2.

5.4 ADDITIONAL SITE-SPECIFIC OPERATING PROCEDURES

Fire and smoke are serious hazards caused by the presence of elemental phosphorous igniting upon contact with air. The following operating procedures will be followed while collecting soil and groundwater samples that may contain elemental phosphorous:

- Handling of all soil samples which have ignited or are smoking, including capping of brass tubes, soil lithology and description, will be conducted beneath water in a trough to prevent ignition.

- If fire and/or smoke are observed during work activities, work will immediately be stopped and sand or water applied to any exposed waste material or contaminated equipment.

- Fugitive dust will be controlled by applications of water spray sufficient to suppress dust. When air monitoring results support the need, the appropriate air-purifying respirators will be worn as directed by the Site Safety Officer.

- Elemental phosphorous fires or P_2O_5 aerosols encountered during work will be controlled, to the extent feasible, by saturating the area with water, then covering the surface area with sand.

5.5 DECONTAMINATION PROCEDURES

The following decontamination procedures will be followed for workers or equipment that has been exposed to elemental phosphorous.

5.5.1 Heavy Equipment

Heavy equipment contaminated with phosphorous will be decontaminated prior to personnel decontamination. Drillers will steam clean their augers at low pressure after use preferably at locations near the individual drilling operations. Contaminant systems will be set-up for collection of decon fluids and materials. All decon fluids and sediment that have come into contact with phosphorous will be placed in 55-gallon drums, labeled, and stored at the Site in an open area designated by the SSO.

Vehicles that become contaminated with phosphorous or sediment containing phosphorous will be cleaned prior to leaving the site. The wheel wells, tires, sides of vehicles will be pressure washed clean of visible debris at a location to be determined by the SSO.

5.5.2 Samples and Sampling Equipment

The same decontamination line will be used for sampling equipment decon as is used for personnel decon. At a minimum the following is performed:

- Hand augers and buckets will be washed in TSP solution or equivalent and rinsed in distilled water.

- Sampling equipment will be brushed clean and rinsed with distilled water or other appropriate cleaning material.

5.5.3 Decon Wastes

- Spent decon solutions will be drummed, characterized, and then disposed of as appropriate.

- Decontamination shall be performed in a manner that minimizes the amount of waste generated.

5.6 PROCEDURES FOR WASTE HANDLING OF ANTICIPATED WASTES

5.6.1 Waste Generation

Anticipated: Yes__X__ No_____

Types: Liquid_x_ Solid_x_ Sludge___ Gas

Quantity: Expected Volume of solid__Unknown_____

Expected Volume of liquid__Unknown_____

Characteristics: Corrosive_x_ Ignitable_x_ Radioactive___ Volatile_x_

Toxic_x_ Reactive_x_ Unknown___ Carcinogenic_x__

Other (specify):_____

Known Non-Hazardous: Yes___ No_x__

Known Hazardous Waste or Extremely Hazardous Waste: Yes_x_ No___

Potentially Hazardous Waste or Extremely Hazardous Waste: Yes_x_ No

Waste Requires Analysis: Yes_x__ No___

Specify Type:__Phosphorous, VOCs, Metals_____

5.6.2 Storage and/or Treatment Methods Proposed:

PPE known or potentially known to have come in contact with elemental phosphorous will be saturated and contained in 55-gallon drums filled with water. Excess drilling cuttings containing phosphorous, or potentially containing phosphorous, will be saturated and also placed and stored within 55-gallon drums. All non-aqueous waste generated must be stored beneath water. All drums must be stored on Site, and labeled as directed by the SSO.

5.6.3 Disposal

Disposal of stored hazardous material will be determined by the Project Manager at completion of work.

5.7 SITE INSPECTIONS

Conduct site inspections weekly utilizing the Project Manager/Field Supervisor Job Safety Checklist, HS 5-1 (Attachment 7).

---

*Temporary storage of hazardous waste without a permit is limited to 90 days. Label all temporary storage containers with:

(1) "Contents Under Analysis"
(2) The composition of the waste (soil, drilling, cuttings, etc.)
(3) The nature of known contaminants and their hazardous properties; (e.g., soil contaminated with phosphorous, ignitable, inhalation and dermal hazard);
(4) The name of generator (FMC)
(5) The date of accumulation; and,
(6) A phone contact for questions

NOTE: Remind client to conduct weekly inspections of all hazardous waste drums.

6.0 EMERGENCY RESPONSE PROCEDURES

The Emergency Response Plan has been prepared to address the Site specific nature of hazards and potential emergencies. Emergency procedures will be implemented as appropriate.

6.1 EMERGENCY RESPONSE PLANNING

Step 1: Post site map which includes Site description, evacuation routes, safe distances and assembly area. Note location of utilities main shut-offs and disconnects on site map. Review this information during initial Tailgate Safety training and periodically.

Step 2: Complete and post Emergency Response Contact List, directions and map to hospital. Ensure that emergency communications equipment is available.

Step 3: Notify local authorities (e.g., fire and police) of your presence and integrate any emergency plans with local requirements. Post hospital route and verify hospital route is accessible (Attachment 6).

Step 4: Provide emergency equipment for first aid, emergency decontamination, fire protection, personal protection and spill response (see below). Designate vehicle for emergency transport.

Step 5: Assure that personnel certified in first aid and CPR are available to respond to injuries within four (4) minutes.

Step 6: Conduct training for site personnel in emergency response during initial orientation. Establish alarm and methods of notification and communication during an emergency.

6.2 LINES OF AUTHORITY AND PERSONNEL RESPONSIBILITIES

During an emergency incident, the Field Supervisor shall have the authority to commit the necessary resources for responding to the emergency, and he shall assume the following responsibilities:

Step 1: Determine the extent of the incident and direct the emergency response efforts.

Step 2: Direct the SSO to conduct perimeter air monitoring, and monitor wind speed and wind direction to determine the extent of impacted areas.

Step 3: Alert site personnel of the emergency using an air-horn or other suitable means of communication. If necessary, initiate evacuation procedures.

Step 4: Make the required notifications. As a minimum, the McLaren/Hart Project Manager and the McLaren/Hart Health and Safety Manager must be notified immediately. Additional

notifications and assistance from outside agencies may be required based on the extent of the incident.

Step 5: Prepare the Accident/Injury Report (HS 8-1) and send it to the Corporate Health and Safety Director and the Health and Safety Manager.

If assistance is requested from an outside agency (i.e., Fire Department), the Incident Commander will assume charge when he arrives on the scene.

6.3 Evacuation Procedures

If evacuation is required, the Field Supervisor shall:

Step 1: Activate the communication system to alert Site workers of evacuation. Personnel shall be advised to remain upwind of contaminants, if possible, and proceed to the designated assembly area.

Step 2: Account for all personnel at the assembly area.

Step 3: Notify the client of the need to initiate evacuation procedures for other Site personnel.

Step 4: Notify the Fire and Police Departments and request their assistance for evacuating the surrounding area and residences.

6.4 Emergency Medical Treatment

The two most important considerations in rendering first aid to a person who has been contaminated with phosphorous are, first, speed in stopping the combustion of phosphorous, and second, the removal of phosphorous from the skin and clothing. First aid measures will be started immediately to minimize the extent and seriousness of the injury. All injured persons will be referred to a physician even though the injury appears slight.

When phosphorous has come in contact with the skin, water should be applied immediately by submerging the affected part or by flushing the area copiously for at least 30 minutes. Contaminated clothing will be removed immediately. If immersion or continuous flushing is not practicable, the affected area will be washed with a 10 percent solution of copper sulfate, which will coat the phosphorous particles and prevent combustion.

Since phosphorous particles will ignite if exposed to air, adhering or imbedded particles must be removed. This can be done with tweezers while the affected part is immersed in water. The luminous phosphorous particles can be seen best in a darkened room. If immersion is not practical and the affected part has been treated with copper sulfate solution, the black coloring imparted to the particles by the solution will make them easy to see.

If a burn is severe or involves a large area, the injured person should be watched closely for evidence of shock. Shock will be treated promptly by laying the person down and keeping him reasonably warm until a physician arrives. No oil or ointment will be applied to phosphorous burns at any time unless the attending physician approves.

If even a minute quantity of phosphorous enters the eyes, the eyes will be irrigated immediately with large amounts of water. The eyelids will be held open during the irrigation to insure that all the surface tissue of the eyes and lids are thoroughly flushed. A physician, preferably an eye specialist, will be called immediately. No oils or oily ointment will be instilled in the eyes unless ordered by the physician.

If phosphorous is swallowed in either sediment or contaminated water, a physician will be called immediately. There is no established antidote. First aid will consist of inducing the person to vomit by giving him large quantities of water or salt solution (1 tablespoon of salt to one quart of water) or by tickling or gently stroking the back of the throat with the finger or a blunt probe, such as the handle of a teaspoon. Since the absorption of phosphorous extends over a period of hours, attempts at inducing vomiting should be continued until countermanded by a physician. Animal or vegetable fats or oils will not be given as these increase the rate of absorption.

Persons who have been exposed to phosphorous vapor or heavy concentrations of smoke from burning phosphorous will be moved immediately into fresh air. If the individual has respiratory distress or a persistent cough, oxygen should be given if someone qualified to administer it is present. A physician will be called.

The following shall occur in case of an emergency or accident:

Refer to the Hospital Route Directions and Map. If an injury/medical emergency occurs, the following procedures shall be used:

Step 1: Notify the Field Supervisor immediately.

Step 2: The Field Supervisor shall ensure that medical treatment is provided for the injured person immediately. The Field Supervisor shall summon the first aid responders and notify the hospital and the local Emergency Medical Service (EMS) if necessary.

Step 3: If the injured/ill person is within the exclusion zone, steps should be taken to decontaminate him/her and remove the PPE if it can be done without worsening the injury.

Step 4: First aid responders shall use universal precautions for infection control when providing first aid. Refer to McLaren/Hart's Health and Safety Procedure HS 27 "Bloodborne Pathogens."

Step 5: Prepare the Accident/Injury Report (HS 8-1) and distribute it to the Corporate Health and safety Director and the Health and Safety Manager within 24 hours.

6.5 SPILL CONTROL

If a spill occurs, the following steps shall be taken to mitigate the incident:

Step 1: Notify the Field Supervisor, and he/she shall assess the extent of the spill to determine if it can be safely mitigated with the personnel and protective equipment available at the site.

Step 2: If the release is beyond the field team's capabilities, the Field Supervisor shall evacuate the site personnel to a safe location upwind of the release, and notify the Project Manager and Fire Department.

Step 3: The Project Manager shall notify the client, Health and Safety Manager, Corporate Health and Safety Director, and regulatory agencies, if necessary.

Step 4: If the spill can be safely mitigated using defensive actions, first don the appropriate PPE. Initially, Level C PPE should be worn until air monitoring indicates a downgrade in PPE is appropriate.

Step 5: Take steps to secure the area and to prevent unauthorized persons from entering the area.

Step 6: Take steps to contain the spill and to prevent it from reaching sewers, storm ditches, etc.

Step 7: Clean up the spill with absorbent, neutralizers, soil removal as appropriate. Place waste in sealed, labeled containers for disposal.

7.0 RECORDKEEPING

The Project Manager (PM) will assure that all field documentation is properly completed in a timely manner. All HASP documentation, including monitoring results, calibration logs, tailgate safety meeting forms, utility clearance and utility maps, and Project Manager/Field Supervisor Jobsite Safety Checklists, are to be forwarded to the Project Manager for review and signature on a regular basis (recommended weekly). Once reviewed by the PM, HASP forms should then be distributed to the HSM and to the project file.

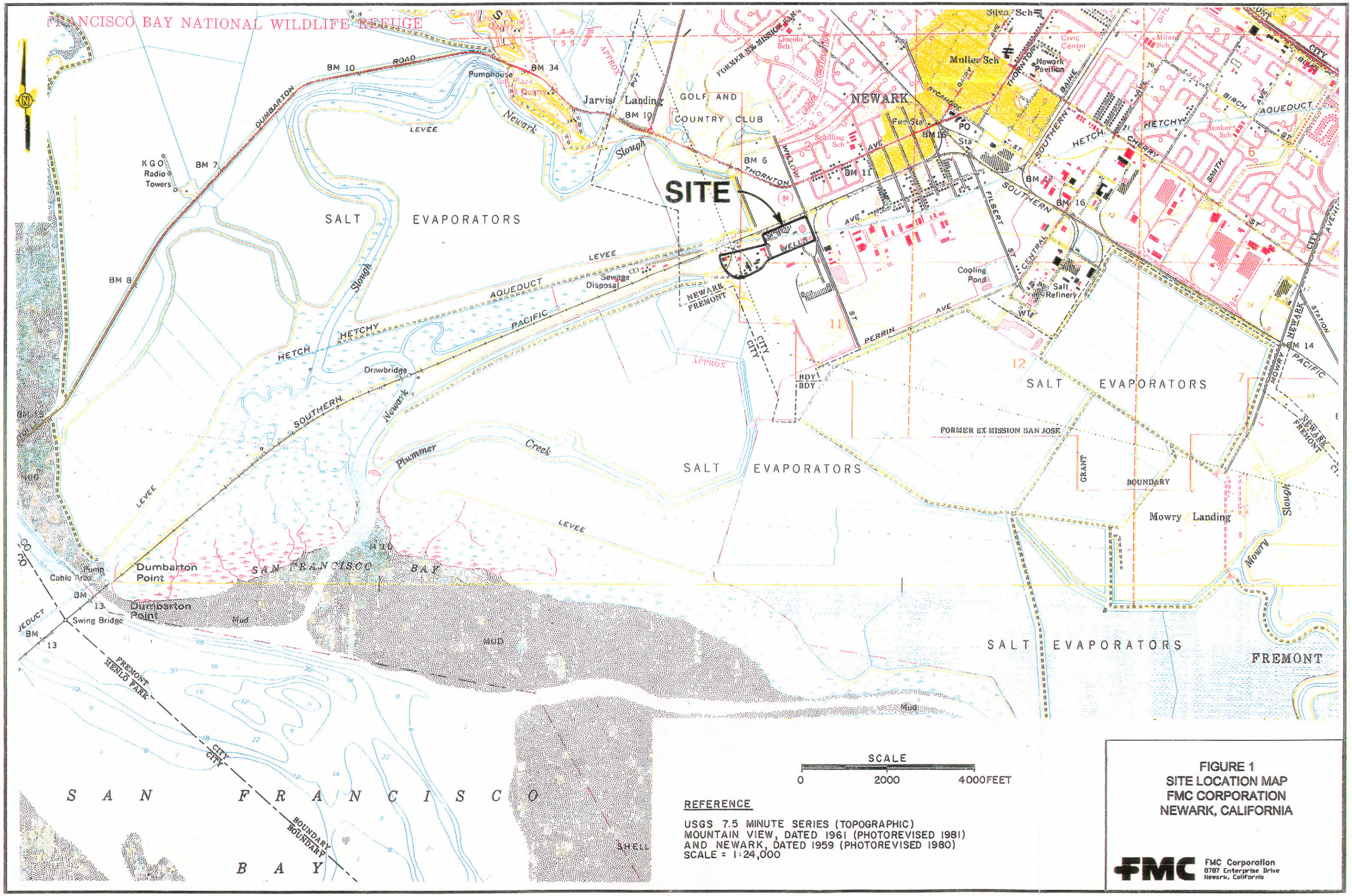
The HSM will review and initial all forms indicating acceptance of finding. The HSM will contact the PM to question records finding as appropriate.

(Indicated forms that should be completed.)

FORM NAME	FORM	APPLICABLE	
		YES	NO
Signed Cover Sheet	-		
Signature and Acknowledgement	SECTION 1-5		
Training Verification (McLaren/Hart)	TABLE 1-2		
Training Verification (Subcontractor)	TABLE 1-3		
Job Safety Checklist	HS 5-1		
Tailgate Safety Meeting	HS 5-2		
Direct Reading Form	HS 5-3		
Instrument Calibration	HS 5-4		
Emergency Response Contacts	HS 13-1		
Confined Space Entry Permit	HS 14-2		
Utility Clearance Request	HS 15-1		
Utility Clearance Checklist	HS 15-2		
Hot Work Permit	HS 30-1		

ATTACHMENT 1

SITE MAP(S)

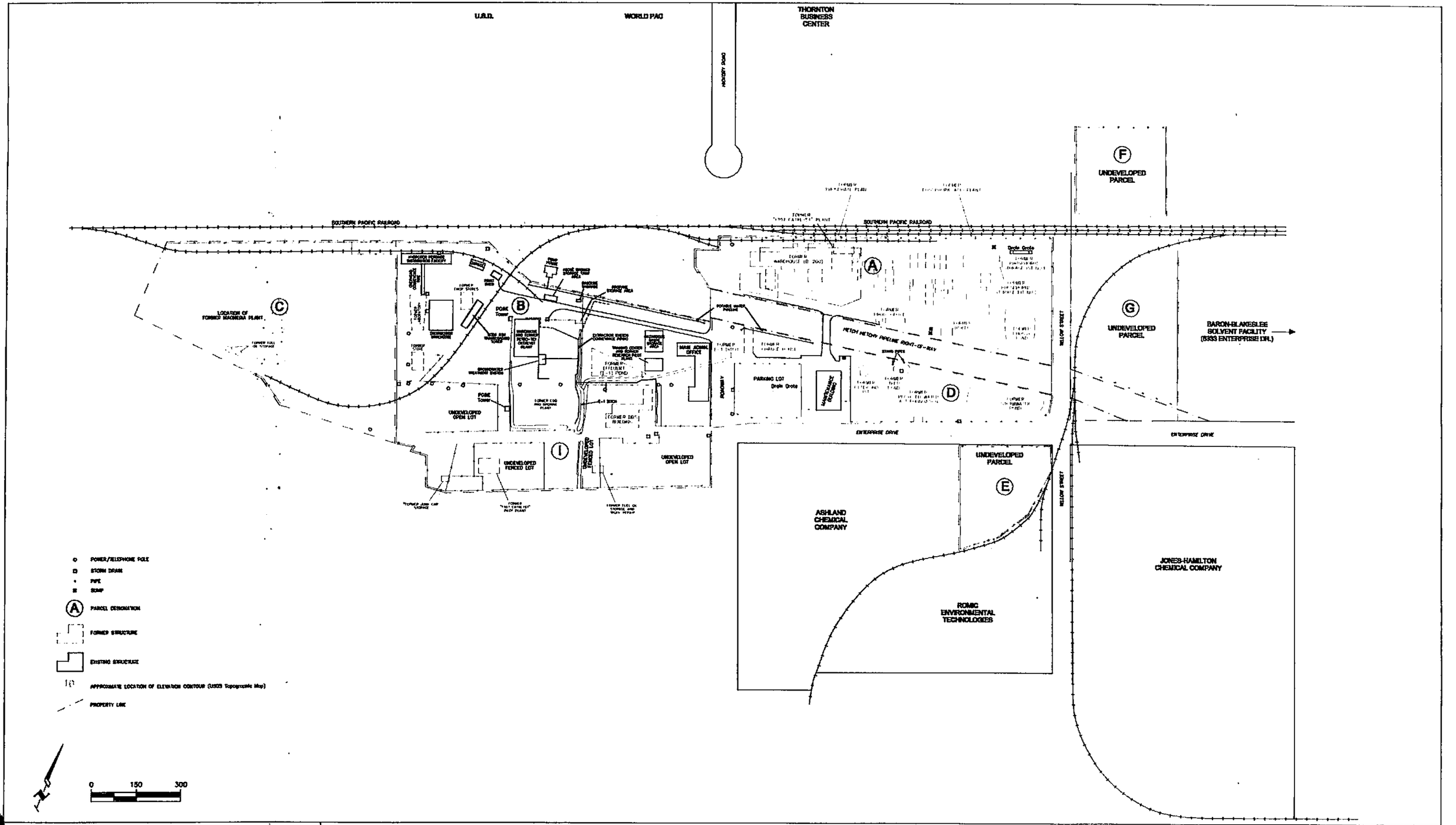


REFERENCE

USGS 7.5 MINUTE SERIES (TOPOGRAPHIC)
MOUNTAIN VIEW, DATED 1961 (PHOTOREVISED 1981)
AND NEWARK, DATED 1959 (PHOTOREVISED 1980)
SCALE = 1:24,000

FIGURE 1
SITE LOCATION MAP
FMC CORPORATION
NEWARK, CALIFORNIA

FMC Corporation
6787 Enterprise Drive
Newark, California



FMC Corporation
8787 Enterprise Drive
Newark, California

NEWARK, CALIFORNIA

FIGURE 2
SITE MAP AND SURROUNDING SITES

J:\CAD_DATA\FMC\NEWARK\WP_0798\F2_0798.DWG

ATTACHMENT 2

UTILITY CLEARANCE CHECK AND

UTILITIES LOCATION MAP

McLaren Hart
ENVIRONMENTAL ENGINEERING CORPORATION

CONTACT SERVICE ALERT AGENCY BEFORE YOU DIG

Date:_____ Ticket No._____
Dig Alert Expiration Date:

UTILITY CLEARANCE REQUEST

Work/Clearance Previously at this location? Y ☐ N ☐

Today's Date:_____ Dig-In Start Date:_____
Project Name:_____ Task No.:_____
Exact Location of Utility Clearance (address, etc.):_____
Facility Contact Name:_____ Telephone No.: ( )_____
Facility Engineer Name:_____ Telephone No.: ( )_____
Site Description (Include Operational Constraints/Hazards):_____

What Facility Utility Drawings are Available? If available, please provide.

(Completed by Project Manager/Delegate) **CHECKLIST** (Completed by Clearance Engineer)

1. Site/Facility Drawings Available?	Y ☐ N ☐	FIELD VERIFICATION
2. Checked with (Fac. Engr.., Facility Contract, Other)?	Y ☐ N ☐	
3. Emergency/Safety Shut-Off Switches Located on Utility Plan?	Y ☐ N ☐	

IDENTIFY KNOWN UTILITY (CHECK EVERY SITE)			INITIAL/DATE	NOTES
A. Water Lines	Y ☐	N ☐	A.	
B. Sanitary/Industrial Sewer	Y ☐	N ☐	B.	
C. Storm Drains	Y ☐	N ☐	C.	
D. Electrical Lines or Vaults	Y ☐	N ☐	D.	
E. Natural Gas	Y ☐	N ☐	E.	
F. Liquid Fuel	Y ☐	N ☐	F.	
G. Steam	Y ☐	N ☐	G.	
H. Compressor Air	Y ☐	N ☐	H.	
I. Telephone/Cable	Y ☐	N ☐	I.	
J. Overhead Lines or Pipes	Y ☐	N ☐	J.	
K. Others (List)	Y ☐	N ☐	K.	

Clearance Engineer: (Name - Print) (Signature) (Date)

McLaren/Hart Review (Proj. Mgr/Delegate) (Name - Print) (Signature) (Date)

Client Review: (Name - Print) (Signature) (Date)

Attachments: Must be Included!

Site Safety Plan (By P.M.)
Site Sketch (By Clearance Engineer)

Distribution:

Project Manager_____
Field Supervisor_____
Others (List):_____

MARK UTILITIES MARKED BY COLOR CODE:

Temporary Survey Markers	- Pink	Gas/Oil/Steam	- Yellow
Sewer	- Green	Electric	- Red
Water	- Blue	Proposed Excavation	- White
Communications/Cable TV	- Orange		

ATTACHMENT 3

DIRECT READING REPORT AND

INSTRUMENT CALIBRATION LOG

McLaren Hart
· ENVIRONMENTAL ENGINEERING CORPORATION

INSTRUMENT CALIBRATION LOG

Page of

Client Name and Site:	Project Manager:	Task Number:

Calibration Event:

Person Calibrating:	Date:
Instrument Type:	Calibration Gas:
Model:	Calibration Gas Concentration (ppm):
Serial #:	Reading (ppm):
Calibrator Model:	Adjusted Reading (If Necessary):
Comments:	

Person Calibrating:	Date:
Instrument Type:	Calibration Gas:
Model:	Calibration Gas Concentration (ppm):
Serial #:	Reading (ppm):
Calibrator Model:	Adjusted Reading (If Necessary):
Comments:	

Person Calibrating:	Date:
strument Type:	Calibration Gas:
del:	Calibration Gas Concentration (ppm):
Serial #:	Reading (ppm):
Calibrator Model:	Adjusted Reading (If Necessary):
Comments:	

Person Calibrating:	Date:
Instrument Type:	Calibration Gas:
Model:	Calibration Gas Concentration (ppm):
Serial #:	Reading (ppm):
Calibrator Model:	Adjusted Reading (If Necessary):
Comments:	

Person Calibrating:	Date:
Instrument Type:	Calibration Gas:
Model:	Calibration Gas Concentration (ppm):
Serial #:	Reading (ppm):
Calibrator Model:	Adjusted Reading (If Necessary):
Comments:	

ents:

NOTE: Return to HSM Upon Completion of Site Work.

McLaren Hart
ENVIRONMENTAL ENGINEERING CORPORATION

DIRECT READING AIR MONITORING LOG

DATE:_____

PROJECT NAME_____ PROJECT NO.:_____

Time	Location	Activity	Instrument	Substance/ Agent	Concentration	Initials

Weather Conditions:_____ Wind Speed:_____ Wind Dir.:_____ Temp.:_____

Comments:_____

Copy to Health and Safety Manager and project file.

H&S Manager Review_____ Date_____

(INFORMATION ONLY)

ATTACHMENT 4

INITIAL MOBILIZATION HEALTH AND SAFETY CHECKLIST

INITIAL MOBILIZATION HEALTH AND SAFETY CHECKLIST

This checklist should be used by the Site Safety Officer during the initial site mobilization to ensure that all site personnel are aware of applicable site H&S requirements and complying with the HASP.

		Initials
1.	HASP cover sheet is signed and current.	_____
2.	Review Health and Safety Plan (HASP) with employees.	_____
3.	All site personnel (and subcontractors) must sign HASP Acknowledgement Sheet.	_____
4.	Check that training certifications are current and available on-site for all site personnel:	
-	40-Hour HAZWOPER Training	_____
-	8-Hour Refresher Training (within past year)	_____
-	Supervisor Training (for Field Supervisor and Project Manager)	_____
-	Medical Certification	_____
-	Respirator Fit Test (if Level C PPE may be required)	_____
-	First Aid and CPR Certification (for at least one person on-site)	_____
5.	The following notices should be posted in the office area:	
-	OSHA Poster	_____
-	Hospital Route Map	_____
-	Emergency Contacts/Telephone List	_____
-	Site Map showing evacuation routes and assembly areas	_____
-	State posters as required	_____
6.	Check that PPE is available on-site as specified in the HASP. At a minimum, most projects require Level D with provisions for upgrading to Level C:	
-	Hard hat (check that suspension is properly attached and in good condition)	_____
-	Safety glasses with side shields (check for ANSI Z87.1 embossment on frames)	_____
-	Steel-toed safety boots	_____
-	Ear plugs available, if needed	_____
-	Respirators stored in a clean, sanitary condition (i.e., sealed bags)	_____
-	Chemical protective clothing with duct tape (if upgrade is needed)	_____
7.	Ensure that air monitoring equipment and required calibration gas/devices are available on-site as specified in the HASP.	_____

8. Ensure that decontamination equipment is available as specified in the HASP. Generally, the following decontamination equipment is often required for personnel decontamination stations:

- Containers and labels for disposal of used PPE _____
- Plastic sheeting to cover ground _____
- Tubs and scrub brushes for outer PPE/boot wash and rinse _____
- Detergent and rinse water _____
- Separate provisions for cleaning, disinfecting and drying respirators _____

9. Ensure that the site control and emergency response equipment is readily available on-site as specified in the HASP. Generally, the following equipment is required for most sites:

- First aid kit and bloodborne pathogens response kit and blanket _____
- Communications equipment _____
- Vehicle designated for emergency use _____
- Fire extinguisher (ensure it is charged and inspected monthly) _____
- Emergency eyewash/flushing equipment (if corrosive chemicals are used) _____
- Hazard warning tape _____
- Flashlight and tool kit _____

10. Ensure that containers of chemicals brought on-site are labeled with the identity and appropriate hazard warning. Also, MSDSs must be on-site for each chemical. _____

11. Ensure that the required forms are available on-site and used to document field activities in accordance with the HASP. _____

ATTACHMENT 5

TAILGATE SAFETY MEETING FORM

McLaren Hart
ENVIRONMENTAL ENGINEERING CORPORATION

TAILGATE SAFETY MEETING

DATE_____ TIME_____ PROJECT NO._____

SITE LOCATION_____

_____

TYPE OF TRAINING

_____ Technical Transfer/H&S Meeting _____ Tailgate Safety Meeting

_____ HASP Reading/Review _____ Other:_____

_____

TRAINING PRESENTED BY:_____

TOPICS COVERED:_____

_____

_____

ATTENDEES

NAME PRINT	SIGNATURE

SITE SUPERVISOR:_____ DATE:_____

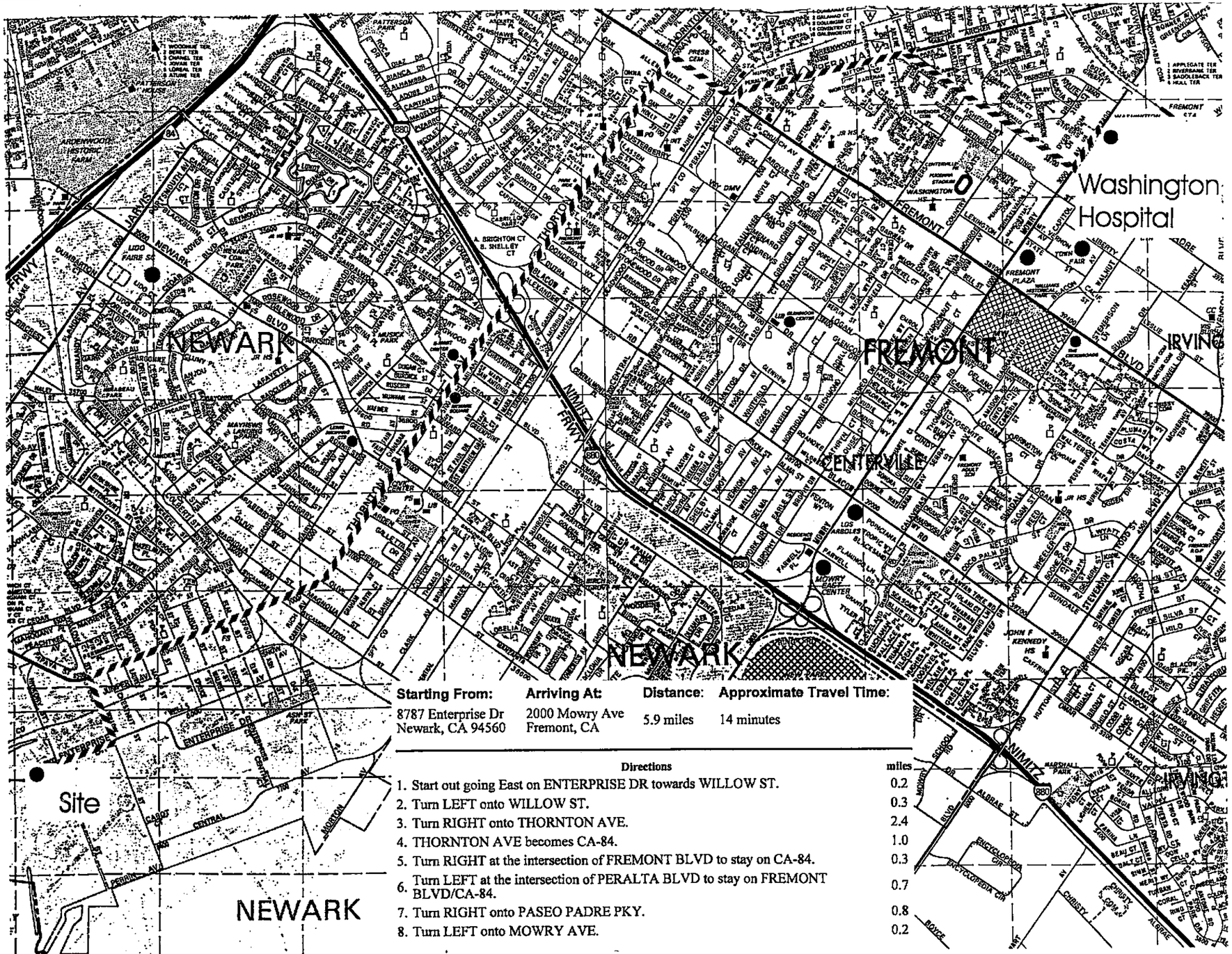
(Copy to Health and Safety Manager and project file.)

H&S Manager Review_____ Date_____

HS 5-2

ATTACHMENT 6

HOSPITAL ROUTE MAP



Starting From:	Arriving At:	Distance:	Approximate Travel Time:
8787 Enterprise Dr Newark, CA 94560	2000 Mowry Ave Fremont, CA	5.9 miles	14 minutes

Directions	miles
1. Start out going East on ENTERPRISE DR towards WILLOW ST.	0.2
2. Turn LEFT onto WILLOW ST.	0.3
3. Turn RIGHT onto THORNTON AVE.	2.4
4. THORNTON AVE becomes CA-84.	1.0
5. Turn RIGHT at the intersection of FREMONT BLVD to stay on CA-84.	0.3
6. Turn LEFT at the intersection of PERALTA BLVD to stay on FREMONT BLVD/CA-84.	0.7
7. Turn RIGHT onto PASEO PADRE PKY.	0.8
8. Turn LEFT onto MOWRY AVE.	0.2

McLaren Hart
ENVIRONMENTAL ENGINEERING CORPORATION

HOSPITAL ROUTE MAP
FMC NEWARK

ATTACHMENT 7

PROJECT MANAGER/FIELD SUPERVISOR JOBSITE SAFETY CHECKLIST, HS 5-1

McLaren Hart
ENVIRONMENTAL ENGINEERING CORPORATION

PROJECT MANAGER/FIELD SUPERVISOR JOBSITE SAFETY CHECKLIST

Client Name

Site Name

Project Number

Date of Inspection

Project Manager/Site Supervisor

Auditor

A. Adequate at time of inspection
B. Need immediate attention
C. Item not applicable
N/A No items in section applicable

Check one of the following:

		A	B	C	N/A
A. Posters & Records					
1.	OSHA poster displayed?				
2.	Site supervisor holding weekly meetings - recording?				
3.	Emergency medical numbers posted?				
4.	Copy of OSHA regulation on jobsite?				
5.	Have utility contacts been made/recorded?				
6.	Are safety "tail-gate" meetings daily?				
7.	Blank accident report forms available?				
8.	Are MSDSs available?				
B. Housekeeping & Sanitation					
10.	General housekeeping of jobsite?				
11.	Passageways and walkways clear?				
12.	Nails removed from lumber?				
13.	Materials of all types properly stockpiled?				
14.	Is an area provided for waste and trash and is it removed regularly?				
15.	Adequate lighting in passageways, stairways, and work areas?				
16.	Toilet facilities adequate and clean?				
17.	Sanitary supply of drinking water?				
18.	Disposable drinking cups and refuse container available?				
	Means provided for sanitizing personal protective equipment?				
C. Fire Protection					
19.	Are "No Smoking" or "Flammable" signs posted at all storage and fueling locations?				
20.	Clear access provided to all fire fighting equipment/are inspections recorded?				
21.	Location of all fire fighting equipment prominently marked?				
22.	Are flammable liquids stored in approved containers?				
23.	Fire extinguishers adequate size?				
24.	Large fuel tanks properly diked and separated?				
D. First Aid					
25.	Is an individual size first aid kit available?				
	First aid kits well stocked?				
	Trained first-aider on jobsite?				

Check one of the following:

		A	B	C	N/A
E. Electrical					
28.	Distribution boxes covered or marked?				
29.	GFI's in use or positive grounding been tested?				
30.	Temporary lighting electrically protected?				
F. Tools					
31.	Damaged or broken tagged out of service?				
32.	Proper storage space provided?				
33.	Operating guards on all power tools?				
34.	Persons using power actuated tools trained?				
35.	Are guards provided on grinders?				
36.	Airhose couplers secured or safety valve in				
37.	Tools being properly used?				
38.	Correct personal protection being used?				
39.	Extension cords tested for assured ground?				
G. Structures					
40.	Floors opening covered or guardrailed?				
41.	Standard guardrailing on scaffolds, bridge decks, floors of buildings, work platforms, and walkways?				
42.	Work areas clear of debris, snow, ice, and grease?				
43.	Stairways provided with handrails?				
44.	Ladders properly constructed?				
45.	Side rails of ladders extend 36" above landing?				
46.	Scaffolds properly anchored, braced, and plumb?				
47.	Protection provided over vertical rebars working above?				
48.	Safety belts in use when guardrails are				
49.	Employees clear of swinging crane loads?				
50.	Tag lines used on suspended crane loads?				
51.	Gas cylinders separated, secured upright, and capped if not in use?				
52.	Safety lines in use on suspended scaffolds?				
53.	Heating devices properly ventilated?				
H. Drill Rigs					
54.	Rig at least 20 feet from power lines?				
55.	Rig inspected daily?				
56.	Rig "kill" switch operational?				
57.	PPE worn?				
58.	Work area free of debris?				
58.	Hand tools in good condition?				
59.	Wire rope inspected and in good condition?				

A. Adequate at time of inspection.
Need immediate attention.
C. Item not applicable.
N/A Not items in section applicable.

Check one of the following:

		A	B	C	N/A
	Traffic Control				
60.	Advance signing at approaches to work area?				
61.	Correct message on signs?				
62.	Flag persons properly dressed and equipped?				
63.	Flag persons performing properly?				
	Welding & Cutting				
64.	Using right type of eye protection?				
65.	Gauges, valves, torches, and lines in good condition and free of oil and grease?				
66.	Cylinders not in use capped?				
67.	Cylinders in use or storage secured upright?				
68.	Anti-flashback valves at torch?				
69.	Stored oxygen separated from actylene by 20 feet?				
70.	Fire extinguisher near welding or cutting operations?				
71.	Adequate ventilation provided?				
72.	Grounding for arc welding machine?				
73.	All parts of arc welding outfits properly insulated?				
	Heavy Equipment				
74.	Operators wearing hard hats?				
75.	Hearing protection being used?				
76.	Dust control?				
77.	Haul road adequate and maintained?				
78.	Equipment speeds excessive for safety?				
79.	[illegible]ns and back-up alarms functioning?				
80.	[illegible]ng cabs on machines when clearing?				
81.	[illegible]nes shut-down when refueling or lubricating?				
82.	Seat belts on machines with ROPS?				
83.	Steps and hand holds adequate and safe conditions?				
84.	Adequate lighting of haul roads at night?				
85.	Parked or unattended equipment have blade lowered to the ground?				
86.	No hitchhikers riding on equipment?				
87.	Full fire extinguisher near refueling truck?				
88.	Dump man prominently located?				
89.	Overhead guard on fork lift truck?				
90.	Vehicles with restricted rear visibility equipped with operating back-up alarms?				
	Cranes				
91.	Power line distance from machines?				
92.	Annual inspection?				
93.	Cables in safe condition?				
94.	Rear swing protection and pinch point guarding?				
95.	Exposed gears, shaft, and belts guarded?				
96.	Fire extinguisher, boom angle indicator, load capacity chart and hand signal poster in crane?				
97.	Signs and/or flags on cranes in transit?				
98.	Operator making daily inspections and test?				
	Trenching & Excavations				
99.	Trench side shored, layed back or boxed?				
100.	Utilities contacted and located before digging?				
101.	Ladder in trench?				
102.	Stop logs placed where necessary along top of				
103.	[illegible]vated material stockpiled at least [illegible] from the edge of the trench?				

Check one of the following:

		A	B	C	N/A
104.	Laser warning signs in place?				
105.	Adequate ventilation in pipe?				
106.	Traffic control adequate?				
107.	Sides of excavation for building shored or protected?				
108.	Oxygen level tested in manholes, trenches, confined space greater than 5 feet deep?				
109.	Public protected from exposure to open excavation?				
	Miscellaneous				
110.	Procedures established to handle toxic and carcinogenic materials?				
111.	Fall protection being used on steel erection?				
112.	Walls properly braced (concrete and block construction)?				
113.	Guards in place and used on wood-working machines?				
114.	Explosives being used, transported, and stored in compliance with regulations?				
115.	Belts, pulleys, shafts, gears, and chains guarded on all machinery and equipment?				
116.	Masonry saws grounded and personal protective equipment being used?				
	Confined Spaces				
117.	Supervisor has inspected site for confined spaces?				
118.	Confined space entry permit is utilized?				
119.	Atmosphere is monitored for O^2/LEL and toxic gases?				
120.	Personnel have been trainedin confined space entry?				
121.	Does standby personnel have CPR training?				
	Hazardous Waste Operations				
122.	SSHP available on-site and current?				
123.	Project staff have 40-hr/8-hr Hazwoper Training?				
124.	Subcontractors provided proof of appropriate training?				
125.	Respirators worn per Action Level Table Criteria?				
126.	Is PPE worn as required?				
127.	Are hardhats being worn?				
128.	Is instrumentation calibrated prior to use?				
129.	Is direct reading instrument data recorded on form provided for this purpose?				
130.	Is personnel/equipment decontamination performed?				
131.	Are MSDS's available for hazardous materials?				
132.	If toxic fumes, vapors, dusts present, is ventilation adequate?				
133.	Is hospital route map posted on site?				
134.	Is first aid kit available on site?				

- This checklist does not include hazards on every site but is intended to remind you of the most common hazards.

Unsafe acts and/or practices observed.

I, the undersigned supervisor, have reviewed the indicated hazards and will take the necessary action to immedately correct them.

Signature of Project Supervisor _____ Date _____

Signature of Project Manager _____ Date _____

Project Manager Distribution:
___ H&S Manager
___ Project File
___ Other_____

ATTACHMENT 8

EMERGENCY CONTACTS

Identify Meeting Area (Perform Head Count): _____

EMERGENCY CONTACTS
(To be Posted)

TITLE	NAME	PHONE NUMBER
EMERGENCY		
Police	Emergency Service	911
Fire	Emergency Service	911 or (650) 321-4433
Local Hospital	Washington Hospital	(510) 797-1111
Local Ambulance/Rescue	Emergency Service	911
Poison Control Center	Washington Hospital	(510) 707-1111
Hazardous Waste National Response Center	HAZMAT	(800) 424-8802
PROJECT/BUSINESS		
Health & Safety Manager	Dave Durst	Office: (916) 638-3696
IH Coordinator	Sonja Echeverria	Office: (510) 748-5635
Project Manager	Doug Beadle	Office: (510) 748-5664 Pager: (510) 448-0414 Home: (925) 228-7801
Corporate Human Resources Dept.	Sharon Clark	Office: (916) 638-3696
Client Contact	Zahra Zahir	Office: (408) 289-3141
Subcontractors*		
Subcontractors*		
Site Safety Officer	Nathan King	Office: (510) 748-5647 Pager: (510) 448-8243

* Subcontractors will be added as necessary

Site Location: *(nearest cross streets for directing response teams)*
FMC Newark site, 8787 Enterprise Drive, Newark, CA

APPENDIX D

LABORATORY QA/QC MANUALS

CALIFORNIA LABORATORY SERVICES
(CLS LABORATORY)
QUALITY ASSURANCE MANUAL

CLS Labs

Quality Assurance Manual (QA Manual)

3249 Fitzgerald Road Rancho Cordova, CA 95742 (916) 638-7301 Fax (916) 638-4510

C L S Labs

Quality Assurance

Programs Documents

March 1, 1998
(Revision 5.4)

☐ Controlled ☑ Uncontrolled

Copy No. 98011-6a Issue Date 7/16/98

Issued to:

3249 Fitzgerald Road
Rancho Cordova, CA 95742
(916) 638-7301 Fax: (916) 638-4510

Table of Contents

Table of Contents

Table of Contents

Table of Contents

List of Tables

List of Figures

1.0 INTRODUCTION

The purpose of CLS Labs (CLS) Quality Assurance Manual is to document the minimum quality assurance requirements for the laboratory. This Quality Assurance Manual provides ready reference for analysts and clients on CLS's formal policy pertaining to the accuracy and reliability of analytical tests performed in the laboratory.

The policies contained within this CLS Quality Assurance Manual are intended to be generally applied to all laboratory operations. The manual is periodically updated to provide for the addition of new methods and procedures as they are developed.

1.1 CLS ANALYTICAL SERVICES

CLS Labs (CLS) is an environmental testing laboratory providing a wide range of analytical services to both the public and private sectors. CLS laboratories are located in Rancho Cordova, California and features modern facilities and equipment. The staff is comprised of chemists, scientists, and technicians from a broad range of academic and environmental disciplines. The staff recognizes the need for high quality and legally defensive data, and the impact that it has on the decisions its diverse clientele make. It is our company mission to provide our customers with high quality, and cost effective laboratory services that will meet and/or exceed our customers' expectations.

1.2 LABORATORY ORGANIZATION AND RESPONSIBILITY

Since the demands on an environmental testing laboratory can be great and diverse in nature, the CLS laboratories are structured into distinct and effective departments. These departments have clearly defined objectives and responsibilities that are directly involved in the analytical testing process. The structure of the CLS laboratories provide a method for high quality analytical operations while providing routes for Quality Assurance efforts to function unimpeded by the operational analysis of samples. The minimum responsibilities of laboratory personnel are defined as follows with the laboratory organization outlined in Figure 1-1.

* **President, CEO**

  The President is responsible for the management of the entire laboratory both financial and technical. It is the Presidents job to implement corporate goals, objectives and policies. The President is in direct communication with the Quality Assurance Manager.

* **Laboratory Director**

  Ultimate responsibility for the laboratory and Quality Assurance is that of the Laboratory Director. The Laboratory Director communicates with the Quality Assurance Manager and the Laboratory Co-Director to ensure that the CLS Quality Assurance/Quality Control manual and SOPs are followed as written. The Laboratory Director works with each department supervisor to implement the QA/QC procedures of this manual. It is the Laboratory Directors job to see that the non-laboratory departments (administration, marketing, etc..) of CLS work with their laboratory counterparts to achieve high quality results.

* **Department Supervisors**

CLS is divided into six analytical departments: GC, GC/MS, HPLC, Organic Extraction, Inorganic Analyses, and Microbiology Analyses; each department has its own supervisor. The department supervisors provide supervision of group operations, implement the laboratory quality assurance plan, ensure proper scheduling and execution of analysis, assure that proper analysis techniques are being used (use of approved SOPs), review all data before it is released to data management, and report all discrepancies to the QA department.

* **Client Services/Project Management**

Client Services/Project Management serves as the primary laboratory contact for CLS clientele. Any changes in the scope of work will be processed through these departments. These departments monitor the progress and timeliness of analytical work, review ongoing work orders and all subsequent final laboratory reports for accuracy and adherence to the QA Plan, submit required documentation and laboratory certification data to clients prior to analyzing field samples, assure that proper sample handling techniques (login, storage, preservation, etc..) are adequate for the type of samples received, and give technical expertise when requested.

* **Field Services/Health and Safety**

Field services have the responsibility of proper sampling and transportation of samples to and from CLS. Field service personnel are required to know CLS's QA policies and report directly to the Laboratory Director. The Laboratory Health and Safety Officer is responsible for monitoring implementation of the Laboratory Health and Safety Plan, and interfacing with the QA Manager for compliance to laboratory documents. These responsibilities are addressed in the Laboratory Health and Safety Plan.

* **Administration**

Administration is responsible for the management of financial operations, including accounting and procument of all laboratory items. It is the Administrations job to ensure that purchased items and services meet the QA Plan requirements and perform as outlined in this document.

* **Marketing**

Marketing is responsible for supporting client regulatory programs, coordinating pre-project meetings, establishing contractual terms and conditions, overseeing the projects, and communicating the client's quality needs.

* **Information Services**

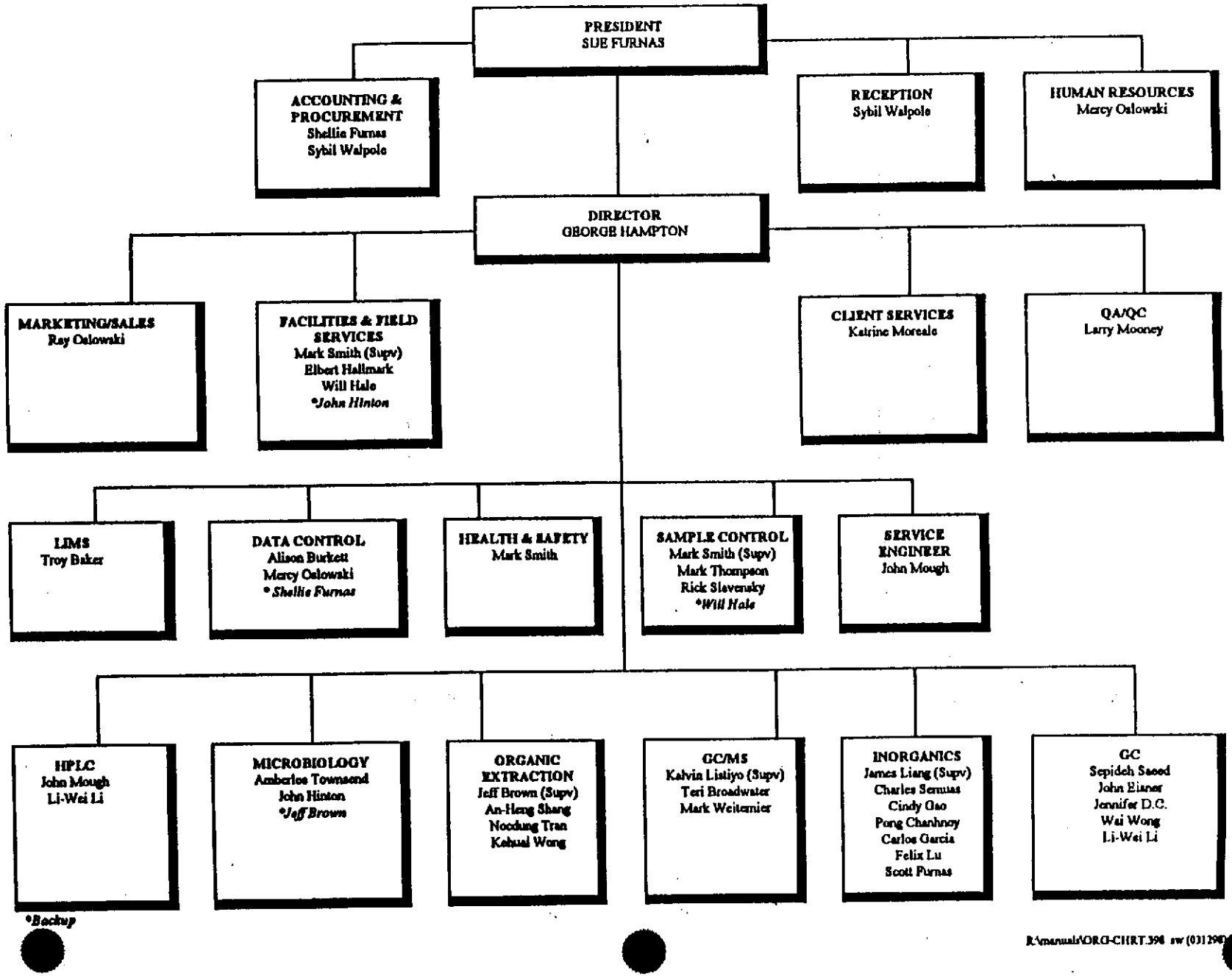
Information Services is responsible for all electronic data (transfer and receiving) and the programming and implementation of the laboratory LIMs system. This department works with the QC department to help implement QC standards through the use of electronic programming.

* **Quality Assurrance/Quality Control**

Quality Assurance (QA) and Quality Control (QC) will coordinate with chemists to implement the policies set up in this QA Manual. The QA Manager and a QC Chemist are responsible to monitor daily laboratory QA/QC activities as follows:

- Ensure that all records, logs, SOPs, project plans, and analytical results are maintained in a retrievable fashion
- Ensure that copies of SOPs, project plans, and contract requirements are distributed to laboratory personnel involved with sample analysis
- Review 5% percent of laboratory QA/QC data before that data is sent to clients.
- Ensure that analysts are analyzing QC samples, maintaining control charts, and implementing and documenting corrective action
- Ensure that instrument logs, extraction logs, standard logs, and QC documents are maintained and are completed with the correct information
- Ensure that samples are properly labeled and stored, and that the instruments are properly calibrated through monthly audits

The effectiveness of the QA/QC program will be continuously evaluated by the QA/QC department. Unacceptable findings will be reported to the Laboratory Director.



ORGANIZATION CHART

Figure 1-1

R:\manuals\ORG-CHRT.398 sw (031298)

1.3 OBJECTIVES OF THE QA PROGRAM

The primary objective of the Quality Assurance program is to produce quality data which is of known precision and accuracy and legally defensible. This ensures that the data can be relied on to represent the true value for a given sample. When extended to the field sampling process, the data will accurately represent the larger volume from which the sample was taken.

1.4 CLS QUALITY ASSURANCE PROGRAM

The CLS Quality Assurance/Quality Control Program is an essential part of any analytical procedure. The program has been integrated into every phase of laboratory operations. The purpose of the QA/QC program is twofold. Initially, the program detects and corrects problems in the measurement process to ensure that all data is valid, of known precision and accuracy, and legally defensible. Secondly, it is designed to monitor and control the quality of the data generated by the laboratory, thereby ensuring that errors are kept to a statistically acceptable level and corrective action taken when necessary. The program is maintained by rigorous attention to detail and a commitment to a thorough, on-going QC auditing, evaluation and improvement program.

