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FINAL WORK PLAN AND GROUNDWATER QUALITY ASSESSMENT PLAN

TRENCH 5 AND LINE 6

October, 1993

Prepared By:
THE EARTH TECHNOLOGY CORPORATION

U.S. Army
Environmental
Center

FINAL

WORK PLAN

ACCELERATED GROUNDWATER QUALITY ASSESSMENT TRENCH 5 AND LINE 6 IOWA ARMY AMMUNITION PLANT, MIDDLETOWN, IOWA

OCTOBER, 1993

Prepared for:

U.S. ARMY ENVIRONMENTAL CENTER
Aberdeen Proving Ground, Maryland 21010

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The subject document is a work plan for conducting an accelerated groundwater quality assessment of the Ash Disposal Cell in Trench 5, and of Line 6 at the Iowa Army Ammunition Plant, Middletown Iowa. The assessment is being completed in accordance with RCRA Permit, EPA ID# IA 7213820445 to determine if the groundwater portion of each unit can be clean closed under terms of the permit. The assessment includes (1) drilling and collecting soil samples for chemical an physical analyses from three boreholes at the Ash Disposal Cell in Trench 5; (2) completing the three boreholes at the Ash Disposal Cell in Trench 5 as monitoring wells in the shallow aquifer at that location; (3) collecting five rounds of groundwater samples for chemical analysis from the three new monitoring wells at the Ash Disposal Cell in Trench 5 and from 10 existing monitoring wells at the two units; completing an interim report that statistically compares upgradient and downgradient monitoring wells at each unit for general indicators of groundwater quality; and completing a report that assesses overall groundwater quality at each unit. The work plan is comprised of four separate plans: Project Management Plan, Data Collection Quality Assurance Plan, Data Management Plan, and Health and Safety Plan.

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WORK PLAN

The U.S. Army Environmental Center (USAEC), Aberdeen Proving Ground, Maryland, contracted The Earth Technology Corporation (TETC) to perform an Accelerated Groundwater Quality Assessment for the purpose of closing the groundwater portion of the Ash Disposal Cell in Trench 5 of the Inert Disposal Area (IDA) and Line 6 at the Iowa Army Ammunition Plant (IAAP), Middletown, Iowa. This assessment is being conducted as part of the U.S. Army Installation Restoration Program (IRP) with all specific activities and project responsibilities as defined in Contract Number DAAA15-91-D-0009, Delivery Order 0009.

This Work Plan describes all tasks to be performed in order to complete the Accelerated Groundwater Quality Assessments at the two units. It is prepared in accordance with, and all activities specified herein are to be completed in accordance with RCRA Permit, Environmental Protection Agency (EPA) Identification Number (ID) IA 7213820445; Subtitle C of RCRA (42 USC Sections 6921-6939b); and USAEC Contract Number DAAA15-91-D-0009. This Work Plan is separated into four separate plans:

- Project Management Plan (PMP),
- Data Collection Quality Assurance Plan (QAP),
- Data Management Plan (DMP), and
- Health and Safety Plan.

The PMP defines the objectives of the groundwater quality assessment, describes activities that will be undertaken to meet those objectives, establishes a schedule for completing the assessment, and introduces key personnel responsible for successfully completing the assessment. In addition, the PMP provides a general background of the IAAP and unit-specific backgrounds of the Ash Disposal Cell in Trench 5 and Line 6. It also describes the environmental setting in which the IAAP is located.

The QAP documents all monitoring procedures: sampling, field measurements, and sample analysis performed during the groundwater quality assessment to ensure that all information, data, and resulting decisions are technically sound, statistically valid, and properly documented.

The Data Management Plan details the documentation and tracking of assessment-derived data and results. It also identifies the data documentation materials and procedures that will be used in the assessment.

The Health and Safety Plan establishes an effective health and safety program for the assessment that is consistent with company policy, appropriate regulations, and accepted health and safety standards.