Many important phases of Quality Assurance cannot be adequately documented. The QA/QC program procedures must be used, and the analyst must apply experienced "reasoning" to his evaluation of results as an additional check on the validity of the QC and sample data. This is increasingly important with today's high dependence on electronic "automated" analytical systems. Thus a vital requirement for the environmental analyst is to have a grasp of the concepts behind the procedure as well as the actual analytical steps. Limitations of the methods and potential interferences must be known. Additionally, knowledge of the regulations and the basis for the regulatory limits is important in helping prescribe the analytical procedure and in properly interpreting the results.

1.5 QA MANUAL SUMMARY

The organization of this manual is presented in the table of contents. Essentially the manual follows the logical progression of analytical work and the application of the Quality Assurance Program in the laboratory. The program can be divided into four major areas.

1.5.1 Pre-Analytical Procedures

The pre-analytical work includes the various aspects of sampling, preservation and storage, documentation, materials and standards and calibration.

1.5.2 Procedures Concurrent with Analysis

This group of procedures includes Quality Control steps such as blanks, spikes, replicates, etc., as well as analytical methodology.

1.5.3 Data Reduction and Evaluation

Both QC and sample data must be evaluated and QC checks performed to ensure the data obtained is valid and falls within acceptable precision and accuracy limits.

1.5.4 Data Reporting and Record Maintenance

Specific reporting formats may be required for different projects, but all data must be reviewed before being released. Additionally, records are maintained indefinitely to allow access for future inquiries about the data.

1.6 ANALYTES AND ANALYTICAL METHODS

The principle methods used for the analysis of drinking waters, wastewaters, and hazardous wastes come from USEPA procedures as referenced in Section 6. All analysis performed at CLS comply to the EPA Methods listed in Table 6-1.

Table 1-2 summarizes the analytes and methods CLS routinely performs. CLS has written procedures for the bench level analysis using these methods that comply with all EPA specifications.

ANALYTICAL METHODS

A. ORGANIC CHEMICAL TESTING

		Water	*Soil/Solids /Waste*
1.	Halogenated Volatile Organics	EPA 601	EPA 8010
2.	Nonhalogenated Volatile Organics	EPA 8015	EPA 8015
3.	Aromatic Volatile Organics	EPA 602	EPA 8020
4.	Purgeable Aromatics and Halocarbons	EPA 502.2	
5.	Phenols	EPA 604	EPA 8040
6.	Phthalate Esters	EPA 606	EPA 8060
7.	Nitrosamines	EPA 607	
8.	Nitrogen/Phosphorus Pesticides	EPA 507	
9.	Organochlorine Pesticides	EPA 505/508/608	EPA 8080
10.	Polychlorinated Biphenyls	EPA 505/608	EPA 8080
11.	Polynuclear Aromatic Hydrocarbons	EPA 610(GC)	EPA 8100
		EPA 610(LC)	EPA 8310
12.	Chlorinated Hydrocarbons	EPA 612	EPA 8120
13.	Organophosphorus Pesticides	EPA 614	EPA 8140
14.	Chlorinated Herbicides	EPA 515.1/615	EPA 8150
15.	Purgeable Organic Compounds by GC/MS	EPA 524.2/624	EPA 8240/8260
16.	Semi-volatile Organic Compounds by GC/MS	EPA 525/625	EPA 8270
17.	Carbamates	EPA 531.1/632	
18.	Nitroaromatics	EPA 8330	EPA 8330
19.	Formaldehyde	EPA 8315	EPA 8315
20.	Oil & Grease	EPA 1664	EPA 1664

Table 1-2 Analytical Methods

ANALYTICAL METHODS (cont.)

B. INORGANIC CHEMICAL TESTING

	Water	*Soil/Solids/Waste*
1. Aluminum	EPA 200.7/200.8	EPA 6010/6020
2. Antimony	EPA 200.7/200.8/204.2	EPA 6010/6020/7041
3. Arsenic	EPA 200.7/200.8/206.2	EPA 6010/6020/7060
4. Barium	EPA 200.7/200.8/208.2	EPA 6010/6020/7081
5. Beryllium	EPA 200.7/200.8/210.2	EPA 6010/6020/7091
6. Boron	EPA 200.7/200.8	EPA 6010/6020
7. Cadmium	EPA 200.7/200.8/213.2	EPA 6010/6020/7131
8. Chloride	EPA 300.0	
9. Chromium,hex	EPA 7196	EPA 7196
10. Chromium,total	EPA 200.7/200.8/218.2	EPA 6010/6020/7191
11. Cobalt	EPA 200.7/200.8/219.2	EPA 6010/6020/7201
12. Copper	EPA 200.7/200.8/220.2	EPA 6010/6020/7211
13. Cyanide	EPA 335.1/335.2	EPA 9010
14. Fluoride	EPA 300.0/340.2	
15. Gold	EPA 200.7/200.8/231.1	EPA 6010/6020
16. Iron	EPA 200.7/200.8/236.1	EPA 6010/6020/7380
17. Lead	EPA 200.7/200.8/239.2	EPA 6010/6020/7421
18. Lithium	EPA 200.7/200.8	EPA 60106020
19. Magnesium	EPA 200.7/200.8	EPA 6010/6020/7450
20. Manganese	EPA 200.7/200.8/243.2	EPA 6010/6020/7461
21. Mercury	EPA 200.8/245.1/7470	EPA 6020/7471
22. Molybdenum	EPA 200.7/200.8/246.2	EPA 6010/6020/7481
23. Nickel	EPA 200.7/200.8/249.2	EPA 6010/6020/7521
24. Nitrate	EPA 300.0	
25. Phosphorus	EPA 200.7/200.8	EPA 6010/6020
26. Potassium	EPA 200.7/200.8/258.1	EPA 6010/6020/7610
27. Selenium	EPA 200.7/200.8/270.2	EPA 6010/6020/7740
28. Silicon	EPA 200.7/200.8	EPA 6010/6020
29. Silver	EPA 200.7/200.8/272.2	EPA 6010/6020/7761
30. Sodium	EPA 200.7/200.8/273.1	EPA 6010/6020/7770
31. Strontium	EPA 200.7/200.8	EPA 6010/6020
32. Sulfate	EPA 300.0	
33. Sulfide	EPA 376.1/376.2	EPA 9030
34. Thallium	EPA 200.7/200.8/279.2	EPA 6010/6020/7841
35. Tin	EPA 200.7/200.8	EPA 6010/6020
36. Titanium	EPA 200.7/200.8	EPA 6010/6020
37. Vanadium	EPA 200.7/200.8	EPA 6010/6020
38. Zinc	EPA 200.7/200.8/289.1	EPA 6010/6020/7950

Table 1-2 Analytical Methods (cont.)

ANALYTICAL METHODS (cont.)

C. DRINKING WATER TESTING

		Method
1.	General Mineral	
a.	Calcium, Magnesium, Sodium, Potassium	EPA 200.7
b.	Alkalinity	EPA 310.1
c.	Anions	EPA 300.0
d.	Fluoride	EPA 340.2
2.	General Physical	
a.	pH	EPA 150.1
b.	Specific Conductance	EPA 120.1
c.	Total Dissolved Solids	EPA 160.1
d.	Turbidity	EPA 180.1
e.	Methylene Blue Active Substances (MBAS)	EPA 425.1
3.	Primary/Secondary Inorganic	
a.	Aluminum, Barium, Copper, Iron, Manganese, Silver, and Zinc	EPA 200.7
b.	Arsenic	EPA 206.2
c.	Cadmium	EPA 213.2
d.	Chromium	EPA 218.2
e.	Lead	EPA 239.2
f.	Mercury	EPA 245.1
g.	Selenium	EPA 270.2
4.	Regulated Organic	
a.	Volatile Organic Compounds	EPA 502.2/524
b.	DBCP and EDB	EPA 504
c.	Organochlorine Pesticides	EPA 505
d.	Nitrogen/Phosphorus Pesticides	EPA 507
e.	Chlorinated Herbicides	EPA 515.1
f.	Carbamate Pesticides	EPA 531.1

Table 1-2 Analytical Methods (cont.)

ANALYTICAL METHODS (cont.)

D. HAZARDOUS WASTE TESTING

		Method
1.	Corrosivity (pH)	EPA 9040/9045
2.	Ignitability (Flashpoint)	EPA 1010
3.	Reactivity	
	a. Cyanide	EPA 9010
	b. Sulfide	EPA 9030
4.	Toxicity/Soluble Constituents	
	a. California Waste Extraction Test	California Title 22
	b. Toxicity Characteristic Leaching Procedure (TCLP)	EPA 1311
5.	HazCat	Turkington/CLS
6.	FTIR Qualitative Scan	CLS

E. MICROBIOLOGICAL TESTING

		Method
1.	Total & Fecal E. Coli Coliforms by Multiple Tube Fermentation	9221 *
2.	Total & E. Coli Coliforms by MMO-MUG Technics	9223B *
3.	Heterotrophic Plate Count	9215B *
4.	Total Coliform by Multiple Tube Fermentation	9221B *
5.	Fecal/E. Coli by Multiple Tube Fermentation	9221C *
6.	Fecal Streptococci by Multiple Tube Fermentation	9230B *

* Standard Method - 18th Ed.

Table 1-2 Analytical Methods (cont.)

2.0 SAMPLE RECEIPT, PRESERVATION AND STORAGE

Laboratory analyses are performed to produce data representative of conditions when the sample was obtained. To provide representative samples for analysis, both field and laboratory personnel must satisfactorily perform their activities. Although the purpose of this manual is to define the laboratory Quality Assurance Program, several aspects of the field and sampling operations are briefly discussed because of the significant effect of field procedure on the resulting analytical data quality.

2.1 SAMPLING PROCEDURES AND DOCUMENTATION

Proper sampling in the field requires consideration of many aspects including:

* Sampling technique
* Containers used
* Labeling the containers
* Preservation and Storage
* Transportation
* Documentation
* Identifying the type of analysis required to give results useful for the intended purpose

The items discussed in this section touch on several of these key elements in environmental sampling and analysis.

2.1.1 Chain of Custody

An overriding consideration for resulting data is the ability to demonstrate that the samples have been obtained from the locations stated and that they have reached the laboratory without alteration. Evidence of collection, shipment, laboratory receipt and laboratory custody until disposal must be documented to accomplish this.

Documentation is accomplished through a "chain of custody" record that records each sample and the individuals responsible for sample collection, shipment and receipt. A sample is considered in custody if it is:

* In a person's actual possession
* In view after being in physical possession
* Locked up so that no one can tamper with it after having been in physical custody
* In a secured area, restricted to authorized personnel.

Figure 2-1 represents a chain of custody form (COC) that is used by CLS personnel in collecting and shipping samples. CLS shall not accept samples collected by ANY client for analysis without a correctly prepared COC.

The COC shall be signed by each individual who has the samples in their possession. Preparation of the COC shall be as follows:

* The chain of custody record shall be initiated in the field by the person collecting the sample for every sample. Every sample shall be assigned a unique identification number that is entered on the COC. Samples can be grouped for shipment and use a common form.

* The record shall be completed in the field to indicate project, sampling team and other necessary information.

* If the person collecting the sample does not transport the samples to the laboratory or deliver the sample containers for shipment, the first block for Relinquished By_____, Received By _____ shall be completed in the field.

* The person transporting the samples to the laboratory or delivering them for shipment shall sign the record form as Relinquished By _____.

* If the samples are shipped to the laboratory by commercial carrier, the COC shall be sealed in a watertight container, placed in the shipping container and the container sealed prior to giving it to the carrier.

* If the samples are directly transported to the laboratory, the COC shall be kept in possession of the person delivering the samples.

* For samples shipped by commercial carrier, the waybill shall serve as an extension of the chain of custody record between the final field custodian and receipt in the laboratory.

* Upon receipt in the laboratory, the Quality Control Manager, or representative, shall open the shipping containers, compare the contents with the COC record and sign and date the record.

* If discrepancies occur, the sample in question shall be segregated from normal sample storage and the field personnel immediately notified.

* COC records shall be maintained with the records for a specific project, becoming part of the data package.

Multipart COCs may be used so that a copy can be returned to the person shipping the samples after they are received in the laboratory and after the samples are disposed of by the laboratory. Otherwise, photocopies will be made and distributed.

CLS Labs CHAIN OF CUSTODY CLS ID No:_____ LOG NO. 25238

REPORT TO:
ADDRESS
PROJECT MANAGER PHONE#
PROJECT NAME
SAMPLED BY
JOB DESCRIPTION
SITE LOCATION

CLIENT JOB NUMBER
DESTINATION LABORATORY
☐ CLS (916) 638-7301
3249 FITZGERALD RD.
RANCHO CORDOVA, CA
95742
☐ OTHER

PRESERVATIVES

ANALYSIS REQUESTED

FIELD CONDITIONS:
COMPOSITE:

TURN AROUND TIME: 1 DAY | 2 DAY | 5 DAY | 10 DAY
SPECIAL INSTRUCTIONS

DATE	TIME	SAMPLE IDENTIFICATION	MATRIX	CONTAINER NO.	CONTAINER TYPE

INVOICE TO:
P.O. #
QUOTE #

SUSPECTED CONSTITUENTS
SAMPLE RETENTION TIME
PRESERVATIVES: (1) HCL (2) HNO3 (3) = COLD (4)

RELINQUISHED BY (SIGN)	PRINT NAME / COMPANY	DATE / TIME	RECEIVED BY (SIGN)	PRINT NAME / COMPANY

RECD AT LAB BY: DATE / TIME: CONDITIONS / COMMENTS:

SHIPPED VIA ☐ FED X ☐ UPS ☐ OTHER_____ AIR BILL #

Figure 2-1 Chain of Custody Form

2.1.2 FIELD COLLECTION AND SHIPMENT

Prior to collecting samples, the collection team must consider the analyses to be performed so that proper sample containers and shipping containers can be assembled and proper preservatives added to containers. In addition, field logs and record sheets, chain of custody forms (COC) and analysis records must be assembled.

All records required for documentation of field collection must be completed by the field team. The primary documenting record is the COC and sample receiving log-in book as discussed in Section 2.2.

In addition to initiating the COC, field personnel are responsible for uniquely identifying (required on the COC) and labeling samples, providing proper preservation and packaging samples to preclude breakage during shipment.

2.1.2.1 Labeling

Every sample shall be labeled to identify:

* Project or job number
* Unique sample number
* Sample location (such as a bore hole and depth or grid coordinates)
* Sampling date and time
* Person obtaining the sample
* Sample preservation/conditioning method, if applicable
* Analysis requested

2.1.2.2 Sample Containers and Preservation

Samples must be placed in containers compatible with the intended analysis and properly preserved. Also, collectors of samples must consider the time interval between acquiring the sample and analysis (holding time) so that the sample is representative. Table 2-1 provides requirements for various analytical parameters with respect to the type of container, preservation method and maximum holding time between collection and analysis.

2.1.2.3 Sample Transportation

Shipping containers are to be sealed prior to shipment, whether shipped by direct transport by field personnel or commercial carrier. The only exception to this is if sufficient holding time exists so that the samples can be held in the field but it will be necessary to re-ice the containers prior to or during transport.

2.1.2.4 Request for Analysis

The final step in providing information to the laboratory is the Request for Analysis. The Request for Analysis, included on the CLS COC (Figure 2-1), shall be completed by the field personnel and included with the COC record. Another form, provided by the client, may be substituted for the COC

providing sufficient information is included and a COC accompanies the sample. It is imperative that the Request for Analysis be provided to enable the lab to comply with maximum allowable sample holding times.

2.2 RECEIPT OF SAMPLES AND CHAIN OF CUSTODY

Samples are stored either in the cold room at 4°C or in a refrigerator or freezer depending on the type of samples and analysis. Samples for volatile analyses such as EPA 601/602 are stored in separate refrigerators and chemists are required to sign the internal COC when removing samples from storage so to retain the sample's unique COC.

The first step in the laboratory receipt of samples is obtaining the information requested on the COC. The information will be checked by the laboratory sample custodian when they fill out the Sample Receipt Form (Figure 2-2). If any information is missing upon receipt of the samples, the sample custodian will notify the QC Coordinator who shall inform the client immediately. All samples received are to be logged-in immediately or within 24 hours of their arrival. All log-in information is entered into the computer information system. Each sample is labelled, and a work order is issued and distributed to the chemists assigned with the analysis.

The QC Coordinator will receive the samples and:

* Examine all samples and determine if proper temperature and preservation have been maintained during shipment. If samples have been damaged during shipment, the remaining samples shall be carefully examined to determine whether they were affected. Any samples affected shall be also considered damaged. It will be noted on the COC record that specific samples were damaged and that the samples were removed from the sampling program. Field personnel will be notified as soon as possible that samples were damaged and that they must be re-sampled, or the testing program changed to avoid the cause of damage.

* Compare samples received against those listed on the chain of custody.

* Verify that sample holding times have not been exceeded.

* Sign and date the chain of custody form and attach the waybill to the chain of custody.

* Place the samples in adequate laboratory storage.

* Enter the samples in the laboratory sample log-in book.

* Notify the Laboratory Manager or Department Supervisor of sample arrival.

* Place the completed chain of custody records in the project file.

After sample receipt and inspection, the log-in personnel will sign the COC. For samples delivered by mail or by a third party, the client should include a signed COC form with all the required information. A signed copy of the COC form will be included in the final report and in a QC package report to be kept in our archive room.

If samples collected by CLS personnel arrive without COC or incorrect chain of custody records, the following shall be done by the QC Coordinator:

* If the chain of custody (COC) is incorrect, a memorandum to the Project Manager and field personnel is prepared stating the inaccuracy and correction. The memorandum must be signed and dated by the person originating the COC and the QC Coordinator. The memorandum will serve as an amendment to the COC. If the information on the COC cannot be corrected by the QC Coordinator or the field personnel, the samples affected shall be removed from the program.

* If the COC is not shipped with the samples, the field personnel shall be contacted and a memorandum prepared that lists the persons involved in collecting, shipping and receiving the samples and the times, dates and events. Each person involved must sign and date this memorandum. The completed memorandum will be maintained in lieu of the COC.

2.3 PRESERVATION, STORAGE AND DISPOSAL

2.3.1 Sample Preservation

Preservation of Samples is addressed in several of the references in Section 6. Additionally, Table 2-1 summarizes preservation methods.

2.3.2 Laboratory Storage of Samples

The primary considerations for sample storage are:

* Extracting and/or analyzing samples within the prescribed holding time for the parameters of interest.

The requirements of Table 2-1 for temperatures and holding times shall be used. Placing of samples in the proper storage environment is the responsibility of the QC Coordinator, who should notify the Laboratory Director, or department supervisor, if there are any samples that must be analyzed immediately because of holding-time requirements.

2.3.3 Sample Disposal

Ultimate disposition of the samples is part of the Sample Management program. The information on disposal is noted on the Chain of Custody (COC), dated, and signed by the appropriate staff. There are several possibilities for sample disposition:

* The sample may be completely consumed during analysis.

* Samples may be returned to the client or location of sampling for disposal.

* The samples may be stored after analysis. Proper environmental control and holding time must be observed if reanalysis is anticipated. Otherwise environmental conditions for storage will not be observed.

The Laboratory Director shall determine disposition of samples if not specified on the COC (Figure 2-1). In general, CLS does not maintain samples and extracts longer than 30 days beyond receipt of analytical data by the customer, unless otherwise specified.

2.4 Initiation of Testing Program

As stated in Section 2.1.1, the COC (including the Analysis Request) shall be submitted with the samples to the laboratory.

If the analytical program is not defined with the sample shipment, the QA Coordinator shall immediately notify the Field Manager responsible for the work for definition of the analysis program. If the samples are external to CLS, the Laboratory Director shall contact the client to determine the testing program. The QA Coordinator will store the samples as appropriate. The COC and sample log-in book remain the primary sample documents.

The Laboratory Director and Laboratory Co-Director are responsible for prioritizing samples on the basis of holding time and required reporting time into the laboratory sample stream.

REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

NAME	CONTAINER[1]	PRESERVATION	HOLDING TIME
Bacterial Tests:			
Coliform, fecal and total	P,G	Cool, 4°C, 0.008% $Na_2S_2O_3$	6 hours
Fecal, streptococci	P,G	Cool, 4°C 0.008% $Na_2S_2O_3$	6 hours
Inorganic Tests:			
Acidity	P,G	Cool, 4°C	14 days
Alkalinity	P,G	Cool, 4°C	14 days
Ammonia	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days
Biochemical oxygen demand	P,G	Cool, 4°C	48 hours
Bromide	P,G	None required	28 days
Biochemical oxygen demand, carbonaceous	P,G	Cool, 4°C	48 hours
Chemical oxygen demand	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days
Chloride	P,G	None required	28 days
Chloride, total residual	P,G	None required	Analyze immediately
Color	P,G	Cool, 4°C	48 hours
Cyanide, total and amenable	P,G	Cool, 4°C NaOH to pH>12 to chlorination 0.6 g ascorbic acid	14 days
Fluoride	P	None required	28 days
Hardness	P,G	HNO_3 to pH<2, H_2SO_4 to pH<2	6 months
Hydrogen ion, pH	P,G	None required	Analyze immediately
Kjeldahl and organic nitrogen	P,G	Cool, 4°C H_2SO_4 to pH<2	28 days
Metals:			
Chromium VI	P,G	Cool, 4°C	24 hours
Mercury	P,G	HNO_3 to pH<2	28 days
Metals, except chromium VI and mercury	P,G	HNO_3 to pH<2	6 months
Nitrate	P,G	Cool, 4°C	48 hours
Nitrate-nitrite	P,G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Nitrite	P,G	Cool, 4°C	48 hours
Oil and grease	G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Organic carbon	P,G	Cool, 4°C, H_2SO_4 to pH<2	28 days

Table 2-1

REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

NAME	CONTAINER[1]	PRESERVATION	HOLDING
Orthophosphate	P,G	Filter immed,Cool 4°C	48 hours
Oxygen, dissolved probe	G bottle	None required	Analyze immediately
Winkler	G bottle	Fix on site store in dark	8 hours
Phenols	G only	Cool, 4°C, H_2SO_4 to pH<2	28 days
Phosphorus,(elemental)	G	Cool, 4°C	48 hours
Phosphorus, total	P,G	Cool, 4°C, H_2SO_4 to pH<2	28 days
Residue, total	P,G	Cool, 4°C	7 days
Residue, Filterable	P,G	Cool, 4°C	7 days
Residue, Nonfilterable, (TSS)	P,G	Cool, 4°C	7 days
Residue, Settleable	P,G	Cool, 4°C	48 hours
Residue, volatile	P,G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific Conductance	P,G	Cool, 4°C	28 days
Sulfate	P,G	Cool, 4°C	28 days
Sulfide	P,G	Cool, 4°C, add zinc acetate plus sodium hydroxide to pH>9	7 days
Sulfite	P,G	None required	Analyze immediately
Surfactants	P,G	Cool, 4°C	48 hours
Temperature	P,G	None required	Analyze
Turbidity	P,G	Cool, 4°C	48 hours
Organic Tests:			
Purgeable Halocarbons	G,Tef-lined	Cool, 4°C 0.008% $Na_2S_2O_3$	14 days
Purgeable aromatic hydrocarbons	G,Tef-lined	Cool, 4°C 0.008% $Na_2S_2O_3$ HCl to pH2	14 days
Acrolein and acrylonitile	G,Tef-lined	Cool, 4°C 0.008% $Na_2S_2O_3$ adjust pH to 4-5	14 days
Phenols	G, Tef-lined	Cool, 4°C 0.008% $Na_2S_2O_3$	7 days until extraction 40 days after extraction
Benzidines	G, Tef-lined	Cool, 4°C 0.008% $Na_2S_2O_3$	7 days until extraction
Phthalate esters	G, Tef-lined	Cool, 4°C	7 days until extraction 40 days after extraction

Table 2-1

REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

NAME	CONTAINER[1]	PRESERVATION	HOLDING
Nitrosamines	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$	40 days after extraction store in dark
PCBs, acrylonitrile	G, Teflon-lined cap	Cool, 4°C	40 days after extraction
Nitroaromatics and isophorone	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$	40 days after extraction store in dark
Polynuclear aromatic hydrocarbons	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$	40 days after extraction store in dark
Haloethers	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$	40 days after extraction
Chlorinated hydrocarbons	G, Teflon-lined cap	Cool, 4°C	40 days after extraction
TCDD	G, Teflon-lined cap	Cool, 4°C, 0.008% $Na_2S_2O_3$	40 days after extraction
Total organic halogens	G, Teflon-lined cap	Cool, 4°C, H_2SO_4 to pH<2	7 days
<u>Pesticide Tests:</u>			
Pesticides	G, Teflon-lined cap	Cool, 4°C, pH 5-9	40 days after extraction
<u>Radiological Tests:</u>			
Alpha, beta and radium	P,G	HNO_3 to pH<2	6 months

[1] Polyethylene (P) or Glass (G)

Table 2-1

SAMPLE LOG-IN FORM

CLS# N_____ COC# _____ Date received _____

Received by: _____

Delivered by: _____

Packaging: cooler _____ DOT packing _____ other (specify) _____

Did package come with shipping slip? . . . . . yes no

If yes, tracking number _____

Were custody seals present? . . . . . yes no

If yes, how many?_____ Date _____ Signed?. . . . yes no Intact? . . . . . yes no

Custody papers sealed? . . . . . yes no Inside packaging? . . . . . yes no

Did sample containers arrive intact? . . . . . yes no

If no, list any samples broken _____

Shipping preservation: blue ice_____ ice_____ none_____ other_____

Temperature upon receipt: _____ °C

Geiger counter test . . . . . Negative Positive

Chain of custody filled out properly? . . . . . not present yes no

Did receiver sign chain of custody in correct place? . . . . . yes no

Were sample labels complete?

(ID, date, time, signature, preservative) . . . . . yes no

Did sample labels agree with chain of custody? . . . . . yes no

Were correct containers used for tests indicated? . . . . . yes no

If no, was pink slip filled out noting discrepancy? . . . . . yes no

Also, if no, was customer called and notified? . . . . . yes no

Were correct preservatives verified? . . . . . N/A yes no

If yes, pH of non-volatile samples _____

Was sufficient amount of sample delivered? . . . . . yes no

Were bubbles absent in VOA samples? . . . . . N/A yes no

Date samples were logged in _____ By whom _____

Additional comments: _____

_____

Figure 2-2

3.0 MATERIALS AND STANDARDS/SOURCES AND PREPARATION

The quality of reagents, solvents, gases, water and laboratory vessels used in analyses must be known so that their effect upon analytical results can be defined. Materials purchased by CLS Analytical meet the requirements stated below or as denoted in specific analytical procedures and are controlled as stated. Requirements must also be met for internally prepared materials such as water and compressed air.

The Quality Control Manager or other person as assigned by the Laboratory Director will retain responsibility for purchasing materials and controlling them in the laboratory. The duties of the materials coordinator include:

* Specifying in purchase orders suitable grades of materials (grade should be defined by the QC Coordinator or Laboratory Director)

* Verifying upon receipt that materials meet requirements and that, as applicable, material certificates are provided and maintained in the laboratory record system

* Identifying and storing materials

* Verifying that material storage is properly maintained and removing materials from use when expired.

3.1 REQUIREMENTS FOR REAGENTS, SOLVENTS, AND GAS

Chemical reagents, solvents and gas are available in a variety of grades of purity, ranging from technical grade to ultra-pure grades. The purity required varies with the type of analysis. The parameter measured and the sensitivity and specificity of the detection system are important factors in determining the purity of the reagents required.

Standards are obtained from NIST, commercial sources and are traceable to EPA, NIST CRADA (Cooperative Research And Development Agreement) or A2LA (American Association for Laboratory Accreditation). Our commercial suppliers include credible companies such as Ultra-Scientific, Chem Service, VWR, Aldrich,...etc. If after having checked all sources this is not possible, the best possible commercial standard will be traced down to a primary standard, and the supplier will be requested to provide QC data to support their accuracy and purity claims. Certificates for all standards are obtained and kept in a special log book/file which is available for review and inspection. If two sources of a standard are used, at least one standard shall have a certificate and the other shall be traceable to the certified standard through comparative study. All standards, stock or working, are labeled by their name and a unique identification number, traceable to the standard logbooks. Expiration dates are also found on the labels and in the logbooks. No expired standards shall be used. All log books pertaining to standards and standard traceability are audited monthly by the QA/QC department.

The lot numbers and sources of all standards and standard preparation reagents are recorded in special log books so that they can be traced for inspection or review.

CLS has SOPs for the procurement, storage and usage of all standards. These SOPs contain procedures for the ordering and purchasing of standards and reagents, the proper recording of all information pertaining to standards, the storage and storage time limitation of standards, and the correct analytical use of standards.

Carrier gas, solvents, acids and deionized water are checked on a batchwise basis. In this way it is possible to avoid systematic contamination of samples without repeating a set of samples as would be the case if we relied only on method blanks to detect such contamination.

3.1.1 General Inorganic Analyses

In general, Analytical Reagent Grade (AR) reagents and solvents are adequate for inorganic analyses. Primary standard reagents shall be used for standardizing all volumetric solutions. All prepared reagents shall be checked for accuracy.

Individual analytical methods specify the reagents that require frequent standardization, or special treatment. The Analyst must comply with these special operations. To minimize potential deterioration, the Analyst should prepare a limited volume of such reagents, depending on the quantity required over a given period of time.

3.1.2 Trace Metals Analyses

All standards used for atomic absorption and emission spectroscopy shall be spectro-quality. It is recommended that other reagents and solvents also be spectro-quality. In many cases, AR grade may be satisfactory. Standards are prepared by the Analyst, or purchased directly provided the materials meet the requirements of the analytical method.

In general, fuel and oxidant gas used for atomic absorption can be commercial grade.

Compressed air can be commercially supplied, dry grade or supplied by laboratory air compressors if adequate pressure is maintained and the air is filtered to remove oil, water and possible trace metals.

3.1.3 Organic Chemical Analyses

AR is the minimum acceptable grade for materials used for organic analyses; use reference grade standards only as necessary. Special note should be made of the assay of standard materials.

Some GC detectors require that solvents, standards and samples be free of certain classes of compounds. For example, use of the flame photometric detector requires that reagents and solvents be free of sulfur and phosphorus interference.

Pesticide-quality solvents are required for low-concentration work. AR grade solvents are adequate for analyzing industrial waste samples. However, the contents of each solvent lot must be checked to determine suitability for the analyses. Similarly, all analytical reagents and other chemicals must also be routinely checked.

For sample cleanup procedures, the adsorbents most commonly used for column chromatographic cleanup of sample extracts are Florisil, silica gel and alumina. These are pre-activated according to the analytical method requirements and checked for interfering constituents.

3.1.4 Water

Deionized water is used for dilution, preparation of reagent solutions and final rinsing of glassware. Distilled water is usually not of sufficient purity because distillation will not remove certain contaminants. Water quality shall be determined daily by measuring specific conductance and shall be recorded in a log book. A specific conductance less than 0.06 umho/cm at 25 °C is required. This is equivalent to less than 0.1 mg/L of ionized material.

Organic-free water is required for microbiological and volatile organic analyses. Organic-free water may be verified by the purge-and-trap technique on the GC.

However, when determining trace organics by solvent extraction and gas chromatography, specialty water such as HPLC grade water with sufficiently low background must be used. Pre-extraction of the water with the solvent used in the analysis may be helpful in eliminating organic compounds in the water.

3.1.5 Compressed Air

Compressed air must be free of oil, water and dirt and of high quality, dry grade.

3.2 CONTAINERS

Containers used in the laboratories can affect the quality of results. Material composition, volumetric tolerances and cleaning are important considerations in laboratory containers. Sample containers are discussed in Section 2.1.

3.2.1 Composition of Laboratory Containers

Soft glass containers are not recommended for general use, especially for the storage of reagents. The glass recommended for general use is chemically resistant borosilicate glass, such as is manufactured under the trade names of Pyrex or Kimax. This glassware is satisfactory for analyses performed by CLS unless otherwise noted in the sampling or testing procedure. The use of plastic vessels, containers and other apparatus made of Teflon, polyethylene, polystyrene and polypropylene is desirable for certain specified applications.

The following guidelines should be considered when selecting the material composition of laboratory vessels:

* Borosilicate or polyethylene bottles are to be used for the storage of reagents and standard solutions, unless otherwise specified.

* Plastic containers should not be used for reagents and solvents used in organic analyses.

* Dilute metal solutions have a tendency to plate out on container walls over long periods of time; therefore, dilute metal standard solutions should be prepared at the time of analysis.

* The use of disposable glassware is satisfactory for some analyses, such as the use of disposable test tubes as sample containers for use with some automatic samplers.

* Plastic bottles of polyethylene and Teflon are satisfactory, in general, for the shipment of water samples. However, strong mineral acids such as sulfuric acid and organic solvents readily attack polyethylene.

* Borosilicate glassware is not completely inert, particularly to alkalis. Standard solutions of silica, boron and the alkali metals should be stored in polyethylene bottles.

3.2.2 Volumetric Container Specifications

CLS shall use glassware of sufficient accuracy as required for the analytical procedure for the measurement of sample or reagent volumes. This includes volumetric flasks, volumetric pipets and accurately calibrated burets. Less accurate types of glassware, including graduated cylinders and serological and measuring pipets, have specific uses when less exact volumes are permitted by the analytical procedure.

In general, volumetric containers will not be calibrated by CLS unless required by a specific analytical method. However, containers, primarily glassware, shall be purchased with the objective of meeting the correct end use of the container in an analytical procedure. Thus, for example, if an analytical method requires that Class A glassware be used, the Analyst shall fully comply with the method.

3.2.3 Glassware Cleaning Requirements

Methods of cleaning glassware are selected according to the substances that are to be removed and the analytical analysis required.

For inorganic analytical uses, all glassware will be placed into detergent water mix immediately after use and must not be allowed to dry. After a thorough soaking (at least 2 hours) glassware will be scrubbed and rinsed with hot water. All metals preparation glassware will soak for a minimum of 12

hours in a 10% nitric acid bath. The glassware will then be rinsed with D.I. water air dried and stored in a upright position.

Glassware used for phosphate determinations will not be washed with detergents containing phosphates. This glassware must be thoroughly rinsed with tap water and deionized water. For ammonia and Kjeldahl nitrogen determination, the glassware must be rinsed with ammonia-free water.

Glassware used in the determination of trace organic constituents in water, should be as free as possible of organic contaminants.

Glassware used for organic analysis should be soaked in hot water containing detergent for two hours, then scrubbed, resoaked in chem-solve for two hours, rinsed with D.I. water and allowed to dry. Once the glassware has dried it will be rinsed with methanol, air dried and stored with open end sealed with aluminum foil. In addition, glassware is heated in a kiln at 720°C to assure it is contaminant free.

Sampling bottles are all purchased certified clean, but if not they will follow the above procedure for cleaning, depending on the analysis requested. Bottles used for the collection of samples for organic analyses are rinsed successively with acid cleaning solution, tap water, deionized water, and, finally, several times with a redistilled solvent such as acetone, hexane, petroleum ether or chloroform. Caps should be washed with detergent, rinsed with tap water, deionized water and solvent. Liners are treated in the same way as bottles and are stored in a sealed container.

Alternate methods for cleaning may be used if it is demonstrated (such as by blank analysis) that the result is satisfactory. Also, disposable glassware may be used if applicable to the analytical procedure.

3.3 STORING AND MAINTAINING REAGENTS AND SOLVENTS

The following shall apply for storing and maintaining reagents and solvents:

* All standards and reagents will be logged into the standard log book, and the work standard log book, upon receipt or formulation of.
* Standard reagents and solvents are stored in accordance with the manufacturer's recommendations.
* Light-sensitive standard reagents or solvents are stored in a cool, dark place.
* Organic reagent standards are stored at or below 4 °C.
* Organic reference materials are stored in a freezer (at or below 0°C).

* Adsorbents for thin-layer and column chromatography are stored in the containers in which they are supplied, or according to the requirements of the individual analytical methods.

* When fresh stock solutions are required, dilutions of the old and new standard are compared to determine consistency.

* Standards are not maintained longer than recommended by the manufacturer or as specified in the analytical method.

4.0 INSTRUMENT CALIBRATION, MAINTENANCE AND REPAIR

Modern environmental chemical analysis is heavily dependent on properly maintained and calibrated instruments. The sensitivity and reliability of these high precision instruments require periodic maintenance and calibration to assure precise and accurate measurements. Therefore, CLS standard procedures include routine instrument calibration and maintenance.

4.1 CALIBRATION

The calibration program verifies that equipment is of the proper type, range, accuracy and precision to provide data compatible with specified requirements. All instruments and equipment that measure a quantity, or whose performance is expected at a stated level, are subject to calibration.

This section of the QA Manual prescribes the practices used by the laboratory to implement a calibration program. Implementation is the responsibility of the laboratory management and analysts. The Quality Assurance Coordinator shall review the implementation of the program.

Two types of calibration are discussed in this section:

* Operational calibration that is routinely performed as part of instrument usage, such as the development of a standard curve for use with an atomic absorption spectrophotometer. Operational calibration is generally performed for instrument systems.

* Periodic calibration that is performed at prescribed intervals for equipment, such as balances and ovens. In general, equipment that can be calibrated periodically is a distinct, single purpose unit and is relatively stable in performance.

4.1.1 Calibration Program

The program of calibration for laboratory instruments contains the following elements:

4.1.1.1 Calibration Procedures

Whenever possible, recognized procedures, such as those published by ASTM or the USEPA, or procedures provided by manufacturers shall be adopted by CLS. If established procedures are not available, a procedure shall be developed considering the type of equipment, stability characteristics of the equipment, required accuracy and the effect of operational error on the quantities measured. As a minimum, the procedures shall include:

* Equipment to be calibrated
* Reference standards used for calibration

* Calibration technique and sequential actions
* Acceptable performance tolerances
* Frequency of calibration
* Calibration documentation format

4.1.1.2 Calibration Frequency

Instruments and equipment shall be calibrated at prescribed intervals and/or as part of the operational use of the equipment.

Frequency shall be based on the type of equipment, inherent stability, manufacturer's recommendations, values provided in recognized standards, intended use, effect of error upon the measurement process, and prior experience. Calibration frequency is given in the method working SOP's which are in every CLS laboratory.

4.1.1.3 Calibration Reference Standards

Two types of reference standards are used within every CLS laboratory for calibration:

* PHYSICAL STANDARDS such as weights for calibrating balances and certified thermometers for calibrating working thermometers and ovens. These are generally used for periodic calibration.

* CHEMICAL STANDARDS such as Standard Reference Materials (SRMs) provided by the National Institute of Standards and Technology (NIST), EPA check standards, laboratory control standards or working (calibration) standards.

Whenever possible, physical reference standards shall have known relationships to nationally recognized standards (e.g., NIST) or accepted values of natural physical constants. If national standards do not exist, the basis for the reference standard shall be documented.

Physical reference standards shall be used only for calibration and shall be stored separately from equipment used in analyses.

In general, physical reference standards shall be at least four to ten times as accurate as the requirements for the equipment that they are used to calibrate; physical standards should be recalibrated every three years by a certified external agency.

Whenever possible, chemical reference standards shall be directly traceable to NIST SRMs. If SRMs are not available, compounds of certified high purity will be used to prepare calibration standards.

4.1.1.4 Calibration Records

Records shall be prepared and maintained for each piece of equipment subject to calibration. Records demonstrating accuracy of reference standards shall also be maintained.

Records for periodically calibrated equipment shall include, as appropriate:

* Identification number of equipment and type of equipment
* Calibration frequency and acceptable tolerances
* Identification of calibration procedure used
* Date calibration was performed
* Identity of CLS personnel and/or external agencies performing calibration
* Reference standards used for calibration
* Calibration data
* Certificates or statements of calibration provided by manufacturers and external agencies, and traceability to national standards
* Information regarding calibration acceptance or failure and any repair of failed equipment

Records for periodically calibrated equipment shall be maintained in the Instrument Use Log (Figure 4-1). The Logs are to be kept at the instrument for easy access by the analyst.

For instruments and equipment that are calibrated on an operational basis, calibration generally consists of determining instrumental response against compounds of known composition and concentration or the preparation of a standard response curve of the same compound at different concentrations. Records of these calibrations are maintained in several ways:

* The calibration data are kept with analytical sample data, and
* A log book is prepared for each instrument that contains all calibration data.

The former method provides response factor information directly with analytical data so that the analytical data can be readily processed and verified. The latter method provides an ongoing record of the calibration undertaken for a specific instrument; however, to process and verify the analytical data, the log must be used in conjunction with the raw data.

Also, the raw data package is complete as a unit. However, if samples from several projects are processed together, the calibration data must be copied and included with each group of data.

For operational calibration, the following procedures are used:

* Calibration data should be included with the raw analytical data. If samples from different projects are processed together, calibration data shall be copied and included

* A file should be maintained for each instrument in the Laboratory Operating Records that includes:
  - Calibration instructions (curve preparation, linear range); Procedures for chemical standards preparation
  - A bound instrument use log book maintained by the Analyst that contains:
    a. Notice of calibration failure and repairs
    b. Midpoint standard response
    c. Brief notice of calibrations performed

Working log books are indexed in the Laboratory Operations Records and maintained at the instruments by the analyst. All entries are made in indelible ink and signed and dated by the analyst.

Instrument ID's_____
California Laboratory Services
Instrument Use Log

QC Batch	Date	Analyst	Sample No.	Instrument Set Up

Figure 4-1 Instrument Use Log

4.1.2 Operational Calibration

Operational calibration is performed as part of the analytical procedure. Included is the analysis of a method blank and the preparation of a standard response (standard calibration) curve.

A brief discussion of the analysis of method blanks and preparation of standard curves and guidelines for the major instrument systems within the laboratory follows.

4.1.2.1 General Calibration Procedures

The initial phase of a laboratory testing program requires the selection and certification of the method best suited for an individual parameter. Certification, or verification, is the elimination or minimization of determinate errors that may be due to analyst error, the use of less-than-optimum equipment, reagents, solvents or gases. The quality of materials, even though they are AR grade or better, may vary from one source to another. The analyst must determine, through the use of reagent and/or solvent blanks, if materials are free from interfering substances that could affect the analysis. Other steps in certifying the method include the determination of a method blank and the preparation of a standard calibration curve.

4.1.2.1.1 Method Blank

After determining the individual reagent or solvent blanks, the analyst defines the method blank to determine if the cumulative blank interferes with the analysis. The method blank is defined by following the procedure step by step, including the addition of all of the reagents and solvents, in the quantity required by the method. If the cumulative blank interferes with the determination, steps must be taken to eliminate or reduce the interference to a level that will permit the combination of solvents and reagents to be used.

If the blank interference cannot be eliminated, the magnitude of the interference must be considered when calculating the concentration of specific constituents in the samples analyzed.

A method blank should be determined whenever an analysis is made. The number of blanks is determined by the method of analysis and the number of samples analyzed at a given time.

4.1.2.1.2 Standard Calibration Curve

Concurrent with the preparation of reagent and method blanks, a standard calibration curve is prepared for the instrumentation. Preparation of a standard calibration curve is accomplished by using calibration standards.

Calibration standards are also referred to as "working standards". They are prepared by mixing the species to be analyzed into the solvent that is to be introduced into the instrument.

The concentrations of the calibration standards are chosen to cover the working range of the instrument. All sample measurements are made within this working range. The calibration curve is prepared by plotting instrument response versus concentration of the species analyzed. Actual sample concentrations are then read directly from the calibration curve or determined by interpolation. Data reduction is done manually and/or by electronic data systems.

4.1.2.2 Calibration of the Gas Chromatograph and Gas Chromatograph/MassSpectrometers

Calibration of the gas chromatographs or gas chromatograph/mass spectrometers for organic compound analyses is performed simultaneously with the standardization of the instrument. A five-point standard curve is initially analyzed to calibrate instrument response and to define the working range of the instrument for the compounds of interest.

After initial calibration is established, mid-point calibration standards are run to confirm continuing instrument calibration.

Response Factors (RF) are to be calculated for each compound at each concentration level (acceptable response factors are given in the individual method SOP's). These RF will be averaged to generate the mean RF for each compound over the range of the standard curve. The mean response factor will be used to calculate the sample concentration of the compound of interest. When sample responses exceed the range of the standard curve, the sample will be diluted to fall within the range of the standard curve and be reanalyzed. The results of the daily GC standardization will be tabulated and filed with the corresponding sample analyses.

4.1.2.3 Calibration of Inductively Coupled Plasma Spectrometer (ICP, ICP/MS) and Atomic Absorption Spectrophotometer (AA)

The ICP, ICP/MS and AA are standardized for the metal of interest by the analysis of a set of calibration standards prepared by diluting a stock solution of known concentration. Five working standards are prepared by dilution of the stock standard. The concentration of the calibration standards is chosen so as to cover the working range of the instrument. Subsequently, all sample measurements are made within this working range. Once the working standards are prepared, they are analyzed on the ICP, ICP/MS or AA, and the instrument response is calibrated to provide a direct readout in milligrams of metal per liter of water.

The calibration is accomplished by inputting the metal concentration equivalent to the readout in absorbance units during analysis of the working standards.

Once the instrument has been initially calibrated, the analysis of the working standards is repeated during sample analysis to standardize instrument response during analysis and confirm the calibration settings. A typical analysis sequence is as follows:

* Working standards are prepared by dilution of a stock standard solution for the metal of interest
* A calibration curve within the working range of the instrument is established by analysis of five working standards
* The working standards are reanalyzed to confirm the calibration settings. If the calibration settings are not confirmed, the instrument is recalibrated
* The samples are analyzed for the metal of interest
* During sample analysis, a midpoint standard is analyzed to monitor instrument stability. If the analysis indicates that instrument calibration has changed, the instrument is recalibrated and the analysis is repeated
* Following completion of the sample analyses, the working standards are reanalyzed to confirm calibration settings. If calibration settings are confirmed, the analysis is completed. However, if the calibration settings are not confirmed, the problem is corrected and the analyses are repeated
* Analysis data may be input (if available) into a computer data file for later calculation and normalization for matrix effects

4.1.3 Periodic Calibration

Periodic calibration shall be performed for equipment such as balances, thermometers, ovens and furnaces that are required in analytical methods, but that are not routinely calibrated as part of the analytical procedure. Documentation of calibration shall be kept for each equipment item.

Calibration requirements are determined within the laboratory depending upon the equipment used and its operating function. Following is an example for the calibration of balances with examples of a calibration data sheet to serve as a guideline for the preparation of laboratory-specific procedures.

4.1.3.1 Balances

All balances shall be calibrated daily using weights traceable to the National Institute of Standards and Technology (NIST). Calibration weights shall be Class S or better and shall be recertified every year. If balances are calibrated by an external agency, verification of their weights shall be provided.

Calibration of balances shall be to approximately 95 percent of balance capacity. Acceptance for balances that are direct reading to 0.01 gram shall be +/- 0.01 g for 0 to 100 g and +/- 0.1 percent

of the applied weight for more than 100 g. Figure 4-2 provides an example data sheet that can be used for balance calibration.

Date	Weights Applied to Balance	Balance Reading	Tested By:

Figure 4-2 Balance Log

4.2 INSTRUMENT MAINTENANCE AND REPAIR

The purpose of instrument maintenance is to maintain proper equipment performance and to prevent instruments and equipment from failing during use. An adequate maintenance program increases reliability of a measurement system and includes equipment cleaning, lubricating, reconditioning adjustment and/or testing.

Within the laboratory, the Laboratory Director is responsible for preparation and documentation of the program. Department Supervisors shall implement the program, and the QC Coordinator shall review implementation to verify compliance.

CLS's maintenance program considers several factors:

1. Instruments, equipment and parts thereof that are subject to wear, deterioration or other change in operational characteristics without periodic maintenance.

2. Spare parts that should be available within the laboratory to minimize downtime.

3. Frequency that maintenance is required.

Preventive maintenance should be documented as discussed below and the records stored. A file for each instrument should be maintained by the department supervisors. The instrument file should include:

* Spare parts list
* External service contracts
* Checklist of items to be serviced and directions for maintenance or manufacturer's instrument manuals
* Record of periodic maintenance

The record of maintenance can be documented using Figure 4-3. It should be noted if parts are replaced or if the instrument has deteriation from use, etc. Key elements of the maintenance program are:

1. A listing of the instruments and equipment that are included in the program.

2. The frequency of maintenance considering manufacturer's recommendations and/or previous experience with equipment. Frequency should be stated in terms of monthly or quarterly.

3. For each instrument in the program provide:
   a. A list of spare parts maintained by the laboratory
   b. External service contracts
   c. Items to be checked and/or serviced during maintenance and directions for performing maintenance (if external service is not provided, or if not stated in manufacturer's instrument manuals)

Instrument ID

Date	Time	Name	Maintenance/Service/Parts/Remarks

Figure 4-3 Instrument Maintenance Log

5.0 QUALITY CONTROL SAMPLE ANALYSIS

This section discusses samples that are routinely added to the normal laboratory sample stream to demonstrate that the laboratory is operating within prescribed requirements for accuracy and precision. Quality control samples are of known content and concentration (with the exception of field blanks) to ensure that accuracy and precision can be determined and control charts can be prepared. Evaluation of these data are discussed in Section 7.1.

Following is a discussion of the major types of quality control samples. QC samples will be analyzed as recommended herein, unless analytical procedures prescribe other specific QC sample analysis. If the procedure is specific, the procedural requirements will be met.

As stated, Section 7.1 presents the statistical analyses of these samples.

5.1 ANALYSIS AND FREQUENCY OF BLANKS

5.1.1 Trip Blank Analyses

Volatile organics samples are susceptible to contamination by diffusion of organic contaminants through the Teflon-faced silicone rubber septum of the sample vial; therefore, trip blanks shall be analyzed to monitor for possible sample contamination during shipment. Trip blanks will be prepared by filling two VOA vials with organic-free water and shipping the blanks with the field kit. Trip blanks accompany the sample bottles through collection and shipment to the laboratory and are stored with the samples. Following the analyses, if the trip blanks indicate possible contamination of the samples, depending upon the nature and extent of the contamination, the samples may be corrected for the trip blank concentration or the sources re-sampled.

Results of trip blank analyses should be maintained with the corresponding sample analytical data in the project file.

5.1.2 Method Blank Analyses

A method blank is a volume of deionized laboratory water for water samples, or a purified solid matrix for soil/sediment samples, carried through the entire analytical procedure. The volume or weight of the blank must be approximately equal to the sample volume or sample weight processed. A method blank should be performed with each analytical batch of samples. Analysis of the blank verifies that method interferences caused by contaminants in solvents, reagents, glassware and other sample processing hardware are known and minimized. Results of method blank analyses will be maintained with the corresponding analytical data in the project file. For a method blank to be acceptable for use with the accompanying samples, the concentration in the blank of any analyte of concern must be no higher than the highest of either:

1) The detection limit, or
2) Five percent of the regulatory limit for that analyte, or

3) Five percent of the concentration in the sample.

5.2 ANALYSIS AND FREQUENCY OF REPLICATES

5.2.1 Replicate Sample Analyses

Replicate analyses are performed to evaluate the precision of an analysis. Results of the replicate analyses are used to determine the relative difference between replicate samples. Criteria for evaluating replicate sample results are provided in Section 7.1. A replicate analysis should be performed on every group of twenty samples analyzed. Replicate analysis results should be summarized on the quality control data summary form.

The frequency of replicates is specified in many analyses, and CLS analyzes, as a minimum, the percentage of replicate specified. The replicate aliquots are carried through the entire workup and analytical scheme.

Care is taken to assure that soils and hazardous wastes are replicated at least as frequently as waters and wastewaters.

5.2.2 Blind Replicate Analysis

A blind replicate sample is a replicate sample that has been introduced as a separate sample by the Quality Control Manager during the log-in process or prior to analysis. Evaluation of the replicate is discussed in Section 8.1. This data is reported to and summarized by the Quality Control Manager.

5.3 ANALYSIS AND FREQUENCY OF SPIKED SAMPLES

Samples are spiked with known amounts of chemical entities being measured in order to determine the percent recovery.

5.3.1 Matrix Spikes

At least one matrix spike (MS) and one matrix spike duplicate (MSD) will be analyzed per analytical batch (if not enough sample is available for matrix spike than a Laboratory Control Sample and a Laboratory Control Sample Duplicate will be used as QC samples). A matrix spike is defined as a sample matrix that has predetermined quantities of stock solutions of certain analytes added prior to sample extraction/digestion and analysis.

To evaluate the effect of the sample matrix upon analytical methodology, a separate aliquot sample should be spiked with the analyte of interest and analyzed with the sample. The percent recovery for the respective analyte will then be calculated.

If the percent recovery falls outside quality control limits, the data should be evaluated and the sample reanalyzed if criteria are not met. Matrix spike results should be summarized on the quality control data summary sheets.

5.3.2 Regulatory Spikes

When sample analysis requires values within a specified percent recovery of a regulatory limit, the sample will be spiked with a standard of concentration (suggested in the method) and the spiked sample analyzed. Recoveries are calculated and reported by percent basis. In this manner, the spike serves to provide information on accuracy of the procedure.

5.3.3 Replicate Spikes

Certain methods specify running replicate spikes. A regulatory spike is a subpart of replicate spike. Frequently, the replicate spike is run at one to five times the concentration of the observed sample value or at one to five times the background level, depending on method requirements.

5.4 STANDARDS AND REFERENCE MATERIALS

Standards and reference materials will be obtained per procedures specified in Section 3. Proper laboratory analysis procedure requires the use of the following types of standards and reference materials.

5.4.1 Laboratory Control Samples

A laboratory control sample (LCS) and a laboratory control sample duplicate (LCSD) will be processed with each analytical batch. A LCS is defined as a known matrix spiked with compound(s) representative of the target compounds, which is run through the entire analytical procedure. Only the LCS needs to be reported, unless the MS or MSD fail their parameters. The results of the LCS are compared to control limits established for both precision and bias to help determine the useability of the data.

5.4.2 Working or Calibration Standards

Calibration of Instruments such as GC, ICP, and AA requires use of standard solutions. These calibration standards are carefully prepared by volumetric or gravimetric methods and standardized against the laboratory control standards before use in the laboratory.

Because instrument response and calibration curves are subject to change and can vary from day to day, a midpoint standard or check standard will be analyzed at the beginning of analysis, every 10 samples thereafter and at the end of sample analysis.

Analysis of this standard is necessary to verify the standard curve and may serve in some cases to be sufficient for calibration. This value should be entered in the instrument calibration log whenever performed. Check standard analyses results should be summarized on the quality control data summary form.

5.4.3 Surrogates

A surrogate is an organic compound which is similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which is not normally found in environmental samples. Surrogates are typically spiked into the samples prior to extraction and thereby provide recovery data for sample workup. Although such data is typically derived from compounds closely related to the compounds under investigation, it is not compound-specific and in the strict sense should not be used for making corrections for recovery. Since the information is provided with every sample, it is nevertheless very useful in detecting both sample-specific and systematic recovery problems. Surrogates will be run on all organic analysis including spikes and blanks. If surrogate recoveries exceed their specified control limits corrective action will be implemented as specified in the individual method SOPs.

5.4.4 Certified Reference Materials

On a quarterly basis, the Quality Control Manager should introduce a group of prepared verification samples (Standard Reference Materials) into the analytical testing regime. Results of these data will be summarized, evaluated and presented to laboratory management for review and corrective actions, if appropriate.

The data are reported to and summarized by the Quality Control Manager. Certified Reference Materials are acquired from such sources as the National Institute of Standards and Technology, EPA (performance evaluation standards), the American Industrial Hygiene Association, and ERA.

5.4.5 QC Batches

A number of samples of similar matrix, origin and composition which are analyzed together with the same method sequence and the same lots of reagents with manipulations common to each sample within the same time period or in continuous sequential time periods shall be known as a QC batch.

The number of total samples in an QC batch should not exceed twenty samples plus the number of samples required to perform QC evaluation of the twenty initial samples.

A sequential number will be assigned to the QC batch prior to batching a number of samples. This number will be obtained by using the next sequential number available as recorded in the QC Batch Log Book.

The QC Batch Log Book will contain information pertaining to each QC batch and will include the sequential batch number, date batch assigned, analysis to be performed, analyst who assigned the batch, the sample numbers to be analyzed, and additional notes as required.

5.5 INTER/INTRA-LABORATORY PERFORMANCE EVALUATIONS

The performance of CLS's laboratories is monitored by the participation in the EPA's Inter-Laboratory performance evaluation program. This program includes the EPA's Water Pollution (WP)

and Water Supply (WS) programs. Under these programs the EPA issues blind PE samples with known concentrations to participatory laboratories every six months. CLS also receives PE samples from NIST. CLS obtains intra-laboratory PE samples from commercial companies such as Environmental Resource Associates.

The chemists, the Laboratory Director and the company President are kept informed of all inter/intra-laboratory performance evaluations. If a method fails or is found to be suspect, appropriate corrective actions are taken immediately. If any results are found to be outside the established control limits, the method will be evaluated and the problem resolved prior to performing any additional tests.

6.0 PERFORMANCE AND SYSTEMS AUDIT

A QA audit is an independent assessment of the measurement system. The purpose of the performance audit is to qualitatively and quantitatively assess the data output generated at any level within the laboratory during the data collection. The results of the audit are formulated into a report detailing the overall system performance and deficiencies, plus any recommendations.

6.1 QUALITY ASSURANCE AUDITS

The QA manager or QC chemist will perform a performance audit monthly. Audits are considered an essential part of the CLS Quality Assurance Program. CLS conducts two types of audits; a system audit to qualitatively evaluate the operational details of the QA program, and a performance audit to evaluate the quantitative outputs of all measurement systems.

These audits are combined into one summary audit. The audit includes: (1) laboratory inspection to ensure the laboratory, instruments and equipment, etc., are kept in good condition, and all records of standard preparation, calibration, sample preparations, etc., are documented; (2) data validation: selected tests/reports will be audited, and the complete QC package from log-in to report generation will be checked; (3) Assessment of QC sample analysis; (4) Record filing and retreivability. A checklist will be used by CLS QA personnel when performing audits to assure that nothing is overlooked. Major elements of the audits are listed below:

- SOPs are available and updated
- Standards are not expired
- Lab notebooks have been signed and reviewed
- Instrument performance and logs are updated
- Properly trained chemist(s) are performing analysis
- Traceability of all analysis
- Safety practices of laboratory personnel

The audit results will be documented and given to the laboratory director and all managers, as well as being available for review by the company President.

6.2 SUBCONTRACTOR LABORATORIES

CLS periodically sends samples to other laboratories for analysis that are not performed at CLS. Before CLS sends samples to a contract laboratory, CLS requires an updated ELAP certificate, contractors QA Manual, and WS/WP results. In addition, CLS may submit QA samples to assure sample integrity.

7.0 ANALYTICAL PROCEDURES

CLS utilizes USEPA prescribed methods whenever applicable. Other sources of analytical methods may be used for other analyses if widely recognized by industrial and government laboratories. Industry standard methods are published by USEPA, American Public Health Association (APHA), American Society for Testing and Materials (ASTM), National Institute for Occupational Safety and Health (NIOSH), and American Industrial Hygiene Association (AIHA).

A brief summary of the method sources for performing "certified" analyses, as well as other commonly used references, is located in Table 7-1.

Analysis will be performed in accordance with the methods cited herein unless specific project requirements or needs dictate modification of the cited methods or adoption of an alternate method. An example of this would be Coliform analysis. Under the "Total Coliform Rule," coliform analysis can be invalidated either from consequences of interference or a positive result as a consequence of laboratory error.

If analysis is performed in an alternate manner, the method shall be documented in the project records.

Accurate environmental analysis involves the need for several activities to be performed in coordination with or coincidental to actual analysis; e.g. 1) sample procurement and storage (Section 3) as above to preserve sample integrity, 2) Instrument Calibration, 3) Analysis of QC samples, standards to assess recovery, matrix affects, range within linearity, 4) Extraction of the analytes from the matrix. Each of these aspects is discussed elsewhere in this manual.

7.1 SOPs

CLS relies heavily on the use of Standard Operating Procedures (SOPs). CLS's SOPs not only include the instrumentation and method procedures but include all aspects of the complete analytical process, from sample receipt to waste disposal.

No procedure or task is accepted for use until an appropriate SOP has been written and approved by both the QA/QC Manager and Laboratory Director. All SOPs are reviewed by the QA/QC Manager annually or after any modifications or alteration. SOPs are kept in the appropriate lab areas, readily available to each analyst.

Federal Register, 40 CFR Part 136, Oct. 26, 1984.

"Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater," EPA 600/4-82-057, July 1982.

"Methods for the Chemical Analysis of Water and Wastes," EPA 600/4-79-020, Revised, March 1983.

"Methods for the Determination of Organic Compounds in Drinking Water", EPA 600/4-88/039, December 1988.

"Standard Methods for the Examination of Waste and Wastewater," 17th Ed. APHA-AWWA-WPCF, 1989.

"Standard Methods for the Examination of Waste and Wastewater," 18th Ed. APHA-AWWA-WPCF, 1992.

"Test Methods for Evaluating Solid Waste," USEPA SW-846, November 1986, Third Edition.

"Test Methods for Evaluating Solid Waste," USEPA SW-846, November 1990, Third Edition Update I.

A number of additional methods are summarized in the "AB 1803 Methods Manual" issued by the California Department of Health Services, 1984.

Table 7-1 Basic References for Analytical Methods

8.0 QUALITY CONTROL DATA PROCESSING AND VALIDATION

Data processing and validation within the analytical laboratory ensure that results reported correctly represent the analyses performed. This function has two primary activities:

* The processing of quality control sample results to demonstrate that analyses are within laboratory prescribed bounds for accuracy, precision and completeness.

* Sample reduction and validation to demonstrate that numerical computation of data is correct and that it is correctly reported.

This section discusses the computation process and Section 9.0 discusses maintenance of resulting records.

8.1 PROCESSING OF QUALITY CONTROL DATA

This section discusses the analytical treatment of the data resulting from the quality control samples discussed in Section 5.

8.1.1 Assessment of Data Precision and Accuracy

All data generated must be evaluated for precision and accuracy by the following procedure. Quality control sample analyses are performed as appropriate for organic or inorganic sample analyses as discussed in Section 5. The protocol used will be in accordance with specific analytical procedures if QC requirements are stated in the procedure.

8.1.1.1 Frequency and Types of QC Samples

Reagent or Method Blank-A reagent and/or method blank is prepared and analyzed with each batch of samples.

Trip Blank-Trip blanks are analyzed to determine possible sample contamination during collection and shipment to the laboratory. Trip blanks are applicable to volatile organics analysis (VOA) where volatile contaminants can be introduced from ambient air on site, during shipment and in the laboratory.

Calibration Curve-A calibration curve consisting of standards and a reagent blank are prepared for each parameter. If the standard curve is within acceptance criteria for the method in use, the standard curve will be verified by the analysis of a midpoint standard.

Replicate Minimum-As a minimum, one sample in every sample set of twenty samples is analyzed in replicate.

Mid-Concentration Spike -As a minimum, two samples in every sample set of twenty samples is spiked at a mid-concentration level to provide a final concentration within the expected range of the samples.

Blind Replicate-A blind replicate, unknown to the analyst, is introduced by the Quality Control Department quarterly. Blind replicates are routinely used for the analysis of metals, water quality parameters and organics analyses that do not require separate extraction.

Standard Reference Materials-Standard Reference Materials (SRMs) are introduced at least annually into the testing scheme by the Quality Control Manager to evaluate the testing procedure and the analyst's performance.

Check Standards- A check standard consisting of deionized water spiked with the parameter of interest is analyzed. Check standards are routinely used for the analysis of metals, water quality parameters and some organics parameters.

Surrogate Standard Spike-Every sample is spiked with the required and appropriate surrogate standards prior to extraction and analysis for volatile organic compounds, and base/neutral and acids.

Internal standards-Internal standards are added to samples as prescribed in each specific method.

Laboratory Control Samples-Laboratory Control Samples are substituted twice per analytical batch. They serve to check for laboratory induced artifact contamination.

8.1.1.2 Acceptable Limits of QC Samples

When the analyses of a sample set are completed, the results will be reviewed and evaluated to assess the validity of the data set. Review is based on the following criteria:

Method Blank Evaluation- The method blank results are evaluated for high readings characteristic of background contamination. If high blank values are observed, laboratory glassware and reagents should be checked for contamination and the analysis halted until the system can be brought under control. For a method blank to be acceptable for use with the accompanying samples, the concentration in the blank of any analyte of concern must be no higher than the highest of either:

1) The detection limit, or
2) Five percent of the regulatory limit for that analyte, or
3) Five percent of the concentration in the sample.

Trip Blank Evaluation-Trip blank results are evaluated for high readings similar to the reagent and/or method blanks described above.

If high trip blank readings are encountered, the procedure for sample collection, shipment and laboratory analysis should be reviewed. If both the reagent and/or method blanks and the trip blanks exhibit significant background contamination, the source of contamination is probably within the laboratory. In the case of VOA, ambient air in the laboratory and reagents should be checked as possible sources of contamination.

High trip blank readings for other parameters may be due to contaminated sample bottles or cross-contamination due to sample leakage and poorly sealed sample containers.

Calibration Standard Evaluation-The calibration curve is evaluated to determine linearity through its full range, and that sample values are within the range defined by the low and high standards. If the curve is not linear, sample values must be corrected for nonlinearity by deriving sample concentrations from a graph or by using an appropriate algorithm to fit a nonlinear curve to the standards.

Replicate Sample Evaluation-Replicate sample analysis for the sample set is used to determine the precision of the analytical method for the sample matrix. The replicate results are used to calculate the precision as defined by the relative percent difference (RPD). The precision value, RPD, should be plotted on control charts for the parameter determined.

If the precision value exceeds the warning limit for the given parameter, the appropriate Department Supervisor, Laboratory Director or the Quality Control Manager is notified. If the precision value exceeds the control limit, the sample set must be reanalyzed for the parameter in question.

Matrix Spike Evaluation-The observed recovery of the spike versus the theoretical spike recovery is used to calculate accuracy as defined by the percent recovery. The accuracy value, (percent recovery) may be plotted on a control chart for the parameter determined. If the accuracy value exceeds the warning limit for the given parameter, the appropriate Supervisor, Manager or the Quality Control Manager is notified.

Blind Replicate Evaluation-The blind replicate analysis is evaluated in the same manner as described above for the replicate sample analysis and is treated as a replicate result for purposes of evaluating the precision of the analytical method.

Reference Standard Evaluation-Standard Reference Materials analyses are compared with true values and acceptable ranges. Values outside the acceptable ranges require corrective action to determine the source of error and provide correction action. All sample analyses should be halted pending this evaluation. Following correction of the problem, the Standard Reference Material should be reanalyzed.

Laboratory Control Sample Evaluation-The results of the Laboratory Control Sample analysis are compared with the true values, and the percent recovery of the sample is calculated. If correction is required, the control sample and the samples in its batch should be reanalyzed to demonstrate that the corrective action has been successful.

Surrogate Standard Evaluation-The results of surrogate standard determinations are compared with the true values spiked into the sample matrix prior to extraction and analysis and the percent recoveries of the surrogate standards are determined. For aqueous and soil matrices, these laboratory established surrogate control limits should be compared with the control limits given in SW846 or laboratory generated.

If recovery is not within limits, the following are required:

- Check to be sure that there are no errors in the calculations, surrogate solutions or internal standards. If errors are found, recalculate the data accordingly.
- Check instrument performance. If an instrument performance problem is identified, correct the problem and re-analyze the extract.
- If no problem is found, re-extract and re-analyze the sample.
- If, upon re-analysis, the recovery is again not within limits, flag the data as "estimated concentration".

8.1.2 Statistical Evaluation of QC Data

As part of the analytical quality control program, CLS determines precision and accuracy for each parameter analyzed.

Initially, when these data are compiled, the evaluation is applied over a broad concentration range. As more data is accumulated, precision and accuracy determinations are updated and criteria developed to define precision and accuracy over specific concentration ranges.

8.1.2.1 Control Chart Evaluation

Precision and accuracy criteria will be applied to each parameter that is analyzed. When analysis of a sample set is completed, the quality control data is reviewed and evaluated through the use of control charts to validate the data set.

Control charts may be established for all major analytical parameters.

A minimum of seven measurements of precision and accuracy are required before control limits of two standard deviations shall be considered valid. Once established, control limits are updated as additional precision and accuracy data become available by the Quality Control Manager.

8.1.2.1.1 Analytical Precision

General Considerations

To determine the precision of the method and/or laboratory analyst, a routine program of replicate analyses is performed. The results of the replicate analyses are used to calculate the relative percent difference (RPD), which is the governing quality control parameter for precision.

The RPD for replicate analyses is defined as 100 times the difference (range) of each replicate set, divided by the average value (mean) of the replicate set. For replicate results D_1 and D_2, the RPD is calculated from:

$$RPD = \frac{|D_1 - D_2|}{\frac{D_1 + D_2}{2}}$$

When the RPD is obtained for at least seven replicate pairs, the average RPD and the standard deviation are calculated using:

$$\overline{m} = \frac{\sum_{i=1}^{n} m_i}{n}$$

and

$$S_m = \sqrt{\frac{\sum_{i=1}^{n} (m_i - \overline{m})^2}{n-1}}$$

where

m_i = the RPD of a replicate pair,
$\bar{m}$ = the average of the Relative Percent Difference determination,
S_m = the standard deviation of the data set of RPD determinations,
n = the number of RPD determinations.

When constructing a control chart for a specific parameter, the Warning and Control Limits are then calculated from the following:

$$\text{Upper Control Limit} = \bar{m}+3S_m$$
$$\text{Lower Control Limit} = \bar{m}-3S_m$$
$$\text{Upper Warning Limit} = \bar{m}+2S_m$$
$$\text{Lower Warning Limit} = \bar{m}-2S_m$$

A control chart is established by plotting the RPD of each replicate pair on a graph generated as follows:

* The average of the RPD determinations for the original data set is established as the midpoint on the Y axis of the graph.

* The Upper Warning and Control Limits calculated above are plotted as solid horizontal lines across the graph at their respective points on the Y axis above the mean of the RPD determinations.

* The calculated RPD of each replicate pair is plotted on the graph to determine whether the RPD is within the Warning and Control Limits of the Control Chart.

* If the RPD plots between the Warning and Control Limits, the group leader, laboratory director or quality control manager is notified for a decision as to how to proceed.

* If the RPD plots outside the Control Limits, the data set is invalid and the analysis is stopped until the source of error has been determined and corrective action taken. Once the error source has been resolved, the data set is reanalyzed.

8.1.2.1.2 Analytical Accuracy

When a program for evaluation of analytical accuracy is established, the evaluation is applied over the entire range of spiking concentrations. As more data are accumulated, the evaluation procedure is refined to define the analytical accuracy of the method over specific concentration ranges.

To determine the accuracy of an analytical method and/or the laboratory analyst, a periodic program of sample spiking is conducted. The results of sample spiking are used to calculate the quality control parameter for accuracy evaluation, the Percent Recovery (%R).

The %R is defined as the observed concentration minus the sample concentration, divided by the true concentration of the spike, all multiplied by 100.

$$\%R = \frac{O_i - O_s}{T_1} x100$$

where

%R = The Percent Recovery,
O_i = The Observed Spiked Sample Concentration,
O_s = The Sample Concentration and
T_1 = The True Concentration of the Spike.

When the Percent Recovery is obtained for at least ten spiked samples, the mean percent recovery and the standard deviation are calculated using the formulae:

$$\%\bar{R} = \frac{\sum_{i=1}^{n} \%R_i}{n}$$

and

$$S_R = \sqrt{\frac{\sum_{i=1}^{n} (\%R_i - \%\bar{R})^2}{n-1}}$$

where

%R	=	the Mean Percent Recovery
$\%R_i$	=	the Percent Recovery of a Single Spiked Sample,
n	=	the number of results and
S_R	=	the Standard Deviation of the data set of Percent Recovery determinations.

The Warning and Control Limits are then calculated from the following equations:

Upper Control Limit = $\%R+3S_R$
Lower Control Limit = $\%R-3S_R$
Upper Warning Limit = $\%R+2S_R$
Lower Warning Limit = $\%R-2S_R$

A control chart (as shown in Figure 8-1) is generated by plotting the Percent Recovery data on a graph as follows:

* The average of the Percent Recovery determinations for the original data set is established as the midpoint on the Y axis on the graph.

* The Upper Warning and Control Limits calculated above are plotted as solid horizontal lines across the graph at their respective points on the Y axis above the mean of the Percent Recovery determinations.

* The Lower Warning and Control Limits calculated above are plotted as solid horizontal lines across the graph at their respective points on the Y axis below the mean of the Percent Recovery determinations.

* The calculated Percent Recovery of each spiked sample is plotted on the graph to determine whether the Percent Recovery is within the Warning and Control Limits of the Control Chart.

* If the Percent Recovery plots between the Warning and Control Limits, the group leader, laboratory director or quality control manager is notified for a decision as to how to proceed.

* If the Percent Recovery plots outside the Control Limits, the data set is invalid and the analysis is stopped until the source of error has been determined and corrective action taken. Once the source has been corrected, the data set is reanalyzed.

* When an additional ten "Percent Recoveries" have been determined, the Warning and Control Limits are recalculated for the entire data set and the Control Chart for the corresponding parameter is updated.

All control charts are maintained by the Quality Control Manager.

8.1.2.2 Corrective Action/Out-of-Control Situations

In general, any result falling outside of control limits (generally set at +/- 3 standard deviation units) will require initiation of corrective action. Whenever this situation occurs, it will be immediately brought to the attention of the QA Coordinator and the laboratory Director.

The nature of corrective action will vary depending on interpretation of the seriousness of the situation by the QA Coordinator. Isolated outliers may be impossible to explain, and if warranted by previous and subsequent data, the outlier may be ignored. Consecutive recurrence of outliers will be viewed as indicative of a problem situation, and the process will be reviewed.

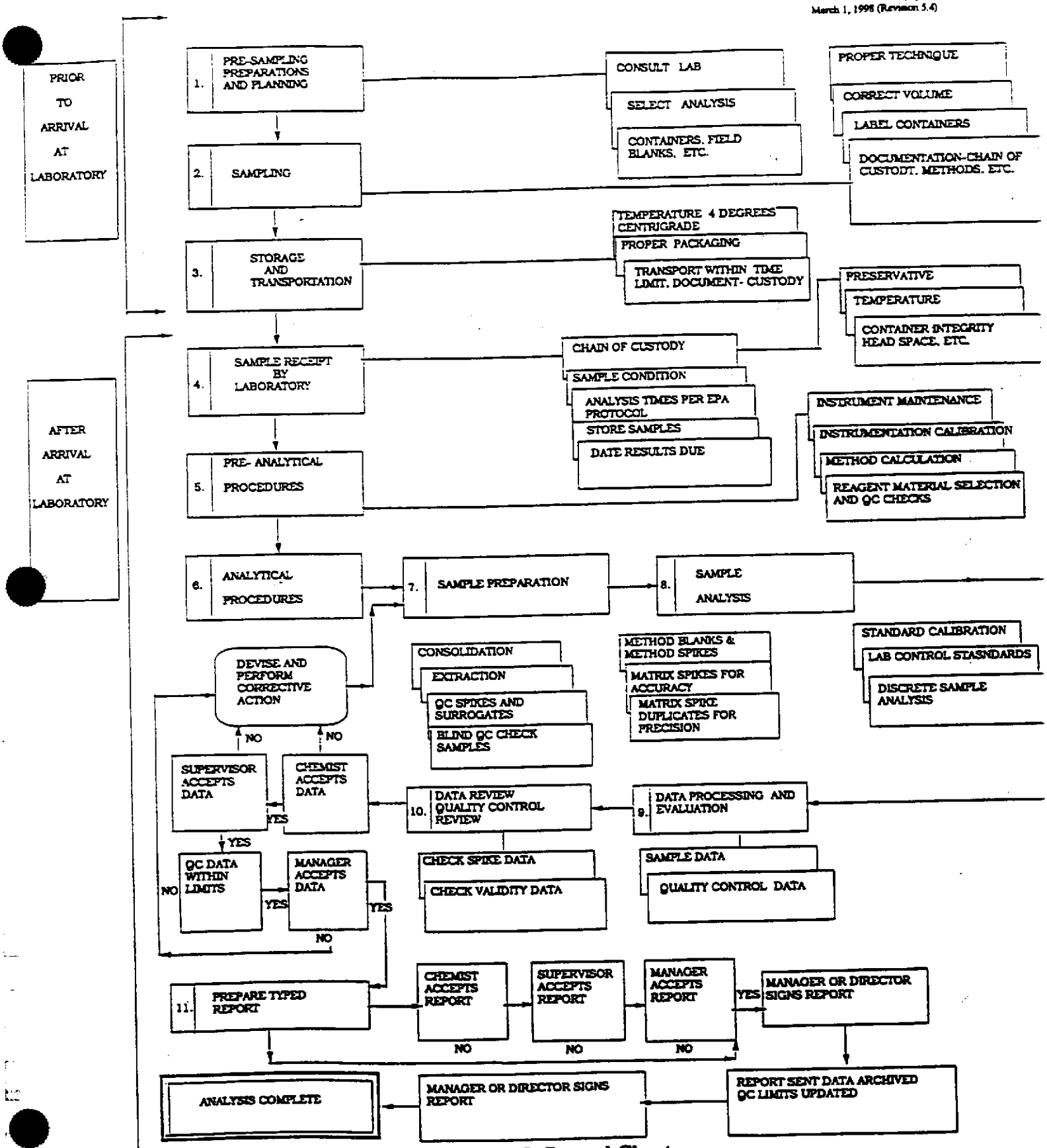


Figure 8-1 QC Control Chart

Most commonly, the out-of-control situation will require a series of corrective measures instituted to re-establish analytical validity. All analysis with the implicated method and instrumentation will be stopped until the problem is identified and resolved.

Review of recent historical data will be made to determine the time of the first variance from valid data, and data collected after that time discarded. Whenever possible all analyses performed after the last valid control check will be repeated.

Immediately following resolution of the out-of-control situation, an increased percentage of spikes and replicates will assure the situation is back to normal. This will continue until the QA Coordinator is satisfied that total resolution of the problem has occurred.

8.2 DATA VALIDATION

Data validation begins with the processing of data (including QC data) and continues through review of the data and the reporting of analytical results. Data processing will be performed by the Analyst independent of the data acquisition and processing. The Supervisor reviews (validates) that the data processing has been correctly performed and continues through verifying that the reported analytical results correspond to the data acquired and processed. Final review of the data to be reported is by the laboratory director.

8.2.1 Data Processing

In general, data will be processed by an Analyst by:

1. Manual computation of results directly on the data sheet or on calculation pages attached to the data sheets or
2. Input of raw data for computer processing or
3. Direct acquisition and processing of raw data by a data processing system (computer).

If the data is manually processed by an Analyst, all steps in the computation shall be provided including equations used and the source of input parameters such as response factors, dilution factors and calibration constants. If calculations are not performed directly on the data sheet, calculations should be done on standard calculation paper and attached to the data sheets. The analyst shall sign and date in ink each page of calculations. Full signature and date in ink are required in all instances.

For data that are input by an analyst and processed using a computer, a copy of the input shall be kept and uniquely identified with the project number and other information as needed. The samples analyzed shall be evident and the input signed and dated by the analyst.

If data are directly acquired from instrumentation and processed, the analyst shall verify that the following are correct: project and sample numbers, calibration constants and response factors, output parameters such as units and numerical values used for detection limits (if a value is reported as less than). The analyst shall sign and date the resulting output.

8.2.2 Review of Data Processing

Following is a discussion of the method to be used for reviewing (checking) data processing.

* The analyst performing the data processing shall give an analyst independent of the work the data package. The package shall include, as appropriate, raw data, data sheets, strip charts, computer input/output, calculations, sources for input parameters such as response factors.

* The independent analyst (checker) shall review the data for:
  - Appropriateness of equations used.
  - Correctness of numerical input.
  - Numerical correctness of all calculations. This should be done by performing numerical computations.
  - Correct interpretation of strip charts.

* All entries and calculations that the checker reviews shall be marked in ink with a check mark. The checking process must be thorough enough to validate that the results are correct. If the checker disagrees with any part of the computations, the checker shall mark through the number with a single line and place the revised number above it.

* Any changes made by the checker shall be re-checked by the originator. If the originator agrees with the change, no action is necessary. If the originator disagrees, the originator and checker must resolve the difference so they agree with the result presented.

* The checker shall sign originals and date in ink all pages of the data package (except for groups of printouts such as chromatograms). Signing and dating indicates that the reviewer agrees with the calculations and that any changes made have been agreed to by the originator.

* If the data have been processed by computer, the reviewer shall also check the input entries. If the checker disagrees with the input, the number should be marked through with a line and the corrected number indicated above it. Corrections must be re-checked by the originator as discussed above.

If an input error is identified and the data have been processed, it will be necessary to reprocess the data. In this event, the checker shall mark the second set of input to indicate agreement with the input changes. The checker shall sign and date in ink the computer input to indicate agreement.

* Raw data that are automatically acquired and processed do not require any validation at this point beyond that previously discussed.

* The reviewed data are maintained as discussed in Section 8.

8.2.3 Review of Data Reporting

Review of data reports is required to verify that information reported by the laboratory corresponds with processed analytical results. Intermediate steps performed after the processed data are checked to prepare the data report (such as data summaries) do not require validation. Preparation of the report is the responsibility of the department supervisor or laboratory director.

After the draft data report is prepared (generally in tabular form), the reported results should be checked against the reviewed processed data so that transcription errors do not occur. The checking process follows:

* Using the draft report, all data entries are checked. The checker can be an analyst or department supervisor. The checker is not required to be independent of the work because only the transcription from the reviewed data to data report is being checked.

* The draft data report should be checked so that the items cited for data presentation in Section 9.0 are complete and correct. Corrected entries are marked through with a single line and the correct entry is provided. The reviewer will indicate that corrections have been made in the report by placing a second check mark by the correction after comparing the change with the revised copy. The checker shall sign and date every page of the data report in ink.

* Use of the draft data report results in checkprint that should be maintained as a record to demonstrate the review.

* If data printouts, such as chromatograms are included in the data report, review is not required for the data printout.

9.0 DATA REPORTS AND MANAGEMENT RECORDS

9.1 DATA REPORTS

The format and content of a data report is dependent upon project needs, such as: whether or not explanatory text is required, client or contract requirements and government agency reporting formats. However, the final data presentation shall be checked in accordance with data verification requirements of Section 9 and approved by the Laboratory Director.

Also, data presentation reports include:

* Sample identification number used by CLS and/or the sample identification provided to the laboratory, if different than identification used in the laboratory.

* Chemical parameters analyzed, reported values and units of measurement.

* Reporting limit of the analytical procedure if the reported value is less than the reporting limit.

* Data for a chemical parameter are reported with consistent significant figures for all samples.

* Results of Quality Control sample analysis if appropriate.

9.2 RECORDS MANAGEMENT

CLS maintains all records in two categories. Specific regulatory or contractual demands may require additional documentation and in these instances, records shall be maintained as externally required.

9.2.1 Project Specific Documents

These are records and documents pertinent to a project. Examples of individual project specific documents are correspondence, chain of custody and data reports.

9.2.2 General Laboratory Operation Documents

These documents demonstrate overall laboratory operation, such as instrument log books and control charts. These records will directly affect the data for a specific project, but in general their applicability is not limited to one project.

9.3 RETENTION OF RECORDS

Records and files with be archived chronologically by subject and retained indefinitely. The only exceptions to this are general files regarding general management and file 400.5 which contain OSHA 200 Forms; these files will be archived for 5 years.

SAMPLE RECEIPT AND HANDLING OF SUSPECTED WHITE PHOSPHORUS CONTAINING SOILS.

1.0 White phosphorus is released into the environment from smoke munitions in the form of small, discrete particles. These particle persist in soils, sediments, and may occur as suspended or colloidal particles in anoxic waters. Therefore, some samples or sample aliquots from a given location may contain P_4 particles while others do not.

1.1 Soil samples received at lab will be handled carefully and inspected visually to ensure adequate wetting of said soil or sediment sample and placed in a refrigerator @ 4 degrees C..

1.2 All suspected P_4 samples shall be affixed with colored tape, noting the presence of P_4 in said sample. Only qualified personnel shall handle said samples.

Soil/Sediment Sample Extraction

2.0 Working inside a nitrogen-laden glove box, placed inside a fume hood, carefully homogenize the soil/sediment in its original container using a spatula. Weigh out 40 g. of homogenized wet sample into a pre-weighed 120-ml glass jar.

2.1 While still inside glove box, add 10.0 ml of degassed Type I reagent-grade water and 10.0 ml isooctane to the sample in the glass jar, seal the jar with a PTFE-lined cap.

2.2 Vortex the jar for one minute, then remove from glove box and place on shaker for 18 hours (overnight), ensuring during the course of the agitating phase that aliquot remains moist with liquid extract.

2.3 Remove aliquot of isooctane layer to a suitable container, then fill remaining jar with Type I reagent -grade water for disposal.

Disposal of Soil/Sediment Extracts

3.0 Place all jars containing soil/sediment extracts with water in metal drum with vermiculite and saturate with water.

3.1 Label said drum with, "*Waste phosphorus (white), 4.2, UN1381, PG I*", material will then be sent to Laidlaw Environmental for incineration.

MOUNTAIN STATES ANALYTICAL, INC.
LABORATORY QUALITY ASSURANCE PLAN

LABORATORY QUALITY ASSURANCE PLAN

This document is a generic quality assurance plan, with no specific project information. This Mountain States Analytical, Inc. Quality Assurance Plan conforms with the following guidelines:

EPA QAMS 005/80
ASME NQA-1
DOE Order 5700.6C
ISO Guide 25

among others.

Mountain States Analytical, Inc.
The Quality Solution

Mountain States Analytical, Inc.

The Quality Solution

July 17, 1998

Mr. Nathan King
McLaren Hart
1320 Harbor Bay Pkwy.
Suite 100
Alameda, CA 94502-6578

Dear Mr. King:

Please find the Laboratory Quality Assurance Plan enclosed per our conversation regarding the FMC project. We look forward to being able to work with your company in the future. Please let us know if you would like any additional information that is not enclosed in the LQAP.

In response to your request for an understanding of how we will be able to handle the potential phosphorus from FMC, please accept the following. We have been doing extensive work with FMC for the past seven years. Because of the special precautions needed in handling white phosphorus, we have given most of our laboratory staff special instructions regarding safety procedures for handling this material. The majority of our senior laboratory technicians have been working with white phosphorus for four to five years. Our chief sampler, who is responsible for collecting the samples at FMC is HAZMAT and OSHA 40 hour trained. He personally instructs any lab technician that will come in contact with a potential phosphorus sample of any special instructions for each sample. The samples are always returned to FMC because of the obvious liability.

We are very confident in our ability to process any sample regardless of possible phosphorus content, and we are especially comfortable with samples from FMC. Should you require any further clarifications in this area, please feel free to call us. Thank you for the opportunity to work with you.

Sincerely,

Rolf E. Larsen
Client Services Director

10 Years of Quality Service

Corporate Office
1645 West 2200 South, Salt Lake City, Utah 84119
801-973-0050 • 1-800-973-6724(MSAI) • FAX 801-972-6278
e-mail: service@msailabs.com

Southwest States Region
6223 Bayonne, Spring, Texas 77389
281-320-2842 • FAX 281-320-0989
e-mail: gbrewer@msailabs.com

MEMBER NCL II

LABORATORY QUALITY ASSURANCE PLAN

Mountain States Analytical, Inc.
Revision 1.1
January 16, 1998

Warning: The information contained herein is of a highly confidential and proprietary nature. Mountain States Analytical, Inc. (MSAI) specifically prohibits the dissemination or transfer of this information to any person or organization not directly affiliated with the project or purpose for which it was prepared.

Approvals:

Douglas W. Later, Ph.D.
President/Laboratory Director

Earl M. Hansen, Ph.D.
Executive Vice President Business Services

Beth A. Ebling, B.S.
Organic Department Leader

Jan D. Barbas, M.S.
Inorganic Department Leader

Rolf E. Larsen, B.A.
Client Services Leader

David H. Bunting, B.S.
Quality Assurance Director

These individuals received official copies of the MSAI Laboratory Quality Assurance Plan and should receive any subsequent official revisions.

Table of Contents

Laboratory Quality Assurance Plan

This document provides the laboratory portion of the response to EPA's "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" QAMS-005/80, Sections 5.1 - 5.16 as revised December 29, 1980, and EPA-600/4-83-004, February 1983. Guidance was also obtained from:

"Preparation Aids for the Development of Category 1 Quality Assurance Project Plans," Office of Research and Development, USEPA, EPA/600/8-91/003, February 1991.

"Requirements for Quality Control of Analytical Data for the Environmental Restoration Program," Martin Marietta Energy Systems, Inc., ES/ER/TM-16

ISO/IEC Guide 25: "General Requirements for the Competence of Calibration and Testing Laboratories".

DOE Order 5700.6C,"Quality Assurance", USDOE, August 1991

As much as possible, the procedures in this document have been standardized to make them applicable to all types of environmental monitoring and measurement projects. However, under certain site-specific conditions, all of the procedures discussed in this document may not be appropriate. In such cases it will be necessary to adapt the procedures to the specific conditions of the investigation.

List of Tables and Figures (Continued)

List of Company Policies and Procedures

List of Tables and Figures

Introduction and Description

It is the policy of Mountain States Analytical, Inc. (MSAI) to provide clients with scientifically valid and legally defensible analytical data. This Laboratory Quality Assurance Plan (LQAP) describes quality assurance and quality control procedures used during the generation of analytical data. Tests will be performed according to analytical methods approved by the U.S. Environmental Protection Agency (EPA) as specified in **40 CFR** (Code of Federal Regulations). Typically, the most recently promulgated reference versions will be used unless there is a specific requirement to use earlier versions. Method sources include USEPA SW-846[1], USEPA method publications (600/4-79-020, 600/4-91-010, 600/R-93/100, 600/4-88/039, etc.), Contract Laboratory Program (CLP) Statements of Work[2] for Inorganic and Organic analytes, **Standard Methods for the Analysis of Water and Wastewater**, 18th edition and American Society for Testing and Materials (ASTM) book of standards. Proven instruments and techniques will be used to identify and measure the concentrations of volatiles, semivolatiles, and pesticide compounds, inorganic elements, and general chemistry test analytes. The laboratory will employ state-of-the-art GC/MS and GC procedures to perform organic analyses. Also, instrument procedures for total organic carbon (TOC), total organic halides (TOX), and infrared (FTIR) spectroscopic methods will be used for analysis of organic compounds. Inorganic analyses will be performed using graphite furnace atomic absorption (GFAA) spectrophotometry, inductively coupled plasma (ICP) spectroscopy, cold vapor AA (CVAA), flame AA (FAA), or hydride generation AA (HAA). General chemical analyses will use appropriate instrumentation, such as a UV/Vis spectrophotometer, turbidimeter, pH meter, conductivity meter, and so forth. The client is responsible for providing specific requirements for any given project, especially if the requirements differ from the information presented in this document.

---

[1] Test Methods for Evaluating Solid Waste - Physical/Chemical Methods. SW-846 (3rd Edition, Update IIB, January 1995).

[2] USEPA Contract Laboratory Program, Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, ILM04.0
USEPA Contract Laboratory Program, Statement of Work for Organics Analysis, Multi-Media, Multi-Concentration, OLM03.1

Laboratory Organization and Personnel

The objectives of the Laboratory Quality Assurance Plan (LQAP) are to establish procedures that will ensure that data generated in the laboratory are within acceptable limits of accuracy and precision, to ensure that quality control measures are being carried out, and to ensure accountability of the data through sample and data management procedures. To this end, a Quality Assurance Department has been established at Mountain States Analytical, Inc. (MSAI). The Director of Quality Assurance reports directly to the Laboratory Director and has no direct responsibilities for data production, thus avoiding any conflict of interest.

The attached organizational chart shows the key personnel of Mountain States Analytical, Inc. Qualifications of key individuals may also be found in Appendix A.

The Client Services Group is responsible for sample management, client services, field sampling, and waste management. The Sample Administration group, within Client Services, is responsible for receiving samples, signing the external chain-of-custody, checking sample conditions, assigning unique laboratory sample identification numbers, initiating internal chain-of-custody forms, assigning storage locations, checking and adjusting preservation, and sample storage and disposal. Each client is assigned a Client Manager to enhance communication and to ensure that the client's needs are met. Trained field samplers are available on staff.

The Laboratory Operations Group is responsible for performing laboratory analyses, quality control as specified in the methods, instrument calibration, and technical data review. Data are reported using a computerized Laboratory Information Management System (LIMS), which tracks sample progress through the laboratory and generates client reports when all analyses are

clients and markets. This is done through participation in trade organizations and keeping informed of new projects and business opportunities.

complete. Quality control data are entered onto the same system, or other computerized systems, for purposes of charting and monitoring data quality.

The Quality Assurance Department is responsible for reviewing quality control data, conducting audits in the laboratory and reporting findings to management, controlling all analytical methods and standard operating procedures, submitting blind samples to the laboratory, and ensuring that appropriate corrective action is taken when quality problems are observed.

In addition, the Quality Assurance Department reviews the contents of the deliverables, when data packages are requested, for completeness and to be sure that all quality control checks were performed and met specifications. This step includes review of holding times, calibrations, instrument tuning, and results of blanks, duplicates, matrix spikes, surrogates, and laboratory control samples. Every attempt to meet specifications will be made, with any item outside the specifications noted in the case narrative of the data package. The laboratory will not validate data regarding useability since this generally requires specific knowledge about the site.

The responsibilities of the Support Services Group are accounting, payroll, human resources, computer information system management, communication, document control, and physical facilities' maintenance. The document control function also includes the responsibility for mailing analysis reports to clients.

The InSciTe Research Division performs studies and analyses that fall outside the scope of the routine laboratory analyses. This group generated test data used by the USEPA to approve an advanced sample preparation device.

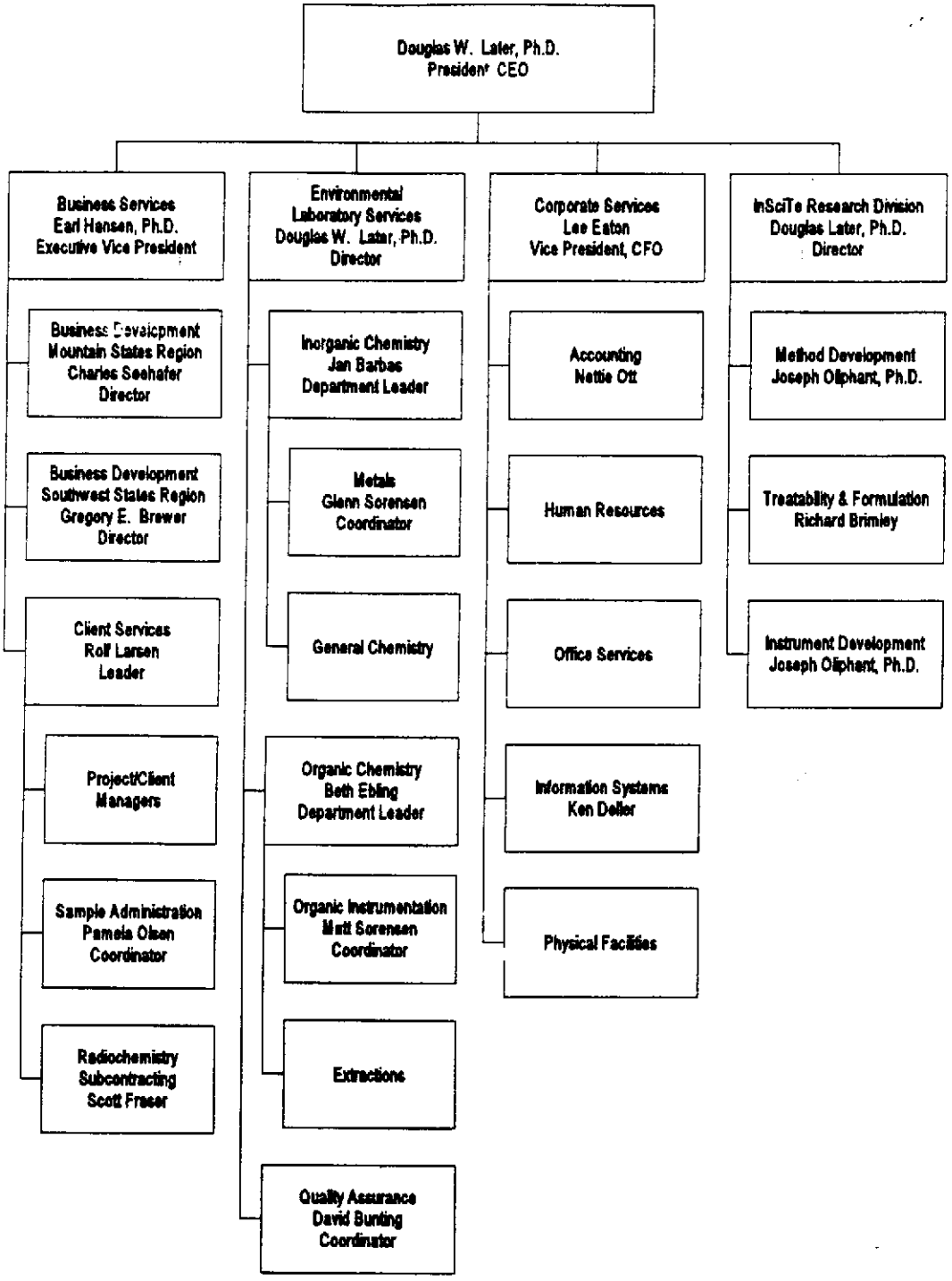
The Business Development Group actively promotes the capabilities of Mountain States Analytical, Inc. to a growing number of

Training and Qualification

Mountain States Analytical, Inc. possesses a professional and well-qualified staff. Every effort is made to hire the most qualified candidates. Internal training programs include not only technical on the job training, but value-added topics, such as total quality, ethics, and leadership. Scheduled, regular tests are conducted to ensure that employees have a good understanding of quality assurance and safety policies and procedures. A Training Coordinator oversees the various training activities to ensure that company-wide and department training is scheduled, carried out and documented. Documentation of training and acquired skills is explained in the following policy and procedure.

Figure 4-1

Organization of Mountain States Analytical, Inc.



leader and the staff member are jointly responsible for maintaining the training record.

Training Requirements. The group leader will ensure that members of the group receive the necessary training. An entry in the training record authorizes the employee to perform an analysis or function that will affect an analytical result. Before a staff member's training is complete, execution of a function will be supervised by a group leader or an experienced person designated by the group leader.

Evaluation of competency will be based on **knowledge** and **performance**. **Knowledge** is verified by training completion date and a statement that the SOP, CPP or analytical method was read and understood. Acceptable **performance** is determined from an applicable test. For an analyst, the preferred test criteria are precision and accuracy of results when performing a quadruplicate study, or analyzing a quality control standard.

Record Keeping. The following items, if applicable, are to be recorded in the Personnel Training Record.

- Pertinent skills (i.e., analytical methods, instrumental techniques, calibrations, etc.). Include the date of training completion, the name of the trainer, and, whenever possible, evidence of competency. Evidence of competency may include favorable results of known quality control samples, quadruplicate studies, proficiency samples from internal and external performance evaluation studies, and comparison of the analyst's results to those of an experienced analyst.

- Previous laboratory experience. A copy of a résumé is acceptable.

- Attendance at seminars or completion of special courses offered in-house or by outside organizations. A

COMPANY POLICY AND PROCEDURE: CPP-QA-016

Title: Personnel Training Records

Purpose:

To ensure that technical personnel who influence the quality of MSAI's services are properly trained and that an appropriate record of that training is kept.

Scope:

This policy establishes training requirements, identifies who must keep Personnel Training Records, and explains how training is documented.

Background Information:

The training received by technical personnel is of great importance to clients, regulatory agencies, and accrediting bodies. Personnel Training records demonstrate that laboratory personnel have been adequately prepared for the duties they perform. Certain regulations governing our laboratory operations require that training records be kept. Personnel Training Records may also help present analysts' qualifications during court testimony.

Policy/Procedure:

A Personnel Training Record is kept for each regular staff member. Training records for temporary or periodic staff members may be kept at the discretion of the group leader and Training Coordinator.

The Training Coordinator will ensure that each employee has a training record and understands this policy document. The group

Forms:

This policy and procedure includes a set of forms for summarizing key information in the training record.

Note: These forms help summarize training information, but they do not take the place of raw data, certificates, narrative descriptions of training, performance evaluation reports, etc.

Form I, MSAI Training Record Cover Sheet (Figure 4-2)

Use this form to list education, positions held and work experience.

Form II, Training Courses (Figure 4-3)

This form is used to record completed training courses.

Form III, Company Policies Read and Understood (Figure 4-4)

This is a record of policies and procedures that have been read and understood.

Form IV, Instrument Training and Proficiency (Figure 4-5)

Training on maintenance, calibration, and use of instruments and equipment is summarized using Form IV.

Form V, Method and SOP Training and Proficiency (Figure 4-6)

Use this form to record understanding, training, and proficiency in analytical methods and standard operating procedures.

training certificate is acceptable.

- Comprehension of policies and procedures. Each employee must read designated policies and procedures relating to quality assurance, safety (general laboratory and radiation safety), in addition to the SOPs that apply to his/her job.

- Scores from written tests on company policies and procedures and job-specific SOPs.

Each time a staff member's job description is changed due to training or promotion, a copy of the current job description must be included in the training record. The job description includes the position title and summary of duties of a staff member, and it differs from the job performance evaluation tool known as a job plan. Job plan and performance review information are private information and must be kept separate from the training record.

On a regular basis, at least annually, the Training Coordinator will check that all training records are maintained with current information. The employee should review the training record prior to a performance review to ensure that all training received during the review period has been documented. The group leader will also ensure that all training is recorded and will review, initial, and date each entry.

Knowledge of designated policies and procedures will be verified annually. However, it is especially important that revisions to pertinent SOPs and analytical methods be read and understood as soon as they are distributed. Technical staff members will be retrained and retested before performing analytical methods and procedures for which they have no record of proficiency within one year.

Figure 4-3

Form II

Name: _____

TRAINING COURSES

TITLE OF COURSE	TRAINER	DATE	LEADER SIGN/DATE
MSAI Values/Ethics Course			
MSAI MQS Quality Course			

Figure 4-2

Form I

MSAI Training Record Cover Sheet

Employee: _____

Employee Number: _____

Starting Job Title: _____

Degree/Education: _____

_____

Previous Laboratory Experience: _____

_____

_____

_____

Promotion Title: _____ Date Effective: _____

_____

_____

_____

_____

Additional Training Information:

- Current Job Description
- Training Course Summary
- Company Policies Summary
- Instrument Proficiency
- Methods/SOPs/Proficiency Summary

MSAI FORM: 10007 CPP-QA-016 October 20, 1995

Figure 4-5

Form IV

Name: _____

INSTRUMENT TRAINING AND PROFICIENCY

INSTRUMENT	FUNCTION	TRAINING		LEADER SIGN/DATE
		TRAINER	DATE	
	CALIBRATION			
	MAINTENANCE			
	PERFORMANCE EVAL			

Figure 4-4

Form III

Name: _____

COMPANY POLICIES READ AND UNDERSTOOD

CPP NUMBER	CPP NAME	DATE READ or TEST PASSED	LEADER SIGN/DATE

Quality Assurance Objectives

General Policy Statement

The major function of an independent laboratory is to generate technical information. Mountain States Analytical, Inc. (MSAI) provides information from chemical analyses, along with the additional information that is necessary for proper interpretation of the results.

MSAI's clients use this information for a variety of purposes. It may be used to demonstrate compliance with a government regulation; to evaluate a raw material for a manufacturer; to demonstrate the value or quality of a finished product; to establish the basis for a patent; or to settle a legal dispute. From the client's point of view, this information has an intrinsic value greater than its monetary cost. Since this information is so important, it is necessary to produce it under a program which will assure that the information meets specific quality objectives commensurate with its intended use. This section describes the Quality Assurance objectives under which we operate at Mountain States Analytical, Inc.

Quality Assurance Objectives

The objectives of MSAI's Quality Assurance Program are:

- Establish and follow quality control procedures that will ensure that data generated in the laboratory are within acceptable limits of precision and accuracy.

- Establish and follow procedures to document that these quality control measures are being carried out.

- Establish and follow procedures to ensure the "accountability" of data for each sample submitted—that is,

Form V

Name: _____

METHOD AND STANDARD OPERATING PROCEDURE TRAINING AND PROFICIENCY

METHOD/SOP		DATE READ	TRAINING		PERFORMANCE TEST PASSED	LEADER SIGN/DATE
NUMBER	NAME		TRAINER	DATE		

MSAI Form: 10011 CPP-QA-016 October 20, 1995

Figure 4-6

demonstrated precision on comparable samples for the analytical method used. The degree of agreement for duplicate measurements is expressed as the relative percent difference (RPD). Evaluation of the RPD is based on statistical evaluation of past laboratory data or guidelines within the analytical methods. The formula used to calculate the RPD is found in Section 15.

Accuracy - Accuracy is a measure of the nearness of an individual measurement, or the mean of a set of measurements, to the true or expected value. Analyzing a reference material of known concentration or reanalyzing a sample which has been spiked with a known concentration/amount are ways to determine accuracy. To the extent they are available, Standard Reference Materials (SRM)[1] and certified reference materials are used. At MSAI, accuracy is expressed as a percent recovery (%R). Evaluation of the %R is based on statistical evaluation of past laboratory data, certified acceptance limits or guidelines within the analytical methods. The formulas used to calculate the %R are found in Section 15.

Completeness - Completeness is a measure of the quantity of valid data acquired from a measurement process compared to the amount that was expected to be acquired under the measurement conditions. Overall completeness is evaluated by the data user because the laboratory does not always have full knowledge of project-specific data quality objectives. The laboratory can measure in-house completeness. The completeness of an analysis can be documented by including in the data deliverables sufficient information to allow the data user to assess the quality of the results. Additional information will be stored in the laboratories' archives, both hard copy and electronic storage media. There are Quality Assurance policies and procedures established to prescribe a level of record keeping necessary to evaluate completeness.

---

[1] SRM refers to Standard Reference Materials certified and supplied by the National Institute of Standards and Technology (NIST).

to ensure that the reported results actually apply to the sample as submitted.

- Establish and follow procedures to ensure that for any result reported to a client, we can determine the condition of the sample, date of analysis, the method of analysis, the analyst, the raw data generated, the condition of any instrument or equipment used, and the state of the quality control system at the time of the test.

- Establish and follow procedures that minimize the possibility of loss of, damage to, or tampering with samples or analytical data.