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LIST OF ACRONYMS & ABBREVIATIONS

AEC	Atomic Energy Commission
ASTM	American Society for Testing Materials
BGS	Below Ground Surface
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulation
CGI	Combustible Gas Indicator
CLP	Contract Laboratory Program
CPR	Cardiopulmonary Resuscitation
CRL	Certified Reporting Limits
CRZ	Contamination Reduction Zone
CWP	Contaminated Waste Processor
DMP	Data Management Plan
DQO	Data Quality Objectives
E&E	Ecology and Environment, Inc.
EP	Extraction Procedure
EWI	Explosive Waste Incinerator
FFA	Federal Facility Agreement
g/cm^3	grams per cubic centimeter
GOCO	Government Owned, Contractor Operated
gpd	Gallons per day
IAAP	Iowa Army Ammunition Plant
ID	Inside Diameter
IDA	Inert Disposal Area
IRDMIS	Installation Restoration Data Management Information System
kg	Kilograms
LEL	Lower Explosive Limit
MSL	Mean Sea Level
NIST	National Institute of Standards and Technology
NPDES	National Pollution Discharge Elimination System
OSHA	Occupation Safety and Health Administration
PCB	Polychlorinated Biphenyls
PID	Photoionization Detector
POC	Point-of-Contact
PPE	Personal Protective Equipment
ppm	Parts per million
PTFE	Polytetrafluoroethene
PVC	Polyvinyl Chloride
QAC	Quality Assurance Coordinator
QAP	Quality Assurance Plan
QC	Quality Control
RCRA	Resource Conservation and Recovery Act
RDX	Cyclotrimethylenetrinitramine

LIST OF ACRONYMS & ABBREVIATIONS

Continued

RFA	RCRA Facility Assessment
RI/FS	Remedial Investigation/Feasibility Study
SARM	Standard Analytical Reference Materials
SHSO	Site Health and Safety Officer
SI	Site Investigation
SOP	Standard Operating Procedures
SVOC	Semi-volatile Organic Compounds
SWMU	Solid Waste Management Units
SWV	Standing Water Volume
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TETC	The Earth Technology Corporation
TNT	Trinitrotoluene
TOC	Total Organic Carbon
TOX	Total Organic Halogens
USACOE	U.S. Army Corps of Engineers
USAEC	U.S. Army Environmental Center
USAEHA	U.S. Army Environmental Hygiene Agency
USATHAMA	U.S. Army Toxic and Hazardous Materials Agency
USCGS	U.S. Costal and Geodetic Survey
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VOA	Volatile Organic Analyte
VOC	Volatile Organic Compounds

1.0 PROJECT MANAGEMENT PLAN

1.1 INTRODUCTION

This Project Management Plan defines the objectives of the accelerated groundwater quality assessment, describes activities that will be undertaken to meet those objectives, establishes a schedule for completion of the assessment, and introduces key personnel responsible for the successful completion of the assessment. In addition, the Project Management Plan provides a general background of the Iowa Army Ammunition Plant (IAAP) and unit-specific backgrounds of the Ash Disposal Cell in Trench 5 and at Line 6. It also describes the environmental setting in which the IAAP is located.

1.2 SCOPE

The scope of this investigation is to conduct an accelerated groundwater quality assessment of the Ash Disposal Cell in Trench 5 of the Inert Disposal Area (IDA) and Line 6 at the IAAP, Middletown, Iowa in accordance with their Resource Conservation and Recovery Act (RCRA) Permit, U.S. Environmental Protection Agency (USEPA) ID No. IA 7213820445.

1.3 OBJECTIVES

The overall objective of this investigation is to characterize and assess groundwater quality in the shallow aquifer at both the Ash Disposal Cell in Trench 5 and at Line 6. These assessments will be used to determine if these units can be clean closed under their RCRA Permit, USEPA ID No. IA 7213820445. Figure 1-1 shows the location of the two sites.

The field program for the accelerated groundwater assessment is summarized in Table 1-1 and is described below:

1.3.1 THE ASH DISPOSAL CELL IN TRENCH 5

Twenty-two soil samples will be collected during the drilling of three boreholes at the Ash Disposal Cell in Trench 5 and analyzed at an analytical laboratory approved by the U.S. Army Environmental Center (USAEC). These soil samples will be collected at 1 foot below ground surface (BGS), and at 10-foot intervals thereafter, beginning at 10 feet BGS and continuing to total depth in each borehole. The three boreholes will be located hydraulically downgradient of the Ash Disposal Cell in Trench 5. The location of the boreholes will be proposed by the U.S. Army and approved by the USEPA prior to the start of fieldwork. The soil samples will be analyzed for the parameters outlined below:

- Target Compound List (TCL) volatile organic compounds (VOCs)
- TCL semi-volatile organic compounds (SVOCs)
- TCL Pesticides/Polychlorinated Biphenyls (PCBs)
- Explosives (2,4,6-TNT, 2,4-DNT, 2,6-DNT, Tetryl, RDX, HMX)

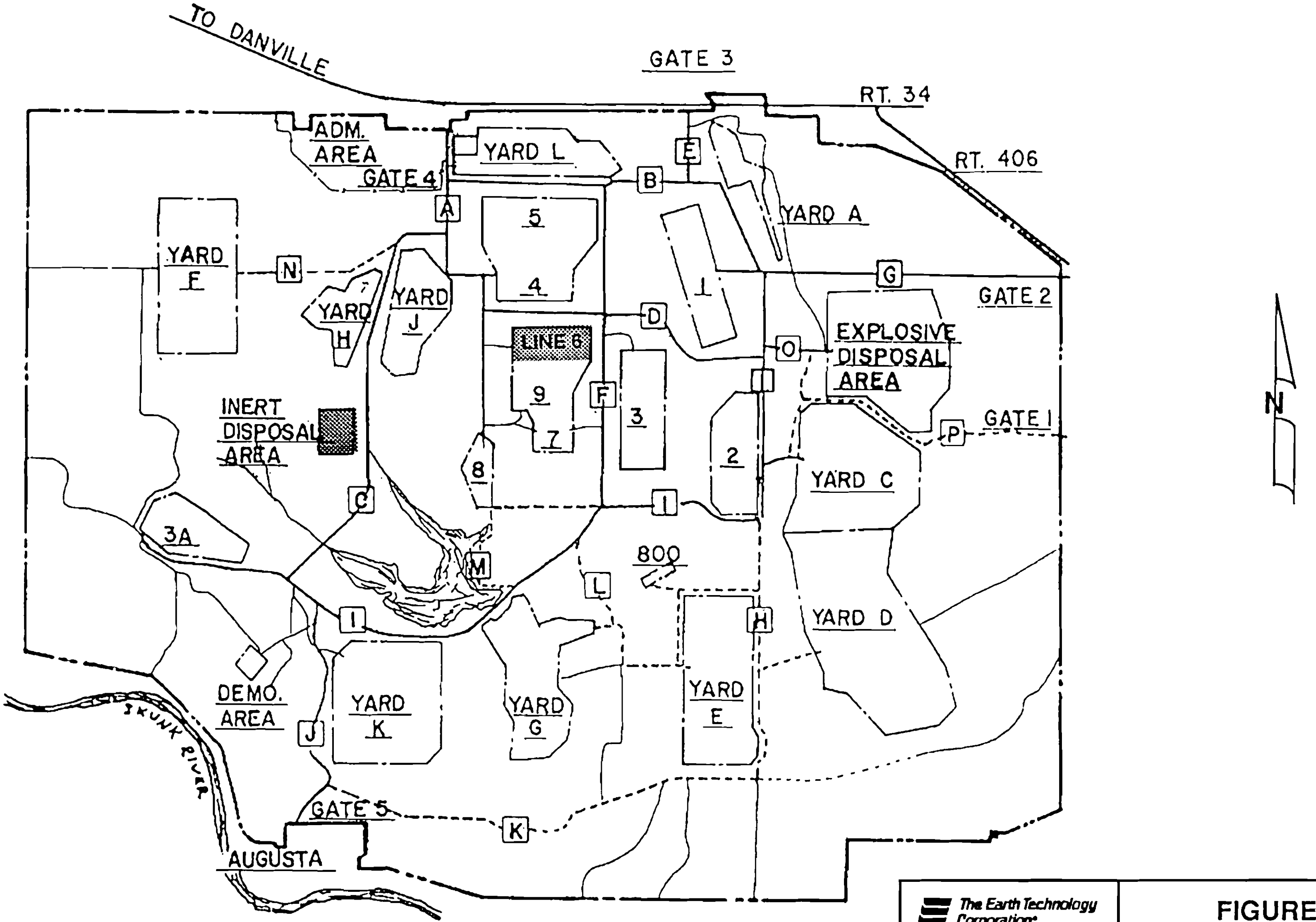

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FIGURE 1-1

IAAP FACILITY MAP

TABLE 1-1
FIELD PROGRAM

Field Activities	Trench 5	Line 6
Number of Boreholes (1)	3	0
Maximum Depth of Boreholes	50 feet	0
Maximum Number of Soil Samples for Laboratory Analysis	33	0
Frequency of Soil Sampling (Rounds)	1	0
Number of Monitoring Wells	6	0
Maximum Number of Ground Water Samples for Laboratory Analysis	30	45
Frequency of Ground Water Sampling (Rounds)	5	5
Type and Number of Field QC Samples	Trip Blanks 1 Per Shipment of VOC Bottles	
	Field Blanks 1 Per Round	
	Rinseate Blanks 1 Per Analysis Per Round	
	Duplicate Samples 5% of All Field Samples	

(1) All boreholes will be converted into monitoring wells.

- Metals (Arsenic, Barium, Cadmium, Chromium, Silver, Mercury)
- Sulfate
- Nitrate
- pH

The three boreholes drilled at the Ash Disposal Cell in Trench 5, will be completed as monitoring wells in the shallow aquifer at the unit. Five rounds of groundwater samples will be collected during the assessment from each of these new shallow downgradient monitoring wells, as well as from three existing shallow monitoring wells (T-1, T-2, T-3, and G-4) at the Ash Disposal Cell in Trench 5. Groundwater samples collected from the monitoring wells at the Ash Disposal Cell in Trench 5 will be analyzed by an USAEC-approved laboratory for the following parameters:

- Coliform Bacteria
- TCL VOCs
- Total Organic Halogens (TOX)
- Total Organic Carbon (TOC)
- SVOCs
- Explosives (2,4,6-TNT; 2,4-DNT; 2,6-DNT; Tetryl, RDX, HMX)
- TCL Pesticides/PCBs
- 2,4-D
- 2,4,5-TP Silvex
- Phenols (Total)
- Fluoride
- Chloride
- Sulfate
- Nitrate
- Ammonia
- Total Metals (Arsenic, Barium, Cadmium, Chromium, Iron, Lead, Manganese, Mercury, Selenium, Silver, Sodium)
- Dissolved Metals (Arsenic, Barium, Cadmium, Chromium, Iron, Lead, Manganese, Mercury, Selenium, Silver, Sodium)
- Gross Alpha
- Gross Beta
- Radium
- Temperature
- pH
- Specific Conductance

1.3.2 LINE 6

Five rounds of groundwater samples will be collected during the assessment from nine existing shallow monitoring wells (T-10, T-13, T-16, T-19, T-22, T-25, T-28, T-31, T-34) completed in the shallow aquifer at Line 6. Groundwater samples will be analyzed by an USAEC-approved laboratory for the following parameters:

- TOX
- TOC
- Explosives (RDX, Tetrazene)
- Total Metals (Antimony, Barium, Lead, Mercury, Sodium)
- Dissolved Metals (Antimony, Barium, Lead, Mercury, Sodium)
- Total Cyanide
- Sulfate
- Nitrate
- Ammonia
- pH
- Temperature
- Specific Conductance

1.4 SCHEDULE

Figure 1-2 presents the overall project schedule. This schedule outlines tentative dates for soil sampling and monitoring well installation/development, and five rounds of groundwater sampling. It also includes tentative dates for all assessment deliverables.