Quality Assurance (QA) is the overall program for providing confidence that quality objectives are being met. Quality control (QC) is the routine application of procedures for obtaining set standards of performance in the monitoring and measurement process. Data quality requirements are based on the intended use of the data, the measurement process, and the availability of resources. The quality of data generated and processed in the laboratory will be assessed for Precision, Accuracy, Completeness, Representativeness, and Comparability as defined in this section. These specifications will be met through precision and accuracy criteria specified in Section No. 12 and assessment procedures in Section No. 15. Additional data quality specifications include detection limits, which are presented in Section No. 10 and the method by which they are obtained in Section No. 15, and blanks, which detect the presence of interfering contamination and are described in Section No. 15. A complete set of written procedures assures comparability of data by assuring consistency of operations and assessment procedures.

Precision - Precision is determined by measuring the agreement among individual measurements of the same property, under similar conditions. The laboratory objective is to equal or exceed the

are subject to an annual review to keep them current. Revisions are reviewed, approved and controlled. Table 5-1 provides an index of QA Policies and Procedures in place to support the Quality Assurance Objectives. These requirements are supported by QA and QC specifications included in SOPs and Analytical Methods.

Records Management

CPPs and SOPs specify records and provide procedures for recordkeeping and control of records. Records include information about the receipt, condition, handling, analysis, and disposal of samples. Analysis records include printed, written, and electronic data acquired for samples and QC. Also, records in support of analysis cover traceability of standards and reagents, equipment maintenance and calibration, analyst qualifications and training, etc. Records are stored under secure conditions (see Section No. 8) for at least ten years. A filing system is in place to facilitate retrieval of archived records. Computer backup procedures are followed routinely to protect electronic records from loss.

Representativeness - Representativeness expresses the degree to which data accurately represent the media and conditions being measured. The representativeness of the data from the sampling site depends on the sampling procedure. Sample collection is the responsibility of the client, unless the client requests that the laboratory collect the sample. In the later case, MSAI has trained staff, certified by the State of Utah through Rule R311-201 of the Utah Administrative Code for sampling activities covered by the rule. Written procedures containing acceptable sampling practices are followed. Samples are homogenized, if required, as part of the laboratory sample preparation. Duplicates may establish the representativeness of laboratory subsampling.

Comparability - Comparability conveys the confidence with which one set of data can be compared to another. The analytical results can be compared to other laboratories by using traceable standards, standard methodology and consistent reporting units. The Laboratory Quality Assurance Program documents internal performance, and the interlaboratory studies document performance compared to other laboratories.

Establishment and Control of Policy and Procedure Documents

To ensure attainment of the quality assurance objectives, this LQAP, Company Policy and Procedure documents (CPP) and Standard Operating Procedures (SOP) are in place detailing the requirements for the correct performance of laboratory procedures. Analytical Methods are written to give instruction and provide clarification for the methods used for analysis.

Plans (including the LQAP, Chemical Hygiene Plan and Waste Management Plan), CPPs, SOPs and Analytical Methods are reviewed for technical accuracy and reviewed and approved by the QA Department prior to implementation. The distribution of current documents and archiving of those that are outdated are controlled through a master file. Plans, CPPs, SOPs and Analytical Methods

Sampling Procedures

In order for meaningful analytical data to be produced, the samples analyzed must be representative of the system from which they are drawn. It is the responsibility of the client to ensure that the samples are collected according to accepted or standard sampling methods. If the laboratory is requested to collect samples, MSAI has trained staff, knowledgeable about proper representative sampling. Sample collection staff are certified by the State of Utah, through Rule R311-201 of the Utah Administrative Code for applicable sampling activities. A set of standard operating procedures are written to ensure that sampling is done according to established procedures. It is the responsibility of the client to identify the correct sampling site and specific location. When required, a project-specific sampling plan will be used as guidance for collecting samples.

The laboratory will provide appropriate sample containers, required preservatives, chain-of-custody forms, shipping containers, labels, and custody seals. The sample containers are purchased precleaned from outside suppliers. Container traceability documentation is available upon request.

Each lot of preservative will be recorded in a notebook and checked for contaminants before use. The appropriate sample bottle will be preserved with the new preservative and filled with deionized water to represent a sample. It will be analyzed by the methods which require that preservative. Analysis results are maintained for each preservative lot number.

Trip blanks will be prepared by the laboratory, as specified by the client, and accompany sample containers at the

Table 5-1

Quality Assurance Policies and Procedures	
Document #	**Document Title**
QA-001	Sample Receipt and Log-In
QA-002	Sample Storage and Disposal
QA-003	Chain-of-Custody Documentation
QA-004	Analytical Methods
QA-005	Validation and Authorization of Analytical Methods
QA-006	Analytical Methods for Non-Routine Analyses
QA-007	Subcontracting to Other Laboratories
QA-008	Laboratory Notebooks
QA-009	Reagents, Chemicals, and Standards
QA-010	Instrument and Equipment Calibration
QA-011	Instrument and Equipment Maintenance
QA-012	Data Entry and Verification
QA-013	Data Storage and Security
QA-014	Quality Control Records
QA-015	Investigation and Corrective Action of Unacceptable Quality Control Data
QA-016	Personnel Training Records
QA-017	Quality Assurance Audits
QA-018	Proficiency Samples
QA-019	Electronic Data Integrity, Security, and Recovery
QA-020	Emergency Response for Refrigeration Systems
QA-021	Sample Collection
QA-022	Corrective Action

Sample Custody

If the samples are collected by the laboratory, the date and time of collection are recorded in the sampler's logbook and on the field (or external) chain-of-custody form. Otherwise, the client is responsible for initiating sample custody in the field before shipment.

Samples are unpacked and inspected in the sample receipt area. At this time, the samples are examined for breakage and agreement with the associated client paperwork. The shipping container or cooler temperatures will be checked upon receipt and recorded. As the samples are unpacked, the sample label information will be compared with the chain-of-custody record and any discrepancies or missing information will be documented. If necessary, the cooler will be closed and placed in cold storage until instructions and resolution of any discrepancies are received from the client.

A member of the Sample Administration staff will act as sample custodian for the samples. To ensure accountability of our results, a unique identification number is assigned to each sample as soon as possible after receipt at the laboratory. When samples requiring preservation by either acid or base are received at the laboratory, the pH will be measured and documented, except samples designated for volatile analysis. Volatile analysis samples are checked for correct pH at the time of analysis. Samples requiring refrigeration will be stored in MSAI's walk-in cooler and other sample storage coolers maintained at 4°C ± 2°C. A computerized laboratory information system is used to track samples (by the MSAI sample # assignment) and tracks custody of the sample from receipt until the time of its disposal. The laboratory building security system allows the

project required frequency. Analyte-free water will also be provided for field blanks.

When requested, the laboratory will provide coolers with reusable refrigeration gel packs to be frozen for sample transport. Samples should be shipped to the laboratory in ice, or frozen gel packs. Upon arrival at the laboratory, samples are stored in a refrigeration unit at 4°C ± 2°C.

Table 7-1

Sample Containers, Preservatives, and Holding Times for Aqueous and Solid Samples

Analysis	Matrix	Vol.(ml) or Wt. (g) Required	Container: P=Plastic G=Glass Q=Quartz	Preservation[a]	Holding Time[b] From Date/Time of Collection
Acidity	w/ww	100 ml	P or G	Cool, 4°C	14 days
Alkalinity	w/ww	400 ml	P or G	Cool, 4°C	14 days
Ammonia	w/ww	1000 ml	P or G	Cool, 4°C;H_2SO_4 to pH < 2	28 days
BOD or Carbonaceous BOD	w/ww	1000 ml	P or G	Cool, 4°C;	48 hours
Boron	w/ww	1000 ml	P(PTFE) or Q	HNO_3 to pH < 2	6 months
Bromide	w/ww	50 ml	P or G	(None required)	28 days
COD	w/ww	100 ml	P or G	Cool, 4°C;H_2SO_4 to pH < 2	28 days
Chloride	w/ww	100 ml	P or G	(None required)	28 days
	sw	25 g	P or G	(None required)	None
Chlorine, total residual	w/ww	200 ml	G (amber)	(None required)	15 min[g]
Hexavalent Chromium	w/ww	200 ml	P or G	Cool, 4°C	24 hrs
	sw	100 g	P or G	Cool, 4°C	*
Corrosivity	w/ww	100 ml	P or G	(None required)	15min (pH)[g], or None
	sw	25 g	P or G	(None required)	None
Cyanide (Total)	w/ww	1000 ml	P or G	Cool, 4°C; NaOH to pH>12	14 days[f]
	sw	25 g	G	Cool, 4°C	14 days[f]
Fluoride	w/ww	100 ml	P	(None required)	28 days
Hardness	w/ww	50 ml	P or G	HNO_3, to pH < 2	6 months
Ignitability	w/ww	250 ml	P or G	(None required)	None
	sw	150 g	P or G	(None required)	None
Kjeldahl Nitrogen	w/ww	1000 ml	P or G	Cool, 4°C;H_2SO_4 to pH < 2	28 days
Metals (CVAA, FAA, GFAA, HAA, and ICP)	w/ww	1000 ml	P	Cool, 4°C; HNO_3 to pH<2	180 days[c]
	sw	100 g	G	Cool, 4°C	180 days[c]
Moisture	sw	20 g	P or G	Cool, 4°C	None
Nitrate-nitrite	w	150 ml	P or G	Cool, 4°C; H_2SO_4 to pH < 2	28 days

Footnotes are found on page 6 of 14

entire facility to be designated as a secure area. A map of the laboratory buildings is attached in Section 8 (See Figure 8-1.) MSAI's routine procedure is to use internal sample tracking forms for tracking custody of samples within the laboratory. If requested, a hand-to-hand internal chain-of-custody will be provided as described in the attached CPP-QA-003. The laboratory chain of custody may begin with the preparation of bottles or the completion of the field chain of custody. The procedures for sample log-in, storage and disposal, and chain-of-custody documentation are detailed in the CPP-QA documents included in this section (QA-001, QA-002, and QA-003).

Sample Containers, Preservatives, and Holding Times

MSAI follows the requirements of SW-846 and 40 CFR 136, Table II for containers, preservatives, and holding times. See Tables 7-1 and 7-2. Sample bottles are prepared according to the requirements for the sample matrices and analyses to be performed, and the appropriate preservatives are added before transfer to the field. MSAI preserves samples (except volatiles) found to be improperly preserved when received and records the as-received pH on the chain of custody.

Holding times are determined from the time of sample collection unless project requirements specify otherwise. Contract Laboratory Program (CLP) sample holding times are determined from the verified time of sample receipt (VTSR).

Table 7-1 (Continued)

Sample Containers, Preservatives, and Holding Times for Aqueous and Solid Samples					
Analysis	Matrix	Vol.(ml) or Wt. (g) Required	Container: P=Plastic G=Glass	Preservation[a]	Holding Time[b] From Date/Time of Collection
Reactivity	liquid/ solid	30 g	G	Cool, 4°C	None
Residue, total/filterable/ nonfilterable/volatile	w/ww	500 ml	P or G	Cool, 4°C	7 days
Residue, settleable	w/ww	1000 ml	P or G	Cool, 4°C	48 hrs
Semivolatiles (Acid, Base, Neutral Extractables)	w/ww	2x1000 ml	G (amber)	Cool, 4°C; $Na_2S_2O_3$	7 days[d f]
	sw	125 g	G	Cool, 4°C	14 days[d f]
Specific Conductance	w/ww	125 ml	P or G	Cool, 4°C	28 days
Sulfate	w/ww	200 ml	P or G	Cool, 4°C	28 days
	sw	20 g	P or G	Cool, 4°C	None
Sulfide	w/ww	200 ml	G	Cool, 4°C; NaOH; Zn acetate	7 days
	sw	20 g	G	Cool, 4°C; Zn acetate	None
Total Organic Carbon (TOC)	w/ww	125 ml	G	Cool, 4°C; H_2SO_4 to pH<2	28 days
	sw	20 g	G	Cool, 4°C	None
Total Organic Halogen (TOX)	w/ww	500 ml	G	Cool, 4°C; H_2SO_4 to pH<2	28 days
	sw	100 g	G	Cool, 4°C	None
	oil	50 g	G	Cool, 4°C	None
Toxicity Characteristics Leaching Procedure (TCLP)	w/ww	3000 ml	G	Cool, 4°C	(Table 7-2)
	sw	200 g	G	Cool, 4°C	(Table 7-2)
	oil	3000 ml	G	Cool, 4°C	(Table 7-2)
Volatiles by GC (Includes BTEX, MTBE, Naphthalene and Aromatics)	w/ww	3x 40 ml	G	Cool, 4°C; HCl to pH<2	14 days
	sw	100 g	G	Cool, 4°C	14 days
Volatile Halocarbons by GC	w/ww	3x40 ml	G	Cool, 4°C, $Na_2S_2O_3$	14 days
	sw	100 g	G	Cool, 4°C	14 days

Footnotes are found on page 6 of 14

Table 7-1 (Continued)

Sample Containers, Preservatives, and Holding Times for Aqueous and Solid Samples					
Analysis	Matrix	Vol.(ml) or Wt. (g) Required	Container: P=Plastic G=Glass	Preservation[a]	Holding Time[b] From Date/Time of Collection
Nitrate or Nitrite (separate analytes)	w/ww	150 ml	P or G	Cool, 4°C	48 hrs
	sw	20 g	P or G	Cool, 4°C	None
Nonhalogenated Volatile Organics (Includes TPH and Alcohols)	w/ww	2x1000 ml	G (amber)	Cool, 4°C	14 days
	sw	125 g	G	Cool, 4°C	14 days
TPHDiesel RangeOrganics (DRO) - micro extraction	w/ww	2x40 ml	G	Cool, 4°C	14 days
Oil and Grease	w/ww	2x1000 ml	G (amber)	Cool,4°C; H_2SO_4or HCl to pH< 2	28 days
	sw	50 g	G	Cool, 4°C	None
Organochloride and OrganophosphatePesticides, PCBs, and Herbicides	w/ww	2x1000 ml	G (amber)	Cool, 4°C; $Na_2S_2O_3$	7 days[d,f]
	sw	125 g	G	Cool, 4°C	14 days[d,f]
Orthophosphate	w/ww	75 ml	P or G	Cool, 4°C	48 hrs
Oxygen, dissolved	w/ww	300 ml	G	(None required)	15 min[g]
Paint Filter Liquid Test (Free Liquids)	liquid/ solid	125 g	G	(None required)	None
pH	w/ww	100 ml	P or G	Cool, 4°C	15 min[g]
	sw	50 g	P or G	Cool, 4°C	None
Phenolics	w/ww	2x1000 ml	G (amber)	Cool, 4°C; H_2SO_4 to pH<2	28 days
	sw	250 g	G	Cool, 4°C	None
Phenols by GC	w/ww	2x1000 ml	G (amber)	Cool, 4°C; $Na_2S_2O_3$	7 days[d]
	sw	100 g	G	Cool, 4°C	14 days[d]
Phosphorus, total	w/ww	75 ml	P or G	Cool, 4°C;H_2SO_4 to pH < 2	28 days
	sw	20 g	G	Cool, 4°C	None
Polycyclic Aromatic Hydrocarbons (PAH)	w/ww	2x1000 ml	G (amber)	Cool, 4°C: $Na_2S_2O_3$	7 days[d]
	sw	125 g	G	Cool, 4°C	14 days[d]

Footnotes are found on page 6 of 14

COMPANY POLICY AND PROCEDURE: CPP-QA-001

Title: Sample Receipt and Log-In

References:

40 CFR Part 136, Guidelines Establishing Test Procedures for the Analysis of Pollutants
SOP-SA-101, Sample Receiving and Documentation
SOP-RA-127, Receiving Radioactive Samples
SOP-SA-102, Sample Entry

Purpose:

To establish requirements for sample receipt, sample inspection, and log-in that will ensure adequate laboratory sample management.

Scope:

This policy establishes the requirements for the receipt, inspection, and log-in of samples. It specifies that samples be assigned unique identification numbers.

Background Information:

It is important that samples received at the laboratory be logged-in properly to ensure that each is assigned a unique identification number. Unique identification numbers are used to prevent sample loss or mix-up and to provide accountability of analytical results. Sample temperature and preservation must be

Table 7-1 (Continued)

Sample Containers, Preservatives, and Holding Times for Aqueous and Solid Samples					
Analysis	Matrix	Vol.(ml) or Wt. (g) Required	Container: P=Plastic G=Glass	Preservation[a]	Holding Time[b] From Date/Time of Collection
Volatiles by GC/MS	w/ww	2x 40 ml	G	Cool, 4°C; HCl to pH<2	14 days[f]
	sw	100 g	G	Cool, 4°C	14 days[f]
Turbidity	w/ww	125 ml	P or G	Cool, 4°C	48 hrs

Footnotes: (Table 7-1)

[a] pH Adjustment with acid/base is performed on water samples only.

[b] Samples will be analyzed as soon as possible after collection. The times listed are the maximum times that samples will be held before analysis and still be considered valid.

[c] Mercury must be analyzed within 28 days (26 days from VTSR for CLP).

[d] Analysis must be within 40 days of extraction.

[e] Analysis must be within 24 hours of extraction.

[f] CLP Cyanide holding time is 12 days from VTSR.
CLP Volatiles holding time is 10 days from VTSR.
CLP Semivolatiles and Pesticides holding times are: 5 days for water extraction and 10 days for soil extraction from VTSR; analysis 40 days from extraction.

[g] "Analyze immediately" is interpreted as 15 minutes or less. Such tests are typically done in the field because holding times are exceeded when samples reach the laboratory. MSAI will observe a 24 hour laboratory turn around time on such analyses.

Table 7-2

TCLP Holding Times

	From field collection to TCLP extraction	From TCLP extraction to complete analysis
Volatiles	14 days	14 days
Semivolatiles	14 days	7/40 days*
Pesticides and Herbicides	14 days	7/40 days*
Mercury	28 days	28 days
All other metals	180 days	180 days

* The first holding time is for sample preparation/the second holding time is for analysis

Sample Administration will enter sample information into the Laboratory Information Management System (LIMS). The procedure will be detailed in SOP-SA-102.

1. The LIMS will assign a unique identification number to each sample. Sample Administration personnel will assign a refrigerator location for each group of samples and will enter this location in the LIMS.

2. Samples will be entered into the LIMS as soon as feasible. This will be done on the day of receipt, unless receipt is after normal receiving hours or additional sample information is needed. Shipments that cannot be immediately entered into the LIMS will be placed in refrigerated storage until they can be entered.

3. Sample Administration will communicate special conditions to analytical personnel and project managers. Special conditions might include rush sample requests, samples with short or soon-to-expire holding times, and non-standard analytical requirements.

4. Computer-generated labels will be affixed to each sample container. The label information will include the MSAI sample number, the storage location, the sample date, and the client ID #.

5. Once the samples are properly labeled, they will be stored in the assigned refrigerator location.

Sample administration will generate a sample group report that lists the samples with their assigned tests and includes other

verified upon receipt to preserve the validity of the samples analyzed by the laboratory.

Policy/Procedure:

Sample receipt will be performed by Sample Administration. All client correspondence relating to the samples will be given to Sample Administration. Sample Administration will inspect and verify the condition of samples received.

1. Samples that meet MSAI's acceptance criteria will be received. SOP-SA-101 will specify the acceptance criteria and the procedure for receiving. Acceptance criteria will include the radioactivity criteria of SOP-RA-127, which will be in conformance with MSAI's radioactive material license. The chain of custody will be signed upon sample receipt.

2. Inspection will include measurement and recording of temperature within the shipping containers and coolers.

3. All sample shipments will be verified against the chain of custody. Discrepancies will be noted on the chain of custody and the project manager will be notified. The project manager will notify the client, if necessary.

4. The samples, except volatile organic samples, will be tested for pH to ensure proper preservation. Preservation criteria will be consistent with 40 CFR 136. If preservation criteria are not met, Sample Administration will document that fact and add the appropriate preservative. Clients will be notified for preservation problems that might adversely affect sample integrity.

COMPANY POLICY AND PROCEDURE: CPP-QA-002

Title: Sample Storage and Disposal

References:

SOP-SA-103, Sample Maintenance
CPP-QA-003, Chain of Custody Documentation
CPP-QA-020, Emergency Response for Refrigeration Systems
SOP-SA-105, Sample Disposal and Monitoring of Waste Containments

Purpose:

To establish requirements for sample storage, release to analysts, and disposal that will ensure sample integrity while in the custody of Mountain States Analytical, Inc.

Scope:

This establishes the requirements for storing samples, retrieving and returning samples for analysis, and discarding samples when they are no longer needed.

Background Information:

The integrity of MSAI's analytical data must be ensured by proper sample storage conditions. The objective of proper sample storage is to prevent sample deterioration prior to analysis. Sample Administration is responsible for assigning storage locations and monitoring the orderly storage of samples in locations from which they can easily be retrieved for analysis. Sample Administration is also responsible for making sure that

relevant sample information. This group report will be reviewed for accuracy and completeness by the project manager. When the report is determined to be accurate, it will be sent by facsimile to the client and then filed in a folder created specifically for the sample group.

The sample group folder will be used to collect the following information: the chain of custody, LIMS reports (acknowledgments, analysis reports, revised analysis reports, QC summaries, and invoices), client correspondence, and telephone logs.

Samples requiring data package deliverables will be grouped into sample delivery groups (SDG) by Sample Administration personnel. An SDG will contain samples from only one client and will usually be matrix-specific. An SDG worksheet will be filled out with the SDG name, a list of included samples, and the samples designated to be spiked. The SDG worksheet will be circulated to the affected departments.

All samples shall be returned to clients, stored for an extended period, or disposed of according to procedures in SOP-SA-105, which will conform to applicable federal and local regulations. Clients will be given the opportunity to select from among these options.

Sample Administration will obtain from the LIMS system a report of samples due for disposal to ensure that samples are not discarded prematurely.

samples are not discarded before the proper discard date and that the client has been contacted regarding the disposal of samples.

Policy/Procedure:

Sample Administration will determine the appropriate temperature and location (refrigerator or freezer) for sample storage for each group of samples as they are entered into the LIMS system. Sample groups will be assigned a specific storage location and will be stored in this location while in the custody of the laboratory. Separate designated refrigerators are used to store all samples for Volatile Organic Compound (VOC) analysis to avoid contamination.

Analysts will request and obtain samples from Sample Administration by filling out a sample request form. The sample request procedure and form will be described in SOP-SA-103. Samples will be returned promptly to Sample Administration after the portion needed for analysis is removed. If the client has requested internal chain of custody documentation for its samples, the internal chain of custody section of CPP-QA-003 will be followed.

The temperature of each refrigerator or freezer used for storing samples will be checked daily and recorded in ink on log sheets posted on the storage units. Refrigerator temperatures will be maintained at 4°C ± 2°C and freezer temperatures at -15°C ± 5°C. If the temperature of a unit is observed to be outside these operating parameters, corrective actions will be taken in accordance with CPP-QA-020.

Definition:

A sample is in custody if it is:

1. In physical possession of an MSAI employee.
2. In view after being in physical possession.
3. Locked up so that no one can tamper with it.
4. In a secure area restricted to authorized personnel.

Policy/Procedure:

External chain of custody requirements will be observed for all samples received with a field chain of custody.

1. If requested by the client, an external chain of custody form will be initiated by the person packing the sample bottles for shipment to the client. If the bottles are delivered by an MSAI driver, the driver shall sign the form when relinquishing the bottles. Drivers must also sign chain of custody forms when picking up samples that require such documentation.

2. When samples arrive at the laboratory, Sample Administration will inspect the samples, receive them, and sign the external chain of custody form, if one is provided with the samples. If the sample was picked up by an MSAI driver, the driver must sign to relinquish custody of the sample to Sample Administration.

3. The completed external chain of custody forms will be filed in the group folder.

COMPANY POLICY AND PROCEDURE: CPP-QA-003

Title: Chain of Custody Documentation

References:

SOP-SA-105, Sample Disposal and Monitoring of Waste Containments

Purpose:

To establish requirements for external and internal chain of custody documentation.

Scope:

This policy covers the preparation and use of internal chain of custody documentation and the treatment, by the laboratory, of external chain of custody documentation. Internal chain of custody procedures covered by this policy require a specific form and greater security than the requisition procedure used for normal samples.

Background Information:

In order to demonstrate the reliability of our analytical data, an accurate written record tracing the possession of a sample from the time of collection, to its receipt at the laboratory, its handling within the laboratory, to its disposal must be maintained. This documentation may be required by a regulatory agency or used as evidence in a legal case.

Sample disposal usually takes place after the chain of custody forms are returned to the client. For that reason, the transfer of samples from storage to disposal will be documented on a separate waste disposal report (See SOP-SA-105).

4. The original external chain of custody, a certified exact copy, or a carbonless copy will be returned to the client with the sample analysis reports.

Internal chain of custody documentation will be kept upon client request or for samples that are known to be involved in a legal dispute.

1. Sample Administration will enter the test code for "Internal Chain of Custody" in the LIMS and label the sample to inform analysts of the need for internal chain of custody documentation.

2. Sample Administration will initiate internal chain of custody forms to account for each sample container at the time of log-in. The internal chain of custody forms will accompany the sample containers.

3. All changes of custody shall be documented on the form by both the relinquisher and the receiver. This includes exchanges between analysts within the same laboratory section.

4. If additional containers of the sample are created (such as for sample extracts or digestates), additional internal chain of custody forms shall be created by the preparer to accompany the new containers.

After all analyses are completed, the internal chain of custody forms will be placed in the group folder to be forwarded to the client with the sample analysis reports.

Facilities and Equipment

Facilities and Security

The laboratory's physical facilities are located in the Metro Business Park at 1645 and 1615 West 2200 South, Salt Lake City, Utah. The facility occupies approximately 13,000 square feet including laboratories, offices, a conference room, a data processing center, refrigerated and room-temperature storage areas, employee lunch room, and garage area. Mountain States Analytical is strategically located on a major freeway access and near the Salt Lake City International Airport.

The laboratory's air-handling systems have been specially designed and installed to protect sensitive instruments and prevent sample contamination. Positive pressure rooms house the gas chromatography, gas chromatography/mass spectrometry, and inductively coupled plasma spectrometry instruments. Separate negative pressure laboratories are used for general chemistry, metals digestions, and organic sample extraction. Separate refrigeration systems are used for volatile and nonvolatile sample storage. The main refrigerated storage area for samples is secured by an access and temperature alarm system.

The laboratory is protected by a state-of-the-art security and alarm system designed to protect the integrity of both the physical facilities and our analytical data. The security system includes smoke detectors in all laboratories, door contacts on all outside doors, and passive infrared detectors along the hallways. A breach of any of these systems will trigger the alarm and notify on-site staff and the 24-hour surveillance company. The alarm system will also be activated if the temperature of the walk-in refrigerator used for sample storage falls outside EPA specifications.

Mountain States Analytical, Inc.

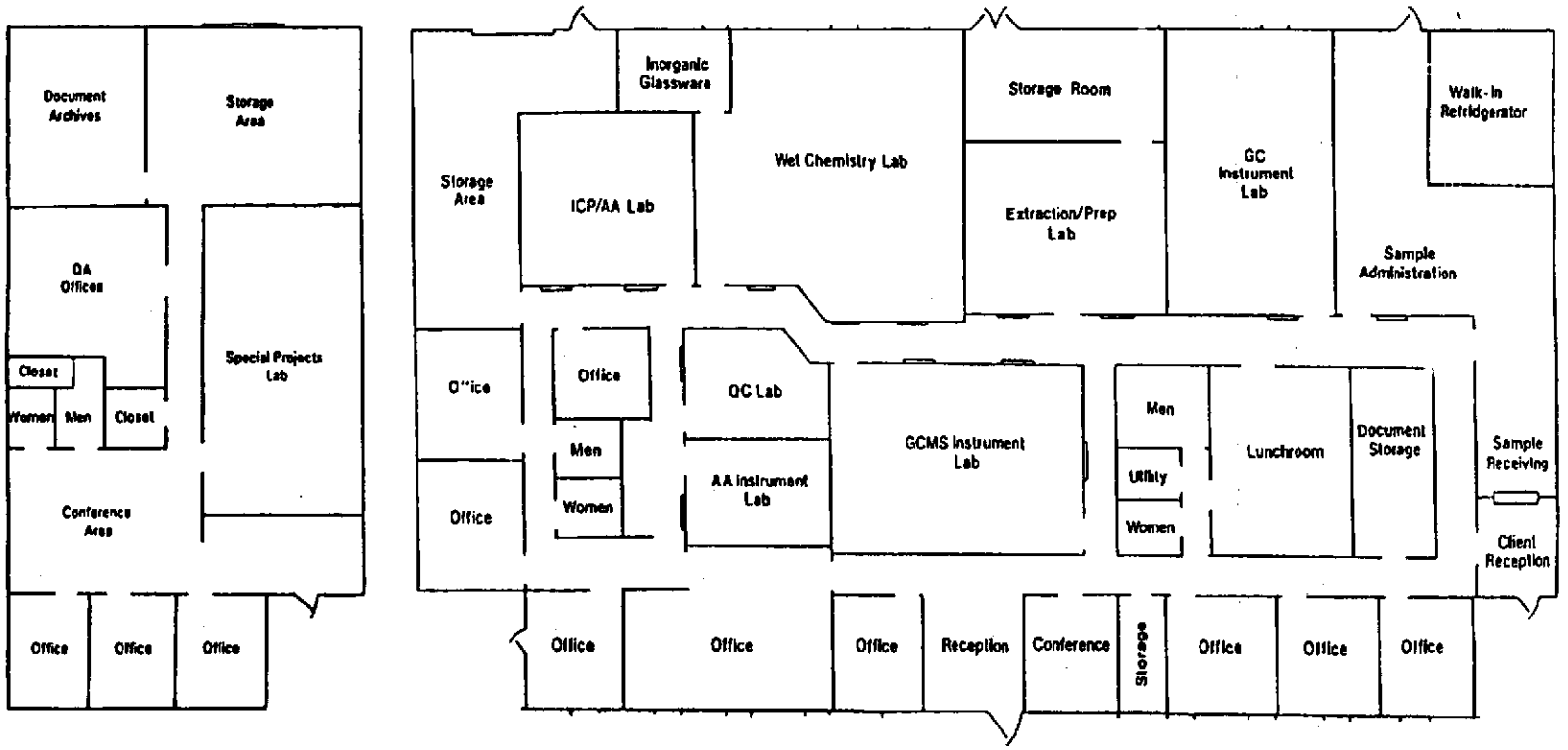


Figure 8-1

MSAI's security procedures ensure that only authorized laboratory personnel have access to client samples. All outside doors except the main entrances are kept locked, and the main entrances are monitored by a receptionist who registers visitors during business hours. Also, designated laboratory personnel must enter an access code to retrieve samples from or return samples to the walk-in refrigerator and data archival storage areas. In addition to providing security, this helps track custody of client samples through the laboratory and ensures restricted access to stored client data and documents.

Mountain States Analytical, Inc. operates on a Novell network with mirrored hard drives and backup systems for data archival and system recovery. Backup tapes are rotated to an offsite storage. These items are given a high priority in our efforts to maintain data security and integrity. Our network contains a LIMS (laboratory information management system), with multi-level security for internal data integrity. The LIMS tracks all samples from receipt to final disposition. Results are entered by verified data entry and direct data download from much of our testing equipment. The database software is written in Clipper using Dbase and Foxpro database and index formats. Printed reports, data packages and QC charts are generated from within this system. Electronic data is downloaded from the system in a variety of formats per client requirements.

A Hewlett-Packard ChemServer is used for data collection, processing, control charting and data package generation for all Organic instrumentation in the laboratory. The hardware consists of an HP Model 735 Server running HPUX 9.05, VUE 3.0, Target 3.3 and Envision 3.3 from Thru-Put Systems. Three X_Terminal stations and three Pentium PC workstations running Hummingbird emulation software are attached to the ChemServer.

Instrument	Units	Manufacturer/Model No.
Gas Chromatography / Mass Spectrometry		
Gas Chromatograph/Mass Spectrometer: Includes capillary and packed column injection ports with septum purge,quadrupole MSD with turbo pumps, capillary direct interfaces, and autosampler.	2	Hewlett-Packard Model 5970 MSD Model 5890 GC Model 7673A AS
Gas Chromatograph/Mass Spectrometer: Includes capillary and packed column injection ports with septum purge, MSD Quadrupole with turbo pumps, jet separator and capillary direct interfaces, and Purge & Trap interface.Equipped with:	2	Hewlett-Packard Model 5970/5890
(1) Automatic Purge & Trap	1	Tekmar, Model LSC 2000
(2) Automatic Purge & Trap	1	Tekmar, Model 3000
(3) Autosampler for Purge & Trap (16 Stations)	2	Tekmar, Model ALS 2016
(4) Automatic Sample Heater (16 Stations)	1	
GC/LC/MS Data System: Includes Micro 24 CPU,304 MB Disk Drive, 2 MB RAM, RTE Rev. F data handling software	2	Hewlett-Packard A-Series RTE, Rev. F
GC/LC/MS Data System: Includes Micro 24 CPU, 150 MB Disk Drive, 2 MB RAM, RTE Rev. F data handling software	2	Hewlett-Packard A-Series RTE, Rev. F
Supercritical Fluid Chromatography		
Supercritical Fluid Chromatograph: with chemiluminescence detector, restrictor interface, and data system.	1	Lee Scientific, Model 600 SFC Thermedics Detection, Model 543
Supercritical Fluid Chromatograph: with mass spectrometric detector, restrictor interface, 10,000 psi pumping system, and data system	1	Lee Scientific, Model 600 SFC Finnigan INCOS 50 MS Data General Data System

Instruments and Equipment

Instrument	Units	Manufacturer/Model No.
Gas Chromatography		
Gas Chromatograph with Autosampler: Includes electron capture detectors and electronic pressure control.	2	Hewlett-Packard Model 5890, Series II GC Model 7673A AS
Gas Chromatograph with Autosampler: Includes capillary capability with flame ionization detectors.	2	Hewlett-Packard Model 5890-II GC
Gas Chromatograph with Autosampler: Includes capillary capability and nitrogen/phosphorus detectors.	1	Hewlett-Packard Model 5890-II GC Model 7673A AS
Gas Chromatograph: Purge & trap with capillary capability with electro-conductivity and photoionization detectors.	1	Tracor Model 540
Gas Chromatograph: Purge & trap with capillary capability with the following:	2	Hewlett-Packard Model 5890, Series II
1) tandem photoionization/ electroconductivity detector	2	OI Analytical, Model 4430/4420
2) tandem photoionization/ flame ionization detector	1	OI Analytical, Model 4430/4450
3) automatic Purge & Trap	2	Tekmar, Model LSC 2000
4) autosamplers for Purge & Trap	2	Archon, Model 5100A
5) electronic pressure control	1	
ChemStation Data Processing System	5	Hewlett Packard 3365 Software on 486 or better computers
Chromatographic Integrator	1	Hewlett Packard Model 3393A

Instrument	Units	Manufacturer/Model No.
Atomic Absorption and Emission Spectrophotometry (Continued)		
Atomic Absorption dedicated Graphite Furnace Spectrophotometer: Transverse furnace including AS-70 furnace autosampler, Zeeman background correction, and EDL dual lamp power supply	1	Perkin Elmer 4100ZL DEC 316SX computer Okidata printer
Atomic Absorption Spectrophotometer: Includes flame, cold vapor and hydride accessories with deuterium and Smith-Hieftje background correction, autosampler, computer and a printer	1	Thermo-Jarrel Ash Model 8000 AVA880 Hydride/Cold vapor generator AS150 Autosampler 486DX computer
Inductively Coupled Argon Plasma Atomic Emission Spectrometer: Simultaneous instrument includes 2 kW generator, crystal controlled at 27.12 MHz with autotuning, power stabilization, feedback loop, and direct coupling. Built-in peristaltic pump, cross flow nebulizer. 30 elements.	1	Thermo-Jarrel Ash ICAP 61E 486 computer printer
Inductively Coupled Argon Plasma Atomic Emission Spectrometer: Simultaneous, variable wavelength instrument includes a charge injection device (CID) detector with high resolution option. Includes a 2 kW generator, crystal controlled at 27.12 MHz with autotuning, power stabilization, feedback loop and direct couping. Built-in peristaltic pump, high solids nebulizer, argon mass flow controller, with low flow/low power & high flow/high power operation. All ICP elements.	1	Thermo-Jarrel Ash ICAP IRIS HR TJA 300 sample changer Pentium computer
Atomic Absorption Spectrophotometer: Includes flame, hydride and cold vapor accessories.	1	Varian SpectrAA 20 VGA-76 vapor generation accessory Citizen Printer Model HP-500
Radiochemistry Instrumentation		
Alpha, Beta, Gamma Radiation Detector	2	Ludlum Model 3 Model 44-9 Probe
Alpha-Beta/Gamma Detector	1	Ludlum Model 2929 Model 43-10-1 Probe

Instrument	Units	Manufacturer/Model No.
Organics Data System: UNIX File Server, TCP/IP, with operating system software Other hardware: X Terminals PC-X Terminals	 1 3 3	 Hewlett-Packard Chem Server, UNIX, Model 735 (TCP/IP) with HPUX 9.05, VUE3.0, and Target 3.3 software H-P Envizex, 'a' Series Pentium based PC computers
Ion Chromatography		
Ion Chromatograph: Includes a conductivity detector and data system.	1	Dionex, Model DX500 Dionex, CD20 detector
Liquid Chromatography		
Uses Ion Chromatograph gradient pump and a UV/Vis detector and integrator.	1	(see Ion Chromatograph) Lee Scientific 501UV/vis Detector H-P, 3388 Integrator
Infrared Spectrophotometer		
Fourier Transform Infrared Spectrophotometer	1	Perkin Elmer, Model 283B
Organic Sample Preparation Instruments and Equipment		
Accelerated Solvent Extraction with programmable microprocessor controlled extraction capabilities. Includes 25 position sample and extract collection carousel	1	Dionex Model GP-40-1
Automated Soxhlet, 6 position, solvent extractor	1	Tecator, Soxtec 1043
Gel Permeation Chromatograph UV/Vis Detector (also used by theLiquid Chromatograph)	1	Analytical Bio-Chemistry Laboratories GPC Model Auto Prep 1002-A
Continuous liquid-liquid extraction system	10	Kontes
N-Evap nitrogen concentrator	1	Organomation, Model 115
Atomic Absorption and Emission Spectrophotometry		
Atomic Absorption Graphite Furnace Spectrophotometer: Includes direct injection furnace, multi-element Zeeman background correction, automatic sample dispenser,computer operating system,and color printer.	1	Varian SpectrAA 400Z IBM Computer Model PS/2 30286 Citizen Printer Model HSP-500

Instrument	Units	Manufacturer/Model No.
Ultrasonic Bath Extractor	1	Fisher Scientific Model B-2200 R-1
Centrifuge	2	Damon/IEC Division Model HN-SII
Top Loading Electronic Balance	1	Fisher Model XL300
Top Loading Electronic Balance	1	Denver Instrument Co. Model 400, XE Series
Top Loading Electronic Balance	1	Mettler Model PC4000
Top Loading Electronic Balance with filter chamber	1	Mettler Toledo, Model AB104
Top Loading Electronic Balance	1	Fisher Model XD-800
General Instrumentation and Equipment (Continued)		
Top Loading Electronic Balance	1	Denver Instrument Co. Model XL-300
Electronic Balance	1	Fisher Model 200G
Electronic Balance	2	Mettler H31AR
BOD Incubator	2	Isotemp/Fisher Model 146
Oven, Drying	3	Isotemp/Fisher Series 200
Autoclave with dryer	1	Napco Model 8000 DSE
Muffle Furnace	1	Lindberg Model 58114
Pyro-Multi-Magnestir	1	Lab-Line Instrument Model 1268
Thermolyne Hot Plate	2	Fisher Type 2200
Water Bath	2	Precision Model 184
Water Bath	2	Precision Model 186
Lab Refrigerator (43 cubic feet)	4	Isotemp/Fisher Model 348G
Refrigerator (14 cubic feet)	1	Kenmore Model 106
Refrigerator/Freezer (4.8 cubic feet)	2	Marvel Industries, Model 61AF
Refrigerator/Freezer Flammable Materials (13.1 cubic feet)	2	Fisher, Precision Model 813
Refrigerator/Freezer (9 cubic feet)	1	Kelvinator

Instrument	Units	Manufacturer/Model No.
General Instrumentation and Equipment		
TOC Analyzer: Equipped with purging and sealing unit	1	O. I. Corporation Model 700 Model 524
TOX Analyzer: Equipped with dual absorption modules	1	Mitsubishi Chemical Industries Model TOX-10
Ultraviolet Spectro- photometer	2	Milton Roy Company Spectronic 21DV
General Instrumentation and Equipment (Continued)		
Turbidimeter	1	Hach Model 2100N
Ion Analyzer	2	Orion Model EA940
Conductivity/TDS	1	Orion Model 124
Conductivity Meter	1	Orion Model 160
Conductivity Meter	1	Yellow Springs Inst., Model 33
Closed-Cup Pensky-Martin Flashpoint Apparatus	1	Boekel Flashpoint Tester Model 152800
Closed-Cup Flashpoint Apparatus, Pensky-Martin	1	Kohler Instrument Co. Model 16200
COD Reactor (block digester)	1	Hach 45600
Bomb Calorimeter	1	Parr Model 1341 EB
Midi Cyanide Distillation apparatus	1	Andrews Glass 110-10-R
Zero Headspace Extractor	2	Associated Design Model 3740
Zero Headspace Extractor	24	Analytical Testing & Consulting Services, Inc.
Toxicity Rotator (12 sample capacity), non-volatile	1	In-house, SW-846 design
Toxicity Rotator (28 sample capacity), volatile	1	In-house, SW-846 design
Ultrasonic Probe Extraction System	2	Heat Systems Model XL2020 (1) Model 550 (1)

Vehicle Fleet

Sample pick-up service is offered to all clients within reasonable driving distance from the laboratory. Currently, services are available for Salt Lake City, Ogden, Provo/Orem, the surrounding vicinities of these cities, and southern Idaho. The laboratory also has a four-wheel drive truck for field operations.

Instrument	Units	Manufacturer/Model No.
Freezer (17.5 cubic feet)	1	Fisher Isotemp Model 425F
Refrigerator/Freezer (4 cubic feet)	1	Goldstar, Model GR131OW
Walk-in Cooler: 3200 cubic feet. Galvanized steel with air defrost timer and room temperature control to 4±2°C.	1	Hussman
Laboratory Information Management System Hardware (Main System)		
Network 486 PC Server with 2 GB of hard disk storage and 32 MB of RAM, operating with Novell Netware	1	486 PC
486 (or higher) PC workstations	35	Various manufacturers
Field Sampling Instrumentation and Equipment		
Sigma Programmable Portable Sampler with integral flowmeter	1	Sigma Streamline 800SL Flowmeter #1378
Portable pH/Temperature Meter	1	Orion Model 230A
Gas Detector ("sniffer") with capability to detect O_2, H_2S, TOX, and LEL	1	Dynamation Combo 434
Core Soil Sampler	1	AMS
Soil Probe	1	AMS

The preceding list includes the major equipment and instruments that demonstrate specific capabilities. The laboratory is also equipped with flammable solvent and acid storage cabinets, approximately 40 linear feet of ventilated hood space, 120 square-foot canopy hood, several types of extraction/distillation devices including glassware and heating mantles, KD evaporative concentrators, miscellaneous glassware and chemicals, three tri-bed Culligan deionized water systems for delivery of Type II reagent water (ASTM D1193) for laboratory applications, and other equipment required for laboratory operations.

Calibration Procedures and Frequency

Procedures for initial calibration and continuing calibration verification are in place for all instruments within the laboratory. The calibrations generally involve checking instrument response to standards for each target analyte. The source and accuracy of standards used for this purpose are integral to obtaining the best quality data. Standards used at Mountain States Analytical, Inc. (MSAI) are purchased from commercial supply houses either as neat compounds or as solutions with certified concentrations. The accuracy and quality of these purchased standards are verified through documentation provided by these commercial sources. Most solutions and all neat materials require subsequent dilution to an appropriate working range. All dilutions performed are documented and the resulting solution is checked by obtaining the instrument response of the new solution and comparing with the response to an independent reference or the solution currently in use. Any discrepancies between the responses are investigated and resolved before the new solution is used. Each standard is assigned a code which allows traceability to the original components. The standard container is marked with the code, name of solution, concentration, date prepared, expiration date, and the initials of the preparer. Shelf-life and storage conditions for standards are included in the standard operating procedures for each analytical method. Old standards are replaced before their expiration date.

Each instrument is calibrated at the analytical method prescribed frequency using one or more concentrations of the standard solution. As analysis proceeds, the calibration is checked for any unacceptable change in instrument response. If the calibration check verifies the initial response, the analysis proceeds. If the calibration check indicates that a significant change in instrument response has occurred, then minor corrective

Table 9-1

Calibration Criteria					
Instrument • Method	Calibration			CCV	
	Fre-quency	# Calib. Points	Acceptance Criteria	Fre-quency	Acceptance Criteria
GC/MS Volatiles •524.2	After CCV fails	5	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %RSD≤ 20%	Every 8 hours	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %D ≤ 30%
GC/MS Volatiles •624	After CCV fails	5	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %RSD ≤ 35%	Every 24 hours	Check standard within limits
GC/MS Volatiles •8240/8260	After CCV fails	5	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %RSD for CCC ≤ 30%	Every 12 hours	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %D for CCC ≤ 25%
GC/MS Volatiles •CLP	After CCV fails	5	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %RSD for CCC ≤ 30%	Every 12 hours	RF for SPCC's ≥0.300 except for bromoform ≥0.25; Max %D for CCC ≤ 25%

Footnotes and the key to abbreviations are on page 8

maintenance and reverification are required prior to proceeding with the analysis. If minor corrective maintenance fails to remedy the calibration noncompliance, then a new calibration is initiated. Necessary maintenance and repair are performed prior to the recalibration.

Calibration records are usually kept in the form of raw data with the other instrument print-outs. In cases where no data system is used, calibration data are manually recorded in notebooks. Any maintenance or repair is also recorded in a notebook. The information recorded, either in the notebooks or on the instrument print-out, includes the date, instrument ID, employee name and identification number, and concentration or code number of the standard.

The frequency of calibration and calibration verification, number of calibration points used, and acceptance criteria for each of the instruments to be used, are listed on Table 9-1. In addition to checking the instrument response to target compounds, the GC/MS instruments are checked to ensure that standard mass spectral abundance criteria are met. Prior to each calibration, instruments being used for volatile compound analysis are tuned using bromofluorobenzene (BFB) and instruments being used for semivolatile analysis are tuned using decafluorotriphenyl-phosphine (DFTPP). The key ions and their abundance criteria are listed in Table 9-2.

MSAI calibrates laboratory thermometers at least yearly with a reference thermometer that is certified traceable to NIST standards yearly by an outside calibration laboratory. Weights used for balance calibration are compared monthly against a set of Class S weights that are calibrated yearly by an outside calibration laboratory.

Table 9-1 (Continued)

Calibration Criteria*					
Instrument • Method	**Calibration**			**CCV**	
	Fre-quency	**# Calib. Points**	**Acceptance Criteria**	**Fre-quency**	**Acceptance Criteria**
GC Pesticides •508	Each new run or after CCV fails	3 Minimum 5 Recom-ended	%RSD of ≤20%, otherwise use calibration curve	Every 8 hours; start and end of analysis day	%D ≤20%
GC Pesticides •608	Each new run or after CCV fails	3 Minimum	%RSD of ≤10, otherwise use calibration curve	Every 10 samples	%D ≤15%
GC Pesticides •8080	Each new run or after CCV fails	5	%RSD of ≤20%, otherwise use calibration curve	Every 10 samples	%D ≤15%,
GC Pesticides •8081	Each new run or after CCV fails	5	%RSD of ≤20%, otherwise use calibration curve	Every 10 samples	%D ≤15%,
GC Pesticides •CLP	Each new run or after CCV fails	3	%RSD of ≤20%, otherwise use calibration curve	Every 10 samples	%D ≤25%

Footnotes and the key to abbreviations are on page 8

Table 9-1 (Continued)

Calibration Criteria*					
Instrument • Method	**Calibration**			**CCV**	
	Frequency	**# Calib. Points**	**Acceptance Criteria**	**Frequency**	**Acceptance Criteria**
GC/MS Semivolatiles •625	After CCV fails	3	RF for SPCC's ≥0.050; Max %RSD for CCC ≤ 35%	Every 24 hours	%D ≤ 20%
GC/MS Semivolatiles •8270	After CCV fails	5	RF for SPCC's ≥0.050; Max %RSD for CCC ≤ 30%	Every 12 hours	RF for SPCC's ≥ 0.050; Max %D for CCC ≤ 30%
GC/MS Semivolatiles •CLP	After CCV fails	5	RF for SPCC's ≥0.050; Max %RSD for CCC ≤ 30%	Every 12 hours	RF for SPCC's ≥ 0.050; Max %D for CCC ≤ 30%
GC VOA Halocarbons and Aromatics •502.2	After CCV fails	3-5	%RSD of ≤10%, otherwise use calibration curve	Daily	%D ≤ 20%
GC VOA Halocarbons and Aromatics •601/602	After CCV fails	3	%RSD of ≤10%, otherwise use calibration curve	Daily	By compound: See Table 2 in Method 601 and in Method 602
GC VOA Halocarbons and Aromatics •8010/8020	After CCV fails	5	%RSD of ≤20%, otherwise use calibration curve	Every 10 samples	%D ≤15%

Footnotes and the key to abbreviations are on page 8

Table 9-1 (Continued)

Calibration Criteria*					
Instrument • Method	**Calibration**			**CCV**	
	Frequency	**# Calib. Points**	**Acceptance Criteria**	**Frequency**	**Acceptance Criteria**
GFAA •CLP	Each new run	4[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
FAA •200 Series	Each new run	4[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
FAA •7000 Series	Each new run	4[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±20% of true value
FAA •CLP	Each new run	4[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
HAA •206.3/270.3	Each new run	4[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
HAA •7061/7741	Each new run	4[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±20% of true value
Infrared Spectro-photometer •418.1	When CCV fails	5	Correlation coefficient ≥0.995	Every 10 samples	CCV within ±10% of true value
TOC Analyzer •415.1	Daily	2	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
TOC Analyzer •9060	Daily	2	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value

Footnotes and the key to abbreviations are on page 8

Table 9-1 (Continued)

Calibration Criteria*					
Instrument • Method	Calibration			CCV	
	Fre-quency	# Calib. Points	Acceptance Criteria	Fre-quency	Acceptance Criteria
ICP •200.7	Each new run	2[1]	ICV within ±5% of true value	Every 10 samples	CCV within ±5% of true value
ICP •6010	Each new run	2[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
ICP •CLP	Each new run	2[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
CVAA •245.1/245.5	Each new run	6[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
CVAA •7470/7471	Each new run	6[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±20% of true value
CVAA •CLP	Each new run	5[1]	ICV within ±20% of true value	Every 10 samples	CCV within ±20% of true value
GFAA •200.9	Each new run	4[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
GFAA •200 Series	Each new run	4[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±10% of true value
GFAA •7000 Series	Each new run	4[1]	ICV within ±10% of true value	Every 10 samples	CCV within ±20% of true value

Footnotes and the key to abbreviations are on page 8

Table 9-2

Key Ions and Their Abundance Criteria	
Mass	**Ion Abundance Criteria**
BFB Key Ion Abundance Criteria:	
50	15% to 40% of mass 95 (CLP: 8% to 40%)
75	30% to 60% of mass 95 (CLP: 30% to 66%)
95	base peak, 100% relative abundance
96	5% to 9% of mass 95
173	less than 2% of mass 174
174	greater than 50% of mass 95 (CLP: 50% to 120%)
175	5% to 9% of mass 174 (CLP: 4% to 9%)
176	greater than 95% but less than 101% of mass 174 (CLP: >93% but <101%)
177	5% to 9% of mass 176
DTFPP Key Ion Abundance Criteria:	
51	30% to 60% of mass 198 (CLP: 30% to 80%)
68	less than 2% of mass 69
69	mass 69 relative abundance
70	less than 2% of mass 69
127	40% to 60% of mass 198 (CLP: 25% to 75%)
197	less than 1% of mass 198
198	base peak, 100% relative abundance
199	5% to 9% of mass 198
275	10% to 30% of mass 198
365	greater than 1% of mass 198 (CLP: >0.75%)
441	present but less than mass 443
442	greater than 40% of mass 198 (CLP: 40% to 110%)
443	17% to 23% of mass 442 (CLP: 15% to 24%)

CLP refers to specifications in the Statement of Work, OLM03.1

Table 9-1 (Continued)

Calibration Criteria*					
Instrument • Method	**Calibration**			**CCV**	
	Fre-quency	**# Calib. Points**	**Acceptance Criteria**	**Fre-quency**	**Acceptance Criteria**
TOX Analyzer •9020B	Each new run	1	ICV within ±10% of true value	Every 10 samples	CCV within ±15% of true value
Ion Chromatograph •300.0	When CCV fails	6	ICV within ±10% of true value	Every 20 samples	CCV within ±10% of true value
Balances	Daily	2 or 3	Within ±0.1% of true value	N.A.	N.A.
Colorimetric Methods	Quarterly, monthly (cyanide), or when CCV fails	3 or more, depends on method	Correlation coefficient > 0.995	Every 10 samples	within ±10% of true value (±15% for cyanide), see method requirements

Note 1 The number of calibration points for metal analyses includes a calibration blank.