1.5 PERSONNEL ORGANIZATION AND RESPONSIBILITY

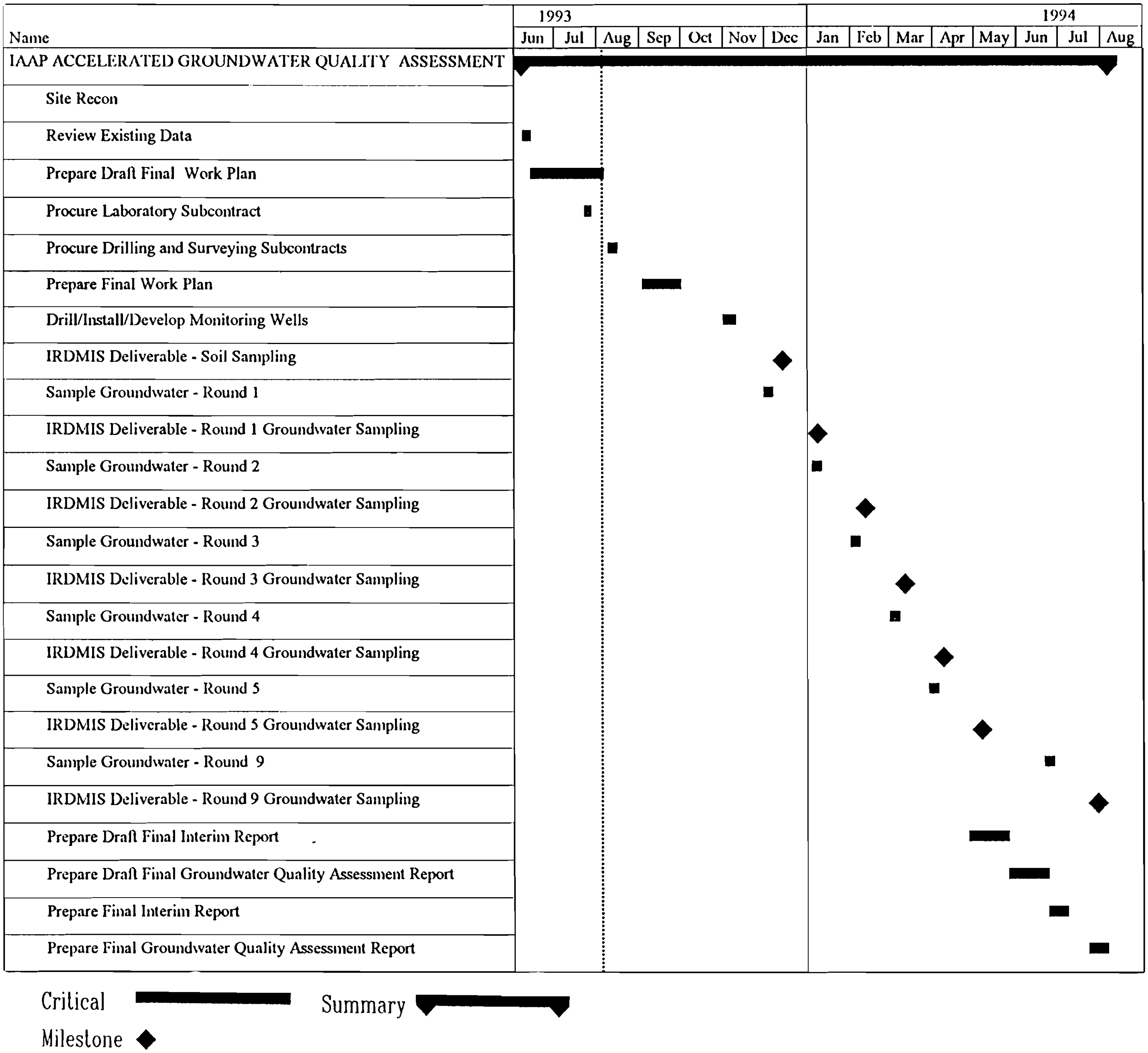
The organization and responsibilities of all personnel involved with the Accelerated Groundwater Quality Assessment of the Ash Disposal Cell in Trench 5 and at Line 6 are discussed in the following sections.

USAEC REPRESENTATIVE

Derek Romitti is the USAEC Project Manager assigned to the IAAP. As USAEC Project Manager, Mr. Romitti is responsible for the overall direction, coordination, and consistency of the accelerated groundwater quality assessment. Mr. Romitti is also responsible for coordination with the USEPA for this assessment.

The Earth Technology Corporation (TETC) Project Personnel: TETC has assembled a project team who will complete the activities identified in Contract DAAA15-91-D-0009, Delivery Order 9. The members of TETC project team and their relationships are presented in Figure 1-3. Project responsibilities for key personnel are described below.

Program Manager: Mr. Thomas Hastings is TETC Program Manager for USAEC Contract Number DAAA 15-91-D-00009 that includes the Accelerated Groundwater Quality Assessment at the IAAP. As Program Manager, Mr. Hastings is responsible for the overall direction, coordination, and technical consistency of the program. He is also responsible for contract compliance and for review and approval of all contract changes and resource allocations for this overall assessment.



Delivery Order No. 9
DAAA15-91-D-0009
Project No. 931978

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FIGURE 1-2

SCHEDULE

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Organizational Structure
Iowa Army Ammunition Plant - Accelerated Ground Water Quality Assessment

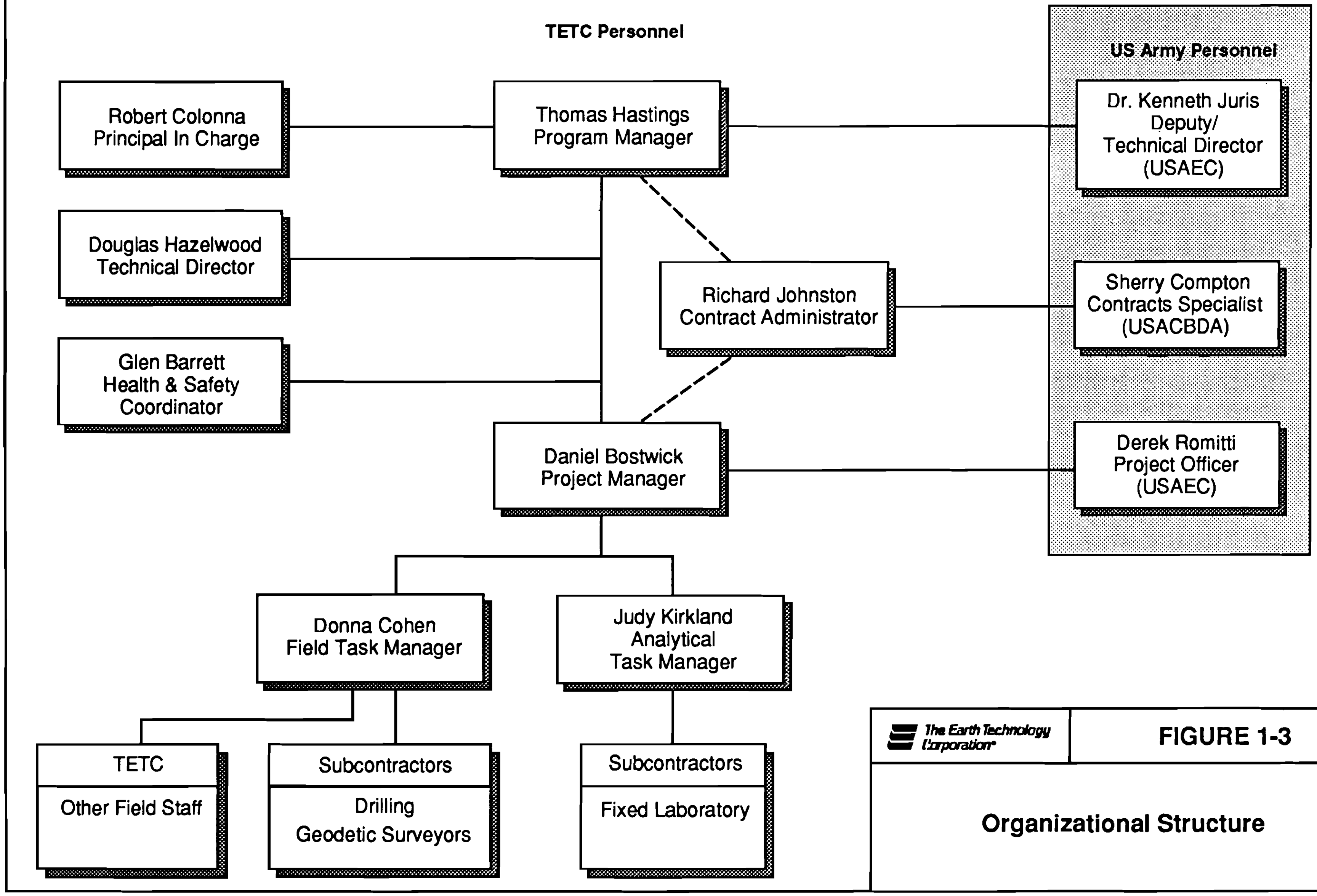

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FIGURE 1-3

Organizational Structure

Technical Director: Mr. Douglas Hazelwood is TETC Technical Director for the Accelerated Groundwater Quality Assessment at the IAAP. In this capacity, Mr. Hazelwood will provide technical review of all project plans and deliverables. He will also consult with the Program and Project Managers to resolve issues pertaining to data quality or the quality of the reports produced for this assessment.