*Abbreviations to Table 9-1

CCV:	Continuing Calibration Verification
ICV:	Initial Calibration Verification
SPCC's:	System Performance Check Compounds
CCC:	Calibration Check Compounds
RF:	Response Factor
%RSD:	Percent Relative Standard Deviation
%D:	Percent Difference
C-cal:	Continuing Calibration
ICP:	Inductively Coupled Plasma Spectrophotometer
CVAA:	Cold Vapor Atomic Absorption Spectrophotometer
GFAA:	Graphite Furnace Atomic Absorption Spectrophotometer
FAA:	Flame Atomic Absorption Spectrophotometer
HAA:	Hydride Atomic Absorption Spectrophotometer

Analytical Procedures

The analytical procedures to be used for the preparation and analysis of water, sediment, and soil for organic and inorganic analytes are those described in USEPA methods publications (200 Series, 500 Series, and 600 Series), the USEPA SW-846, 3rd Edition, Update IIB, January 1995, CLP (SOW ILM04.0 and SOW OLM03.0), and *Standard Methods for the Examination of Water and Wastewater*. Copies of the standard references and the in-house analytical procedures are located in the laboratory and available for use by analysts. Copies of analytical methods are available upon request.

Tables 10-1 through 10-3 list the methods for which Mountain States Analytical, Inc. maintains certification from its resident state of Utah, as well as from several other states and accreditation programs. Table 10-4 lists Contract Laboratory Program (CLP) methods. Tables 10-5 through 10-20 list method detection limits (MDL) and limits of quantitation (LOQ), or contract required quantitation limits (CRQL) and contract required detection limits (CRDL) for CLP tests.

METHOD[a]	DESCRIPTION
	Nutrient Methods
350.2	Ammonia, Titrimetric, Potentiometric, Distillation Procedure
300.0	Nitrate, Ion Chromatography
300.0	Nitrate/Nitrite, Ion Chromatography
353.3	Nitrate/Nitrite, Colorimetric, Manual Cadmium Reduction
300.0	Nitrite, Ion Chromatography
354.1	Nitrite, Spectrophotometric
300.0	Orthophosphate, Ion Chromatogr.
365.3	Orthophosphate, Colorimetric
365.3	Phosphorus, All Forms, Colorimetric, Ascorbic Acid, Two Reagents
300.0	Sulfate, Ion Chromatography
375.4	Sulfate, Turbidimetric
351.3	Total Kjeldahl Nitrogen (TKN)
	Residue Methods
160.1	Residue Filterable (TDS)
160.2	Residue Nonfilterable (TSS)
160.5	Residue Settleable Matter, Volumetric
160.3	Residue Total, Gravimetric, Dried at 103 - 105 °C
160.4	Residue Volatile, Gravimetric, Ignition at 550 °C
	Demand Methods
405.1	BOD (5 day, 20 °C)
SM 5210B[b]	Carbonaceous BOD
410.4	COD, Colorimetric, Automated; Manual

METHOD[a]	DESCRIPTION
	Demand Methods (Continued)
360.1	Dissolved Oxygen, Membrane Electrode
415.1	TOC, Combustion or Oxidation
	Organic Methods
601	Purgeable Halocarbons, GC/ELCD(ECD)
602	Purgeable Aromatic, GC/PID
608	Organochlor Pesticides, GC/ECD
608	PCBs, GC/ECD
624	Purgeables, P&T/GC/MS
625	Base/Neutrals & Acids, GC/MS
	Miscellaneous Methods
330.4	Chlorine, Total Residual
SM D3500-Cr-D[b]	Chromium, Hexavalent, Colorimetric
110.2	Color, Colorimetric, Platinum-Cobalt
335.2	Cyanide, Titrimetric, Spectrophotometric
335.1	Cyanide, Amenable to Chlorination
413.1	Oil and Grease, Gravimetric, Separatory Funnel Extraction, Total Recoverable
1664	Oil and Grease, Hexane extractables, Gravimetric
420.1	Phenols, Spectrophotometric, Manual 4-AAP Total Recoverable with Distillation
180.1	Turbidity, Nephelometric

These footnotes apply to Table 10-1 and Table 10-2.

[a] All methods are EPA methods, except where noted.

[b] "SM" represents *Standard Methods for the Examination of Water and Wastewater.*

Table 10-1 Clean Water Act Methods

METHOD[a]	DESCRIPTION
	Metals Methods
200.7	Aluminum, ICP, AES
202.1	Aluminum, AA, Direct Aspiration
200.7	Antimony, ICP, AES
204.2	Antimony, AA, Furnace
200.7	Arsenic, ICP, AES
206.2	Arsenic, AA, Furnace
200.7	Barium, ICP, AES
208.1	Barium, AA, Direct Aspiration
200.7	Beryllium, ICP, AES
210.1	Beryllium, AA, Direct Aspiration
210.2	Beryllium, AA, Furnace
200.7	Cadmium, ICP, AES
213.1	Cadmium, AA, Direct Aspiration
213.2	Cadmium, AA, Furnace
200.7	Chromium, ICP, AES
218.1	Chromium, AA, Direct Aspiration
218.2	Chromium, AA, Furnace
200 .7	Cobalt, ICP, AES
219.1	Cobalt, AA, Direct Aspiration
219.2	Cobalt, AA, Furnace
200.7	Copper, ICP, AES
220.1	Copper, AA, Direct Aspiration
220.2	Copper, AA, Furnace
200.7	Iron, ICP, AES
236.1	Iron, AA, Direct Aspiration
200.7	Lead, ICP, AES
239.1	Lead, AA, Direct Aspiration
239.2	Lead, Furnace
200.7	Manganese, ICP, AES
243.1	Manganese, AA, Direct Aspiration
243.2	Manganese, Furnace
245.1	Mercury, Cold Vapor, Manual
200.7	Molybdenum, ICP, AES
246.1	Molybdenum, AA, Direct Aspiration
246.2	Molybdenum, AA, Furnace
200.7	Nickel, ICP, AES
249.1	Nickel, AA Direct Aspiration
249.2	Nickel, AA, Furnace
200.7	Selenium, ICP, AES
270.2	Selenium, AA, Furnace

METHOD[a]	DESCRIPTION
200.7	Silver, ICP, AES
272.1	Silver, AA, Direct Aspiration
272.2	Silver, AA, Furnace
200.7	Thallium, ICP, AES
279.2	Thallium, AA, Furnace
282.1	Tin, AA, Direct Aspiration
200.7	Titanium, ICP, AES
200.7	Vanadium, ICP, AES
286.1	Vanadium, AA, Direct Aspiration
286.2	Vanadium, AA, Furnace
200.7	Zinc, ICP, AES
289.1	Zinc, AA, Direct Aspiration
	Mineral Methods
305.1	Acidity, Titrimetric
310.1	Alkalinity, Titrimetric(pH 4.5)
200.7	Boron, ICP, AES
300.0	Bromide, Ion Chromatography
200.7	Calcium, ICP, AES
215.1	Calcium, AA, Direct Aspiration
215.2	Calcium, Titrimetric, EDTA
300.0	Chloride, Ion Chromatography
325.3	Chloride, Titrimetr, Mercuric Nitrate
300.0	Fluoride, Ion Chromatography
340.2	Fluoride, Potentiometric, Ion Selective Electrode with Bellack Distillation
130.2	Hardness, Total (mg/L as CaCO3) Titrimetric, EDTA
200.7	Magnesium, ICP, AES
242.1	Magnesium, AA, Direct Aspiration
150.1	pH, Electrometric
200.7	Potassium, ICP, AES
258.1	Potassium, AA, Direct Aspiration
370.1	Silica, Dissolved, Colorimetric
200.7	Sodium, ICP, AES
273.1	Sodium, AA, Direct Aspiration
120.1	Specific Conductance
376.1	Sulfide, Titrimetric, Iodine

Table 10-3 RCRA (SW-846) Methods

METHOD	DESCRIPTION
	Metals Methods
6010A	Aluminum, ICP
7020	Aluminum, AA, Direct Aspiration
6010A	Antimony, ICP
7040	Antimony, AA, Direct Aspiration
7041	Antimony, AA, Furnace Technique
6010A	Arsenic, ICP
7060A	Arsenic, AA, Furnace Technique
7062	Arsenic, AA, Borohydride Reduct.
6010A	Barium, ICP
7080	Barium, AA, Direct Aspiration
7081	Barium, AA, Furnace Technique
6010A	Beryllium, ICP
7090	Beryllium, AA, Direct Aspiration
7091	Beryllium, AA, Furnace Technique
6010A	Cadmium, ICP
7130	Cadmium, AA, Direct Aspiration
7131	Cadmium, AA, Furnace Technique
6010A	Chromium, ICP
7190	Chromium , AA, Direct Aspiration
7191	Chromium, AA, Furnace Technique
7196A	Chromium, Hexavalent
6010A	Cobalt, ICP
7200	Cobalt, AA, Direct Aspiration
7201	Cobalt, AA, Furnace Technique
6010A	Copper, ICP
7210	Copper, AA, Direct Aspiration
7211	Copper, AA, Furnace Technique
6010A	Iron, ICP
7380	Iron, AA, Direct Aspiration
6010A	Lead, ICP
7420	Lead, AA, Direct Aspiration
7421	Lead, AA, Furnace Technique
6010A	Lithium, ICP
7430	Lithium, AA Direct Aspiration
6010A	Manganese, ICP
7460	Manganese, AA, Direct Aspiration
7470A	Mercury, Manual Cold-Vapor, Technique
7471A	Mercury, Manual Cold-Vapor Technique
6010A	Molybdenum, ICP

METHOD	DESCRIPTION
7480	Molybdenum, AA, Direct Aspiration
7481	Molybdenum, AA, Furnace Technique
6010A	Nickel, ICP
7520	Nickel, AA, Direct Aspiration
6010A	Selenium, ICP
7740	Selenium, AA, Furnace Technique
7742	Selenium, AA Borohydride Reduct.
6010A	Silver, ICP
7760A	Silver, AA, Direct Aspiration
7761	Silver, AA, Furnace Technique
7780	Strontium, AA, Direct Aspiration
6010A	Thallium, ICP
7841	Thallium, AA, Furnace Technique
7870	Tin, AA, Direct Aspiration
6010A	Vanadium, ICP
7910	Vanadium, AA Direct Aspiration
7911	Vanadium, AA, Furnace Technique
6010A	Zinc, ICP
7950	Zinc, AA, Direct Aspiration
	Minerals
6010	Boron, ICP
6010A	Calcium, ICP
7140	Calcium, AA, Direct Aspiration
6010A	Magnesium, ICP
7450	Magnesium, AA, Direct Aspiration
6010A	Phosphorus, ICP
6010A	Potassium, ICP
7610	Potassium, AA, Direct Aspiration
6010A	Sodium, ICP
7770	Sodium, AA, Direct Aspiration
	Organic Methods
8020A	Aromatic Volatile Organics
8150A/8151	Chlorinated Herbicides
8010A	Halogenated Volatile Organics
8021	Halogenated Volatile Organics
8330	Explosives
8015A	Nonhalogen Volatile Organics
8080/8081	Organochlorine Pesticides
8080/8081	PCB

Table 10-2 Drinking Water Methods

METHOD[a]	DESCRIPTION
	Metals Methods
200.7	Aluminum, ICP
200.9	Antimony, GFAA
200.7A	Arsenic, ICP
200.9	Arsenic, GFAA
206.3	Arsenic, AA, Hydride
200.7	Barium, ICP
200.7	Beryllium, ICP
200.9	Beryllium, GFAA
200.7	Cadmium, ICP
200.9	Cadmium, GFAA
200.7	Chromium, ICP
200.9	Chromium, GFAA
200.7	Copper, ICP
200.9	Copper, GFAA
200.7	Iron, ICP
200.9	Lead, GFAA
200.7	Manganese, ICP
200.9	Manganese, GFAA
245.1	Mercury, AA Cold Vapor
200.7	Nickel, ICP
200.9	Nickel, GFAA
200.9	Selenium, GFAA
200.7	Silver, ICP
200.9	Silver, GFAA
200.9	Thallium, GFAA
200.7	Zinc, ICP
SM 3111B[b]	Zinc, AA, Direct Aspiration
	Minerals Methods
SM 2320B[b]	Alkalinity-Titrimetric
200.7	Calcium, ICP
300.0	Chloride, IC
SM 2510B[b]	Conductivity, Spec. Conductance

METHOD[a]	DESCRIPTION
	Minerals Methods (Continued)
300.0	Orthophosphate, IC
SM 4500-P-E[b]	Orthophosphate, Colorimetric, ascorbic acid
200.7	Sodium, ICP
SM 3111B[b]	Sodium, AA, Direct Aspiration
	Nutrient Methods
300.0	Fluoride, IC
340.2	Fluoride, Potentiometric, Ion Selective Electrode
300.0	Nitrate, IC
300.0	Nitrite, IC
300.0	Sulfate, IC
	Organic Methods
502.2	Total THMs, GC/ELCD/PID
502.2	VOCs, GC/ELCD/PID
504.1	EDB/DBCP, GC/ECD
507	Nitrog/Phos Pesticides, GC/ECD
508	Chlorinated Pesticides, GC/ECD
508	PCBs, GC/ECD
508A	PCBs (screen), perchlorination
515.1	Chlorophenoxy Herb., GC/ECD
524.2	Total THMs, GC/MS
524.2	VOCs, GC/MS
	Miscellaneous Methods
	Corrosivity/Langlier Index
SM 4500-Cn-E[b]	Cyanide, Total, Colorimetric
150.1	pH, Electrometric
SM 2450C[b]	Total Dissolved Solids (TDS)
180.1	Turbidity, Nephelometric
SM 4500-Cl-F[b]	Chlorine, Residual

Table 10-4 EPA Contract Laboratory Program (CLP) Methods

METHOD	DESCRIPTION
	Inorganics Methods (ILM04.0)
200.7 CLP-M	Aluminum, ICP
204.2 CLP-M	Antimony, AA, Furnace Technique
200.7 CLP-M	Arsenic, ICP
206.2 CLP-M	Arsenic, AA, Furnace Technique
200.7 CLP-M	Barium, ICP
200.7 CLP-M	Beryllium, ICP
200.7 CLP-M	Cadmium, ICP
213.2 CLP-M	Cadmium, AA, Furnace Technique
200.7 CLP-M	Calcium, ICP
200.7 CLP-M	Chromium, ICP
218.2 CLP-M	Chromium, AA, Furnace Technique
200.7 CLP-M	Cobalt, ICP
200.7 CLP-M	Copper, ICP
200.7 CLP-M	Iron, ICP
200.7 CLP-M	Lead, ICP
239.2 CLP-M	Lead, AA, Furnace Technique
200.7 CLP-M	Magnesium, ICP
200.7 CLP-M	Manganese, ICP
245.1 CLP-M	Mercury, Manual Cold-Vapor, Technique, Water
245.5 CLP-M	Mercury, Manual Cold-Vapor, Technique, Soil/Sediment
200.7 CLP-M	Nickel, ICP
200.7 CLP-M	Selenium, ICP
270.2 CLP-M	Selenium, AA, Furnace Technique
200.7 CLP-M	Silver, ICP
200.7 CLP-M	Sodium, ICP
200.7 CLP-M	Thallium, ICP
279.2 CLP-M	Thallium, AA, Furnace Technique
200.7 CLP-M	Vanadium, ICP
200.7 CLP-M	Zinc, ICP
335.2 CLP-M	Cyanide, Total, Water
335.2 CLP-M	Cyanide, Total, Soil/Sediment

METHOD	DESCRIPTION
	Organics Methods (OLM03.1)
VOA	Volatiles, GC/MS
SVOA	Semivolatiles, GC/MS
PEST/ARO	Pesticides/Aroclors, GC

METHOD	DESCRIPTION
	Organic Methods (Continued)
8141A	Organophosphorus Pesticides, Capillary Column
8040A	Phenols, GC
8100	PAH
8270A	Semivolatiles, GC/MS
8240A	Volatiles, GC/MS
8260	Volatiles, GC/MS, Capillary Column
	Miscellaneous Methods
9056	Bromide, Ion Chromatography
9081	Cation Exchange of Soils
9252A	Chloride (Titrimetric, Mercuric Nitrate)
9056	Chloride, Ion Chromatography
9010A	Cyanide Total/Amenable
9056	Fluoride, Ion Chromatography
1010	Ignitability
9056	Nitrate, Ion Chromatography

METHOD	DESCRIPTION
	***Miscellaneous Methods* (Cont.)**
9056	Nitrite, Ion Chromatography
9070	Oil & Grease,Gravimetric, Separatory Funnel Extraction
9071A	Oil & Grease, Extraction for Soil & Sediment
9095	Paint Filter Liquid Test
9040B	pH, Electrometric Measurement
9045C	pH, Soil and Waste
9065	Phenolics, Spectrophotometric, Manual 4-AAP (Distillation)
7.3	Reactivity, Cyanide (Sect. 7.3.3)
7.3	Reactivity, Sulfide (Sect. 7.3.4)
9050	Specific Conductance
1312	SPLP
9038	Sulfates (Turbidimetric)
9030A	Sulfides
1311	TCLP, for Metals, Volatiles, & Semivolatiles
9060	Total Organic Carbon
9020B	Total Organic Halides

Table 10-5 (Continued)

Volatile Priority Pollutant Compound List (GC/MS)*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Toluene	5	5	1	1
Chlorobenzene	5	5	1	1
Ethylbenzene	5	5	1	1
Xylene (total)	5	5	2	1
Xylene (ortho)	5	5	1	1

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."
MDL is defined as "Method Detection Limit."

Table 10-5

Volatile Priority Pollutant Compound List (GC/MS)*

Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Chloromethane	10	10	1	1
Bromomethane	10	10	1	1
Vinyl chloride	10	10	1	1
Chloroethane	10	10	6	1
Acrolein	100	100	5	5
Acrylonitrile	50	50	5	5
Methylene chloride	5	5	2	1
Trichlorofluoromethane	5	5	1	1
1,1-Dichloroethene	5	5	1	1
1,1-Dichloroethane	5	5	1	1
trans-1,2-Dichloroethene	5	5	1	1
Chloroform	5	5	1	1
1,2-Dichloroethane	5	5	1	1
1,1,1-Trichloroethane	5	5	1	1
Carbon tetrachloride	5	5	1	1
Bromodichloromethane	5	5	1	1
1,1,2,2-Tetrachloroethane	5	5	1	1
1,2-Dichloropropane	5	5	1	1
trans-1,3-Dichloropropene	5	5	1	1
Trichloroethene	5	5	1	1
Dibromochloromethane	5	5	1	1
1,1,2-Trichloroethane	5	5	1	1
Benzene	5	5	1	1
cis-1,3-Dichloropropene	5	5	1	1
2-Chloroethylvinyl ether	20	20	8	1
Bromoform	5	5	1	1
Tetrachloroethene	5	5	1	1

Table 10-6 (Continued)

Appendix IX Volatile Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Vinyl acetate	10	10	2	1
Bromodichloromethane	5	5	1	1
2-Chloro-1,3-butadiene	5	5	1	1
1,2-Dichloropropane	5	5	1	1
trans-1,3-Dichloropropene	5	5	1	1
Trichloroethene	5	5	1	1
Dibromochloromethane	5	5	1	1
1,1,2-Trichloroethane	5	5	1	1
1,2-Dibromoethane	5	5	1	1
Benzene	5	5	1	1
cis-1,3-Dichloropropene	5	5	1	1
Methyl methacrylate	5	5	1	1
1,1,1,2-Tetrachloroethane	5	5	1	1
Bromoform	5	5	1	1
trans-1,4-Dichloro-2-butene	10	10	1	1
1,2,3-Trichloropropane	5	5	1	1
2-Hexanone	10	10	2	1
4-Methyl-2-pentanone	10	10	1	1
Tetrachloroethene	5	5	1	1
1,1,2,2-Tetrachloroethane	5	5	1	1
Toluene	5	5	1	1
Ethyl methacrylate	5	5	1	1
Chlorobenzene	5	5	1	1
Pentachloroethane	10	10	1	1
Ethylbenzene	5	5	1	1
1,2-Dibromo-3-chloropropane	10	10	1	1

Table 10-6

Appendix IX Volatile Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Chloromethane	10	10	3	3
Bromomethane	10	10	3	3
Vinyl chloride	10	10	3	3
Dichlorodifluoromethane	5	5	1	1
Chloroethane	10	10	4	4
Methyl iodide	5	5	1	1
Acrolein	100	100	1	1
Acrylonitrile	50	50	1	1
Acetonitrile	150	150	1	1
Methylene chloride	5	5	4	4
Acetone	20	20	6	6
Trichlorofluoromethane	5	5	1	1
Carbon disulfide	5	5	3	3
Propionitrile	100	100	1	1
1,1-Dichloroethene	5	5	2	1
Allyl chloride	5	5	1	1
1,1-Dichloroethane	5	5	2	2
trans-1,2-Dichloroethene	5	5	2	2
Chloroform	5	5	2	2
1,2-Dichloroethane	5	5	2	2
Methacrylonitrile	10	10	1	1
2-Butanone	20	20	9	9
Dibromomethane	5	5	1	1
1,1,1-Trichloroethane	5	5	3	3
1,4-Dioxane	500	500	1	1
Carbon tetrachloride	5	5	2	2
Isobutyl alcohol	300	300	1	1

Table 10-7

Volatiles Compound List for Toxicity Characteristic Leaching Procedure (TCLP) Quantitation* and Regulatory Limits

Compound	Hazardous Waste Identification Number	Quantitation Limit (mg/l)	Regulatory Limit (mg/l)
Benzene	D018	0.05	0.5
Carbon tetrachloride	D019	0.05	0.5
Chlorobenzene	D021	0.05	100.0
Chloroform	D022	0.05	6.0
1,2-Dichloroethane	D028	0.05	0.5
1,1-Dichloroethene	D029	0.05	0.7
2-Butanone (MEK)	D035	0.2	200.0
Tetrachloroethene	D039	0.05	0.7
Trichloroethene	D040	0.05	0.5
Vinyl chloride	D043	0.1	0.2

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Table 10-6 (Continued)

Appendix IX Volatile Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Styrene	5	5	1	1
Xylenes (total)	5	5	5	5
Xylenes (ortho)	5	5	2	2

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."
MDL is defined as "Method Detection Limit."

Table 10-8 (Continued)

Volatiles Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*				
Compound	CAS Number	Quantitation Limits		
		water (ug/l)	low soil (ug/kg)	med soil (ug/kg)
2-Hexanone	591-78-6	10	10	1200
Tetrachloroethene	127-18-4	10	10	1200
1,1,2,2-Tetrachloroethane	79-34-5	10	10	1200
Toluene	108-88-3	10	10	1200
Chlorobenzene	108-90-7	10	10	1200
Ethylbenzene	100-41-4	10	10	1200
Styrene	100-42-5	10	10	1200
Xylenes (total)	1330-20-7	10	10	1200

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

Table 10-8

Volatiles Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*				
Compound	CAS Number	Quantitation Limits		
		water (ug/l)	low soil (ug/kg)	med soil (ug/kg)
Chloromethane	74-87-3	10	10	1200
Bromomethane	74-83-9	10	10	1200
Vinyl chloride	75-01-4	10	10	1200
Chloroethane	75-00-3	10	10	1200
Methylene chloride	75-09-2	10	10	1200
Acetone	67-64-1	10	10	1200
Carbon disulfide	75-15-0	10	10	1200
1,1-Dichloroethene	75-35-4	10	10	1200
1,1-Dichloroethane	75-34-3	10	10	1200
1,2-Dichloroethene (total)	540-59-0	10	10	1200
Chloroform	67-66-3	10	10	1200
1,2-Dichloroethane	107-06-02	10	10	1200
2-Butanone	78-93-3	10	10	1200
1,1,1-Trichloroethane	71-55-6	10	10	1200
Carbon tetrachloride	56-23-5	10	10	1200
Bromodichloromethane	75-27-4	10	10	1200
1,2-Dichloropropane	78-87-5	10	10	1200
cis-1,3-Dichloropropene	10061-01-5	10	10	1200
Trichloroethene	79-01-6	10	10	1200
Dibromochloromethane	124-48-1	10	10	1200
1,1,2-Trichloroethane	79-00-5	10	10	1200
Benzene	71-43-2	10	10	1200
trans-1,3-Dichloropropene	10061-02-6	10	10	1200
Bromoform	75-25-2	10	10	1200
4-Methyl-2-pentanone	108-10-1	10	10	1200

Table 10-9 (Continued)

Semivolatile Priority Pollutant Compound List				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Acenaphthylene	10	330	1	33
Dimethylphthalate	10	330	1	33
2,6-Dinitrotoluene	10	330	1	33
Acenaphthene	10	330	1	33
2,4-Dinitrotoluene	10	330	1	33
Fluorene	10	330	1	33
4-Chlorophenyl phenylether	10	330	1	33
Diethylphthalate	10	330	1	33
1,2-Diphenylhydrazine	10	330	1	33
N-Nitrosodiphenylamine	10	330	1	33
4-Bromophenyl phenylether	10	330	1	33
Hexachlorobenzene	10	330	1	33
Phenanthrene	10	330	1	33
Anthracene	10	330	1	33
Di-n-butylphthalate	10	330	1	33
Fluoranthene	10	330	1	33
Pyrene	10	330	1	33
Benzidine	50	3300	1	33
Butylbenzylphthalate	10	330	1	33
Benz(a)anthracene	10	330	1	33
Chrysene	10	330	1	33
3,3'-Dichlorobenzidine	20	1300	1	33
bis(2-Ethylhexyl)phthalate	10	330	1	33
Di-n-octylphthalate	10	330	1	33
Benzo(b)fluoranthene	10	330	1	33
Benzo(K)fluoranthene	10	330	1	33

Table 10-9

Semivolatile Priority Pollutant Compound List*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
2-Chlorophenol	10	330	1	33
Phenol	10	330	1	33
2-Nitrophenol	10	330	1	33
2,4-Dimethylphenol	10	330	1	33
2,4-Dichlorophenol	10	330	1	33
4-Chloro-3-methylphenol	20	1300	1	33
2,4,6-Trichlorophenol	10	330	1	33
2,4-Dinitrophenol	50	3300	9	297
4-Nitrophenol	50	3300	3	99
2-Methyl-4,6-dinitrophenol	50	3300	1	33
Pentachlorophenol	50	3300	1	33
N-Nitrosodimethylamine	10	330	1	33
bis(2-Chloroethyl)ether	10	330	1	33
1,3-Dichlorobenzene	10	330	1	33
1,4-Dichlorobenzene	10	330	1	33
1,2-Dichlorobenzene	10	330	1	33
bis(2-Chloroisopropyl)ether	10	330	1	33
Hexachloroethane	10	330	1	33
N-Nitrosodi-n-propylamine	10	330	1	33
Nitrobenzene	10	330	1	33
Isophorone	10	330	1	33
bis(2-Chloroethoxy)methane	10	330	1	33
1,2,4-Trichlorobenzene	10	330	1	33
Naphthalene	10	330	1	33
Hexachlorobutadiene	10	330	1	33
Hexachlorocyclopentadiene	10	330	4	132
2-Chloronaphthalene	10	330	1	33

Table 10-10

Appendix IX Semivolatile Compounds				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Acenaphthene	10	1000	1	100
Acenaphthylene	10	1000	1	100
Acetophenone	10	1000	1	100
2-Acetylaminofluorene	10	1000	1	100
4-Aminobiphenyl	10	1000	1	100
Aniline	10	1000	1	100
Anthracene	10	1000	1	100
Benz(a)anthracene	10	1000	1	100
Benzo(b)fluoranthene	10	1000	2	200
Benzo(K)fluoranthene	10	1000	2	200
Benzo(ghi)perylene	10	1000	1	100
Benzo(a)pyrene	10	1000	1	100
Benzyl alcohol	20	2000	1	100
bis(2-Chloroethoxy)methane	10	1000	1	100
bis(2-Chloroethyl)ether	10	1000	1	100
bis(2-Chloro-1-methylethyl) ether	10	1000	1	100
bis(2-Ethylhexyl)phthalate	10	1000	4	100
4-Bromophenyl phenylether	10	1000	1	100
Butylbenzylphthalate	10	1000	2	200
4-Chloroaniline	20	2000	1	100
Chlorobenzilate	10	1000	1	100
4-Chloro-3-methylphenol	10	1000	1	100
2-Chloronaphthalene	10	1000	1	100
2-Chlorophenol	10	1000	1	100
4-Chlorophenyl phenylether	10	1000	1	100
Chrysene	10	1000	1	100

Table 10-9 (Continued)

Semivolatile Priority Pollutant Compound List*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Benzo(a)pyrene	10	330	1	33
Ideno(1,2,3-cd)pyrene	10	330	1	33
Dibenz(a,h)anthracene	10	330	1	33
Benzo(g,h,i)perylene	10	330	1	33

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."
MDL is defined as "Method Detection Limit."
ND is defined as "Not Determined."

Table 10-10 (Continued)

Appendix IX Semivolatile Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Di-n-octylphthalate	10	1000	3	300
Diphenylamine	10	1000	1	100
Ethyl methanesulfonate	10	1000	1	100
Fluoranthene	10	1000	2	200
Fluorene	10	1000	1	100
Hexachlorobenzene	10	1000	1	100
Hexachloro-1,3-butadiene	10	1000	1	100
Hexachlorocyclopentadiene	10	1000	1	100
Hexachloroethane	10	1000	2	200
Hexachloropropene[1]	10	1000	1	100
Indeno(1,2,3-cd)pyrene	10	1000	1	100
Isodrin	10	1000	1	100
Isophorone	10	1000	1	100
Isosafrole	10	1000	1	100
Methapyrilene	50	5000	1	100
3-Methylchloranthene	10	1000	1	100
Methyl methanesulfonate	10	1000	1	100
2-Methylnaphthalene	10	1000	1	100
Naphthalene	10	1000	1	100
1,4-Naphthoquinone[1]	50	5000	1	100
1-Naphthylamine	10	1000	1	100
2-Naphthylamine	20	2000	1	100
2-Nitroaniline	50	5000	1	100
3-Nitroaniline	50	5000	1	100
4-Nitroaniline	20	2000	1	100
Nitrobenzene	10	1000	1	100

Table 10-10 (Continued)

Appendix IX Semivolatile Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
2-Methylphenol	10	1000	1	100
3-Methylphenol	10	1000	1	100
4-Methylphenol	10	1000	1	100
Diallate	10	1000	1	100
Dibenzofuran	10	1000	1	100
Di-n-butylphthalate	10	1000	7	700
Dibenz(a,h)anthracene	10	1000	1	100
1,2-Dichlorobenzene	10	1000	2	200
1,3-Dichlorobenzene	10	1000	1	100
1,4-Dichlorobenzene	10	1000	1	100
3,3'-Dichlorobenzidine	20	2000	1	100
2,4-Dichlorophenol	10	1000	1	100
2,6-Dichlorophenol	10	1000	1	100
Diethylphthalate	10	1000	2	200
Dimethoate[1]	50	5000	1	100
p-(Dimethylamino)azobenzene	10	1000	1	100
7,12-Dimethylbenz(a)anthracene[1]	10	1000	1	100
3,3'-Dimethylbenzidine	10	1000	1	100
a,a-Dimethyl-1-phenethylamine	20	2000	1	100
2,4-Dimethylphenol	10	1000	2	200
Dimethylphthalate	10	1000	3	300
1,3-Dinitrobenzene	10	1000	1	100
2-Methyl-4,6-dinitro-o-cresol	50	5000	1	100
2,4-Dinitrophenol	50	5000	2	200
2,4-Dinitrotoluene	10	1000	1	100
2,6-Dinitrotoluene	10	1000	1	100

Table 10-10 (Continued)

Appendix IX Semivolatile Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
2,3,4,6-Tetrachlorophenol	10	1000	1	100
Tetraethyldithiopyrophosphate	10	1000	1	100
Thionazin	20	1000	1	100
o-Toluidine	10	1000	1	100
1,2,4-Trichlorobenzene	10	1000	1	100
2,4,5-Trichlorophenol	50	1700	1	100
2,4,6-Trichlorophenol	10	1000	1	100
0,0,0-Triethylphosphorothioate	10	1000	1	100
sym-Trinitrobenzene	50	5000	1	100

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."
MDL is defined as "Method Detection Limit."

[1]Since this is either a highly reactive compound or because uncontaminated neat material is unavailable, only semiquantitative data is reported.

Table 10-10 (Continued)

Appendix IX Semivolatile Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
2-Nitrophenol	10	1000	1	100
4-Nitrophenol	50	5000	1	100
4-Nitroquinoline 1-oxide[1]	50	5000	1	100
N-Nitrosodi-n-butylamine	10	1000	1	100
N-Nitrosodiethylamine	10	1000	1	100
N-Nitrosodimethylamine	10	1000	1	100
N-Nitorsodiphenylamine	10	1000	1	100
N-Nitrosodi-n-propylamine	10	1000	1	100
N-Nitrosomethylethylamine	10	1000	1	100
N-Nitrosomorpholine	20	2000	1	100
N-Nitrosopiperidine	10	1000	1	100
N-Nitrospyrrolidine	10	1000	1	100
5-Nitro-o-toluidine	10	1000	1	100
Pentachlorobenzene	10	1000	1	100
Pentachloronitrobenzene	10	1000	1	100
Pentachlorophenol	50	1700	2	100
Phenacetin	10	1000	1	100
Phenanthrene	10	1000	1	100
Phenol	10	1000	1	100
p-Phenylenediamine[1]	100	10000	1	100
2-Picoline	10	1000	1	100
Pronamide	10	1000	1	100
Pyrene	10	1000	1	100
Pyridine	10	1000	1	100
Safrole	10	1000	1	100
1,2,4,5-Tetrachlorobenzene	10	1000	1	100

Table 10-12

Semivolatiles Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*

Compound	CAS Number	Quantitation Limits		
		water (ug/l)	low soil (ug/kg)	med soil (ug/kg)
Phenol	108-95-2	10	330	10000
bis-(2-Chloroethyl)ether	111-44-4	10	330	10000
2-Chlorophenol	95-57-8	10	330	10000
1,3-Dichlorobenzene	541-73-1	10	330	10000
1,4-Dichlorobenzene	106-46-7	10	330	10000
1,2-Dichlorobenzene	95-50-1	10	330	10000
2-Methylphenol	95-48-7	10	330	10000
2,2'-oxybis(1-Chloropropane)	108-60-1	10	330	10000
4-Methylphenol	106-44-5	10	330	10000
N-Nitroso-di-n-propylamine	621-64-7	10	330	10000
Hexachloroethane	67-72-1	10	330	10000
Nitrobenzene	98-95-3	10	330	10000
Isophorone	78-59-1	10	330	10000
2-Nitrophenol	88-75-5	10	330	10000
2,4-Dimethylphenol	105-67-9	10	330	10000
bis(2-Chloroethoxy)methane	111-91-1	10	330	10000
2,4-Dichlorophenol	120-83-2	10	330	10000
1,2,4-Trichlorobenzene	120-82-1	10	330	10000
Naphthalene	91-20-3	10	330	10000
4-Chloroaniline	106-47-8	10	330	10000
Hexachlorobutadiene	87-68-3	10	330	10000
4-Chloro-3-methylphenol	59-50-7	10	330	10000
2-Methylnaphthalene	91-57-6	10	330	10000
Hexachlorocyclopentadiene	77-47-4	10	330	10000
2,4,6-Trichlorophenol	88-06-2	10	330	10000
2,4,5-Trichlorophenol	95-95-4	25	830	25000

Table 10-11

Semivolatiles Compound List for Toxicity Characteristic Leaching Procedure (TCLP) and Quantitation* and Regulatory Limits			
Compound	Hazardous Waste Identification Number	Quantitation Limit (mg/l)	Regulatory Limit (mg/l)
o-Cresol	D023	0.04	200.0**
m-Cresol	D024	0.04	200.0**
p-Cresol	D025	0.04	200.0**
1,4-Dichlorobenzene	D027	0.04	7.50
2,4-Dinitrotoluene	D030	0.04	0.13
Hexachlorobenzene	D032	0.04	0.13
Hexachlorobutadiene	D033	0.04	0.5
Hexachloroethane	D034	0.04	3.0
Nitrobenzene	D036	0.04	2.0
Pentachlorophenol	D037	0.2	100.0
Pyridine	D038	0.04	5.0
2,4,5-Trichlorophenol	D041	0.04	400.0
2,4,6-Trichlorophenol	D042	0.04	2.0

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

**If o-, m-, and p-cresol concentrations canot be differentiated, the total cresol concentration is used.

Table 10-12 (Continued)

Semivolatiles Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*				
Compound	CAS Number	Quantitation Limits		
		water (ug/l)	low soil (ug/kg)	med soil (ug/kg)
2-Chloronaphthalene	91-58-7	10	330	10000
2-Nitroaniline	88-74-4	25	830	25000
Dimethylphthalate	131-11-3	10	330	10000
Acenaphthylene	208-96-8	10	330	10000
2,6-Dinitrotoluene	606-20-2	10	330	10000
3-Nitroaniline	99-09-2	25	830	25000
Acenaphthene	83-32-9	10	330	10000
2,4-Dinitrophenol	51-28-5	25	830	25000
4-Nitrophenol	100-02-7	25	830	25000
Dibenzofuran	132-64-9	10	330	10000
2,4-Dinitrotoluene	121-14-2	10	330	10000
Diethylphthalate	84-66-2	10	330	10000
4-Chlorophenyl-phenyl ether	7005-72-3	10	330	10000
Fluorene	86-73-7	10	330	10000
4-Nitroaniline	100-01-6	25	830	25000
4,6-Dinitro-2-methylphenol	534-52-1	25	830	25000
N-nitrosodiphenylamine	86-30-6	10	330	10000
4-Bromophenyl-phenylether	101-55-3	10	330	10000
Hexachlorobenzene	118-74-1	10	330	10000
Pentachlorophenol	87-86-5	25	830	25000
Phenanthrene	85-01-8	10	330	10000
Anthracene	120-12-7	10	330	10000
Carbazole	86-74-8	10	330	10000
Di-n-butylphthalate	84-74-2	10	330	10000
Fluoranthene	206-44-0	10	330	10000
Pyrene	129-00-0	10	330	10000

Table 10-12 (Continued)

Semivolatiles Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*				
Compound	CAS Number	Quantitation Limits		
		water (ug/l)	low soil (ug/kg)	med soil (ug/kg)
Butylbenzylphthalate	85-68-7	10	330	10000
3,3'-Dichlorobenzidine	91-94-1	10	330	10000
Benzo(a)anthracene	56-55-1	10	330	10000
Chrysene	218-01-9	10	330	10000
bis(2-Ethylhexyl)phthalate	117-81-7	10	330	10000
Di-n-octylphthalate	117-84-0	10	330	10000
Benzo(b)fluoranthene	205-99-2	10	330	10000
Benzo(k)fluoranthene	207-08-9	10	330	10000
Benzo(a)pyrene	50-32-8	10	330	10000
Indeno(1,2,3-cd)pyrene	193-39-5	10	330	10000
Dibenzo(a,h)anthracene	53-70-3	10	330	10000
Benzo(g,h,i)perylene	191-24-2	10	330	10000

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

Table 10-13

Volatiles by GC Volatile Organics List*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Chloromethane	2	2	0.4	0.4
Bromomethane	2	2	0.4	0.4
Dichlorodifluoromethane	1	1	0.2	0.2
Vinyl chloride	2	2	0.4	0.4
Chloroethane	2	2	0.4	0.4
Methylene chloride	1	1	0.2	0.2
Trichlorofluoromethane	2	2	0.4	0.4
1,1-Dichloroethene	1	1	0.2	0.2
1,1-Dichloroethane	1	1	0.2	0.2
1,2-Dichloroethene (*cis*/*trans*)	1	1	0.2	0.2
Chloroform	1	1	0.2	0.2
1,2-Dichloroethane	1	1	0.2	0.2
1,1,1-Trichloroethane	1	1	0.2	0.2
Carbontetrachloride	1	1	0.2	0.2
Bromodichloromethane	1	1	0.2	0.2
1,2-Dichlorpropane	1	1	0.2	0.2
trans-1,3-Dichloropropene	1	1	0.2	0.2
Trichloroethene	1	1	0.2	0.2
Dibromochloromethane	1	1	0.2	0.2
1,1,2-Trichloroethane	1	1	0.2	0.2
cis-1,3-Dichloropropene	1	1	0.2	0.2
2-Chloroethylvinyl-ether	2	2	0.4	0.4
Bromoform	2	2	0.4	0.4
1,1,2,2-Tetrachloroethane	2	2	0.4	0.4
Tetrachloroethene	1	1	0.2	0.2
Chlorobenzene	1	1	0.2	0.2

Table 10-13 (Continued)

Volatiles by GC Volatile Organics List*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Benzene	1	1	0.2	0.2
Toluene	1	1	0.2	0.2
Ethylbenzene	1	1	0.2	0.2
o-Dichlorobenzene	1	1	0.2	0.2
m-Dichlorobenzene	1	1	0.2	0.2
p-Dichlorobenzene	1	1	0.2	0.2

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."
MDL is defined as "Method Detection Limit."

Table 10-14

Pesticide/PCB Priority Pollutant Compound List and Appendix IX Organochlorides				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
alpha-BHC	0.05	5	0.005	1
beta-BHC	0.05	5	0.005	1
gamma-BHC (Lindane)	0.05	5	0.005	1
delta-BHC	0.05	5	0.005	1
Heptachlor	0.05	5	0.005	1
Aldrin	0.05	5	0.005	1
Heptachlor epoxide	0.05	5	0.005	1
4,4-DDE	0.05	5	0.005	1
4,4-DDD	0.05	5	0.005	1
4,4-DDT	0.05	5	0.005	1
Dieldrin	0.05	5	0.005	1
Endrin	0.05	5	0.005	1
Chlordane	1.0	100	0.1	20
Toxaphene	1.0	100	0.1	20
Endosulfan I	0.05	5	0.005	1
Endosulfan II	0.05	5	0.005	1
Endosulfan sulfate	0.05	5	0.005	1
Endrin aldehyde	0.05	5	0.005	1
PCB-1016	1	100	0.2	20
PCB-1221	1	100	0.2	20
PCB-1232	1	100	0.2	20
PCB-1242	1	100	0.2	20
PCB-1248	1	100	0.2	20
PCB-1254	1	100	0.2	20
PCB-1260	1	100	0.2	20

Table 10-14 (Continued)

Pesticide/PCB Priority Pollutant Compound List and Appendix IX Organochlorides*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Methoxychlor**	0.05	5	0.005	1

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."
MDL is defined as "Method Detection Limit."

**This compound used for Appendix IX Organochlorines only.

Table 10-15

Pesticides Compound List for Toxicity Characteristic Leaching Procedure (TCLP) and Quantitation* and Regulatory Limits			
Compound	**Hazardous Waste Identification Number**	**Quantitation Limit (mg/l)**	**Regulatory Limit (mg/l)**
Chlordane	D020	0.03	0.03
Endrin	D012	0.02	0.02
Heptachlor	D031	0.008	0.008
Lindane	D013	0.4	0.4
Methoxychlor	D014	10.0	10.0
Toxaphene	D015	0.5	0.5

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Table 10-16

Pesticides/Aroclors Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*

Compound	CAS Number	Quantitation Limits	
		water (ug/l)	low soil (ug/kg)
alpha-BHC	319-84-6	0.05	1.7
beta-BHC	319-85-7	0.05	1.7
delta-BHC	319-86-8	0.05	1.7
gamma-BHC (Lindane)	58-89-9	0.05	1.7
Heptachlor	76-44-8	0.05	1.7
Aldrin	309-00-2	0.05	1.7
Heptachlor epoxide	111024-57-3	0.05	1.7
Endosulfan I	959-98-8	0.05	1.7
Dieldrin	60-57-1	0.10	3.3
4,4'-DDE	72-55-9	0.10	3.3
Endrin	72-20-8	0.10	3.3
Endosulfan II	33213-65-9	0.10	3.3
4,4'-DDD	72-54-8	0.10	3.3
Endosulfan sulfate	1031-07-8	0.10	3.3
4,4'-DDT	50-29-3	0.10	3.3
Methoxychlor	72-43-5	0.50	17.0
Endrin ketone	53494-70-5	0.10	3.3
Endrin aldehyde	7421-93-4	0.10	3.3
alpha-Chlordane	5103-71-9	0.05	1.7
gamma-Chlordane	5103-74-2	0.05	1.7
Toxaphene	8001-35-2	5.0	170.0
Aroclor-1016	12674-11-2	1.0	33.0
Aroclor-1221	11104-28-2	2.0	67.0
Aroclor-1232	11141-16-5	1.0	33.0
Aroclor-1242	53469-21-9	1.0	33.0
Aroclor-1248	12672-29-6	1.0	33.0

Table 10-16 (Continued)

Pesticides/Aroclors Target Compound List (TCL) and Contract Required Quantitation Limits (CRQL)*			
Compound	CAS Number	Quantitation Limits	
		water (ug/l)	low soil (ug/kg)
Aroclor-1254	11097-69-1	1.0	33.0
Aroclor-1260	11096-82-5	1.0	33.0

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

Table 10-17

Appendix IX Organophosphates*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
Disulfoton	5	50	0.2	10
Methyl parathion	5	50	0.2	10
Ethyl parathion	5	50	0.2	10
Famphur	5	50	0.2	10
Phorate	5	50	0.2	10

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."
MDL is defined as "Method Detection Limit."

Table 10-18

Appendix IX Herbicide Compounds*				
Compound	LOQ		MDL	
	water (ug/l)	soil (ug/kg)	water (ug/l)	soil (ug/kg)
2,4-D	0.5	10	0.1	4
Dinoseb	1.0	20	0.2	10
2,4,5-TP	0.5	10	0.1	4
2,4,5-T	0.5	10	0.1	4

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

LOQ is defined as "Limit of Quantitation."
MDL is defined as "Method Detection Limit."

Table 10-19

Herbicides Compound List for Toxicity Characteristic Leaching Procedure (TCLP) and Quantitation* and Regulatory Limits			
Compound	Hazardous Waste Identification Number	Quantitation Limit (mg/l)	Regulatory Limit (mg/l)
2,4-D	D016	10.0	10.0
2,4,5-TP	D017	1.0	1.0

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Table 10-20

Inorganic Metals Limits of Quantitation (LOQ)*								
	ICP		GFAA		FAA		CVAA/HAA	
Analyte	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg
Aluminum	150	15			500	50		
Antimony	500	50	18	2	300	30		
Arsenic	100	10	13	1.3			20	2.5
Barium	15	2			200	20		
Beryllium	2	0.2	2	0.2	20	2		
Boron	100	10						
Cadmium	15	1.5	2	0.2	25	3		
Calcium	800	80			50	5		
Chromium	15	2	3	0.3	50	5		
Cobalt	15	2	2	0.2	100	10		
Copper	20	2	9	0.9	50	5		
Iron	500	50			600	60		
Lead	150	15	6	0.6	250	25		
Lithium	15	2			10	1		
Magnesium	100	10			50	5		
Manganese	15	2	1	0.1	250	25		
Mercury							0.5	0.3
Molybdenum	100	10	4	0.4	100	10		
Nickel	100	10	4	0.4	150	15		
Phosphorus	500	50						
Potassium	1000	100			50	5		
Selenium	300	30	18	2			15	2
Silica	1000				4000	400		
Silver	15	2	3	0.3	40	4		
Sodium	1500	150			100	10		
Strontium	20	2	0.5	0.05	80	8		

Table 10-20 (Continued)

Inorganic Metals Limits of Quantitation (LOQ)*								
	ICP		GFAA		FAA		CVAA/HAA	
Analyte	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg
Thallium	500	50	3	0.3	100	10		
Tin					100	10		
Titanium	10	1						
Vanadium	15	2	5	0.5	180	18		
Zinc	250	25			100	10		

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

Table 10-21

Inorganic Metals Method Detection Limits (MDL)*

Analyte	ICP		GFAA		FAA		CVAA/HAA	
	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg
Aluminum	30	3			100	10		
Antimony	100	10	3.5	0.4	50	5		
Arsenic	30	3	2.6	0.3			4	0.25
Barium	3	0.3			40	4		
Beryllium	0.3	0.03	0.3	0.03	4	0.4		
Boron	35	3.5						
Cadmium	3	0.3	0.3	0.03	5	0.5		
Calcium	100	10			10	1		
Chromium	5	0.5	0.7	0.07	10	1		
Cobalt	2	0.2	0.5	0.05	20	2		
Copper	5	0.5	2	0.2	10	1		
Iron	100	10			120	12		
Lead	35	3.5	1	0.1	50	5		
Lithium	3	0.3			6	0.6		
Magnesium	50	5			10	1		
Manganese	3	0.3	0.2	0.02	50	5		
Mercury							0.1	0.1
Molybdenum	20	2	0.7	0.07	20	2		
Nickel	15	1.5	0.8	0.08	30	3		
Phosphorus	100	10						
Potassium	200	20			10	1		
Selenium	75	7.5	3	0.3			3	0.13
Silica					400	40		
Silver	5	0.5	0.2	0.02	8	0.8		
Sodium	350	35			20	2		
Strontium	3	0.3	0.1	0.01	20	2		

Table 10-21 (Continued)

Inorganic Metals Method Detection Limits (MDL)*								
	ICP		GFAA		FAA		CVAA/HAA	
Analyte	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg	ug/l	mg/kg
Thallium	100	10	0.6	0.06	20	2		
Tin					20	2		
Titanium	2	0.2						
Vanadium	2	0.2	1	0.1	30	3		
Zinc	60	6			20	2		

*Method detection limits are determined annually. The actual values will vary a small amount from one determination to the next.

Table 10-22

Metals Analyte List for Toxicity Characteristic Leaching Procedure (TCLP) and Quantitation* and Regulatory Limits

Compound	Hazardous Waste Identification Number	Quantitation Limit (mg/l)	Regulatory Limit (mg/l)
Arsenic	D004	0.15	5.0
Barium	D005	1.0	100.0
Cadmium	D006	0.02	1.0
Chromium	D007	0.02	5.0
Lead	D008	0.2	5.0
Mercury	D009	0.0007	0.2
Selenium	D010	0.4	1.0
Silver	D011	0.02	5.0

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Table 10-23

Inorganic Target Analyte List (TAL) and Contract Required Detection Limits (CRDL)*					
Analyte	CAS Number	Contract Required Detection Limit (ug/l)	Instrument Detection Limit (ug/l)		
			ICP	GFAA	CVAA
Aluminum	7429-90-5	200	26.1		
Antimony	7440-36-0	60		2.1	
Arsenic	7440-38-2	10**	19.2	1.1	
Barium	7440-39-3	200	1.3		
Beryllium	7440-41-7	5	0.3		
Cadmium	7440-43-9	5	3.4	0.1	
Calcium	7440-70-2	5000	8.5		
Chromium	7440-47-3	10	5.2	0.4	
Cobalt	7440-48-4	50	3.1		
Copper	7440-50-8	25	4.7		
Iron	7439-89-6	100	52		
Lead	7439-92-1	3**	20.2	1.3	
Magnesium	7439-95-4	5000	16.5		
Manganese	7439-96-5	15	0.9		
Mercury	7439-97-6	0.2			0.1
Nickel	7440-02-0	40	11.8		
Potassium	7440-09-7	5000	81.6		
Selenium	7782-49-2	5**	58.3	1.0	
Silver	7440-22-4	10	5.1		
Sodium	7440-23-5	5000	59.0		
Thallium	7440-28-0	10**	74.2	1.1	
Vanadium	7440-62-2	50	2.4		
Zinc	7440-66-6	20	2.7		

*Specific detection limits are highly matrix dependant. The detection limits listed herein are provided for guidance and may not always be achievable.