Health and Safety Coordinator: Mr. Glen Barrett is TETC Health and Safety Officer for the Accelerated Groundwater Quality Assessment at the IAAP. He is responsible for establishing and administering an effective health and safety program that is consistent with company policy, appropriate regulations, and accepted health and safety standards. Mr. Barrett is also responsible for ensuring that all personnel working on the Accelerated Groundwater Quality Assessment at the IAAP have 40-hour health and safety training, in accordance with 29 Code of Federal Regulation (CFR) 1910.120. The Health and Safety Officer, in conjunction with the Project Manager, will select a site safety coordinator who will be responsible for daily health and safety briefings for all field personnel.

Project Manager: Mr. Daniel Bostwick is TETC Project Manager for the Accelerated Groundwater Quality Assessment at the IAAP. His responsibilities include but are not limited to:

- Coordinating management, field teams, and support personnel.
- Reviewing and approving monitoring well locations, sample collection procedures, and field data recording procedures.
- Implementing corrective actions as specified in this work plan.
- Providing technical direction during all phases of the assessment.

The resumes of key TETC personnel who will be members of the IAAP Accelerated Groundwater Quality Assessment project team are presented in Appendix A.

1.6 SITE BACKGROUND

1.6.1 FACILITY DESCRIPTION

The IAAP is a government-owned, contractor-operated facility. It is operated and maintained by Mason & Hanger-Silas Mason, Co., Inc. under the direct supervision of the U.S. Army. It is located near the town of Middletown, Iowa in Des Moines County approximately 10 miles west of the Mississippi River. The IAAP is a secured, 19,127-acre facility located in a rural setting; approximately 7,751 acres are dedicated for agricultural production. The IAAP is located in the Danville and Burlington 7 1/2 Minute United States Geological Survey Quadrangles. Figure 1-4 is a location map that shows the IAAP relative to southeastern Iowa.

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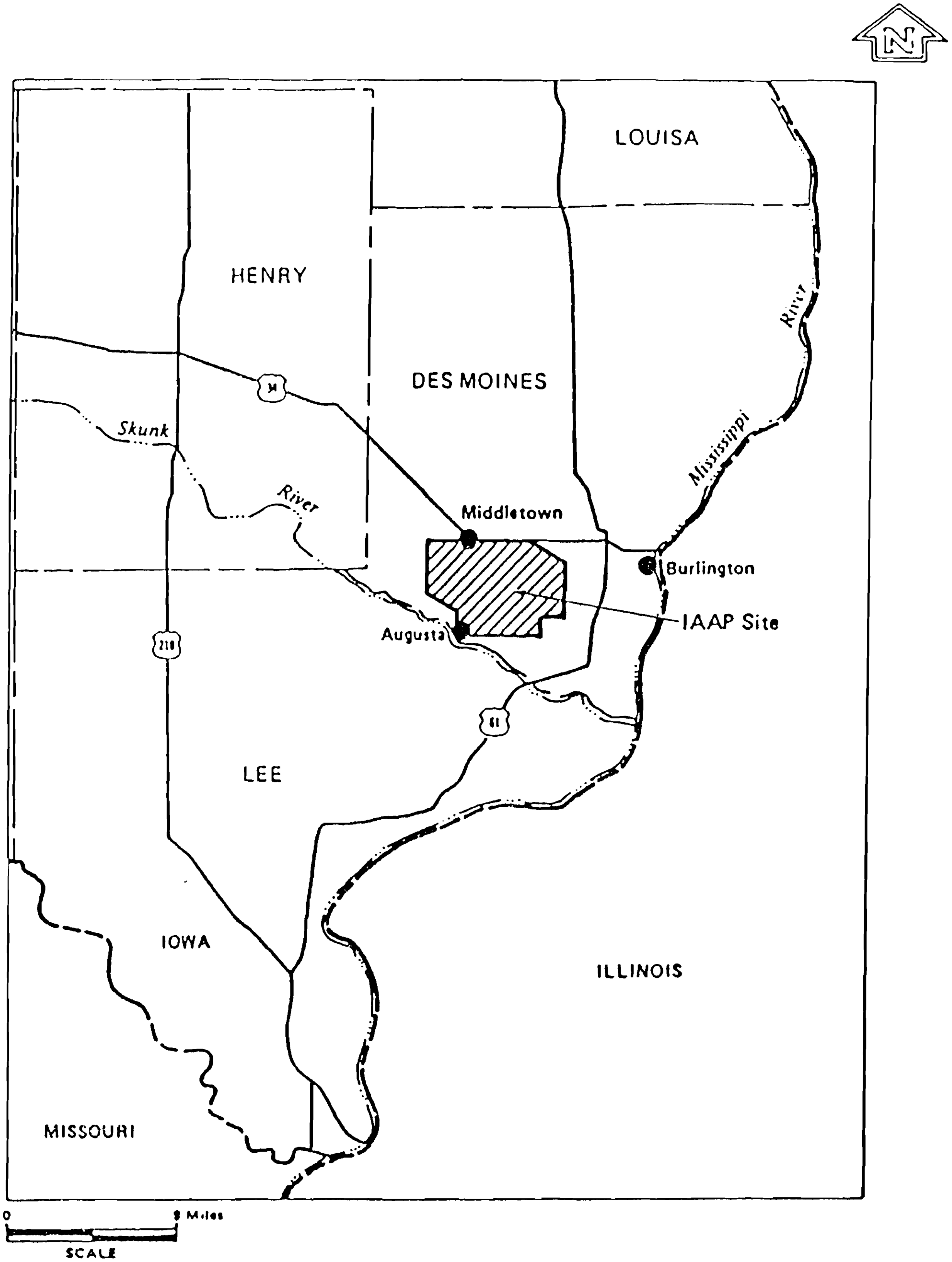