**Graphite furnace required.

Table 10-24

Inorganic General Chemistry Limits of Quantitation and Method Detection Limits

Analyte	Limit of Quantitation		Method Detection Limit	
	water	soil	water	soil
Acidity	5 mg/L	50 mg/kg	1 mg/L	10 mg/kg
Alkalinity	5 mg/L	15 mg/kg	1 mg/L	3 mg/kg
Ammonia	1 mg/L	1000 mg/kg	0.2 mg/L	200 mg/kg
BOD	1.8 mg/L		0.6 mg/L	
Carbonaceous BOD	1.8 mg/L		0.6 mg/L	
Cation Exchange of Soils		0.1 meq/100 g		NIA
Chloride, Titrimetric	3 mg/L	30 mg/kg	1 mg/L	10 mg/kg
Chlorine	0.05 mg/L	0.5 mg/kg	NIA	NIA
COD	50 mg/L		10 mg/L	
Corrosivity/Langiier Index	0.01 units		NIA	
Cyanide	0.01 mg/L	0.5 mg/kg	0.002 mg/L	0.1 mg/kg
Dissolved Oxygen	0.1 mg/L		0.01 mg/L	
Fluoride, ISE	0.2 mg/L	40 mg/kg	0.04 mg/L	8 mg/kg
Hardness,Total	5 mg/L		1 mg/L	
Heat Content, BTU	1000 BTU	1000 BTU	200 BTU	200 BTU
Hexavalent Chromium	0.007 mg/L	0.07 mg/kg	0.002 mg/L	0.02 mg/kg
Ion Chromatograph:				
Bromide	0.5 mg/L	5 mg/kg	0.1 mg/L	1 mg/kg
Chloride	0.5 mg/L	5 mg/kg	0.03 mg/L	0.3 mg/kg
Fluoride	0.1 mg/L	1 mg/kg	0.01 mg/L	0.1 mg/kg
Nitrate	0.05 mg/L	0.5 mg/kg	0.01 mg/L	0.1 mg/kg
Nitrate/Nitrite	0.1 mg/L	1 mg/kg	0.03 mg/L	0.3 mg/kg
Nitrite	0.1 mg/L	1 mg/kg	0.02 mg/L	0.2 mg/kg
o-Phosphate	0.1 mg/L	2 mg/kg	0.04 mg/L	0.4 mg/kg
Sulfate	0.5 mg/L	5 mg/kg	0.08 mg/L	0.8 mg/kg

Table 10-24 (Continued)

Inorganic General Chemistry Limits of Quantitation and Method Detection Limits*				
Analyte	Limit of Quantitation		Method Detection Limit	
	water	soil	water	soil
Ignitability	50°F	50°F	50°F	50°F
Nitrate, Colorimetric	0.15 mg/L	1.5 mg/kg	0.05 mg/L	0.5 mg/kg
Nitrate/Nitrite, Colorimetric	0.15 mg/L	1.5 mg/kg	0.05 mg/L	0.5 mg/kg
Nitrite, Colorimetric	0.01 mg/L	0.1 mg/kg	0.003 mg/L	0.03 mg/kg
Oil & Grease	5 mg/L	50 mg/kg	1 mg/L	10 mg/kg
o-Phosphate, Colorimetric	0.08 mg/L	.8 mg/kg	0.02 mg/L	0.2 mg/kg
Paint Filter Liquid Test	0%	0%	0%	0%
pH	0.01	0.01	0.01	0.01
Phenolics	0.07 mg/L	35 mg/kg	0.02 mg/L	10 mg/kg
Phosphorus,Total	0.08 mg/L	0.5 mg/kg	0.02 mg/L	0.2 mg/kg
Reactivity: CN^-	120 mg/kg	120 mg/kg	24 mg/kg	24 mg/kg
S^{2-}	410 mg/kg	410 mg/kg	136 mg/kg	136 mg/kg
Residue, Filterable (TDS)	24 mg/L		8 mg/L	
Residue, Nonfilterable (TSS)	10 mg/L		3.3 mg/L	
Residue, Settleable, Volumetric	0.2 mg/L		NIA	
Residue, Total	24 mg/L		8 mg/L	
Residue, Volatile	0.1 mg/L		0.1 mg/L	
Specific Conductance	3 umhos/cm	30 umhos/cm	1 umhos/cm	10 umhos/cm
Specific Gravity/ Bulk Density	0.01	0.6 lb/ft^3	0.01	0.6 lb/ft^3
Sulfate, Gravimetric	25 mg/L	60 mg/kg	5 mg/L	20 mg/kg
Sulfate, Turbidimetric	5 mg/L		1 mg/L	
Sulfide	7.5 mg/L	25 mg/kg	2 mg/L	5 mg/kg

Table 10-24 (Continued)

Inorganic General Chemistry Limits of Quantitation and Method Detection Limits*				
	Limit of Quantitation		Method Detection Limit	
Analyte	water	soil	water	soil
Total Kjeldahl Nitrogen	2 mg/L	1000 mg/kg	0.5 mg/L	150 mg/kg
Total Organic Carbon	3 mg/L	50 mg/kg	0.5 mg/L	15 mg/kg
Total Organic Halides	90 mg/L	20 mg/kg	30 mg/L	4 mg/kg
in Oils		200 mg/kg		40 mg/kg
Turbidity	1 NTU		0.2 NTU	

*Specific quantitation limits are highly matrix dependant. The quantitation limits listed herein are provided for guidance and may not always be achievable.

Quantitation limits listed for soil/sediment are based on wet weight.
Quantitation limits calculated on a dry weight basis will be higher.

NIA is defined as "No Information Available."

Table 10-25

CLP Cyanide and Contract Required Detection Limit (CRDL)	
Analyte	Contract Required Detection Limit (ug/l)
Cyanide	10

Data Reduction, Verification, and Reporting

Raw analytical data generated in the laboratories are collected on printouts from the instruments and associated data system, or manually in bound notebooks. Analysts review data as it is generated to determine that the instruments are performing within specifications. This review includes calibration checks, surrogate recoveries, blank checks, retention time reproducibility, and other QC checks described in Section No. 12. If any problems are noted during the analytical run, corrective action is taken and documented.

Each analytical run is reviewed by an analyst for completeness and accuracy prior to interpretation and data reduction. The following calculations are used to reduce raw data to reportable results.

The calculation used by the Laboratory Information Management Systems (LIMS) to determine the reporting concentration is:

$$Conc. = \frac{Q \times DF \times V_f}{I} \times U$$

Where Q = the concentration determined by the analytical procedure (typically mg/L or µg/L)
DF = dilution factor (if needed)
V_f = final extract volume (ml)
I = initial sample volume (ml) or weight (g)
U = unit conversion factor, such as µg to mg (if needed)

Dry weight results are calculated by LIMS according to:

$$Dry\ weight\ result = \frac{(As\ received) \times 100\%}{100\% - (\%\ Moisture)}$$

The calculation used by the organics data system to determine concentration in the extract for GC/MS semivolatiles and GC Organochlorine Pesticides or in the sample itself for GC/MS volatiles is:

$$Q\ (ug/l) = \frac{A_x \times I_s}{A_{Is} \times RRF \times V_i}$$

(Multiply this equation by 1000 if extract was injected.)

Where Q = concentration determined by the data system
A_x = peak area
A_{Is} = internal standard peak area
I_s = amount of internal standard injected (ng)
RRF = relative response factor
V_i = volume of extract injected (ul) or volume sample purged (ml)

For GC analyses, other than Organochlorine Pesticides, an average response factor calibration procedure is used. The equations that the data system uses for calculating analyte concentrations are shown below:

$$Q\ (ug/l) = A_x \times RF_{avg}$$

with average response factor (RF_{avg}) calculated as:

$$RF_{avg} = \frac{\sum_{i=1}^{n} \left(\frac{C_{std}}{A_{std}}\right)_i}{n}$$

Where Q = concentration determined by the data system
A_x = analyte peak height or peak area
A_{std} = analyte peak height or peak area in the *i*th calibration level (of n levels)
C_{std} = analyte concentration in the *i*th calibration level (of n levels)
n = number of calibration levels

The results for inorganic metals analyses are reported in units of micrograms per liter (μg/L) or milligrams per liter (mg/L) for aqueous samples and in milligrams per kilogram (mg/kg) for solids. The instrument data systems determine results directly from a calibration curve relating absorbance or emission intensity to standard concentration in μg/L or mg/L.

Moisture content of solids is calculated as percent moisture:

$$\% \ Moisture = \frac{(C_i + S - C_f) \ x \ 100\%}{S}$$

Where C_i = container's initial weight (g) without sample
S = sample weight (g) added to the container
C_f = container's final weight (g) after drying time

General chemistry results are calculated by many different equations specifically suited to each type of analysis. Exact equations are given in the methods and SOPs. Some general categories are: titration, concentration determined from a calibration curve, gravimetry, and direct reading from a meter.

The generalized titration calculation is:

$$Conc. \ (mg/l, \ mg/kg) = \frac{(T - T_b) \ x \ N \ x \ F}{I}$$

Where T = volume of titrant (ml)
T_b = volume of titrant for the blank (ml)
N = normality of titrant
I = initial sample volume (ml) or weight (g)
F = conversion factor for formula weights and units

Examples of titrimetric methods are acidity, alkalinity, ammonia, calcium (EDTA), chloride, hardness, and sulfides.

Direct readings are reported without calculations, however instrument calibration is a prerequisite. The following are examples:

pH is directly read from a pH meter in standard units.

Specific Conductance is read from a conductivity meter in umhos/cm.

Paint Filter Liquid Test (Free Liquids) is a direct observation test and requires no calculations.

Results are usually reported in mg/l or ug/l for water samples and in mg/kg or ug/kg for solid samples. Soil samples are reported on an as received or on a dry weight basis, depending on the requirements of the client's project. The results are reported by the LIMS on MSAI Analysis Report Forms.

The principle criteria used to determine data quality will be the acceptance criteria described in Sections No. 9 and 12 and protocols specified in laboratory SOPs. Following review, interpretation, and data reduction by the analyst, the data are transferred to the LIMS either by direct data transfer from the analytical data system or manually. This system stores client information, sample results, and QC results. A security system is in place to control access of the LIMS by laboratory personnel and to provide an audit trail for information changes. The data are again reviewed by the Group Leader or another analyst, whose function is to provide an independent assessment, then verified on LIMS. The person performing the peer review step reviews all data, including quality control information, prior to verifying the data. Any errors identified during the review process are corrected to ensure generation of quality data. If data package deliverables have been requested, the laboratory will complete the appropriate forms (CLP-like data package forms) summarizing sample results and the quality control information, and assemble

copies of raw data (instrument printouts, spectra, chromatograms, laboratory notebooks, etc.) Each "fraction" of the data package is technically reviewed by the Group Leader or an experienced analyst in the analytical group producing that portion of the data. This information from the various analytical groups is combined into one package in the client requested format. This package is reviewed by the Quality Assurance Department for conformance with SOPs and to ensure that all QC goals have been met. Any analytical problems are discussed in the case narrative, which is also included with the data package deliverables.

The review of the data by the Quality Assurance Department includes spot checking raw data versus the final report, checking that all pertinent raw data are included and refer to the samples analyzed, review of all QC results for conformance with the method, and review of the case narrative for description of any unusual occurrences during analysis. This review is performed using techniques similar to the validation used by the Sample Management Office for the USEPA's Contract Laboratory Program. The review performed by the laboratory differs from "validation" because it does not address useability of the data, which usually requires some knowledge of the site. The laboratory will make every attempt to meet the requirements of this LQAP, thus reducing the need to assess useability of the data.

The LIMS are programmed to accept and track the results of quality control samples including blanks, spike recoveries, duplicates, controls, and reference materials. These computerized systems are programmed with the acceptance criteria for each type of QC sample and display explanation codes if the data are not within specifications. The LIMS produce control charts to aid in data review. These are available for review by analysts, Group Leaders, and the Quality Assurance Department to assess the severity of observed problems and data trends. If needed, reports are produced by the analytical groups for the

purpose of documenting any corrective actions taken. The flow of data from the time the samples enter the laboratory until the data are reported are summarized in Table 11-1.

Any data recorded manually will be collected in bound notebooks. All entries will be in ink, with no erasures or white-out being permitted. Any changes in data will be made using a single line to avoid obliteration of the original entry and will be dated and signed. Any data resulting from instrument printouts will be dated and will contain the signature and/or identification of the analyst responsible for its generation. After copies of the data are incorporated into the data package deliverables, the originals will be stored in locked archives at the laboratory for a period of ten years.

Project files will be created per client/project and will contain chain-of-custody records, analysis requirements, and laboratory acknowledgments which document samples received, laboratory sample number assignment, and analysis requested. Raw data are filed per batch number assignment and laboratory sample number which correlates to the sample receipt documents. When the project is complete, all documentation is archived in a limited access area and retained for ten years.

Table 11-1

Sample and Data Routing at Mountain States Analytical, Inc.		
	Action	**Personnel Involved**
1	Sample received at MSAI	Sample Administration Staff
2	Sample is entered onto LIMS (lab ID number assigned, analyses scheduled, chain of custody started, storage location assigned)	Sample Administration Staff
3	Sample stored in assigned location (refrigerated, unless noted)	Sample Administration Staff
4	Acknowledgment sent to client	Document Control Staff
5	Sample removed from storage for analysis and returned to the assigned storage location.	Sample Administration Staff
6	Sample obtained for analysis; necessary aliquot taken and sample returned to Sample Administration for storage	Technical Staff
7	Analysis is performed according to selected analytical method; raw data recorded, reviewed, and transferred to computer by analyst or technician*	Technical Staff
8	Computer performs calculations as programmed according to methods	Data Processing
9	Another analyst or supervisor verifies raw data	Technical Staff
10	Data package deliverables** are assembled	Data Package Staff
11	Data packages are reviewed	Quality Assurance Dept.
12	Data packages and analytical reports are reviewed against client requirements prior to mailing or faxing	Client Manager
13	Data packages and analytical reports are sent to the client; copies of all relevant documentation are stored in the archives.	Document Control Staff

* Analyses requiring the analyst's interpretation may involve manual data reduction prior to entry onto the computer.

** Analysis reports not requiring a data package are printed directly from LIMS and are reviewed at step 12 before mailing.

Internal Quality Control Checks

The particular types and frequencies of quality control checks analyzed with each sample are defined in analytical methods. General quality control check guidance is given in USEPA SW-846, the CLP organic and inorganic statements of work, and EPA quality assurance manuals. The quality control checks (QC checks) routinely performed during sample analysis include surrogates, matrix spikes, duplicates, blanks, internal standards, and laboratory control samples. In addition to these checks, some inorganic analyses employ post digestion spikes, analytical spikes, serial dilutions, and interference check samples. The tables in this section list the types and frequencies of the quality control checks performed, along with the acceptance criteria and corrective action to take if a QC check falls outside of its acceptance limit. These tables do not include all the quality control checks because many are method specific. Complete quality control check requirements are included in written methods and SOPs. Calibration checks with their corresponding criteria and frequencies are given in Section No. 9. Limits of Quantitation (LOQs) can be found in Section No. 10. The formulas for calculating results of these quality control checks are found in Section No. 15.

Surrogates (SURR) (used for organic analysis only) - Each sample, matrix spike, matrix spike duplicate, and blank are spiked with surrogate compounds (non-target compounds) prior to purging and extraction in order to monitor preparation and analysis. Surrogates are used to evaluate analytical efficiency by measuring the percent recovery.

Matrix Spikes (MS) - A matrix (soil or water) is spiked at the laboratory with known quantities of specific compounds (typically target compounds) and subjected to the entire analytical

procedure in order to indicate the appropriateness of the method for the matrix by measuring the percent recovery.

Duplicates (DUP, MSD) (duplicate and matrix spike duplicate) - A second aliquot of a matrix/sample is taken at the start of sample preparation and analyzed at the same time as the original sample in order to determine the precision of the method. Recovery of the original or matrix spike compared to the duplicate (or matrix spike duplicate) is expressed as a Relative Percent Difference (RPD).

Blanks (BLK) (method and preparation) - Blanks are analytical controls consisting of a volume of deionized or distilled laboratory water for water samples, or a purified solid matrix for soil/sediment samples. Metal analyses use a digested water blank with soils due to the difficulty in obtaining a purified solid matrix free of metals. Method blanks, reagent blanks and preparation blanks are treated with the same reagents, internal standards and surrogate standards as the samples, and carried through the entire analytical procedure. This type of blank is used to define the level of laboratory background contamination. Field, trip, and storage blanks are used to define the level of background contamination from the corresponding phase of sample handling.

Internal Standards (IS) (used for GC/MS analysis) - Internal standards are compounds added to every standard, blank, matrix spike, matrix spike duplicate, and sample at a known concentration, prior to analysis. Comparison of the peak areas of the internal standards are used for internal standard quantitation as well as to determine when changes in the instrument response will adversely affect quantification of target compounds.

Laboratory Control Samples (LCS) - Aqueous and solid control samples of known composition are analyzed using the same sample

preparation, reagents, and analytical methods employed for the sample. For inorganic analyses, LCS percent recovery must fall within established control limits. For organics, an LCS is run when MS/MSD recovery falls outside established limits. The organic LCS percent recovery must fall within acceptance limits based on statistical evaluation of past laboratory data. When the analytical method specifies acceptance limits for LCS recoveries, the method limits are used unless statistical evaluation justifies tighter limits.

Post Digestion Spike (PDS) (used for inorganics only) - If the matrix spike falls outside of its control limits, the digested parent sample is spiked with known quantities of the analytes that failed, and analyzed. Comparison of PDS and matrix spike results helps to confirm if recoveries are affected by interferences in the digested matrix or if interferences are specific to the digestion process.

Analytical Spike (A) (used for GFAA analysis only) - Graphite furnace analyses are required to spike each sample, blank, and laboratory control sample with a known quantity of the analyte of interest after their digestion. The percent recovery determines the outcome of the data analysis (See Figure 12-1).

Serial Dilutions (L) (used for inorganics only) - If the analyte concentration is sufficiently high (≥50 x the Instrument Detection Limit) an analysis of a 5 fold dilution must agree within 10% of the original determination. If the dilution analysis is not within 10%, a chemical or physical interference effect should be suspected.

Interference Check Sample (ICS) (used for inorganics ICP only) - To verify interelement and background correction factors a solution containing both interfering and analyte elements of known concentration are analyzed at the beginning and end of each analysis run or a minimum of twice per 8 hours.

The results of all quality control samples are entered into the computer along with sample results. The computer is programmed to compare the individual values with the acceptance limits. If the results are not within the acceptance criteria, appropriate corrective action is taken. For some analytical tests, control limits are generated by spreadsheet, and the comparison of results to control limits is done manually. Control Charts are plotted via computer showing mean and standard deviation and indicating trends or method bias. They may be accessed by laboratory personnel.

Quality control data are kept for spikes, duplicates, laboratory control samples, surrogates, calibration verifications, and blanks. Control limit definition and the procedures used to calculate them are found in Section No. 15. The LIMS at MSAI will identify some adverse trends as out-of-control conditions, so that appropriate corrective action may be taken. Most out-of-control trends require visual evaluation for identification.

Acceptance criteria for spikes, duplicates, laboratory control samples, and surrogates will be defined as the more restrictive of the limits given in the method or statistically determined control limits. This definition complies with Utah rules for environmental laboratories. Exceptions are made for acceptance limits defined by a statement of work, such as for CLP.

Table 12-1

GC/MS Volatile Organic Compounds Quality Control* (524.2)

QC Check	Acceptance Limits	Frequency	Corrective Action
SURR: Bromofluorobenzene 1,2-Dichlorobenzene-d4	Smaller of statistical or method limits	Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
MS: Spike all compounds of interest	Smaller of statistical or method limits	Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
MSD: Spike all compounds of interest	Smaller of statistical or method limits	Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
BLK:	≤LOQ[1]	Once for each 8 hour time period	Reanalyze blank and associated samples
IS: Fluorobenzene	-50% to +100% of internal standard area of 8-hour STD Retention time change ≤30 seconds	Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
LCS: Spike all compounds of interest	Smaller of statistical or method limits	Once per group of ≤20 samples per matrix/level when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

*Accuracy is subject to change over time.
[1]A BLK acceptance limit of ≤25 times LOQ (Methylene chloride and acetone) and ≤50 LOQ (2-butanone)is allowed.

Table 12-2

GC/MS Volatile Organic Compounds Quality Control* (624)

QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
SURR: Toluene-d8 Bromofluorobenzene Dibromofluoromethane	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
MS: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
MSD: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
BLK:	≤LOQ[1]		Once for each 12 hour time period	Reanalyze blank and associated samples
IS: Bromochloromethane 1,4-Difluorobenzene Chlorobenzene-d5 1,4-Dichlorobenzene-d4	-50% to +100% of internal standard area of 12-hour STD Retention time change ≤30 seconds		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
LCS: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

*Accuracy is subject to change over time.
[1]A BLK acceptance limit of ≤25 times LOQ (Methylene chloride and acetone) and ≤50 LOQ (2-butanone)is allowed.

Table 12-3

GC/MS Volatile Organic Compound Quality Control* (SW-846)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
SURR: Toluene-d8 Bromofluorobenzene Dibromofluoromethane	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
MS: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
MSD: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
BLK:	≤LOQ[1]		Once for each 12 hour time period	Reanalyze blank and associated samples
IS: Bromochloromethane 1,4-Difluorobenzene Chlorobenzene-d5 1,4-Dichlorobenzene-d4	-50% to +100% of internal standard area of 12-hour STD Retention time change ≤30 seconds		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
LCS: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

*Accuracy is subject to change over time.
[1]A BLK acceptance limit of ≤25 times LOQ (Methylene chloride and acetone) and ≤50 LOQ (2-butanone)is allowed.

Table 12-4

GC/MS Volatile Organic Compound Quality Control* (CLP)

QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
SURR:			Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
	Recov.	Recov.		
Toluene-d8	88-110%	84-138%		
Bromofluorobenzene	86-115%	59-113%		
1,2-Dichloroethane-d4	76-114%	70-121%		
MS:			Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
	Recov.	Recov.		
1,1-Dichloroethene	61-145%	59-172%		
Trichloroethene	71-120%	62-137%		
Benzene	76-127%	66-142%		
Toluene	76-125%	59-139%		
Chlorobenzene	75-130%	60-133%		
MSD:			Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
	RPD	RPD		
1,1-Dichloroethene	14	22		
Trichloroethene	14	24		
Benzene	11	21		
Toluene	13	21		
Chlorobenzene	13	21		
BLK:	≤CRQL[1]		Once for each 12 hour time period	Reanalyze blank and associated samples
IS:	-50% to +100% of internal standard area of 12-hour STD		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
Bromochloromethane 1,4-Difluorobenzene Chlorobenzene-d5	Retention time change ≤30 seconds			

*Accuracy is subject to change over time.
[1]Methylene chloride has a BLK acceptance limit of ≤ 2.5 times its CRQL. Acetone and 2-butanone have a BLK acceptance limit of ≤ 5 times their respective CRQLs.

Table 12-5

GC/MS Semivolatile Organic Compounds Quality Control* (625)

QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
SURR: Nitrobenzene-d5 2-Fluorobiphenyl Terphenyl-d14 Phenol-d6 2-Fluorophenol 2,4,6-Tribromophenol	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Repeat analysis if more than one SURR out per fraction or any recovery <10%. If reanalysis confirms original, document on report and case narrative
MS: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
MSD: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
BLK:	≤LOQ[1]		Once per group of ≤20 samples per matrix/level	Re-extract and reanalyze blank and associated samples
IS: 1,4-Dichlorobenzene-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	-50% to +100% of internal standard area of 12-hour STD Retention time change ≤30 seconds		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
LCS: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Re-extract and reanalyze LCS and associated samples for compounds that failed

*Accuracy is subject to change over time.
[1]Phthalate esters & benzaldehyde have a BLK acceptance limit of ≤ 5 x LOQ.

Table 12-6

GC/MS Semivolatile Organic Compounds Quality Control* (SW-846)

QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
SURR: Nitrobenzene-d5 2-Fluorobiphenyl Terphenyl-d14 Phenol-d6 2-Fluorophenol 2,4,6-Tribromophenol	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Repeat analysis if more than one SURR out per fraction or any recovery <10%. If reanalysis confirms original, document on report and case narrative
MS: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
MSD: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
BLK:	≤LOQ[1]		Once per group of ≤20 samples per matrix/level	Re-extract and reanalyze blank and associated samples
IS: 1,4-Dichlorobenzene-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	-50% to +100% of internal standard area of 12-hour STD Retention time change ≤30 seconds		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative
LCS: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Re-extract and reanalyze LCS and associated samples for compounds that failed

*Accuracy is subject to change over time.
[1]Phthalate esters and benzaldehyde have a BLK accept.limit of ≤ 5 x LOQ.

Table 12-7

GC/MS Semivolatile Organic Compounds Quality Control* (CLP)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
SURR:	%Recov.	%Recov.	Each sample, MS, MSD, BLK, and LCS	Repeat analysis if more than one SURR out per fraction or any recovery <10%. If reanalysis confirms original, document on report and case narrative
Nitrobenzene-d5	35-114	23-120		
2-Fluorobiphenyl	43-116	30-115		
Terphenyl-d14	33-141	18-137		
Phenol-d5	10-110	24-113		
2-Fluorophenol	21-110	25-121		
2,4,6-Tribromophenol	10-123	19-122		
MS:	%Recov.	%Recov.	Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
Phenol	12-110	26-90		
2-Chlorophenol	27-123	25-102		
1,4-Dichlorobenzene	36-97	28-104		
N-Nitroso-di-n-prop.	41-116	41-126		
1,2,4-Trichlorobenz.	39-98	38-107		
4-Chloro-3-methylphe.	23-97	26-103		
Acenaphthene	46-118	31-137		
4-Nitrophenol	10-80	11-114		
2,4-Dinitrotoluene	24-96	28-89		
Pentachlorophenol	9-103	17-109		
Pyrene	26-127	35-142		
MSD:	RPD	RPD	Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
Phenol	42	35		
2-Chlorophenol	40	50		
1,4-Dichlorobenzene	28	27		
N-Nitroso-di-n-prop.	38	38		
1,2,4-Trichlorobenz.	28	23		
4-Chloro-3-methylphe.	42	33		
Acenaphthene	31	19		
4-Nitrophenol	50	50		
2,4-Dinitrotoluene	38	47		
Pentachlorophenol	50	47		
Pyrene	31	36		
BLK:	≤CRQL[1]		Once per group of ≤20 samples per matrix/level	Re-extract and reanalyze blank and associated samples

Table 12-7 (continued)

GC/MS Semivolatile Organic Compounds Quality Control* (CLP)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
IS: 1,4-Dichlorobenz.-d4 Naphthalene-d8 Acenaphthene-d10 Phenanthrene-d10 Chrysene-d12 Perylene-d12	-50% to +100% of internal standard area of 12-hour STD Retention time change ≤30 seconds		Each sample, MS, MSD, BLK, and LCS	Reanalyze sample. If reanalysis confirms original, document on report and case narrative

*Accuracy is subject to change over time.
[1]Phthalate esters have a BLK acceptance limit of ≤ 5 x CRQL.

Table 12-8

Volatile Organic Compounds by GC Quality Control* (502.2)			
QC Check	**Acceptance Limits**	**Frequency**	**Corrective Action**
SURR: Halocarbons: Chlorocyclohexane (ELCD) Aromatics: Fluorobenzene (PID)	Smaller of statistical or method limits	Each sample, MS, MSD, BLK, and LCS	Results would not be reported unless matrix related problems are evident
MS:	Smaller of statistical or method limits	Once per group of ≤20 samples	Run LCS for compounds that failed
MSD:	Smaller of statistical or method limits	Once per group of ≤20 samples	Evaluated by analyst in relationship to other QC results
BLK:	≤LOQ	Once per group of ≤20 samples	Reanalyze blank and associated samples
LCS:	Smaller of statistical or method limits	Once per group of ≤20 samples when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

*Accuracy is subject to change over time.

Table 12-9

Volatile Organic Compounds by GC Quality Control* (601/602)

QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
SURR: Halocarbons: Chlorocyclohexane (ELCD) Aromatics: Fluorobenzene (PID)	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Results would not be reported unless matrix related problems are evident
MS:	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
MSD:	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
BLK:	≤LOQ		Once per ≤20 samples per matrix	Reanalyze blank and associated samples
LCS:	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

*Accuracy is subject to change over time.

Table 12-10

Volatile Organic Compounds by GC Quality Control* (SW-846)

QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
SURR: Halocarbons: Chlorocyclohexane (ELCD) Aromatics: Fluorobenzene (PID)	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS	Results would not be reported unless matrix related problems are evident
MS:	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
MSD:	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
BLK:	≤LOQ		Once per <20 samples per matrix	Reanalyze blank and associated samples
LCS:	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Reanalyze LCS and associated samples for compounds that failed

*Accuracy is subject to change over time.

Table 12-11

Pesticides, PCBs, and Herbicides Quality Control (500 Series)			
QC Check	**Acceptance Limits**	**Frequency**	**Corrective Action**
SURR: Organochloride pesticides: Decachlorobiphenyl Organophosphate pesticides: 2-Nitro-m-xylene Herbicides: 2,4-Dichlorophenyl-acetic acid	Smaller of statistical or method limits	Each sample, MS, MSD, BLK, and LCS during the extraction phase	At least one SURR must pass unless matrix related problems are evident, in which case, document on report and case narrative
MS: Organochloride pesticides: Spike all compounds of interest except PCBs, chlordane, and toxaphene Organophosphate pesticides: Spike for Phorate, Disulfoton, Famphur, Methyl parathion, Ethyl parathion Herbicides: Spike all compounds of interest	Smaller of statistical or method limits	Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
MSD: (Same information as the MS)	Smaller of statistical or method limits	Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results

Table 12-11 (Continued)

Pesticides, PCBs, and Herbicides Quality Control (500 Series)			
QC Check	**Acceptance Limits**	**Frequency**	**Corrective Action**
BLK:	≤LOQ	Once per group of ≤20 samples per matrix/level	Inject a hexane or solvent blank first to ensure the system is clean. Reinject blank. If acceptable, reinject associated samples. If unacceptable, reextract group
LCS: (Same information as the MS)	Smaller of statistical or method limits	Once per group of ≤20 samples per matrix/level when MS/MSD fail	Reextract and reanalyze LCS and associated samples for compounds that failed

Table 12-12

Pesticides, PCBs, and Herbicides Quality Control (600 Series)

QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
SURR: Organochloride pesticides: Decachlorobiphenyl Tetrachloro-m-xylene Organophosphate pesticides: 2-Nitro-m-xylene Herbicides: 2,4-Dichlorophenyl-acetic acid	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS during the extraction phase	At least one SURR must pass unless matrix related problems are evident, in which case, document on report and case narrative
MS: Organochloride pesticides: Spike all compounds of interest except PCBs, chlordane, and toxaphene Organophosphate pesticides: Spike for Phorate, Disulfoton, Famphur, Methyl parathion, Ethyl parathion Herbicides: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Analyze LCS for compounds that failed
MSD: (Same information as the MS)	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results

Table 12-12 (Continued)

Pesticides, PCBs, and Herbicides Quality Control (600 Series)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
BLK:	≤LOQ		Once per group of ≤20 samples per matrix/level	Inject a hexane or solvent blank first to ensure the system is clean. Reinject blank. If acceptable, reinject associated samples. If unacceptable, reextract group
LCS: (Same information as the MS)	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Reextract and reanalyze LCS and associated samples for compounds that failed

Table 12-13

Pesticides, PCBs, and Herbicides Quality Control (SW-846)

QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
SURR: Organochloride pesticides: Decachlorobiphenyl Tetrachloro-m-xylene Organophosphate pesticides: 2-Nitro-m-xylene Herbicides: 2,4-Dichlorophenyl-acetic acid	Smaller of statistical or method limits		Each sample, MS, MSD, BLK, and LCS during the extraction phase	At least one SURR must pass unless matrix related problems are evident, in which case, document on report and case narrative
MS: Organochloride pesticides: Spike all compounds of interest except PCBs, chlordane, and toxaphene Organophosphate pesticides: Spike for Phorate, Disulfoton, Famphur, Methyl parathion, Ethyl parathion Herbicides: Spike all compounds of interest	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Run LCS for compounds that failed
MSD: (Same information as the MS)	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results

Table 12-13 (Continued)

Pesticides, PCBs, and Herbicides Quality Control (SW-846)				
QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
BLK:	≤LOQ		Once per group of ≤20 samples per matrix/level	Inject a hexane or solvent blank first to ensure the system is clean. Reinject blank. If acceptable, reinject associated samples. If unacceptable, reextract group
LCS: (Same information as the MS)	Smaller of statistical or method limits		Once per group of ≤20 samples per matrix/level when MS/MSD fail	Reextract and reanalyze LCS and associated samples for compounds that failed

Table 12-14

Pesticides, PCBs, and Herbicides Quality Control (CLP)

QC Check	Acceptance Limits		Frequency	Corrective Action
	water	soil		
SURR: Decachlorobiphenyl Tetrachloro-m-xylene	%Recov. 30-150% 30-150%	%Recov. 30-150% 30-150%	Each sample, MS, MSD,and BLK during the extraction phase	At least one SURR must pass unless matrix related problems are evident, in which case, document on report and case narrative
MS: Lindane Heptachlor Aldrin Dieldrin Endrin 4,4'-DDT	%Recov. 56-123 40-131 40-120 52-126 56-121 38-127	%Recov. 46-127 35-130 34-132 31-134 42-139 23-134	Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
MSD: Lindane Heptachlor Aldrin Dieldrin Endrin 4,4'-DDT	RPD 15 20 22 18 21 27	RPD 50 31 43 38 45 50	Once per group of ≤20 samples per matrix/level	Evaluated by analyst in relationship to other QC results
BLK:	≤CRQL		Once per group of ≤20 samples per matrix/level	Inject a hexane or solvent blank first to ensure the system is clean. Reinject blank. If acceptable, reinject associated samples. If unacceptable, reextract group

Table 12-15

Inorganics Quality Control (200 Series)			
QC Check	**Acceptance Limits (water and soil)**	**Frequency**	**Corrective Action**
MS: Spike all analytes of interest	Smaller of statistical or method limits	Once per batch*	Confirm matrix effects with a post digestion spike (PDS) or by method of standard additions (MSA)
DUP:	Smaller of statistical or method limits	Once per batch*	Flag the data
BLK: Calibration blanks: Initial Calibration Blank (ICB) Continuing Calibration Blank (CCB)	≤LOQ ICP: statistical control limits	Each wavelength; after every calibration verification	Repeat and average results. If avg fails, correct problem, recalibrate, and rerun from last acceptable CCB
BLK: Preparation blanks (PB)	≤MDL or ≤5% of sample concentration or ≤5% of regulatory limit.	10% or minimum of once per batch*	Reanalyze. If still out, then redigest and reanalyze BLK and associated samples for analytes that failed
LCS: Spike all compounds of interest	Smaller of statistical or method limits	Once per batch*	Redigest and reanalyze LCS and associated samples for analytes that failed
QCS (Quality Control Sample): (ICP only)	±5% of certified value	Once per week, if analyses are done	Prepare new calibration solution

Table 12-15 (Continued)

Inorganics Quality Control (200 Series)			
QC Check	**Acceptance Limits (water and soil)**	**Frequency**	**Corrective Action**
PDS: (Not used for GFAA)	Not Applicable	As needed (e.g.,when MS fails)	Evaluated by analyst in relationship to other QC results
Analytical Spike (A): (GFAA only)	85-115%	Once per batch*	Use method of standard addition (MSA)
Serial Dilution (L): (ICP only)	Within ±10% of the original determination	Once per batch*	Flag the data
ICS: (ICP only)	Within ±20% of true value for the analytes	Each wavelength; after cal. verificationat beginning and end of every run;at least twice every 8 hrs	Recalibrate and rerun samples from last good ICS

*Batch refers to samples prepared together as a group. Batch size is typically ≤20 samples, but requirements may vary by method. Batches are grouped according to matrix, concentration level, and analytical method.

Table 12-16

Inorganics Quality Control (SW-846)			
QC Check	**Acceptance Limits (water and soil)**	**Frequency**	**Corrective Action**
MS: Spike all analytes of interest	Smaller of statistical or method limits	Once per batch*	Confirm matrix effects with a post digestion spike (PDS) or by method of standard additions (MSA)
MSD: Spike all analytes of interest	Smaller of statistical or method limits	Once per batch*	Evaluated by analyst in relationship to other QC results
DUP:	Smaller of statistical or method limits	Once per batch*	Flag the data
BLK: Calibration blanks: Initial Calibration Blank (ICB) Continuing Calibration Blank (CCB)	Statistical limits (mean ± 3s)	Each wavelength; after each calibration verification	Repeat twice and average. If avg of 3 analyses fails, correct any problem, recalibrate, and reanalyze samples after last acceptable CCB.
BLK: Preparation blanks (PB)	≤MDL or ≤5% of sample concentration or ≤5% of regulatory limit	10% or once per batch*	Reanalyze. If still out, redigest and reanalyze BLK and associated samples for analytes that failed
LCS: Spike all compounds of interest	Smaller of statistical or method limits	Once per batch*	Redigest and reanalyze LCS and associated samples for analytes that failed

Table 12-16 (Continued)

Inorganics Quality Control (SW-846)			
QC Check	**Acceptance Limits (water and soil)**	**Frequency**	**Corrective Action**
PDS: (not performed for GFAA)	75-125%	When MS/MSD fail	Evaluated by analyst in relationship to other QC results
Analytical spike (A): (GFAA only)	85-115%	Once per batch*	Analyze by method of standard addition (MSA)
Serial Dilution (L): (ICP only)	Within ±10% of the original determination	Once per batch*	Flag the data
ICS: (ICP only)	Within ±20% of true value for the analytes	Each wavelength; after calibration verificationat beginning and end of every run;at least twice every 8 hrs	Recalibrate and rerun samples from last good ICS

*HAA analyses have a frequency of once per group of ≤10 samples per matrix/level.

Table 12-17

Inorganics Quality Control (CLP)			
QC Check	**Acceptance Limits (water and soil)**	**Frequency**	**Corrective Action**
MS: (Spike all compounds per CLP Inorganic SOW Exhibit E, Table 3)	75-125% except where sample concentration is ≥4 times the spike concentration	Once per SDG* of ≤20 samples per matrix,level and method	Analyze a post digestion spike (PDS) on parent sample and flag the data
DUP:	Sample results <5 x CRDL must be within a CRDL of each other. Others ≤20% RPD	Once per SDG* of ≤20 samples per matrix,level and method*	Flag the data
BLK: Calibration blanks: Initial Calibration Blank (ICB)	≤CRDL	Each wavelength; after init. calibration verification	Correct problem and recalibrate
Continuing Calibration Blank (CCB)	≤CRDL	Each wavelength; after each continuing calibration verification	Correct problem, recalibrate or reslope, and reanalyze samples following last acceptable CCB
BLK: Preparation blanks (PB)	≤CRDL or >CRDL when lowest concentration in samples is >10 times PB concentration	Once per SDG* of ≤20 samples per matrix,level and method	Redigest and reanalyze BLK and associated samples for analytes that failed
LCS: Spike all compounds of interest	80-120% for water Certified limits for soil	Once per SDG* of ≤20 samples per matrix/level and method*	Redigest and reanalyze LCS and associated samples for analytes that failed

Table 12-17 (Continued)

Inorganics Quality Control (CLP)			
QC Check	**Acceptance Limits (water and soil)**	**Frequency**	**Corrective Action**
PDS: (Spike at 2X CRDL or 2X indigenous conc.) (not done for GFAA)	Not applicable	When MS/MSD fail	Not applicable
Analytical Spike (A): (Spike at 2X CRDL) (GFAA only)	85-115%	Each sample, DUP, PB, and LCS	See Figure 12-1
Serial dilution (L): (ICP only)	Within ±10% of the original determination	Once per SDG* of ≤20 samples per matrix/level	Flag the data
ICS: (Includes: ICSA - no limits ICSAB - evaluated) (ICP only)	Within ±20% of true value for the analytes	Each wavelength; after calibration verification; beginning and end of every run, or twice every 8 hrs	Recalibrate and rerun samples from last good ICS

*Sample Delivery Group

Figure 12-1

Graphite Furnace Atomic Absorption Analysis Scheme

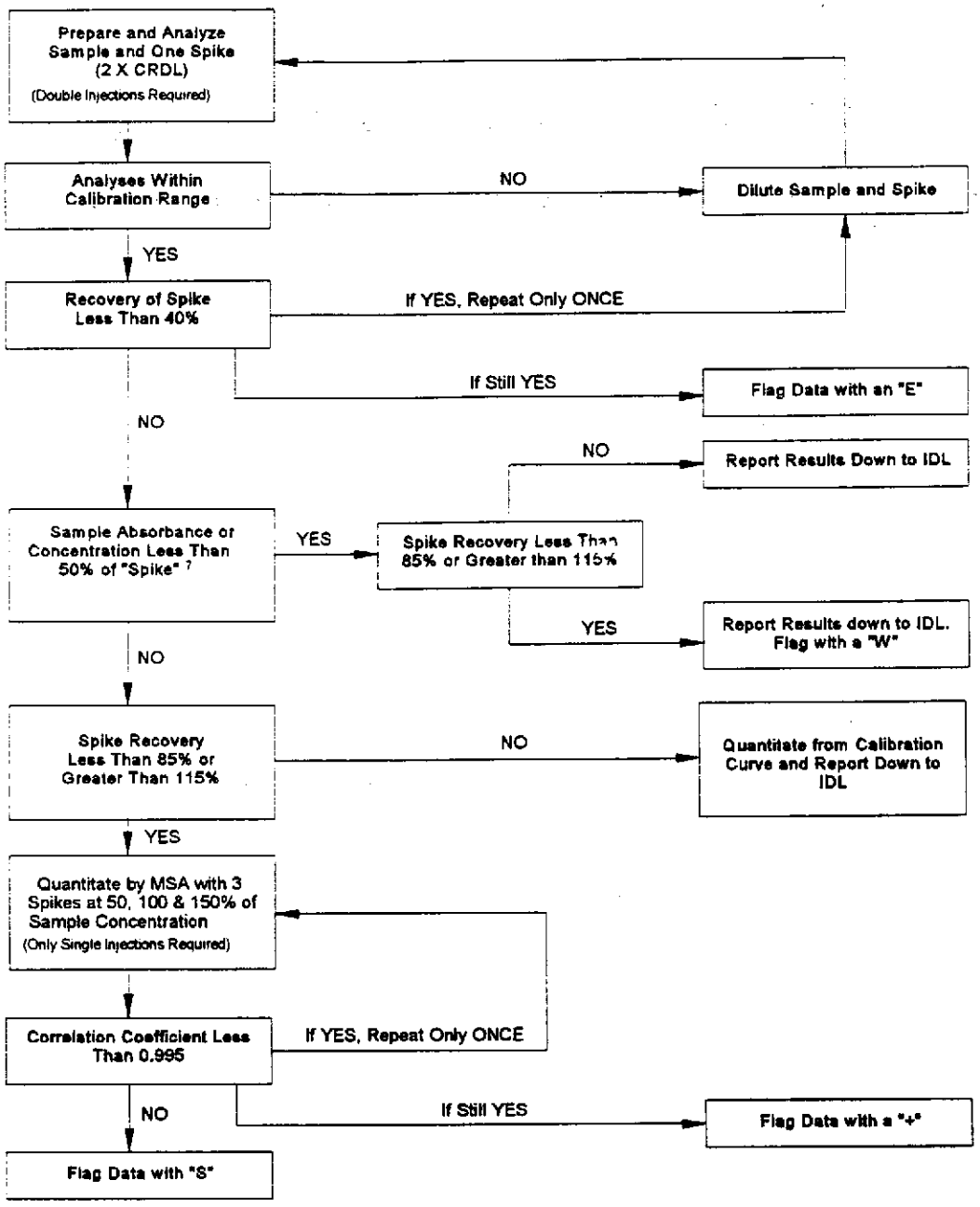


Table 12-18

Anions by Ion Chromatography			
QC Check	**Acceptance Limits***	**Frequency**	**Corrective Action**
MS: Spike all analytes of interest	Statistical limits or 80-120%	Once per 10 samples	Evaluated by analyst in relationship to other QC results
MSD: Spike all analytes of interest	Statistical limits or 80-120% Recovery/ ≤20% RPD	Once per 10 samples	Evaluated by analyst in relationship to other QC results
BLK:	≤LOQ	Before each analysis run	Reanalyze blank, and correct any problem.
LCS: Spike all analytes of interest	Statistical limits or 80-120%	Before each analysis run	Reanalyze LCS, and correct any problem.

*Limits of 80%-120% recovery for the MS, MSD, and LCS will be used until sufficient data points are collected to calculate statistical limits. Likewise, the RPD limit will be 20% for the MSD until statistical limits are determine

Table 12-19

General Chemistry Quality Control*				
Parameter	BLK Limit[1]	MS/MSD Limits[2†]	DUP/MSD RPD Limits[3†]	LCS Limits[†]
Acidity	≤LOQ	NA	NA	90-110%
Alkalinity	≤LOQ	75-125%	≤20%	90-110%
Ammonia	≤LOQ	75-125%	≤20%	90-110%
BOD	≤LOQ	75-125%	≤20%	80-120%
Cation Exchange Capacity	≤LOQ	NA	≤20%	NA
Chloride	≤LOQ	75-125%	≤20%	90-110%
Chlorine residual	≤LOQ	NA	≤20%	90-110%
COD	≤LOQ	75-125%	≤20%	90-110%
Corrosivity	NA	NA	≤20%	90-110%
Cyanide[4]	≤LOQ	75-125%	≤20%	85-115%
Dissolved Oxygen	NA	NA	≤20%	NA
Gradation (grain size)	NA	NA	NA	NA
Fluoride	≤LOQ	75-125%	≤20%	90-110%
Heat Content, BTU	NA	NA	≤20%	90-110%
Hardness	≤LOQ	75-125%	≤20%	90-110%
Hexavalent Chromium	≤LOQ	75-125%	≤20%	90-110%
Ignitability/Flashpoint	NA	NA	≤20%	90-110%
Moisture Percent	NA	NA	≤20%	NA
Nitrate/Nitrite	≤LOQ	75-125%	≤20%	90-110%
Oil and Grease	≤LOQ	75-125%	≤20%	90-110%
Percent Passing (paint filter liquid test)	NA	NA	NA	NA
pH	NA	NA	≤20%	90-110%
Phenolics	≤LOQ	75-125%	≤20%	90-110%
P & MO Endpoints (phenol-phthalein and methyl orange)	≤LOQ	NA	≤20%	90-110%

*See "Notes" on the following page

Table 12-19 (Continued)

General Chemistry Quality Control*				
Parameter	BLK Limit[1]	MS/MSD Limits[2†]	DUP/MSD RPD Limits[3†]	LCS Limits[†]
Phosphorus, Total & Orthophosphate	≤LOQ	75-125%	≤20%	90-110%
Reactivity, Cyanide & Sulfide	≤LOQ	75-125%	≤20%	90-110%
Solids, Settlable	NA	NA	NA	NA
Solids, Total Dissolved (TDS)	≤LOQ	75-125%	≤20%	90-110%
Solids, Total Suspended (TSS) and Total Volatile (TVS)	≤LOQ	NA	≤20%	90-110%
Solids, Total	≤LOQ	75-125%	≤20%	90-110%
Specific Conductance	NA	NA	≤20%	90-110%
Specific Gravity/Bulk Density	NA	NA	≤20%	NA
Sulfate	≤LOQ	75-125%	≤20%	90-110%
Sulfide	≤LOQ	75-125%	≤20%	90-110%
Sulfite	≤LOQ	NA	≤20%	90-110%
Total Kjeldahl Nitrogen (TKN)	≤LOQ	75-125%	≤20%	90-110%
TOC water	≤LOQ	75-125%	≤20%	90-110%
TOC solid	≤LOQ	75-125%	≤35%	90-110%
TOX	≤LOQ	75-125%	≤20%	85-115%
Turbidity	≤LOQ	NA	≤20%	90-110%

*NOTES:

Frequency: Each QC check is performed with 10% frequency

Corrective Action: If either the LCS or BLK is outside the acceptance criteria[1], the QC and associated samples will be prepared again and reanalyzed. If either the MS or DUP is outside the criteria, the data are flagged.

NA is defined as "Not Applicable."

†Acceptance limits for MS/MSD, DUP/MSD, and LCS are the more restrictive of statistical control limits and the fixed limits shown in the table.

[1]Blanks that are greater than the LOQ are acceptable if the associated sample concentrations are greater than 10 times the blank concentration.

NOTES: for Table 12-19 continued

[2]Spikes recoveries are considered insignificant if the sample concentration exceeds 4 times the spike concentration used.

[3]Samples that are less than 5 times the LOQ must be within an LOQ of each other. Otherwise the ≤20% RPD limit applies.

[4]Cyanide by CLP methods will comply with the quality control specifications of ILM04.0, or the most current inorganic CLP Statement of Work.

Performance and Systems Audits

Members of the Quality Assurance Department routinely conduct system audits of each department at Mountain States Analytical, Inc.(MSAI). The audits include reviews of methodology, reagent preparation, equipment calibration and maintenance, quality control results, and training of personnel. The results of the audits and corrective actions, when necessary, are communicated to laboratory personnel and management by means of a written report. Refer to Section No. 16 for corrective action procedures and to Section No. 17 for quality assurance reports to management. Audits by outside organizations including clients, regulatory agencies, and the USEPA are permitted by arrangement with the Quality Assurance Director.

Performance audits consist of both single-blind and double-blind proficiency evaluation samples. Performance audits initiated as single-blind samples are known to analysts, but the target analyte concentrations remain unknown until the results are evaluated. Double-blind samples containing known amounts of target analytes are prepared by the Quality Assurance Department and by commercial suppliers and submitted to the laboratories under fictitious client names. Quarterly performance audits include samples prepared by the Quality Assurance Department and samples from commercial suppliers. MSAI also participates in a number of single-blind interlaboratory performance evaluation programs. Inorganics, pesticide/herbicides, trihalomethanes, volatile organic compounds, semivolatile organic compounds, traditional general chemistry analyses, and geotechnical analyses are analyzed by MSAI for studies conducted by the USEPA, USDOE, and other government and private sector performance evaluation programs.

The following list identifies performance evaluation programs in which MSAI routinely participates.

- USEPA Water Supply (WS) Performance Evaluation Program
- USEPA Water Pollution (WP) Performance Evaluation Program
- USEPA Discharge Monitoring Report-Quality Assurance (DMR-QA)
- NIOSH Environmental Lead Proficiency Analytical Testing (ELPAT)
- USDOE Mixed Analyte Performance Evaluation Program (MAPEP)
- AASHTO Material Reference Laboratory, at the National Institute of Standards and Technology (NIST), Soil Proficiency Sample Program

Preventive Maintenance

In order to ensure timely production of data, Mountain States Analytical, Inc. (MSAI) schedules routine preventive maintenance of instruments based on manufacturer's recommendations. A company policy and procedure document included in this section, CPP-QA-011, specifies equipment maintenance requirements. Maintenance of the laboratory instruments is the responsibility of the technical group using the equipment. A schedule of routinely performed instrument maintenance tasks is found in Table 14-1. Preventive maintenance, as well as corrective maintenance, is recorded in instrument logs kept near the equipment.

Critical spare parts are kept in supply at the laboratory by the technical group using the equipment. Most items not kept in stock at the laboratory are available through overnight delivery from the manufacturer. In addition, MSAI maintains multiple instruments for critical laboratory operations. An instrument and equipment inventory may be found in Section 8. Because MSAI has redundant capacity, the problems of instrument downtime are minimized.

COMPANY POLICY AND PROCEDURE: CPP-QA-011

Title: Instrument and Equipment Maintenance

References:
CPP-QA-008, Laboratory Notebooks
CPP-QA-010, Instrument and Equipment Calibration

Purpose:
To establish the requirement for a system of regular preventive maintenance for all instruments and equipment.

Scope:
This policy assigns responsibility for ensuring preventive maintenance is done and defines the documentation required during the maintenance of equipment.

Background Information:
Instruments and other laboratory equipment occasionally require maintenance, either for preventive reasons or to correct malfunctions. Since the condition of equipment can affect the accuracy and precision of analyses, it is important to keep records of the type of maintenance performed and the date on which it was done.

Definition:
For this document, equipment means any device used in an analysis, such that a malfunction can result in an error in the test results. All laboratory instruments fall into this class, as well as peripheral devices such as ovens, refrigerators, and freezers.

Policy/Procedure:

Each piece of equipment must have a written preventive maintenance schedule if preventive maintenance is recommended by the manufacturer. However, preventive maintenance schedules are recommended regardless of manufacturers' recommendation. Preventive maintenance includes cleaning, oiling, and routine part replacement. It is the responsibility of the Department Manager or Group Leader to ensure that preventive maintenance is scheduled and performed on the equipment and instruments in that department or group. The responsibility for the actual maintenance may be delegated to a qualified analyst.

An equipment notebook will be established for each piece of equipment. Necessary reference information will be recorded in the notebook.

1. The notebook will be issued and numbered in conformance with CPP-QA-008. The cover or first few pages of the book will list the name of the equipment, the manufacturer, the model number, and the serial number.

2. Following the equipment identification, the next few pages will contain the routine preventive maintenance schedules and procedures or a reference to the standard operating procedure (SOP) that contains this information. Acceptance criteria for any checks used to assess proper operation will be included. Appropriate actions to take when acceptance criteria are not met must be available, either in the notebook or the SOP.

3. For major equipment with a service agreement, the contract number, service engineer, and technical service telephone number will be listed. If needed, the calibration data described in CPP-QA-010 may be kept in the same notebook.

All maintenance done on the equipment, no matter how minor, will be recorded in the equipment notebook. This includes both preventive and corrective maintenance. It is acceptable to keep separate notebooks for preventive and corrective maintenance if the preventive maintenance notebook is comprised of preprinted checklists. In non-routine repairs for corrective purposes, the notebook will document the nature of the failure, how and when the defect was discovered, what tests were affected, and what remedial action was taken (if any). All records will be kept in ink and will be signed by the staff member who either did the maintenance or supervised the work of an outside technician from a service firm.

The maintenance record notebook will be kept near the equipment and will be readily available to all personnel responsible for maintenance work.

Any equipment taken out of service because it needs corrective maintenance must be tagged or labeled to prevent use.

Table 14-1

Preventive Maintenance Schedule

Instrument	Preventive Maintenance	Frequency
GC/MS Semivolatiles	Change septum Change inlet Clean source Change oil in vacuum pump Change oil in turbo pump	As needed As needed As needed Semiannually* Semiannually*
GC/MS Volatiles	Change septum Change inlet Clean Tekmar Clean source Change oil in vacuum pump Change oil in turbo pump	As needed As needed As needed As needed Semiannually* Semiannually*
GC Volatiles	Check propanol level Check all flows Conductivity Det. Maint. Clean cell Change reaction tube Change Teflon line Change resin Replace trap Column Maintenance Change PID Lamp	Semiweekly Prior to calib. As needed As needed As needed As needed
GC	Septum change Column maintenance Clean detector Vacuum filters Leak check ECD's	Every 100 injections As needed As needed Semiannually
IC	Change guard column Rinse O-ring and piston Change end-of-line filter Change low pressure in-line filter Clean separation column Change piston seal	Semiannually Weekly As needed As needed As needed Semiannually
Cold Vapor AA, Flame AA, and Hydride AA	Rinse burner head, chamber and trap Clean nebulizer Inspect tubing and O-rings Replace lamp	Weekly (minimum) Weekly Monthly As needed

Table 14-1 (Continued)

Preventive Maintenance Schedule		
Instrument	**Preventive Maintenance**	**Frequency**
GFAA	Rinse workhead assembly	Weekly
	Clean windows	Weekly
	Replace probe tubing	As needed
	Check rinse bottle & drain	Daily
ICP	Clean torch	Weekly
	Clean nebulizer & spray chamber	Weekly
	Replace pump winding	Daily
	Lubricate autosampler	Monthly
	Checking tubing to torch	Monthly
	Check fan filters, clean if needed	Monthly
	Check cool flow, clean if needed	Weekly
	Check water filter, replace if needed	Monthly
Infrared Spectrometer (FTIR)	Check on-demand diagnostics	Monthly
	Check wavenumber with polystyrene film	Monthly
	Change desiccant	Biannually
Total Organic Carbon Analyzer	Check IR zero	Weekly
	Check for leaks	Weekly
	Check acid pump calib.	Bimonthly
	Check persulfate pump calibration	Bimonthly
	Inspect 6-port rotary valve	Monthly
	Inspect sample pump head	Monthly
	Wash molecular sieve	Quarterly
	Check sample loop calibration	Monthly
	Clean gas permeation tube	Quarterly
	Inspect digestion vessel o-rings	6 Months
	Check activated carbon scrubber	6 Months
	Dust back and clean circuit boards	6 Months
	Check IR cell	Annually

Table 14-1 (Continued)

Preventive Maintenance Schedule		
Instrument	**Preventive Maintenance**	**Frequency**
Total Organic Halogen Analyzer	Polish counter electrode Polish sensor electrode Clean loaders and pistons	Daily Biweekly As needed

NOTES:

* Maintenance done under a service contract.

"As needed" maintenance is done in response to frequently monitored indicators, such as visible signs of wear. It is done before operating conditions reach corrective action limits.

Any of these items may be performed more frequently if response during operation indicates this is necessary.

Other instruments and equipment not listed are maintained according to the manufacturer's recommendations.

Routine Procedures Used to Assess Data Quality

This section describes the procedures and calculations used by the laboratory to assess the data quality parameters; specifically, precision, accuracy, completeness, representativeness, and comparability. These parameters are defined in Section No. 5. In addition, the procedures used to determine method detection limits and the limits of quantitation are included in this section. These limits are used in the assessment of data quality by defining the lower bounds of confidence for precision and accuracy criteria. Control limits for precision and accuracy are calculated statistically using data collected from quality control (QC) sample results.

Precision - Precision refers to the repeatability of a sample result when a second aliquot of the same sample is analyzed. The degree of agreement between duplicates is expressed as the Relative Percent Difference (RPD). The RPD is calculated according to the following equation:

$$RPD = \frac{|D_2 - D_1|}{[(D_1 + D_2) / 2]} \times 100\%$$

Where: D_1 = First sample value
D_2 = Second sample value (Duplicate)

Duplicates, and/or duplicate spikes, are analyzed for at least 5% of the samples (each batch or SDG, ≤20 samples.) Acceptance criteria are based on statistical evaluation of past laboratory data or on method specifications. (See Section No. 12.) Quality control sample results are entered into the computer and compared with acceptance limits. Quality control data in the computer system are used to create control charts and to calculate a

historical mean and standard deviation. Control charts provide a graphical means of monitoring precision and bias over time.

Accuracy - Accuracy is a measure of the agreement between the amount of an analyte measured by the test method and the amount actually present. Accuracy is usually expressed as a percent recovery (%R) of surrogates, matrix spikes, and laboratory control samples. Recoveries are calculated according to the following equations:

$$Surrogate\ Recovery = \frac{Qd}{Qa} \times 100\%$$

Where: Qd = quantity determined by analysis
Qa = quantity added to sample

$$Matrix\ Spike\ Recovery = \frac{SSR - SR}{SA} \times 100\%$$

Where: SSR = Spiked Sample Result
SR = Sample Result
SA = Spike added

$$Laboratory\ Control\ Sample\ Recovery = \frac{LCS\ Found}{LCS\ True} \times 100\%$$

Surrogate standards are added to each sample analyzed for organics. Spikes and Laboratory Control Samples are analyzed for at least 5% of the samples (each batch or SDG, ≤20 samples). Refer to Section No. 12 for acceptance criteria for accuracy. For many analyses, the computer is programmed to compare the

individual values with the acceptance limits and inform the analyst if the results meet specification. Where no computer screening of recovery values is available, the comparison is done manually by a qualified analyst. If the results are not within the acceptance criteria, corrective action suitable to the situation will be taken and documented as explained in Section No. 16. This may include, but is not limited to, checking calculations and instrument performance, reanalysis of the associated samples, examining other QC analyzed with the same batch of samples, and qualifying results with documentation of any QC problems in the case narrative.

Commercial quality control materials are run at least quarterly to ensure accuracy of the analytical procedure. Accuracy information determined from reference materials is valuable because variables specific to sample matrix are eliminated.

The data for surrogates, spikes, control materials and reference materials are evaluated for mean and standard deviation in order to determine statistical control limits.

Completeness - Completeness is the percentage determined from the amount of valid data acquired from a measurement system compared to the number of valid measurements that are necessary to meet the project data quality objectives.

$$\%\ Completeness = \frac{Number\ of\ valid\ measurements}{n} \times 100\%$$

Where: n = the total number of measurements necessary to achieve a specified level of confidence in decision making

The laboratory will use computerized work scheduling and sample tracking to ensure that all required measurements are made, including the associated quality controls. As required, the laboratory will include in the data deliverables sufficient

information to allow the data user to assess the quality and validity of the results. This information will include, but is not limited to, summaries of QC data and sample results, chromatograms, spectra, and instrument tune and calibration data. Additional information will be stored in the laboratory's archives, both hard copy and magnetic tape.

Representativeness - The end user determines representativeness by comparison of the measurement results to results of comparable samples for the population being studied. The laboratory contributes to achievement of representativeness objectives by homogenization of samples prior to analysis if required. If sampling is performed by the laboratory, every effort will be made to obtain the most representative samples (refer to Section No. 6).

Comparability - Routine participation in interlaboratory performance evaluations is used to determine that results obtained by Mountain States Analytical, Inc. are comparable to those of other laboratories for the same analytes and matrices. (Refer to Section No. 13 for a list of performance evaluations.) Internal and accreditation audits monitor the consistency with which written standard operating procedures and analytical methods are followed and conform with accepted standard methods.

Method Detection Limit (MDL) - It is important to ascertain the MDL that can be achieved by a given method, particularly when the method is commonly used to determine trace levels of analytes. The Environmental Protection Agency has established a method for determining MDLs in 40 CFR 136, Appendix B.

MDL is defined as follows for all measurements:

$$MDL = t_{(n-1,1-\alpha=0.99)} \times s$$

Where:
- s = standard deviation of the replicate analyses (see the definition later in this section)
- $t_{(n-1,1-\alpha=0.99)}$ = students' t-value for a one-sided 99% confidence level and a standard deviation estimate with n-1 degrees of freedom
- n = number of replicate analyses
- α = area under the t-distribution curve, such that $(1-\alpha) \times 100\%$ is equal to the confidence level

The MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. It is determined from analysis of a sample in a given matrix containing the analyte at an appropriate concentration. The MDL is determined before a method is used to measure samples, annually, and when method conditions change in a way that causes detection limits to change.

Limit of Quantitation (LOQ) - LOQ can be established when the MDL is known. The LOQ is defined as the lowest concentration to which quantitative results may be achieved, under routine laboratory conditions, with a specified degree of accuracy and precision. The EPA and other organizations recommend setting the quantitation limit at a multiple of the MDL. MSAI typically uses a factor between 3 and 10 times the MDL, with due consideration for the particular analyte and matrix.

Data used in the determination of MDLs and LOQs for each method and sample matrix type are kept on file.

Quality Control Limits

Control limits are calculated for quality control samples used to measure precision and accuracy, such as matrix spikes, duplicates, matrix spike duplicates, and laboratory control samples. Also, control limits are calculated for surrogate recoveries in organic analyses. Control limits are determined from the mean and standard deviation of the most recent set of relevant QC results (at least 20 data points) for the analytical method. Mean and standard deviation are calculated as follows:

$$Mean = \bar{X} = \frac{\sum_{i=1}^{n} X_i}{n}$$

and

$$Standard\ Deviation = s = \sqrt{\frac{\sum_{i=1}^{n} (X_i - \bar{X})^2}{n - 1}}$$

Where: X = result of a single measurement
n = the number of measurements used for calculation

Control limits are defined as the mean ± 3s (or three times the standard deviation). Warning limits are defined as the mean ± 2s. Where practical, control limits will be determined as mean ± 2s and the warning limits as mean ± s. The 3s control limits are approximately equal to the 99% confidence limits, and the 2s limits are approximately equal to the 95% confidence limits. Control limits are calculated at least yearly unless fewer than 20 data points are generated.

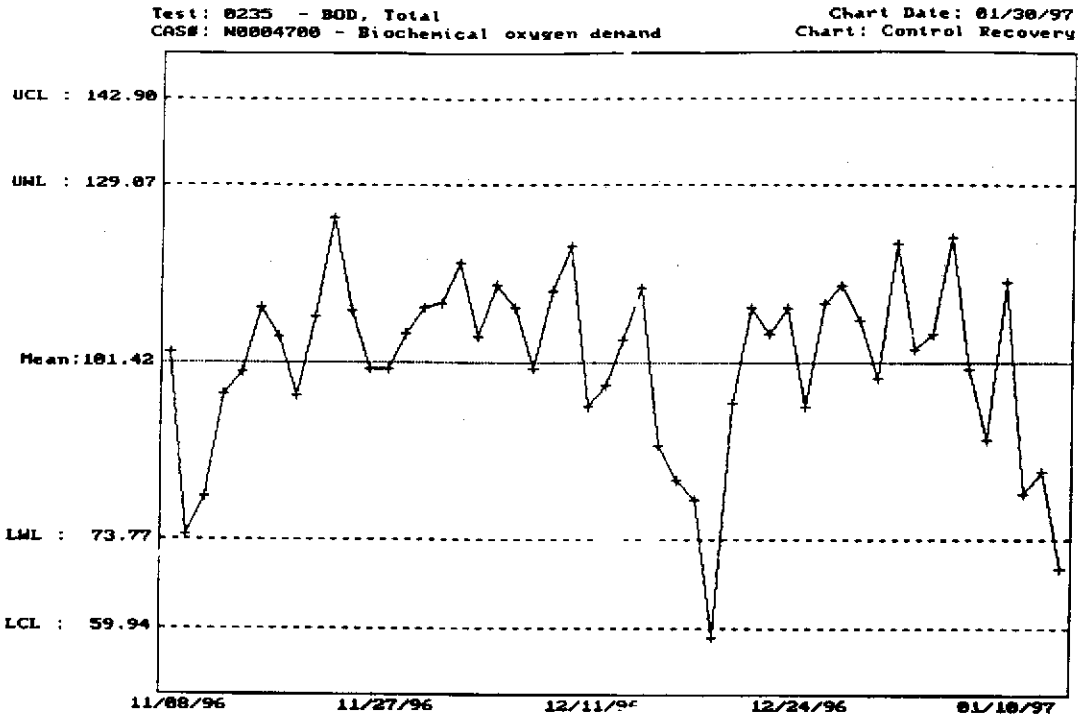
Control data will be maintained in tabular format with the ability to produce control charts when needed. A typical control chart is shown in Figure 15-1. Control charts plot the position of data points with respect to the calculated mean, warning limits and control limits. Out of control trends are identified using a graphical control chart.

A measurement system is considered to be out of control when at least one of the following conditions occurs:

- one result is outside the control limits
- three consecutive results are outside the warning limits
- eight consecutive results are on the same side of the mean
- six consecutive results progressively increase or decrease
- an obvious cyclic pattern is observed

Acceptance limits for matrix spikes, duplicates, matrix spike duplicates, laboratory control samples, and surrogates are the more restrictive of method-specified limits and control limits. Exception will be made for acceptance limits defined by a statement of work, such as for EPA Contract Laboratory Program (CLP).

Figure 15-1
Example of a Control Chart: BOD LCS Recovery



Total Points Graphed	58	For Last 7 Points	
# Points Discarded	0	Corr. Co-efficient	-0.814
# Outliers	1	Slope	-6.96438
Mean Before Discard	101.42	# Points Above Mean	2
Std Dev Before Discard	13.83	# Points Below Mean	5
Mean After Discard	101.42		
Std Dev After Discard	13.83		

#=Discarded D=Diluted Out X=Valid Exception I=Incomplete Data *=Outlier

Test results between 11/08/96 & 01/10/97

11/08/96 114	103.00	12/05/96 031	105.50	12/19/96 031	110.00
11/13/96 031	74.50	12/05/96 031	113.50	12/24/96 114	94.50
11/13/96 031	80.50	12/05/96 031	110.00	12/24/96 114	110.50
11/13/96 031	96.50	12/09/96 122	100.50	12/24/96 114	113.50
11/20/96 031	100.00	12/09/96 122	112.50	12/26/96 122	108.00
11/20/96 031	110.00	12/09/96 122	119.50	12/26/96 122	99.00
11/20/96 031	105.50	12/11/96 031	94.50	12/26/96 122	120.00
11/20/96 031	96.30	12/11/96 031	98.00	01/02/97 031	103.50
11/21/96 031	108.50	12/11/96 031	105.00	01/02/97 031	106.00
11/21/96 031	124.00	12/13/96 031	113.00	01/02/97 031	121.00
11/21/96 031	109.50	12/13/96 031	88.50	01/08/97 122	100.50
11/27/96 031	100.50	12/13/96 031	83.00	01/08/97 122	89.50
11/27/96 031	100.50	12/18/96 122	80.00	01/08/97 122	114.00
11/27/96 031	106.00	12/18/96 122	58.50*	01/10/97 031	81.00
12/03/96 031	110.00	12/18/96 122	95.00	01/10/97 031	84.50
12/03/96 031	110.50	12/19/96 031	110.00	01/10/97 031	69.50
12/03/96 031	117.00	12/19/96 031	106.00		

Corrective Action

Whenever any of the data generated falls outside the established acceptance criteria outlined for instrument tune and calibration (Section No. 9) and Internal QC (Section No. 12), the cause of this irregularity must be investigated, corrected, and documented. The documentation will be used to prevent a recurrence of the problem and to inform management of the situation.

When results are not within acceptance criteria, the appropriate corrective action will be initiated. This may include, but is not limited to, checking calculation and instrument performance, reanalysis of the associated samples, examining other QC analyzed with the same batch of samples, and qualifying results with a comment stating the observed deviation.

Analysts are responsible for recognizing when results exceed acceptance criteria and for taking corrective actions. Specific corrective actions are given in the methods and SOPs, and they are summarized in Section 12 of this document. All QC data must be entered onto the computerized LIMS or QC spreadsheets promptly after their generation so that reports and charts can be generated. In addition, analysts can enter comments to explain any QC result that is outside acceptance limits. Any data outside the acceptance criteria are reviewed by the group leader or coordinator. If the appropriate corrective actions are not taken, the group leader notifies the analyst and ensures that the situation is corrected.

The Quality Assurance Department will review QC data as part of routine data package review. If there are any problems with frequent outliers or any failure to take corrective actions, a formal corrective action request will be issued to the leader of the applicable technical group. A written response from the

technical group will outline the investigation and steps taken to correct the problem. Similarly, the Quality Assurance Department will issue corrective action requests when proficiency audit results are unacceptable. The technical groups will investigate the causes, form a corrective action plan, and reply within a specified time.

The Quality Assurance Department conducts periodic audits that ensure compliance with laboratory SOPs and assist in identifying and correcting any deficiencies. These audits entail observation as procedures are carried out or a review of records to demonstrate traceability and compliance with all documented record keeping procedures. After the audit, the Quality Assurance Department issues written report summarizing the observations and unacceptable findings. The technical groups must respond in writing to the audit report within 30 days of report receipt. The response will provide corrective action plans to be taken along with expected completion dates. Audit results and the corresponding response are communicated to laboratory personnel and management. Audit findings, including those of audits by outside organizations, are formally tracked by the Quality Assurance Department to ensure that corrective action plans are carried out. Also, follow-up audits by the QA Department verify that proper corrective actions have been taken.

Clients' concerns are answered by Client Managers, who work with technical and quality assurance staff to satisfy those concerns. A letter is sent to the client explaining the actions taken and includes any revised reports that result from corrective actions. Copies of corrective action letters sent to clients are kept on file.

A Quality Improvement Team (QIT) consisting of managers, technical group leaders, and client service representatives meets regularly to discuss and resolve laboratory-wide quality issues. All MSAI personnel can submit quality concerns to the QIT for

review. Client concerns are often resolved through the QIT. Issues submitted to the QIT are recorded and tracked to their final disposition.

The policies and procedures regarding corrective actions are given in CPP-QA-022, which follows.

COMPANY POLICY AND PROCEDURE: CPP-QA-022

Title: Corrective Actions

References:

CPP-QA-008, Laboratory Notebooks

Purpose:

This policy establishes a process for correcting out-of-control events, systematic errors, and deficiencies within the laboratory. The process is also used for prevention activities for continuous quality improvement.

Scope:

This policy specifies the conditions and events that will require corrective action responses and establishes the requirements for initiating and completing corrective actions. Continuous quality improvement actions may be initiated by any staff member through the Quality Improvement Team.

Background Information:

Without a formal process for correcting problems or deficiencies in the laboratory, some improvements might not be made, and the same problems could continue. Corrective actions are often required by accrediting agencies and clients in resolution of deficiencies,

audit findings, and incorrect proficiency evaluation results. Corrective action records demonstrate to clients that their concerns have been resolved. Corrective action records are useful for solving recurrent problems and for preventing potential problems.

Policy/Procedure:

Every MSAI employee is responsible for continuous quality improvement. Many improvement actions make an acceptable condition better. For these improvements, documentation is recommended but not required. When conditions exist that do not meet the requirements or expected levels of quality, formal corrective action procedures will be followed. Some items and conditions that require formal corrective actions are:

- Audit findings and client complaints
- Incorrect proficiency sample results
- Out-of-control quality control (QC) results
- Defective data deliverables (analysis reports, quality control summaries, data packages, and electronic data)
- Procedure, calibration, and equipment problems
- Receipt of unacceptable samples or materials

Initiating Corrective Action Requests.

Corrective action requests will begin at the point of detection. Accrediting agencies and clients will request corrective actions for audit deficiencies, unacceptable data deliverables, and missed proficiency samples. The QA Director also will request corrective actions for audit deficiencies, defective data deliverables, out-of-control QC events and other operations problems. Any employee who discovers a situation that negatively affects data quality will correct the problem or request corrective action if the problem is not easily solved.

Requests for corrective action from accrediting agencies will usually be received as a letter. The QA Director will be responsible for responding to these requests. Client complaints and audits may be answered by a Client Manager, but answers to client audit findings will first be reviewed by the QA Director. Client Managers will keep a record of client complaints and notify the QA Director of any systemic and recurrent problems. Corrections made to notebooks will be done according to CPP-QA-008. Corrections made to data deliverables will be recorded and the record kept in the proper location, for example in the group folder or data package archives.

Internal corrective action requests (Figure 16-2) for the Quality Improvement Team (QIT) may be initiated by any employee and will be documented from the time of the request to the final disposition. The QIT consists of representatives from each technical group and some support groups. The purpose of the QIT is to resolve general quality problems in the company. If needed, additional forms may be created and used for documenting corrective actions not within the scope of Figure 16-1 or Figure 16-2.

Example: A checklist might be used by data package reviewers to identify data package errors and by preparers to document that corrections were made.

The following list includes examples of internal corrective action requests and associated documentation.

- A sample is broken during shipment. MSAI documents this fact on the chain of custody. Corrective action is arranged between the client and Project Manager.

- An analyst finds that his instrument is often out of specification due to room temperature shifts. Thermostat adjustments do not correct the problem.

A QIT action request is submitted to the Quality Improvement Team.

- While reviewing control chart data, the QA Director discovers an out-of-control event that is not annotated as having been corrected by the analyst. A corrective action request is submitted to the leader of the appropriate technical group.

- A data reviewer notices that method detection limits are used beyond the applicable date. The analyst is requested to take corrective action.

- The QA Director reports proficiency sample performance results and requests corrective action for incorrect sample results.

Response to Corrective Action Requests.

Corrective action requests will be forwarded to the individual or group that is responsible, or that has the authority or ability to correct the problem. Copies of written requests will be distributed to affected members of the department, group, or team. Pertinent investigation findings and corrective actions taken or alternative actions will be written and returned to the request initiator. When the investigation and corrective action form (Form I) is used, the completed form will be returned to the Quality Assurance department for analysis, closure, and filing. The QIT Leader will maintain a record of completed QIT actions.

The following guidelines for correcting problems involving data quality issues (missed proficiency samples and out-of-control incidents) will produce the appropriate level of investigation and response.

1. Review the recorded result against the raw data for transcription, calculation, or dilution errors. Identify any of these causes, if valid, and include what steps are being taken to prevent a future occurrence of this error.

2. Review the corresponding quality control data. List the pertinent QC results and explain why they support or do not support the error condition.

3. Investigate other possible causes, such as instrument malfunctions, failure to follow the procedure, undesirable trends on control charts. Provide supporting evidence for any of these types of problem causes.

4. Once the cause of the problem is determined, or it is determined that thorough investigative efforts cannot reveal the cause, write the corrective action that is being taken to prevent recurrence of the problem.

5. It is recommended that corrective actions for data quality issues be verified with a proficiency sample having the concentration unknown to the analyst.

Written responses to the corrective action will include a summary of the problem, a brief explanation of known causes or a summary of investigative steps, and either the corrective action taken or the proposed corrective action with a completion date. Where possible, corrective actions will be supported by evidence. For example, the supportive evidence that an MDL study was completed is a copy of the MDL study summary. Responses to audit findings often involve multiple items, so each item must be identified in a manner recognizable to the originator of the audit finding or the recipient of the corrective action response. It is recommended that the finding statement also be written or paraphrased with the corrective action response.

The Quality Assurance Director will verify that corrective actions have been completed as proposed and that corrected procedures continue to be followed. Quarterly internal QA audits will include verification of past corrective actions. Long term issues will continue to be reviewed as long as needed.

Forms, Tables, and Figures:

Figure 16-1 Investigation and Corrective Action Report

Note: This form is used by QA for incorrect proficiency sample results, audit findings, and QC outliers.

Figure 16-2 QIT Action Worksheet

Note: This form is used by all employees for requesting corrective actions or continuous improvement actions.

Figure 16-1

Area Affected:
__Data Quality
__Client Requirement
__Work Condition
__System Efficiency

QIT Action Worksheet

Submit the completed worksheet to the QIT Leader

Requested By	Date	Applicable Sample/Group

Description of Problem / Desired Outcome

Corrective Action Taken

Date Init

Date Required	Date Completed	Response TAT

Notify the originator of the QIT decision or action taken when the issue is closed

Figure 16-2

Mountain States Analytical, Inc.

Number

Investigation and Corrective Action Report

Part I Description of the problem

Initiated by Date

Issued to Response Due

MSAI Sample number(s) involved (if applicable)

Describe the nature of the problem (for example, QC outlier, procedure deviation, client complaint, etc.)

Suspend data reporting until the problem is corrected? Yes or No

Part II Investigation and Corrective Action (Attach separate pages if necessary)

1. List steps taken to investigate the problem

2. List responsible parties (involve each responsible party in the investigation and correction processes.)

3. Explain the probable cause(s) of the problem

4. List steps taken to prevent recurrence of the problem

5. Besides the sample(s) listed above, are there data sent to any clients also affected by this problem? If yes, please explain

Part III Approvals

Group Supervisor	Date	Department Manager	Date
QA Director	Date	Laboratory Director	Date

Quality Assurance Reports to Management

Reports of quality status from the Quality Assurance Department to management are made frequently and in various forms. All results from internal or external performance evaluation samples are circulated to management. A report of each audit performed is prepared and copied to management. A monthly report is submitted to management, summarizing the current status of Quality Assurance Department matters and areas of concern. A list of deficiencies found during QA data package review is included with the monthly report. The QA Director attends regular meetings with laboratory management and is allowed time to discuss QA/QC activities. Through these channels, laboratory management is able to monitor data quality easily and effectively.

Procurement

Mountain States Analytical, Inc. (MSAI) monitors the inventories of materials and supplies regularly to maintain a safety stock of important items. An established policy for requisitioning is followed, including review by the laboratory section leaders, department managers, and the financial manager. Refer to Company Policy and Procedure (CPP) SS-031 below. Vendors with favorable experience are typically used unless the item is not available from the normal vendors.

Internal policy CPP-QA-009, included below, ensures that chemicals, reagents, and standards are tested for suitability before use in analyses. Labels and documentation provide traceability for each lot and container. This policy also establishes that chemicals, reagents, and standards are replaced before their expiration dates.

Subcontract laboratory services are sometimes used by MSAI. The policy CPP-QA-007, included in this section, provides guidance for when to use a subcontractor and establishes the policy for approval of subcontract laboratories.

COMPANY POLICY AND PROCEDURE: CPP-SS-031

Title: Requisitioning Materials, Tools and Supplies

References: Not Applicable

Purpose:

The purpose of this procedure is to ensure timely procurement of such materials, tools and supplies.

Scope:

This document describes when and how to prepare and process internal requisitions for materials, tools and supplies.

Background Information:

Efficient laboratory operations depend upon the timely availability of materials, tools and supplies of the appropriate quality and quantity.

Policy and Procedure:

Each section of the laboratory will establish a location for storing a safety stock of the materials, tools and supply items needed. The location will be labeled to clearly identify the item, primary and secondary vendor, vendor catalog numbers and quantity of that item to be maintained in stock. Safety stock quantities will be established by section coordinators and approved by the group leader and by the laboratory director. (Due to infrequent use or high cost and reasonable availability, some items may not be carried in inventory.)

Section coordinators will review backlogs and inspect safety stock locations weekly to determine which items need to be resupplied.

The section coordinator will prepare internal requisition forms listing the items needed to resupply inventory and meet production requirements including the quantity, preferred vendor, vendor's catalog number, unit price and extended price of each item. When the form is complete, it will be dated and signed then presented to the group leader for approval.

Group leaders will review the requisitions verifying that the items are required and that quantities and prices are correct. A comparison of the proposed purchase to budget should be made in order to verify need. When everything is in order, the group leader will date and sign the requisition and present it to purchasing in support services for processing.

The support services manager will review the requisition. If no financial consideration precludes authorization of the purchase authorization to make the purchase will be indicated by dating and signing the requisition and presenting it to the buyer for processing.

The buyer will compare requisitions to items on back order. If any of the requisitioned items are on back order, the buyer will consult the requisition originators to determine if the requisition should be voided or modified, otherwise the buyer will process a purchase order and arrange timely delivery of the items to MSAI.

Accountability:

The support services manager will update and distribute a weekly purchasing report to group leaders and section coordinators. This report will compare actual expenditures for materials, tools and supplies to planned expenditures on a month-to-date and fiscal year-to-date basis.

Group leaders and section coordinators may use this report to identify favorable and unfavorable spending variances. In order to improve laboratory efficiencies, these variances should be investigated and explained. Types of variances such as purchase price, use and volume variances should be identified and quantified if possible. The objective is to be within plan on a quarterly basis.

COMPANY POLICY AND PROCEDURE: CPP-QA-009

Title: Reagents, Chemicals and Standards

References:
CPP-QA-008, "Laboratory Notebooks"

Purpose:

The purpose of this policy is to establish traceability of materials used for analysis and to ensure that they are of suitable quality.

Scope:

This policy covers methods for documenting inspection, preparation and storage of reagents, chemicals and standards.

Background Information:

The reliability of analytical results depends on the quality of reagents, chemicals and standards used in the analysis.

Policy/Procedure:

Purchased reagents, chemicals and standards:
All reagents, chemicals and standards received at the laboratory will be labeled with the **date of receipt** by the person receiving the materials and labeled with the **date of opening** and **date of expiration.** These dates should be placed on the container label or on a separate label that does not obscure the manufacturer's information. Figure 18-1 includes examples of labels used for

reagents, chemicals, and standards. The department using the material is responsible for these labeling requirements.

- Each container will be identified separately in notebook references to allow traceability. If multiple containers are received from one manufacturing lot, sequential numbers (for example, 1/3 (one of three), 2/3 and 3/3) will be placed on the labels and used in notebook entries.

- Reagents of known stability, such as those bearing a manufacturer's expiration date or based on literature information, will not be used beyond the expiration date.

- Extremely stable reagents may be labeled with a **date of reevaluation** in place of the expiration date. This will prevent unnecessary disposal of useful materials. The reevaluation date is one year from the date of opening unless literature information justifies a longer period. If the reevaluation date is reached before the reagent is consumed, the reagent will be inspected by an experienced chemist for signs of degradation. Suitable analytical methods may be used to assess the continued usefulness of the reagent. The reevaluation will also include review of other indicators of continued chemical integrity, such as associated QC results and trends. If the reagent is suitable for further use, the reevaluation will be documented in a file or notebook, the old reevaluation date on the label will be canceled with a single line, and a new date (not to exceed one year) will be placed on the label.

- Reagents of unknown stability will be given an expiration date of one year or less.

The only exceptions to these labeling procedures are solutions used in high volume (for example, extraction solvents) which are used up in a very short time. However, these should also be labeled if possible.

Solvents, chemicals, and reagents used for extractions, digestions, and sample preparation will be analyzed before use by the methods for which they will be used. The analysis does not have to be done by MSAI if a complete certificate of analysis is supplied with the chemical. A record of manufacturer lot number and quantity will be maintained along with the analytical results validating adequate purity for their intended use. New shipments of solvents, chemicals, or reagents will not be used for clients' analyses until these steps have been followed.

Note: When possible, solvents and acids used in large volumes will be acquired from a given manufacturing lot to reduce acceptance testing and to enhance uniformity.

Many hazardous and nonhazardous reagents, chemicals and standards are shipped with a Material Safety Data Sheet (MSDS), which lists valuable safety information. All MSDS will be filed by the Safety Director in a three-ring binder placed in an accessible location for quick reference. Any employee may review this information.

Chemical solutions and reagents prepared in-house:

All solutions and reagents prepared in-house will be labeled with the name of the solution, the concentration, the date prepared, the expiration date, special storage conditions (if applicable) and the initials of the person who prepared the solution. If the shelf life is known or specified in an analytical method, the

expiration date will correspond to the shelf life. If the shelf life is not known (that is, if the solution is assumed to be stable), an expiration date of one year from the date of preparation may be assumed unless a longer stability time can be documented. There are two exceptions to this labeling procedure.

- Solutions and reagents used for a single day or a single batch of analyses and are then discarded require only sufficient information to identify the material, and if necessary the hazard level. This labeling for identification also applies to containers of reagent water.

- Containers too small to list all information, such as autosampler vials, may be labeled with only the name of the contents if the label is traceable to the complete information written in a notebook.

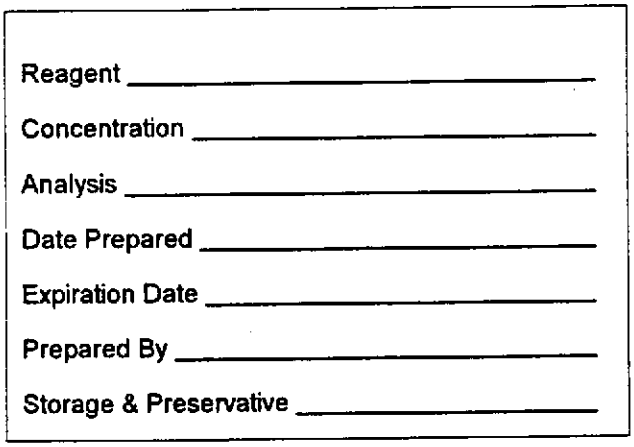
All data pertinent to solution and reagent preparation and standardization will be logged in a bound notebook of the type specified in CPP-QA-008. Each entry must be initialed and dated by the analyst who did the preparation or standardization.

Standards prepared in-house will be given a unique identification code traceable to the preparation data and manufacturer of the stock standards. This identification code will be labeled on the working standard container and will be referenced in laboratory notebooks or instrument printouts.

Example: **An identification code, such as 1234-89, is traceable to the preparation logbook number 1234 and the logbook page number 89. If multiple standard preparations are recorded on the same page, a sequential letter or number gives separate identifications (such as**

1234-89-C). The manufacturer and lot number of the stock standard are written in the logbook at this location.

Figure 18-1
Labels Used for Chemicals, Reagents, and Standards



COMPANY POLICY AND PROCEDURE: CPP-QA-007

Title: Subcontracting to Other Laboratories

Purpose:

To specify the standard protocol for approving qualified subcontract laboratories.

Scope:

This policy specifies the requirements for determining when to accept work that will be subcontracted, the requirements for qualifying a laboratory as a subcontractor and explains the procedure for proper transfer of sample custody to subcontractors.

Background Information:

Occasionally clients request analyses that cannot be performed by Mountain States Analytical, Inc.,(MSAI) due to a lack of personnel, equipment, or time. In these cases, a decision is made by the senior staff or project manager whether to refer the client to another qualified laboratory or accept the work for subcontracting. When work is accepted for subcontracting it is essential that the laboratory chosen to do the work is technically competent and that sample custody is transferred to the subcontractor properly.

Policy:

The senior staff is responsible for determining whether the client should be referred to another laboratory or whether the work should be accepted for subcontracting. Project managers may accept work for subcontracting to approved subcontractors if the

guidelines of this policy are followed. The following criteria will be considered in the decision to accept samples to be subcontracted.

- Most of the analyses can be done by MSAI.
- The analyses done by MSAI represent most of the billable work.
- MSAI has an approved subcontract laboratory capable of performing the analyses.
- The fees that can be charged for the subcontract work will meet profitability goals set by senior staff.
- Indirect benefits, such as additional future work, must be determined at the senior staff level.

Any subcontracting of samples to another laboratory will be clearly communicated to the client.

1. Prior to a project or on acceptance of the samples, the client will be informed that the work will be subcontracted to another laboratory that is qualified to do the work.

2. A verification of the samples submitted will be sent to the client by fax, unless the client requests that verification not be sent.

A laboratory used for subcontracting must be qualified by the Quality Assurance Director. The QA Director reviews the following information to determine whether a laboratory can be qualified.

- The laboratory's Quality Assurance/Quality Control plan.
- The laboratory's list of certifications.
- The laboratory's insurance certificates for workman's compensation and professional liability.
- The laboratory's standard terms and conditions.
- The laboratory's method references for the tests to be performed.

Upon qualification, the laboratory must sign a statement warranting the accuracy of the tests performed for MSAI. In most cases, the subcontract laboratory will be audited initially and as needed by the Quality Assurance Director or a technically qualified employee assigned by the QA Director.

The QA Director will maintain a file of qualified subcontract laboratories.

When samples are sent to a subcontract laboratory, a Chain of Custody form (see Form I) is completed. The current date, requested TAT, requested analyses, sample identification (group and sample numbers), number of containers per sample, and the name of the MSAI project manager will be written on the form.

1. The person relinquishing custody of the samples signs and dates the chain of custody.

2. The pink copy of the Chain of Custody used for subcontracting is added to the group report and filed. The remaining copies are sent with the samples to the subcontractor. The subcontractor will return a signed and

dated copy of the Chain of Custody to MSAI with the final analytical reports.

Note: All documents pertaining to the subcontracting of samples are filed in the group folder.

Each subcontracted analysis result appearing on MSAI reports must be marked with a statement notifying the client that the analysis was subcontracted (for example, "The analysis for [*test name*] was subcontracted to another qualified laboratory"). In addition, the subcontractor's analytical reports must be attached to the MSAI reports when sent to the client.

Forms/Figures/Tables:

Form I Chain of Custody (Figure 18-2)

Mountain States Analytical

10899

Sample Chain of Custody

Client Name: _____ P.O. # _____

Phone #: _____ Fax #: _____

Project Name/#: _____

Sampler: _____

Sample Identification	Date Collected	Time Collected	Grab	Composite	Soil	Water	Other	Total of Containers	Analysis Required	Rush?	Remarks	Temp. of Samples Upon Receipt

Sample relinquished by:	Date	Time	Sample received by:	Name of Shipper	Airbill No.	Date	Time

Received By (Lab)	Date	Time	Seal Intact?

Turnaround Time Requested (please circle): Normal Rush

(Rush TAT is subject to MSAI approval and surcharge)

Report Results By: (Date) _____

Rush results requested by (please circle): Phone Fax

Report Results to: _____

Type of Disposal:	**Authorized for Disposal by:**
Date/Time of Disposal:	**Disposed of by:**

1645 West 2200 South, Salt Lake City, Utah 84119 (801) 973-0050 FAX (801) 972-6278

White Copy - Original Retain by Lab Yellow Copy - Return to Customer Pink Copy - Retain by Sampler

Figure 18-2

Waste Management

Mountain States Analytical, Inc. (MSAI) has a hazardous waste management plan (see CPP-LO-032 in this section) to ensure that hazardous wastes are managed in accordance with applicable regulations governing the generation, accumulation and disposal of hazardous wastes. Hazardous waste sources include unused portions of client samples and process wastes, such as acids, bases, and solvents used in sample preparation and testing. Samples that are not returned to the clients are collected according to waste classification and later sent out for disposal. Process wastes are also collected and stored according to waste type. SOP-SA-105 ensures the proper disposal of expired samples and gives instructions for the proper classification, treatment, storage, containment monitoring, and disposal through licensed waste contractors. The procedure for transferring laboratory process wastes to the containment area is given in SOP-LO-114.

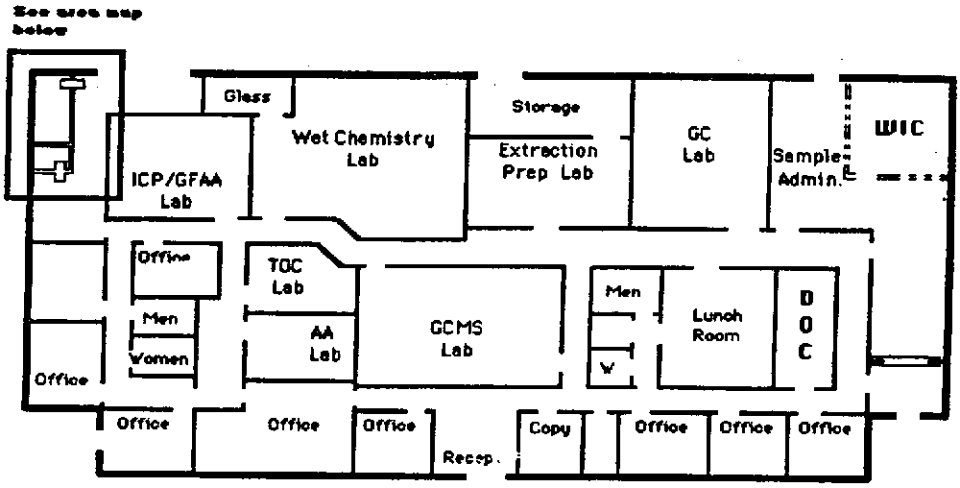
The waste containment area (See Figure 19-1) is located in the southeast corner of the main building. The area is bounded by a four-inch berm designed to hold the contents of one 55-gallon liquid waste drum should it lose its contents. Colored hazard tape is used to delineate the boundaries of the containment area.

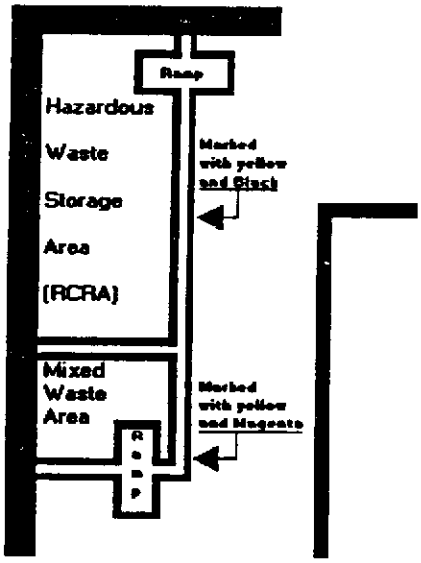
Wastes are collected in separate containers according to waste classification. The general classifications for non-radioactive wastes are drinking water, basic, waste flammable liquid, soils/sludge/solid oils/grease, and water/wastewater. Radioactive and potentially radioactive wastes are stored separately as another class of waste.

Wastes are monitored weekly and a record is kept to document the inspections. Only licensed contractors are employed for the transport and disposal of laboratory wastes.

Figure 19-1

Waste Containment Area





COMPANY POLICY AND PROCEDURE: CPP-LO-032

1 **Title: Hazardous Waste Management Plan**

2 **References:**

10 CFR, Part 20, Subparts I, J, K & L
40 CFR, Parts 261, 262 & 263
49 CFR, Parts 172 through 177
HM-181 DOT regulations (49 CFR)
SOP-LO-114,Laboratory Waste Collection and Transfer to Storage
CPP-LO-026, Emergency Response to Accidents Involving Hazardous Materials
SOP-SA-105, Sample Discard/Monitoring of Hazardous Waste Containments
SOP-RA-125, Radioactive Waste Handling Procedures
SOP-RA-121, Radiation Survey Procedure
SOP-RA-122, Radiation Emergency Procedures
SOP-RA-125, Radioactive Waste Handling Procedures

3 **Purpose:**

To ensure that laboratory hazardous waste is managed in accordance with all applicable regulations governing the generation, accumulation, storage and disposal of hazardous waste and to ensure a healthy and safe workplace for MSAI staff with respect to waste hazards.

4 **Scope:**

This SOP describes MSAI's procedures necessary to comply with State and Federal hazardous waste regulations.

5 Responsibilities:

The following sections outline the responsibilities for managing Hazardous Waste at MSAI:

5.1 Laboratory Hazardous Waste Coordinator (LHWC)

5.1.1 Complete necessary waste materials data sheet.

5.1.2 Review and sign hazardous waste manifests.

5.1.3 Ensure that return manifest and certificates of incineration are returned by the waste disposal company within 30 days from date of shipment.

5.1.4 Perform weekly inspection of the containment area.

5.1.5 Audit facilities designated to receive hazardous waste.

5.1.6 Complete and submit any waste generating summary reports required by Utah State or the Environmental Protection Agency.

5.2 Laboratory Personnel

The following are the responsibilities of laboratory personnel.

5.2.1 Properly segregate waste generated by placing it into the appropriate satellite containers located in the laboratory.

5.2.2 Contact the LHWC if is unsure of the proper waste managementprocedure

5.2.3 Keep all satellite waste containers closed when not in use.

5.2.4 Keep all satellite containers clean and properly labeled

6 Definitions:

6.1 Hazardous Waste

For the purposes of this SOP, Hazardous Waste is defined as any client sample which has expired, or which has no further use, and will not be returned to the client and any associated waste resulting from the analysis of any client sample, except drinking water samples. Expired chemicals, reagents, standards and spiking solutions are also considered to be hazardous waste.

6.2 Contact Hazardous Waste

Any waste, such as disposable pipets or pipet tips, pH strip paper, paper towels, wooden spatulas, etc., which has contacted any sample during analysis (except drinking water samples) is assumed to be hazardous waste. Wash basin water, used for cleaning glassware and which is neutralized to a pH between 5 and 9, will not be considered hazardous waste.

6.3 Hazardous Waste Containment Area

The main storage area for the laboratory's hazardous waste located in the southeast corner of the main laboratory building.

6.4 Associated Waste

Defined as any extract, digestate, sample residue, solvent which remains after sample analysis. All are considered hazardous, except for associated waste derived from drinking water analysis that are not inherently hazardous.

6.5 Satellite Receptacle

Any individual container used within the respective laboratory areas for the temporary storage of hazardous waste before it is transferred to the hazardous waste containment area.

7 Background:

It is critical that MSAI conduct its waste segregation, accumulation and disposal activities in conformance with all existing applicable regulations and in accordance with scientifically-ethical principles.

8 Safety:

Safety procedures described in the MSAI Chemical Hygiene Plan, SOP-LO-114 and SOP-SA-105 should be followed.

9 Policy/Procedure:

9.1 Laboratory Waste Management

Mountain States Analytical (MSAI) generates hazardous waste and is responsible for complying with all applicable regulations as set forth in 40 CFR parts 261, 262 and 263 pertaining to our existing hazardous waste management program. Examples of waste generated at MSAI are TCLP extracts, distillates and residues, metals digestions, organic extracts, chromatographic autosampler vials and contact wastes.

9.2 Samples and waste from sample analysis

9.2.1 Many different types of samples are received for analysis at MSAI. Those that are not returned to

Clients are disposed of using a duly qualified waste disposal contractor. Sample Administration is responsible for the disposal of unused portions of samples according to SOP-SA-105. The procedures for return of samples to Clients are also covered in SOP-SA-105 (for Clients who desire return and for samples which are deemed unacceptable for disposal by MSAI). All samples disposed by MSAI are incinerated at a qualified facility.

9.2.2 All samples, remaining portions of samples and residues of samples remain the property of the Client at all times. Unused portions of samples found or suspected to be hazardous according to State or Federal laws, regulations or guidelines may be returned to the Client upon completion of the analytical work. This includes samples known or suspected to contain hazardous materials.

9.2.3 Any samples which are deemed hazardous (i.e. listed waste codes appear on the manifest or chain-of-custody documentation or a hazardous constituent is known to be present in the sample above threshold levels) and are to be returned to the Client must be returned with all listed waste codes and applicable DOT information present on the accompanying manifest. Additionally, all other information required by 49 CFR must be listed on the paperwork that accompanies the samples which are returned to the Client. This includes a 24-hour emergency phone number (which would be used in the event of an accident or release of hazardous material during transport), the proper chemical name of the hazard and names, addresses and

telephone numbers of appropriate MSAI staff and personnel at the indicated destination facility.

9.3 Contact and Associated Wastes

9.3.1 Each laboratory operation (e.g. wet chemistry, metals, etc.) within MSAI is also responsible for maintaining their own temporary storage of contact and associated wastes (which are derived from sample analysis) in accordance with SOP-LO-114. These laboratory wastes are accumulated in "satellite" waste receptacles located in each laboratory. These receptacles are taken from the individual laboratory regularly, but never less than every 2-3 months, and the contents are deposited in the appropriate container designated in the hazardous waste containment area (located in the southeast corner of the main laboratory building) in accordance with SOP-SA-105. Each satellite receptacle is placarded with the accumulation start date in order to ensure that the 90 day accumulation time cycle is not exceeded. Waste derived from sample analysis (associated and contact waste) must be handled as any other hazardous waste. This includes paper towels, rubber gloves, pipette tips, organic extracts, inorganic digestates, etc. These associated wastes should never be deposited in containers designed for municipal waste if there is any reason to believe they have been contaminated by a hazardous waste or sample. If there is **no good reason** to suspect that associated wastes have been contaminated by hazardous samples during analysis, these wastes should be deposited in the municipal

waste stream in order to minimize total hazardous associated waste.

9.3.2 Liquid extracts derived from sample analysis must be treated as any other hazardous waste and deposited in the appropriate departmental satellite container and then, within 2-3 months transferred to the appropriate hazardous waste container in the containment area.

9.4 Low-level radioactive waste (See also SOP-LO-114)

9.4.1 Low-level radioactive waste is accumulated in each laboratory in separate satellite receptacles for eventual transfer to the hazardous waste containment area. Each receptacle is labeled with a radioactive sticker to distinguish them from non-radioactive waste. Each laboratory is equipped with satellite receptacles for liquid and solid low-level radioactive waste. Contact waste generated from the handling of these types of samples will be deposited in the solid waste receptacles located in each laboratory. The contents of each satellite receptacle will be emptied regularly, but not less frequently than every 2-3 months, into the appropriate low-level radioactive waste drum in the hazardous containment area. SOP-LO-114 refers to procedures governing the management of these wastes in the laboratory. A licensed waste broker will be contacted for pickup and transfer off-site in accordance with any State or Federal laws, regulations or requirments.

9.4.2 All radioactive waste is scanned for radioactivity according to the criteria listed in SOP-RA-005 before being deposited in the hazardous waste containment area. A radioactive disposal log is used to record the disposal of these types of samples. In this manner, MSAI maintains an inventory of radioactive waste which has been disposed. Before shipment off-site, the drums in the waste containment area are screened for radioactivity and the results documented.

9.5 Hazardous Waste Containment Area

9.5.1 Physical description

A hazardous waste containment area has been designated at MSAI in the southeast corner of the west building. This area is bounded by a four-inch containment berm designed to hold the contents of one 55-gallon liquid waste drum should it rupture and completely lose its contents. Magenta/yellow hazard tape (for radioactive waste) and black/yellow hazard tape (for hazardous waste) are used to delineate the boundaries of the waste containment areas. The berms and floor of the containment area are epoxy-coated to prevent any seepage from the containment area.

9.5.2 Containers/Labeling

9.5.2.1 There are four non-radioactive hazardous wastestreams generated at MSAI, each of which is identified by a WMDS (waste material data sheet) number. These are: soils, sludges contact waste, oils or grease (WMDS 222268),

wastewaters (WMDS 212950) oils/solvents/waste/flammable liquids (WMDS 222269) and chromatographic autosampler vials (WMDS 217983) These wastestreams, as well as the specifications of the containers designated to hold each type of waste, are referenced in SOP-SA-105. All containers are labeled in accordance with the requirements contained in 40 CFR, Part 262. This includes the WMDS number for each waste stream, the accumulation start date (or, the date the first sample was deposited into the drum), and any hazard stickers (e.g., corrosive, flammable, etc.) required by DOT HM-101. These wastestreams are profiled and analyzed by our waste disposal contractor every two years to assure that the waste type has not changed significantly.

9.5.2.2 All low-level radioactive waste generated at MSAI has been reduced to four categories:

a. Solid Waste
b. Aqueous Waste
c. Organic liquids
d. Contact Waste

Solid waste includes all sludges, soils and contact waste. Liquid aqueous waste includes all distillates, extracts and digestates which have no organic phase. Organic liquid waste includes freons used for clean-up operations and other organic liquids generated in the laboratory. Chromatographic vials are generated only in the organic

laboratories and are maintained separate for radioactive and non-radioactive waste.

9.6 Weekly Monitoring

Each week, an inspection of the containment area is performed. All containers are inspected for leakage according to SOP-SA-105. The inspector enters his findings in a bound notebook which is available for inspection in this area. In addition, the Radiation Safety Officer, or designee, performs a radiation survey of the containment area as outlined in SOP-RA-121.

9.7 Leaking containers or spills

Any spills found in the hazardous waste containment area or elsewhere in the laboratory will be attended to immediately upon discovery according to CPP-LO-026. Spill kits are located within the containment area and throughout the laboratory facility. If a container is found to be leaking in the containment area, but has not lost its entire contents, it will be overpacked into an 85 gallon drum designed for this purpose. Spilled material which has been cleaned up is deposited in the appropriate waste drum. In addition, SOP-RA-122 is followed for any release involving low-level radioactive wastes.

9.8 Maximum allowable quantities

The maximum allowable quantity which can be stored at this facility is 6000 kg according to 40 CFR, Part 262.34. MSAI is also allowed to store up to this quantity of waste for no more than 90 days. MSAI typically ships hazardous waste off-site every month, so that the accumulated quantity of waste typically

never approaches 6000 kg. In this manner, large quantities of waste are never maintained at MSAI's facility. Another responsibility MSAI has as a hazardous waste generator is to post the name and telephone number of an employee who can respond quickly to a fire or other emergency in the containment area or other area of the facility. This list is in place in the hazardous waste containment area.

9.9 Segregation of low-level radioactive waste from non-radioactive waste

All low-level radioactive waste is segregated from non-radioactive waste at MSAI. Radioactive waste is deposited in drums located in a separate section of the bermed containment area (the north section) bounded by magenta/yellow hazard tape. Any leakage from either type of waste cannot contaminate the other because of a epoxy-sealed berm divider.

9.10 Manifest Operations

9.10.1 Contracting for shipping

MSAI has all hazardous waste transported to a licensed hazardous waste incinerator operated by ENSCO El Dorado, Arkansas facility. A licensed hazardous waste transporter contracted either by MSAI or by the destination facility, is responsible for shipment of waste from MSAI's facility.

9.10.2 Paperwork requirements

All hazardous waste shipments are properly manifested according to DOT HM-181 regulations. All documents are properly completed before arrival of the hazardous waste transporter. In order to help prevent any transport violations, a Sample Administration staff member (usually the LHWC) and the driver of the transport vehicle verify that all data is correct and complete before the waste leaves MSAI's facility. Certificates of incineration and manifestsfor all shipments of hazardous waste are returned to MSAI within 30 days and filed as proof of destruction of samples. These documents are placed in corporate files in the Support Services Department with copies maintained in Sample Administration.

9.11 Reporting

Every even-numbered year, MSAI will prepare the biannual report according to 40CFR 262.41.

10 Quality Control

10.1 A quarterly procedural audit is conducted by QA.

10.2 Periodic inspections are conducted by Safety Officer/Committee and Client Services Leader.

10.3 Semi-annual procedural audits are conducted by the Radiation Safety Officer in addition to weekly radioactive screening surveys.

10.4 Weekly inspections of containment areas are conducted by SA personnel.

10.5 A nonconformance finding by an audit or inspection will result in a written request for corrective action.

11 Forms, Tables, and Figures:

11.1 Form I, (Figure 19-2) Hazardous Waste Containment Weekly Inspection Form (see SOP-SA-105).

11.2 Form II, (Figure 19-3) Hazardous Waste Drum Survey Logbook

Figure 19-2

Mountain States Analytical, Inc. Weekly Waste Drum Inspection

Date Inspected	Drums Closed?	Clearly Labelled?	Corrosion or Leaking?	Initials	Comments
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		
	☐Yes ☐No	☐Yes ☐No	☐No ☐Yes		

Page No. ______________ Reviewed By: ____________

Figure 19-3

Mountain States Analytical, Inc.
Hazardous Waste Drum Survey Logbook
Ludlum Model 3 with Model 44-3 probe
A = Serial # 93966 W/ 090675 B = Serial # 109625 W/ 110400

A or B	Drum No.	Reading (mR/hr)	Initials	Date	Background Reading	Source Reading	Maifest No.	Comments

Page No.________________ Page reviewed________________

Appendix A

Organizational Structure

Mountain States Analytical, Inc., currently has four main operating units: (1) Business Services, that includes Business Development in both the Mountain States and Southwest States Regions, Client Services, Sample Administration and Radiochemistry Subcontracting; (2) Environmental Laboratory Services that includes an Inorganics Department, comprised of Metals and General Chemistry groups, and an Organic Department, comprised of Organic Instrumentation and Extractions groups, and the Quality Assurance Department; (3) Corporate Services with responsibility for accounting, human resources, office services, information systems, and physical facilities functions; and (4) the InSciTe Research Division

The following pages provide professional profiles for the technical and administrative personnel at MSAI.

Douglas W. Later, Ph.D.

President, Laboratory Director, Chief Executive Officer
InSciTe Research Division Director

Professional Experience:
Mountain States Analytical, Inc., 1989 - Present
President and Laboratory Director
Executive Vice President and Laboratory Director
Dionex, Lee Scientific Division, 1988-1989
Vice President, Marketing and Sales
Vice President, Operations
Lee Scientific, 1985-1988
Vice President R&D and Co-founder
Battelle Northwest Laboratories, 1982-1985
Research Scientist, Project Manager

Education:
Ph.D., Brigham Young University, 1982
Major: Analytical Chemistry
B.A., Brigham Young University, 1978
Major: Chemistry

Continuing Education:
Councilor Selling Series, Wilson Associates, 1984
Management Training, Western Leadership Group, 1986
Executive Excellence Series, Covey and Associates, 1987
Supercritical Fluid Chromatography and Extraction, ACS Short Course Instructor, 1988
Strategic and Marketing Planning, ACIL Educational Seminars, 1992
Service Operations Process Optimization, PennState University, 1992
Leadership and Total Quality Management, ACIL Education Institute, 1993
Ethical Fitness, Institute for Global Ethics, 1993
Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1993
Leadership Utah, Salt Lake Area Chamber of Commerce, 1993
Trainer Certification, Total Quality Management, 1994
Recent Advances in Continuous Emission Monitoring, Air Waste and Management Association, 1996
Trainer Certification, Institute for Global Ethics, 1996

Publications and Presentations:
Approximately 150 publications and presentations in the field of analytical chemistry including 4 book chapters; 55 journal publications; 34 published proceedings; 13 government reports; 45 conference, seminar, symposia, workshop, and training presentations.

Awards and Citations:
John Einar Anderson Scholarship Award, 1979
Telford E. Wooley Cancer Research Award, 1981
Innovative Development Institute/Small Business Administration, Small Business Innovative Research of the Year Award, 1988
ACIL S. Preston Millard Service Award, 1996

Experience:
Instrumental Analytical Chemistry
Microcolumn Chromatography
High Resolution Gas Chromatography
Supercritical Fluid Chromatography and Extraction
Chromatographic Detection Systems
Mass Spectrometry
Organic Analytical Chemistry
Polycyclic Aromatic Compound Chemistry
Coal and Fuel Chemistry
Automated Sample Preparation
Accelerated Solvent Extraction
Accelerated Acid Digestion
Industrial Applications of Supercritical Fluid Chromatography and Extraction

Douglas W. Later. Ph.D.
(continued)

Experience: (continued)
Environmental Chemistry
- Hazardous Waste Analyses
- Compliance Monitoring Analyses
- Mixed Waste Analyses
- Explosives Analyses

Memberships and Appointments:
The Institute for Global Ethics
- Member, Since 1996

Utah CEO Group
- Member, 1995-1996

Utah Independent Laboratory Association
- Chair and Co-founder,
- Member, Since 1995

National Environmental Laboratory Accreditation Conference (NELAC)
- Participant, Since 1994
- Onsite Assessment Committee
- Member, 1995-1997

Department of Defense, U.S. Army Armament, Munitions and Chemical Command, PEP Thermal Treatment Test and Evaluation Facility, Technical Steering Committee Member, 1994-1996
The Executive Committee, Member, 1992-1996
Air and Waste Management Association
- Member, Since 1992
- Sectional Education Committee, 1993-1994

Salt Lake City Chamber of Commerce
- Member, Since 1989
- Environmental Affairs Sub-committee, Since 1990
- Utah Leadership, Class of 1993

American Council of Independent Laboratories
- Member, Since 1989
- Member, Services Committee, 1994-1996
- Environmental Section Executive Committee, 1994-1997
- Environmental Section Co-Vice Chair, 1995-1997
- Board of Directors, Since 1995

Association of Official Analytical Chemists
- Member Since 1989

The Journal of Microcolumn Separations
- Editorial Advisory Board, 1988-1989

Journal of Polycyclic Aromatic Hydrocarbons
- Topical Editor, Since 1988-1992
- Editorial Board, Since 1992

International Symposium on Polycyclic Aromatic Hydrocarbons
- Editorial Committee, 1987-1990

International Committee on Polycyclic Aromatic Compounds
- Executive Committee Member, 1984-1990
- Chromatography Subcommittee Chairman, 1984-1988

Sigma Xi, 1981-1983
American Chemical Society
- Member, Since 1979
- Fuel Chemistry Division, 1982-1989
- Analytical Chemistry/Chromatography Division, Since 1987

Earl M. Hansen, Ph.D.

Executive Vice President
Business Services

Professional Experience
Mountain States Analytical, Inc., 1997-Present
Executive Vice President, Business Services
Roy F. Weston, Inc., 1984-1997
Vice President
Division Manager
Manager Business Development
Manager Quality Assurance
Laboratory Manager
Envirodyne Engineers, Inc., 1982-1984
Midwest Research Institute, 1977-1982
Snell Environmental Group, 1973-1977
Clyde E. Williams and Associates, 1972-1973
Notre Dame University, 1968-1971

Education:
Post Doctoral Fellow, 1968-1971
University of Notre Dame
Radiation Laboratory
Ph.D., Michigan State University, 1970
B.A., Chemistry, Wittenberg University, 1963

Continuing Education:
Project Management, AMA, 1978

Publications and Presentations:
Approximately 40 publications and presentations in environmental analytical chemistry, project and laboratory manangement. In addition, authored (or co-authored) 8 government reports.

Awards and Citations:
Distinguished Service Award, Chester COYMCA, 1994
Distinguished Service Award, Int'l Association of Environmental Testing Laboratories (IAETL), 1997

Experience:
Environmental Chemistry
Methods Development
Methods Validation
Sample Collection
Quality Assurance
Business Development
Project Management
Laboratory Management
Contract Management

Memberships and Appointments:
ACIL Member, 1997
American Chemical Society (ACS), Member since 1974
American Assoication for the Advancement of Science (AAAS), Member since 1982
Sigmna Xi, past member

Charles R. Seehafer

Business Development Director
Mountain States Region

Professional Experience:
Mountain States Analytical, 1993 - Present
Business Development Director
FB&D Technologies, Inc., 1990-1993
Business Development Manager
Eaton-Kenway, Inc, 1986-1989
Systems Engineering Manager
Project Engineering Manager
United States Steel Corporation, 1971-1986
Staff Supervisor
Senior Systems Analyst
Methods Engineer
Systems Consultant
Systems Design Supervisor

Education:
B.S., University of New Mexico, 1971
Major: Electrical Engineering

Continuing Education:
Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1995
Total Quality Management, Mountain States Analytical, Inc., 1995
Radiation Safety Course, Mountain States Analytical Inc., 1994
Crosby Quality, Eaton-Kenway, Inc.,1993
Ethical Fitness, Institute for Global Ethics, 1993

Memberships and Appointments:
ACIL Member, 1995-present
Association Iron Steel Engineers, 1972-present

Experience:
Business Development
Environmental Engineering
Wastewater Treatment Systems
Information Management Systems
Quality Assurance
Business Planning
Industrial Engineering
Marketing and Sales
Systems Engineering
Government Subcontracting

Gregory E. Brewer

Southwest States Region
Business Development Director

Professional Experience:
Mountain States Analytical, Inc., 1997-Present
Business Development Director
Southwest Laboratory & Affiliates, 1992-1997
Regional Manager, Southwest Region
PRC Environmental Mgmt., Inc., 1991-1992
Business Development Manager
NET (Gulf Coast), Inc., 1989-1991
Marketing Professional
Golden StrataServices, Inc., 1988-1989
Manager, Analytical Services Group
Injection Technology Specialists, Inc., 1983-1988
Vice President and General Manager
Vice President of Business Development
Oil Plus Ltd., 1982-1983
U.S. Sales Manager
Air Products and Chemicals, Inc., 1981-1982
Marketing Engineer
Black, Sivalls & Bryson, Inc., 1977-1981
Sales Executive
International Systems & Controls, Inc., 1975-1977
Mgmt. Development Program Member

Education:
M.B.A., University of Houston
B.S., Texas A&M University
Major: Zoology
Minor: Chemistry

Continuing Education:
Analysis of Retun on Investment: Capital Expenditures, Mergers and Acquisitions, New York City
Applied Water Technology and Oilfield Water Injection Systems, C.C. Patton & Associates, Inc.
IBM Professional Sales Training, Levels I & II, Houston, TX
OSHA 40 Hours Hazardous Materials Training, Houston, TX

Publications:
Economic Evaluation of the ATC/Wellman Incandescent Two-Stage Coal Gas Producer

Affiliations:
National Association of Corrosion Engineers
Society of Petroleum Engineers
Society of Texas Environmental Professionals
Texas Association of Environmental Professionals
Coal Technology Advisory Committee
PetroSafe 1994 Advisory Committee

Experience:
Business Development
Marketing and Sales
Project Management
Hazardous Waste Disposal
Enhanced Oil Recovery
Injection Fluid System Evaluation
Reservoir Engineering
Alternative Fuels Technologies
Pipeline Industrial Gas Delivery

Shirley A. Chandler

Administrative Assistant, Business Development

Professional Experience:

Mountain States Analytical, Inc., 1990-Present
Administrative Assistant, BD
Document Control Administrator
Receptionist

University of Utah, Center for Engineering Design,
1988-1990
Administrative Secretary

Evans & Sutherland Computer Corp.,1985 -1988
Secretary
Clerk Typist
Electronic Assembly

Experience:

Document Control
Computer Skills
Secretarial Skills
Accounts Payable

Education:

Mountainwest College of Business, Salt Lake City,
1986
Major:Administrative Assistant Course

High School Diploma, Bingham High, 1980
Major: General Education

Continuing Education:

Radiation Safety Course, Mountain States Analytical, Inc., 1996

Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1995

Total Quality Management, Mountain States Analytical, Inc., 1995

Ethical Fitness Seminar, Institute for Global Ethics,
1994

Leadership & Supervisory Skills for Women , Padgett Thompson, 1993

Making the Most of Your Telephone Contacts, US West, 1992

Awards and Citations

Spirit of MSAI Award, Mountain States Analytical,
Inc.,1992

Professional Profile

Chad Peel

Business Development Intern

Professional Experience:
Mountain States Analytical, Inc.,
1992 - Present
Business Development Intern
Courier
Brigham Young University, 1995 - 1996
MTC Instructor

Education:
Currently attending Brigham Young University
Major: International Relations
Minor: Business Management

Awards and Citations:
Deans List, Brigham Young University,1995-1998
High Honors Roll, Brigham Young University, 1993-1994, 1995-1998

Memberships and Appointments:
Phi Kappa Phi, 1997-1998

Experience:
Statistics
Management Skills
Accounting
Office Skills
Computer Skills
Internet Skills

Rolf E. Larsen

Client Services Leader
Project Manager

Professional Experience:
Mountain States Analytical, 1992 - Present
Client Services-Manager I/Group Leader II
Project Manager
Huish Detergents, Inc., 1983-1991
Quality Assurance Manager

Education:
B.A., University of Utah, 1982
Major: Chemistry

Continuing Education:
Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1995
Total Quality Management, Mountain States Analytical, Inc., 1994
Radiation Safety Course, Mountain States Analytical, Inc., 1994
Ethical Fitness, Institute for Global Ethics, 1993

Awards and Citations
Spirit of MSAI Award, Mountain States Analytical, Inc.,1993

Memberships:
Pat Carlisle, Leadership Group, 1996
ACIL Member, 1995

Experience:
Research and Development New Product
Specification Performance Testing Customer Support
Safety Program Development
TSCA, OSHA, CERCLA, and SARA Title III Reporting
Statistical Quality Control

Mark W. Bostrom

Client Services, Project Manager

Professional Experience:

Mountain States Analytical, 1994 - Present
Project/Client Manager II
Project Manager I
Specialist I
ACZ Laboratories, Inc., 1992 - 1994
Marketing Manager
ACZ Laboratories, Inc., 1990 - 1992
Organic Extraction Laboratory Supervisor

Education:

B.S., Western State College, 1987
Major: Business Administration

Continuing Education:

Dunn & Bradstreet Business Education Services, Customer Service, 1996
Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1995
Total Quality Management, Mountain States Analytical, Inc., 1995
Ethical Fitness, Institute for Global Ethics, 1994
Radiation Training Course, Mountain States Analytical, Inc.,1994
Mine Waste Minimization and Remediation Seminar, Fairmont Hot Springs, MT, 1992

Memberships:

Pat Carlisle, Leadership Group, 1996-Present
ACIL Member, 1995-Present
Colorado Hazardous Waste Management Society (CHWMS), 1992-1994
National Ground Water Association (NGWA), 1992-1994
Montana Mining Association (MMA), 1992-1994
Northwest Mining Association (NWMA), 1992-1994
ACIL Member, 1995-present

Experience:

Organic Extraction- (SW-846, EPA 600)
General Chemistry
Business Development
Client Services
RCRA analytical methods and applications
CWA analytical methods and applications
SDWA analytical methods and applications

W. Scott Fraser

Client Services, Project Manager
Chemical Hygiene Officer
Radiation Safety Officer

Professional Experience:
Mountain States Analytical, 1992 - Present
Project Manager I
Chemical Hygiene Officer
Radiation Safety Officer
Chemist I
Associate Chemist
Aptus, Inc., 1992
Chemist
Environmental Radiation & Toxicology Laboratory, 1989-1992
Chemist
Department of Agricultural Sciences, Utah State University,1987-1989
Chemist

Education:
B.S., University of Utah, 1991
Major: Chemistry

Continuing Education:
Dunn & Bradstreet Business Education Services, Customer Service, 1996
8 Hour DOT, HM-181,1996
8 Hour Refresher, OHSA, 1996
Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1995
Total Quality Management, Mountain States Analytical, Inc., 1995
40 Hour Radiation Safety Officer Training, Mountain States Analytical, Inc. 1994
Ethical Fitness, Institute for Global Ethics, 1994
40 Hour Hazardous Materials Training, OSHA, 1992

Awards and Citations:
CRC Chemist of the Year Award, Utah State University, 1987

Memberships and Appointments:
Utah State Radiation Safety, Responsible User, 1991- Present
Great Salt Lake Health Physics Society, Member, 1993 - Present
ACIL Member, 1995 - Present

Experience:
Metals digestion and analysis
Gravimetric and Wet General Chemistry Analyses
Gas Chromatography
Gas Chromatography/ Mass Spectrometry Sample Control
Data Entry and Validation
Standard Operating Procedure Writing
Alpha, Beta, and Gamma Spectrometry
Ion Exchange Chromatography
Radiochemical Separation Techniques
Radiochemical Health & Safety Monitoring
Radioactive Materials Licensing
Radioactive Materials Management
Neutron Activation Analysis
X-Ray Spectroscopy Analysis
Government Subcontracting

Pamela K. Olsen

Sample Administration Coordinator

Professional Experience:

Mountain States Analytical, Inc., 1992 - Present
- *Sample Administrator - Coordinator II*
- *Coordinator I*
- *Administrator III*

EG&G Idaho, Inc, 1987-1992
- *Associate Technician* II
- *Document Control Coordinator*
- *Secretary*

Education:

Associates Degree, Ricks College, 1985
- Major: Arts and Science

Paralegal Certificate, Arizona State University, 1984
- Major: Paralegal

Continuing Education:

Radiation Safety Course, Mountain States Analytical, Inc.,1996

Total Quality Management, Mountain States Analytical, Inc., 1995

Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group,1995

Leadership Skill for Women, Padgett Thompson,1994

Beginning Chemistry, University of Utah, 1994

Ethical Fitness, Institute for Global Ethics, 1993

Hazardous Material Shipper, EG&G Idaho, Inc., 1992

Radiation Worker Training, EG&G Idaho, Inc., 1987-1992

OSHA Training, EG&G Idaho, Inc., 1991

SARA Title III Report Training, EG&G Idaho, Inc., 1991

Awards and Citations:

Presidents Award, Mountain States Analytical, Inc.,1993

Spirit of MSAI Award, Mountain States Analytical, Inc. 1997

Experience:

Sample Management

Chemical Inventory

Requisition Coordinator

Document Control

Internal, EPA, and NEIC Audits

Leon D. Ford

Senior Laboratory Technician, Sample Administration

Professional Experience:

Mountain States Analytical, Inc., 1992 - Present
- *Client Services Senior Laboratory Technician I*
- *Hazardous Waste Coordinator*
- *Laboratory Technician II*
- *Laboratory Technician I*
- *Laboratory Assistant*
- *Courier*

Core-Mark Distributing, 1990 - 1992
- *Inventory Control Coordinator*

Transit Casualty Co., 1988 - 1990
- *Claims Processor*

Education:

Utah Valley Community College, 1987-1988
Major: Business Management

Continuing Education:

State of Utah Groundwater and Soil Sampling, certified since 1993-present

Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1996

Radiation Safety Training, Mountain States Analytical, Inc., 1996

HM-181Training, Department of Transportation, 1995

40 hour Hazardous MaterialsTraining, OSHA 1993;(Recertified, 1994, 1995, 1996)

Total Quality Management, Mountain States Analytical, Inc., 1995

Ethical Fitness Training, Mountain States Analytical, Inc., 1994

Environmental Technology, Utah Valley Community College, 1993

Awards and Citations:

Giant Award, Mountain States Analytical, Inc. 1996

Experience:

Organic, Inorganic, Field Sampling
RCRA & CERCLA Site Sampling
Hazardous Material Sampling
Hazardous Waste Manifesting & Shipping
Sample Preparation
Automated Sampling
Sample Administration
High Volume Air Sampling

Professional Profile

Wendy Seager

Sample Administration Clerk

Professional Experience:

Mountain States Analytical, 1997
- *Sample Administration Clerk*
- *Lab Technician I*

Weber State University
- *Laboratory Assistant, 1995-1997*

Weber State University
- *Teaching Assistant, 1995-1997*

Education:

B.S., Weber State University, 1997
- Major: Psychology
- Minor: Chemistry

Experience:

Computer Skills

Instrumentation
- Single-beam visible spectometer
- Ultraviolet-visible scanning spectrometer
- Gas chromatograph
- Atomic absorption spectrophotometer
- Infrared spectrophotometer
- polarographic analyzer
- Fluorometer
- potentiometer with ion selective electrodes

Coursework:
- Chemistry
- Quantitative Analysis
- Elementary Instrumentation
- Applied Analysis
- Organic Chemistry

Maureen K. Maughan

Sample Administration Clerk

Professional Experience:

Mountain States Analytical, Inc., 1997
Sample Administration Clerk
Bagelby's Bagel Bakery, 1996-1997
Assistant Manager
Targhee National Forest, 1993-1997
Forestry Aid/YCC Crew Boss
Ricks College, 1995-1996
Laboratory Assistant
Bank of Eastern Idaho, 1993-1994
Office Assistant

Education:

University of Utah, current
Majoring in Biology/Botony
A.A.S., Ricks College, 1996

Experience:

Computer Skills
Office Skills
First Aid/CPR Certification
Coursework
General Chemistry
Organic Chemistry
Biology Chemistry

Professional Profile

Jan Barbas

Inorganics Department Leader

Professional Experience:

Mountain States Analytical, 1997-Present
Inorganics Department Leader
Quality Solutions, Inc., 1995-1997
Program Manager
Business Development
Lab Certification and QA Officer
State of Utah, 1991-1995
Laboratory Certification Officer
Quality Assurance Officer
Southland Corporation, 7-11 Stores,
1981-1984
Manager

Education:

Woods Hole Oceanographic Institution
Summer Fellow, 1996
M.S., University of Utah, 1991
Major: Chemistry
B.S., Fort Lewis College, 1987
Major: Chemistry

Awards and Citations:

Employee of the Month, State of Utah
9/95, 10/94, 2/93
Incentive Awards, State of Utah
11/91, 12/92
Small Dollar Award, State of Utah
11/92, 5/95
Stauffer-Rozelle Fellowship, Univeristy of Utah
1987-1988

Experience:

Program Management
Laboratory Certification
Budget Management
Scheduling Workload
Chemical Techniques and Handling
Laboratory Safety
Quality Assurance
Record Keeping
Survey Reports
Sytems Documentation
Web Site Maintenance
Method Development
Microbiology
Technical Support
Computer Skill
Teaching Assistant
Inorganic Instrumentation
Organic Intrumentation
Laboratory Certification

Glenn A. Sorensen

Metals Department Coordinator

Professional Experience:

Mountain States Analytical, Inc., 1988-Present
Lab Operations Co-Leader
Manager II
Manager I
United States Pollution Control, Inc., 1987-1988
Laboratory Manager
Bennett Paint Corporation, 1970-1987
Plant/Laboratory Manager
Hercules Incorporated, 1962-1970
Area Supervisor, Research Chemist
Sunkist Growers Association, 1959-1962
Research Chemist

Education:

B.A., University of Utah, 1959
Major: Chemistry

Continuing Education:

Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1995
Radiation Safety Course, Mountain States Analytical, Inc., 1994
Total Quality Management, Mountain States Analytical, Inc., 1994
Ethical Fitness, Institute for Global Ethics, 1993
First Aid Training Course, American Red Cross, 1987
Bomb Calorimeter Short Course, Leco Corp, 1987
Gas Chromatography Analysis, Varian, 1987
Hazardous Materials Training, Grow Group, 1987
Management Training, Grow Group, 1985
Computer Science, Utah Technical College, 1985-1986
40 Hour Sampling Course, OSHA, 1986
Instrumental Analysis, Utah Technical College, 1984-1985
Atomic Absorption Spectrometry, Short Course, Perkin Elmer, 1982
Safety Training, Hercules, 1963-1964

Publications and Presentations:

Twenty scientific publications in organic and analytical chemistry.

Awards and Citations:

Spirit of MSAI, Mountain States Analytical, Inc., 1990
Employee of the Year, Bennett's Paint Corporation, 1986
Leading Researcher, Sunkist, 1960
The Pauling Scholarship, 1955-1956

Memberships and Appointments:

ACIL Member, 1995
American Chemical Society, 1962-1970

Experience:

Well Sampling and Monitoring
Air Sampling and Monitoring
Environmental Analysis
Safety/Industrial Hygiene
Total Organic Halide
Wavelength Dispersive Analysis
X-Ray Analysis Fluorescence Spectrometry
Gas Chromatography/Mass Spectrometry
Gas Chromatography
Infrared Spectrophotometry
Inductively Coupled Plasma Emission Atomic Absorption Emission, Flame Emission
Data Processing/Computing

Daryl J. Kent

Chemist, Metals Group

Professional Experience:

Mountain States Analytical, 1992-Present
Chemist III

Thermo Jarrell Ash, 1980–1992
Senior Service Engineer

I.A. Theatrical Stage Employees, 1978–1979
Business Agent

Education:

Attended Boise State University
Major: Chemistry

Continuing Education:

Total Quality Management, Mountain States Analytical, Inc., 1994

Radiation Safety Training Program, Mountain States Analytical, Inc.,1994

Ethical Fitness, Institute for Global Ethics, Mountain States Analytical, Inc., 1994

Memberships and Appointments:

Utah State Aeromodelers, 1990 - present

Experience:

Atomic Absorption Inductively Coupled Plasma Spectrometry Plasma Emission Spectometry

Repair and Maintenance of Atomic Absorption and Emission Instruments

Arc/Spark Emission Spectrometry Theory and Practice

Mathew L. Eden

Senior Laboratory Technician, Metals Department

Professional Experience:

Mountain States Analytical, Inc., 1995 - Present
- *Senior Laboratory Technician*
- *General Chemistry Laboratory Technician*

On-Site Environmental Staffing, 1995
- *Drilling Assistant*

Medical Physics, Inc., 1989-1995
- *Assistant Research Scientist*

CompuSave/Micronet, 1988-1989
- *Computer Technician*

Professional Resources, 1986-1988
- *Computer Technician*

Education:

B.A., University of Utah, 1992
- Major: Physics

Continuing Education:

40 Hour Hazardous Waste Operations, OSHA, 1996

Radiation Safety Course, Mountain States Analytical, Inc., 1996

Ethical Fitness, Institute for Global Ethics, 1995

Total Quality Management, Mountain States Analytical, Inc., 1995

Experience:

Instrumentation
- Varian AA20
- ASE
- SFC/MS
- SFC/TEA
- SFC/FID
- Mallinckrot blood Gas/Electolyle Analyzer

Processes
- Soxhlet Extraction
- Extract Concentration by Rotary Evaporation
- Drilling/Sampling Soils
- Preparation and Disposal of Hazardous Materials Used in Research

Membrane Fabrication

Technical Customization of Experimental Equipment

Software:

Microsoft Windows, Word, Quattro Pro, WordPerfect, Excel

Ivan Iucker

Chemist I, Metals Department

Professional Experience:
Mountain States Analytical, Inc., 1996 - Present
Chemist I
Associate Chemist
Granite School District, 1994
Substitute Teacher
University of Utah - Cytogenetics, 1992 - 1994
Lab Technician

Education:
B.S. - University of Utah, 1994
Major: Chemistry

Continuing Education:
Ethical Fitness, Institute for Global Ethics, 1995
Total Quality Management, Mountain States Analytical Inc., 1995
Radiation Safety Course, Mountain States Analytical, Inc., 1996

Experience:
General Chemistry
Sample Preparation and Digestion
Data Entry Experienced in TCLP
TOX
TOC
Cell & tissue culture Preparation
Karyotype a Chromosome
GFAA
CVAA
ICP

Steven S. Jensen

Laboratory Technician, Metals Group

Professional Experience:
Mountain States Analytical, Inc., 1995-Present
Laboratory Technician I
Laboratory Assistant
Rainbo Oil Company, 1992
Cashier
Sizzler Buffet Court and Grill, 1990
Dishwasher/Busser
Mitchell's Nursery & Gifts, 1986
Greenhouse Attendant

Education:
University of Utah, Sophomore
Major: Biology

Experience:
Coursework:
Radiation Safety, 1996
Making Quality a Science Course, 1996
Ethical Fitness Course, 1996

Daniel G. Woodward

Laboratory Assistant, Metals Group

Professional Experience:

Mountain States Analytical, 1997-Present
Laboratory Assistant

Aqua Management, 1995-96
Sales Clerk/Technical Representative

Education:

University of Utah (currently attending)

Experience:

High School Baseball Coach, 1997

LDS Youth Council, 1996-1997
Chairman, Fort Union Stake

Brooke Cline

Data Package Assembler, Inorganic Department

Professional Experience:

Mountain States Analytical, Inc., 1994-Present
Data Package Assembler / Clerk II
Kentucky Fried Chicken, 1988 - 1994
Manager

Education:

High School Diploma, Taylorsville High School, 1992
Major: General Education

Continuing Education:

Radiation Safety Course, Mountain States Analytical, Inc., 1996
Ethical Fitness, Institute for Global Ethics, 1995
Total Quality Management Training, Mountain States Analytical, Inc., 1995

Experience:

Enter Raw Data
Enter Raw Data into WARD Scientific Software to Create Data Packages to Meet Holding Times, TAT's and deadlines
Downloading Instrument Results into Electronic Files
Review Work to Meet Strict Requirements
Payroll

Kristin A. Brown

Data Package Assembler, Inorganics Department

Professional Experience:
Mountain States Analytical, Inc. 1997
Data Package Assembler
Graham Restaurants
Crew Trainer, Customer Service

Education:
B.S., Environmental Engineering, 1997

Experience:
Coursework:
- Air Pollution Control
- Water and Waste Pollution Control
- Hazardous Waste Management
- Environmental Process Mechanics
- Physical Chemistry
- Organic Chemistry
- Quantitative Analysis
- Analytical Instrumentation
- Statistical Process Control
- Organization and Management
- Technical Writing

Farlyn L. Smith

Associate Chemist, General Chemistry

Professional Experience:

Mountain States Analytical, 1992 - Present
Associate Chemist
Senior Technician II
Sample Administration Clerk
Newmont Gold, 1991
Laboratory Technician I
Hercules Aerospace, 1990
Laboratory Inspector
Unisys Corporation, 1989
Assistant Chemist
Gamma Electroplating, Taiwan, 1988
Laboratory Technician

Experience:

Atomic Absorption Spectrometry
Ultra Violet Spectroscopy
General Chemistry
Fire Assay
Mechanical and Physical Testing
Sample Gathering and Preparation
Statistical Process Control Methods

Education:

Associate of Applied Science, Utah Valley Community College, 1988
Major: Electronics Technology,
B.A., Brigham Young University, 1985
Major: Mandarin Chinese
A.S., Ricks College, Rexburg, Idaho, 1982
Major: Chemistry

Continuing Education:

Total Quality Management, Mountain States Analytical, Inc., 1995
Ethical Fitness, Institute for Global Ethics, 1994
Radiation Training Course, Mountain States Analytical, Inc., 1994
TOC Training, Lancaster Laboratories, Inc., 1993

Awards and Citations:

Presidents Award, Mountain States Analytical, Inc.,1997

Nathan W.H. Ludwig

Associate Chemist, General Chemistry

Professional Experience:

Mountain States Analytical, 1992-Present
- *Associate Chemist*
- *Laboratory Technician I*
- *Senior Technician I*

Utah State Health Laboratory, 1992
- *Laboratory Technician/Chemist*

Southern Utah University, 1989–1991
- *Laboratory Assistant*
- *Chemistry Tutor*

U.S. Forest Service, 1988–1989
- *Surveyor*

Experience:
General Chemistry
Sample Preparation and Digestion
Qualitative Analysis
Data Collection and Interpretation
Water Quality Analyses
QC Reporting

Education:

B.S., Southern Utah University, 1991
Major: Chemistry

Continuing Education:

Total Quality Management, Mountain States Analytical, Inc., 1995
Ethical Fitness, Institute for Global Ethics, 1994
Radiation Safety Course, Mountain States Analytical, Inc., 1994

Linda S. Scott

Laboratory Technician, General Chemistry

Professional Experience:

Mountain States Analytical, 1997-Present
Laboratory Technician I
Poco Loco Swim Shop, 1997
Manager
Hind Outlet/G.H. Sports Outlet, 1996-97
Sales Representative/Sunday Manager
City of Boulder Water Conservation Office
Intern
Fresh Choice, 1994-95
Cashier
Cable Car Coffee Company, 1994
Counterperson
Morale Welfare and Recreation, 1992-93
Lifeguard
The Commissary, 1990-92
Self-Employed

Education:

B.A., University of Colorado, Boulder, 1997
Major: Environmental, Population and Organismic Biology
Major: Environmental Studies with Specializations in Biogeochemistry and Climate
Minor: Geology

Experience:

Ecology
Hydrology
Environment and Public Policy
Genetics
Plant Anatomy
Natural Resource Economics
Field Biology
Tropical Conservation Biology
Principles of Ecology
Oceanography

Gordon W. Jensen

Laboratory Technician, General Chemistry

Professional Experience:
Mountain States Analytical, Inc., 1997-Present
Laboratory Technician II
Laidlaw Environmental, 1994-1997
Chemist 1
Standard Laboratories and Commercial Testing and Engineering, 1981-1987
Laboratory Technician

Education:
Weber State College, 1988-1994
College of Eastern Utah, 1988-1994
A.S., College of Eastern Utah, 1991
Certified, Novell Engineer Tract for IntraNetWare, 1997

Certifications:
Certified Novell Engineer for IntraNetWare, 1997
40 Hour OSHA Training
Adult CPR

Experience:
Wet Chemistry
Metals Digestion
Dionx IC
Coal Preparation
CVAA
Sample Preparation Quality Control

Anthony Jones

Laboratory Assistant, General Chemistry

Professional Experience:
Mountain States Analytical, Inc., 1997 - Present
Laboratory Assistant
Utility Coating & Fabrication, 1996-1997
Labor
Remco of America, 1993-1996
Sales/Driver

Education:
High School Diploma, Russellville High, Arkansas, 1990

Experience:
Customer Service Skills
Fork Lift Driver
Collection
Glassware Maintenance

Professional Profile

Bethany A. Ebling

Organics Department Leader

Professional Experience:

Mountain States Analytical, 1995 - Present
Lab Operations Co-Leader
Group Leader I
ACZ Laboratories, 1995
Group Leader
Lancaster Laboratories, Inc., 1989 - 1994
Group Leader
Extrel Corporation, 1988 - 1989
QA/QC Specialist
Carnegie Mellon University, 1986 - 1988
Environmental Engineering Laboratory Coordinator
Princeton University, 1983 - 1985
Laboratory Technician
Purdue University, 1981 - 1982
Laboratory Technician

Education:

B.S., Purdue University, 1981
Major: International Agriculture

Continuing Education:

Radiation Safety Course, Mountain States Analytical, Inc., 1996
Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1995
Ethical Fitness Training, Mountain States Analytical, Inc.,1995
Total Quality Management, Mountain States Analytical, Inc.,1995
Presentation Skills, Lancaster Laboratories, 1993
Service Operations Process Optimization, Penn State University, 1992
Quality Education System, Philip, Crosby Associates, 1990
Supervising People Effectively, Millersville, University, 1990
Entry-Level Management Development Program, Lancaster Laboratories, Inc., 1990
Fundamentals of Groundwater Contamination, Geraghty & Miller, Inc., 1990
Applied Statistics, Penn State Continuing Education, 1990
Introduction to Q&A, The Office Works Training Center, Lancaster, PA., 1989
Chrompack Inc. Basic HPLC course, 1987

Memberships:

Former member of American Chemical Society, 1981-1985
Association of Official Analytical Chemists, 1981-Present

Experience:

Data Entry & Validation
QA/QC Specialist
Standard Operating Procedure Writing
Laboratory Management
General Chemistry
Laboratory Supervisor
Organic Extraction
Organic EPA CLP
Data Review - General Chemistry, GC, GCMS. AA, ICP
Radioactive tracers
Instrumentation:
Spectrophotometer
GCMC
GC
HPLC
AA
Misc. General Chemistry Instruments
Misc. Organic Extraction Instruments

Matthew S. Sorensen

Organic Instrumentation Coordinator

Professional Experience:
Mountain States Analytical, Inc., 1990 - Present
Coordinator IV
Chemist II
Chemist I

Education:
B.S., Weber State University, 1990
Major: Chemistry

Continuing Education:
Environmental Applications of GC/MS, University of Indiana, 1996
Mass Spectra Interpretation Course, Hewlett Packard, 1995
Total Quality Management Course, Mountain States Analytical, Inc., 1995
Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1995
Radiation Safety Course, Mountain States Analytical, Inc., 1994
Ethical Fitness, Institute for Global Ethics, 1993

Awards and Citations:
American Chemical Institution, Outstanding Senior Chemist Award, 1990
Spirit of MSAI Award, Mountain States Analytical, Inc., 1991

Memberships and Appointments:
Pat Carlisle, Leadership Group, 1996
Sigma Xi Chemical Research Society, 1990-present

Experience:
Gas Chromatography
Gas Chromatography/Mass Spectrometry
Infrared Spectrophoto-metry
Environmental Analysis

C. Michael Snyder

Chemist I, Organic Instrumentation

Professional Experience:
Mountain States Analytical, Inc., 1988-Present
Chemist I
Associate Chemist
Senior Technician II

Education:
Associates Degree, Salt Lake Community College, 1991
Major: Physical Science

Continuing Education:
Total Quality Management, Mountain States Analytical, Inc., 1995
Radiation Safety Course, Mountain States Analytical, Inc., 1994
Ethical Fitness, Institute for Global Ethics, 1993
Gas Chromatography Seminar, Restek, 1993

Experience:
General Chemical Analysis
Gas Chromatography
Gas Chromatography/ Mass Spectrometry
Atomic Absorption Spectrometry
Infrared Spectrophotometry
Ion Selective Electrode Analysis
Total Organic Halide Analysis

Troy K. Gunderson

Chemist I, Organic Instrumentation

Professional Experience:

Mountain States Analytical, Inc., 1992 - Present
- *Chemist I*
- *Associate Coordinator*
- *Sr. Laboratory Technician II*
- *Sr. Laboratory Technician I*
- *Laboratory Technician II*
- *Laboratory Technician I*

Nuclear Testing Services, 1992 - 1993
- *Chemist*

HCA St. Mark's Hospital, 1988 - 1992
- *Patient Contact Representative*
- *Assistant Dietician*
- *Food/Nutritional Services, Supervisor*

Education:

B.S., University of Utah, 1990
- Major: Biology

Continuing Education:

Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1996

Radiation Safety Course, Mountain States Analytical, Inc., 1996

Total Quality Management, Mountain States Analytical, Inc., 1995

Ethical Fitness, Institute for Global Ethics, 1993

Awards and Citations:

Honors at Entrance, University of Utah, 1986

Memberships and Appointments:

Phi Kappa Phi, University of Utah, 1990

Golden Key National Honor Society, University of Utah, 1990

Experience:

General Chemistry

Total Organic Halide Analysis

Calibration and Service of
- Toxler Moisture/Density Gauges

ION Chromatography Dionex DX 500
- Gas Chromatography
- Volatile and Semivolitile Analyses

Gas Chromatography/Mass Spectrometry

Professional Profile

Kelly P. Finnegan

Chemist I, Orgainic Instrumentation

Professional Experience:

Mountain States Analytical, Inc., 1992 - Present
Chemist I
Associate Chemist
Westminster College of Salt Lake City,
Organic Chemistry Lab, 1991-1992
Teaching Assistant
Legacy Rare Coins, 1988-1990
Co-owner and Manager

Experience:

GC/MS Semi-volatile analysis
Organic Extraction and analysis of PCBs, Pesticides, Herbicides, and Petroleum Hydrocarbons
Air Quality Analysis at Lancaster Laboratories
Chemistry, Physics, and Spanish Tutoring

Education:

B.S., Westminster College of Salt Lake City, 1992
Major: Chemistry

Continuing Education:

Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1996
"Introduction to MS Interpretation", GC/MS Training Course, Hewlett Packard, 1995
Total Quality Management, Mountain States Analytical, Inc., 1995
Radiation Safety Training, Mountain States Analytical, Inc., 1994
Ethical Fitness, Institute for Global Ethics, 1993
Capillary Chromatography Seminar, Restek, 1992

Awards and Citations:

MSAI Giant Award, Mountain States Analytical, Inc., 1995
Gore Math and Science Endowment, Westminster College, Salt Lake City, 1991-1992
John Stauffer Memorial Scholarship, Westminster College, Salt Lake City, 1991-1992
Sterling Scholar, Kearns High School, 1980

Memberships and Appointments:

Member, Utah Numismatic Society, Since 1984
President, 1989, 1996

John Y. Barton

Senior Technician II, Organic Instrumentation

Professional Experience:

Mountain States Analytical, 1991-Present
- *Senior Laboratory Technician II*
- *Senior Laboratory Technician I*
- *Laboratory Technician II*
- *Laboratory Technician I*

Education:

B.S., Brigham Young University,1995
Major: Psychology

Continuing Education:

Ethical Fitness, Institute for Global Ethics, 1994
Total Quality Management, Mountain States Analytical, Inc., 1994
Radiation Safety Course, Mountain States Analytical, Inc., 1994
Gas Chromatography Seminar, Restek, 1993

Experience:

Pesticide, Herbicide, TPH, Extraction
Preparation of Calibration Standards
QC Charting
Inventory Control
GC Extractions Training for New Employees
HP 5890 Series II Gas Chromatograph
Tekmar ALS 2016 Autosampler
LSC 2000 Purge and Trap Concentrator
Perkin Elmer Infrared Spectrophotometer
HP Chemstation
GC Enviroquant Target
HP 5970 MSD
OI ELCD/PID/FID

Katharine E. Nunn

Associate Chemist, Organic Instrumentation

Professional Experience:

Mountain States Analytical, Inc., 1992 - Present
- *Associate Chemist*
- *Senior Technician II*
- *Senior Technician I*
- *Laboratory Technician I*
- *Laboratory Technician II*

Westminster College, 1987-1992
- *Secretary*

Kmart, 1988-1992
- *Clerk*

Education:

B. S., Westminster College of Salt Lake City,1993
- Major: Biology
- Minor: Physics

Continuing Education:

Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1996

Radiation Safety Course, Mountain States Analytical, Inc., 1995

Total Quality Management, Mountain States Analytical, Inc.,1995

HP, Mass Spectral Interpretation, Mountain States Analytical, 1995

Ethical Fitness, Mountain States Analytical, Inc.,1995

Awards and Citations:

Spirit of MSAI, Mountain States, Analytical, Inc., 1995

Experience:

Organic Extraction & Analysis of PCBs, Pesticides, Herbicides, and Petroleum Hydrocarbons by GC

Resource Coordinator

Biology Departmental Assistant

Lab Assistant

Data Processing

Organic Chemistry

Infrared Spectrophotometry

Desktop Computer Application

Patricia A. Herndon

Laboratory Technician I, Extraction

Professional Experience:

Mountain States Analytical, Inc., 1997 - Present
Laboratory Technician I

Westminster College of Salt Lake, 1993 - 1997
Accounts Payable
Library Assistant
Chemistry Technician
Desk Clerk
File Clerk

Willow Wood Care Center, 1994
Certified Nursing Assistant

Education:

B.S., Westminster College of Salt Lake City
Major: Biology
Minor: Chemistry

Awards and Citations:

Nominated into Who's Who Among Students in American Universities and Colleges, 1997

Dean's List, Westminster College of Salt Lake City, 1996-1997

Experience:

Computer Applications
Accounting
Clerical & Office skills
Librarian
General Chemistry
Organic Chemistry
Quantitative Chemical Analysis
General Physics
Electrophoresis
General Biology
Bacterioloty
Genetics

Sonya S. Palmer

Laboratory Technician I, Extractions

Professional Experience:

Mountain States Analytical, Inc., 1997 - Present
Laboratory Technician I

Westminster College, 1993 - 1997
Intramurals Coordinator
Weightroon Monitor
Desk Clerk

Education:

1997, Westminster College, B.S., 1997
Major: Biology
Minor: Chemistry

Awards and Citations:

Highest Honor for Math and Science, Westminster, 1996-1997

Experience:

General Chemistry
Organic Chemistry
Quantitative Chemical Analysis
General Physics
Electrophoresis
General Biology
Bacteriology
Genetics
Computer Skills

David H. Bunting

Quality Assurance Director

Professional Experience:

Mountain States Analytical, 1992 - Present
- *Quality Assurance Director*
- *Data Package Validator*

Signetics Company, A Division of North American Philips Corporation - 1979-1992
- *QA/Chemistry Laboratory Supervisor*
- *Technical Services Engineer*
- *Laboratory Technician*

Education:

B.S., Brigham Young University, 1982
- Major: Chemical Engineering

Continuing Education:

Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1995

Quality Assurance for the Analytical Laboratory, AOAC, 1995

Radiation Safety Course, Mountain States Analytical, Inc., 1994

Beyond Quality, ACIL Education Institute, 1993

Ethical Fitness, Institute for Global Ethics, 1993

C Programming, Utah Valley Community College, 1992

Communication Skills, Weyant, 1992

Seven Basic Habits of Highly Effective People, Covey & Associates, 1988

Signetics Adaptation, Crosby Quality College, 1982, 1985, 1989

Supervisor Development, Blanchard Training and Development, 1987

Basic Ion Chromatography, Dionex, 1984

Flame AA, Graphite Furnace AA, ICP Short Course, Perkin Elmer, 1984

Pascal Programming, Brigham Young University, 1984

Publications:

One Paper Accepted for Presentation at INTEREX Conference, Orlando, FL, 1988

Awards and Citations:

Spirit of MSAI Award, Mountain States Analytical, Inc., 1994

Giant Award, Mountain States Analytical, Inc., 1993

Support Department Recognition Award, Signetics Orem Plant, 1988

Memberships and Appointments:

Pat Carlisle, Leadership Group, 1996

ACIL Member, 1995

ASQC, 1996

Semiconductor Equipment and Materials International (SEMI), Chemical Reagents Subcommittee, 1987-1992

American Chemical Society, since 1988

American Institute of Chemical Engineers, 1978-1988

Experience:

Statistical Quality Control and Measurement Systems Evaluation

Quality Improvement Team Leadership

Data Package Validator

Inductively Coupled Plasma Emission and Atomic Absorption Spectrometries

Fourier Transform Infrared and Ultraviolet Spectroscopies

Gas Chromatography

Ion Chromatography

Mass Spectrometry

Instrumental Liquids Particle Counting

General Chemistry

Computer Programming

Data Base Management

Instrument Design and Development

Thomas A. Adams

Data Package Specialist I, Quality Assurance Department

Professional Experience:
Mountain States Analytical, 1994-Present
Data Package Specialist I
Telecation, Inc., 1993-1994
Product Specialist
Southwest Research Institute, 1987-1993
Laboratory Technician
Technician
Data Technician
U.S. Army, 1978-1986
EW/SIGINT Systems Operator
EW/SIGINT Intelligence Analyst
Staff Sergeant
Platoon Sergeant

Education:
Pacific Coast BBC, 1977
Major: Graduate of Christian Education

Continuing Education:
Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1996
Ethical Fitness, Mountain States Analytical, Inc., 1995
Total Quality Management, Mountain States Analytical, Inc., 1995
Radiation Safety Course, Mountain States Analytical, Inc., 1994
Good Automated Laboratory Practices, San Antonio, 1992
OSHA HAZMAT Training, San Antonio Community College, 1992
ACAMS Maintenance/Team Leadership, Johnston Atoll (JACADS), 1989
Chemical Surety Course, Johnston Atoll (JACADS), 1988
General Chemistry, Palo Alto Community College, 1987
Pascal Programming, Lowell University, 1985
Front-End Analysis/Job Aids Development, Army Intelligence School, Ft. Devens, MA, 1985
Non-Commissioned Officer Academy, Korea,1984
Computer Programming, Misawa Japan, 1983
Leadership and Management Development, San Antonio, 1981
Biology, Computer Programming, Solano Community College, 1976

Publications:
ENVIROFORMS/Organic CLP Manual, 1993
Advanced Guardrail V Training Course, 1986

Awards and Citations:
Army Achievement Medal (1 OLC), 1986
Army Achievement Medal, 1985
Commandant's List, NCO Academy, 1985
Good Conduct Medal, 1983
Distinguished Honor Graduate, 1982
Good Conduct Medal, 1980

Experience:
Software and Data Validation
Quality Assurance
Gas Chromatography
Field Sampling Supervision
Chemical Alarm Response
ACAMS Team Leadership
Computer Programming
CLP Document Control
Data Entry
Training Course Development
Technical Instruction

Holly C. Argyle

Administrator II, Quality Assurance Department

Professional Experience:

Mountain States Analytical, Inc., 1992 - Present
- *QA Administrator*
- *Data Package Associate Coordinator*
- *Data Entry Clerk*
- *Data Package Assembler*

R.C. Willey, 1989 - 1992
- *General Office*

Shopko, Inc., 1989
- *Sr. Sales Representative*

Education:

High School Diploma, Cyprus High School, 1989
- Major: General Education

Salt Lake Community College, 1995
- Major: General Education

Community Education Classes, currently attending
- Major: General Education

Continuing Education:

Total Quality Management Training, Mountain States Analytical, Inc., 1994

Ethical Fitness Training, Mountain States Analytical, Inc., 1994

Radiation Safety Course, Mountain States Analytical, Inc., 1994

Experience:

QA Validation of Inorganic Data
Data Package Assembly
Diskette Deliverables
Review and Validate Work to Meet Strict Requirements
PBX Operator
Inventory Control
General Office

Lee D. Eaton, Jr.

Vice President, Corporate Services
Chief Financial Officer

Professional Experience:
Mountain States Analytical, Inc., 1991 - Present
Vice President
Support Services Leader
Chief Financial Officer
Lee Scientific, 1986-1991
Chief Accountant
Amjacs Interwest, Inc., 1983-1984
Controller
Cottonwood Care Center, 1978-1983
Administrator

Education:
B.S., Brigham Young University, 1974
Major: Accounting

Continuing Education:
Edward de Bono's Six Hats Lateral Thinking, Pat Carlisle Leadership Group, 1995
Total Quality Management, Mountain States Analytical, 1994
Radiation Safety Course, Mountain States Analytical, Inc., 1994
Ethical Fitness, Institute for Global Ethics, 1993
Service Operations Process Optimization, Penn State, 1992

Awards and Citations:
Presidents Award, Mountain States Analytical, Inc.,1992

Memberships and Appointments:
Pat Carlisle, Leadership Group, 1996
ACIL Member, 1995
Steering Committee, Environmental Testing Industry Compensation Survey, 1995 - Present

Experience:
Internal Control Systems
Inventory Management Systems
Electronic Data Processing
Accounting Systems
Data Base Systems
Word Processors
Spreadsheets
Networking
Various Utilities Programs
Banking Relations
Internal Auditing Systems
Information Systems Design

Nettie R. Ott

Administrator III, Corporate Services

Professional Experience:

Mountain States Analytical, Inc., 1989 - Present
Administrator III
Christensen, Gylhenskog & Co, 1986 - 87
Bookkeeper
Crocker National Bank, 1978 - 1984
Operations Officer/Branch Manager
First Security State Bank, 1969 - 1978
Assistant Manager/Assistant Operations Mgr.

Education:

South High School, Salt Lake, Diploma
Major: General

Continuing Education:

American institute of Banking, 1969
Total Quality Management, Mountain States Analytical, 1996
Ethical Fitness, Institute for Global Ethics, 1995
Radiation Training Course, 1994
Six Thinking Hats, DeBono, 1996

Experience:

Accounts Payable
Accounts Receivables
Payroll
General Ledger
Supervisory Skills
Computer Skills
Customer Service Skills

Velma S. I. Church

Document Control Administrator, Corporate Services

Professional Experience:

Mountain States Analytical, Inc. 1997-present
Document Control Administrator I
Web Illusions, NewHomesUtah.Net 1997
Designer, Co-Owner
Univeristy of Utah, 1995-1997
Chemical Weapons Incineration Research
Dioxin Research
Northern Utah Pollution Research
Friends of the Sea Lion Marine Mammal Center
Volunteer

Experience:

Biological Laboratory Skills
Chemistry Laboratory Skills
Communications
Computers
Web Site
Information Research
Language: Japanese

Education:

B.S., University of Utah, 1997
Major: Biology
Minor: Chemistry

Melanie Zamora

Receptionist/Secretary, Corporate Services

Professional Experience:

Mountain States Analytical, Inc., 1997-Present
Receptionist/Secretary/Clerk II

U.S. Peace Corps, 1997
Rural Community Development Volunteer

Southwest Utah Mental Health, 1995-1997
Outreach Manager

Southern Utah University, 1996-1997
ESL Tutor

Learning is Fun, 1993-1994
Workshop Coordinator

Alaska Aviation Heritage Museum, 1993
Curator's Assistant

Education:

B.A., Southern Utah Unviersity, 1997
Major: English/Creative Writing
Minor: Spanish

A.S, Dixie College, 1995
General Education

Continuing Education:

Awards and Certifications:

CPR, American Red Cross, 1997
First Aid, American Red Cross, 1997
Mental Health Certifications, 1996-1997
Manic Depressive Disorder
Schizophrenia
Bipolar Disorders
Annie Atkin Tanner Poetry Scholarship, Dixie College, 1993-1994

Publications:

The Southern Quill, 1996
The Paunsugaunt Review, 1997

Kenneth J. Deller

Information Systems Administrator, Corporate Services

Professional Experience:

Mountain States Analytical, Inc., 1996 - Present
Information Systems Administrator
Technical Specialist I
CrossLand Mortgage Corp - 1986-1996
Manager-Programmer/Analyst
Blue Cross & Blue Shield of Utah, 1985-1986
Programmer

Education:

High School Diploma, Union High School
Major: General Education
Associates Degree, LDS Business College,
Major: Data Processing

Awards and Citations:

Presidential Recognition Award, CrossLand Mortgage Corp, 1993
Five time CrossLand Mortgage Corp Medal of Valor award recipient

Experience:

IBM PC and Compatibles, Digital, Vax
Operation Systems
DOS, Windows, Novell 3.X, RSTS'
Languages:
Basic, Cobol, Assembly and RPG
Applications:
dBASE/Clipper/FoxPRO, Borland Delphi, Microsoft Visual Basic, Xcellene, R&R Relational Report Writer, MS Office, WordPerfect

Professional Profile