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FIGURE 1-4

Location of Iowa Army Ammunition Plant
Middletown, Des Moines County, Iowa

1.6.2 IAAP History

The IAAP began operations in 1941. Since that time, it has undergone modernization and expansion. World War II supplies were produced at the plant between September 1941 and August 1945. Production of war supplies was resumed at the plant in 1949 and has continued to the present. In the 1960s and early 1970s, the IAAP produced supplies for wars in southeast Asia. During peacetime, production at the plant continued at a reduced level.

In addition to war supplies, nitrogen fertilizer was produced at one of the IAAP lines from 1946 to 1950. Also, the former Atomic Energy Commission operated facilities on the site from 1947 through 1973 (Ecology and Environment, Inc. (E&E), 1987).

The IAAP is currently operating to load, assemble, and pack ammunition items, including projectiles, mortar rounds, warheads, demolition charges, anti-tank mines, anti-personnel mines, and the components of these munitions, including primers, detonators, fuses, and boosters. The loading, assembling, and packing operations use explosive material and lead-based initiating compounds.

1.6.3 Unit Descriptions

1.6.3.1 The Ash Disposal Cell in Trench 5

Site Description: The Ash Disposal Cell in Trench 5 is located at the IDA near the center of the IAAP. Figure 1-5 depicts monitoring wells completed in the shallow aquifer at the Ash Disposal Cell in Trench 5 and proposed locations of monitoring wells to be placed during this assessment, downgradient of the Ash Disposal Cell in Trench 5. The IDA has generally been used for disposal of sanitary wastes such as plastic, tin cans, scrap lumber, waxed cardboard, and household and cafeteria waste. From November 1980 until October 1983, a portion of the Ash Disposal Cell in Trench 5 also received ash from the (1) open burning of explosive-contaminated waste, (2) Explosive Waste Incinerator (EWI), and (3) Contaminated Waste Processor (CWP). When tested, the ash proved to be a RCRA hazardous waste and the disposal of the ash was discontinued at the unit. The unit was closed in 1989 in accordance with standard IAAP procedures for closure of a sanitary landfill, and a network of monitoring wells was installed. The monitoring well network, however, did not fulfill RCRA requirements for closure of the groundwater at the unit.

Past Waste Management Practices: The trench-fill method of landfill operation has been employed at the IDA. In this method, an entire trench is excavated to an approximate depth of 25 feet. Refuse placement begins at the north end of a trench and progresses toward the south. Excavated material is stockpiled next to a trench and used for daily and final cover. A daily cover that is at least six-inches thick is placed over the fill from the stockpiled soil. A final cover that is at least twelve-inches thick is placed over the fill from the stockpiled soil. Materials in the trench are compacted by bulldozers and vehicle travel by trucks working the face of the trench. The final cover slopes to the south (toward natural drainage pathways) at an average grade of two percent. The Ash Disposal Cell in Trench 5 was closed in this manner.

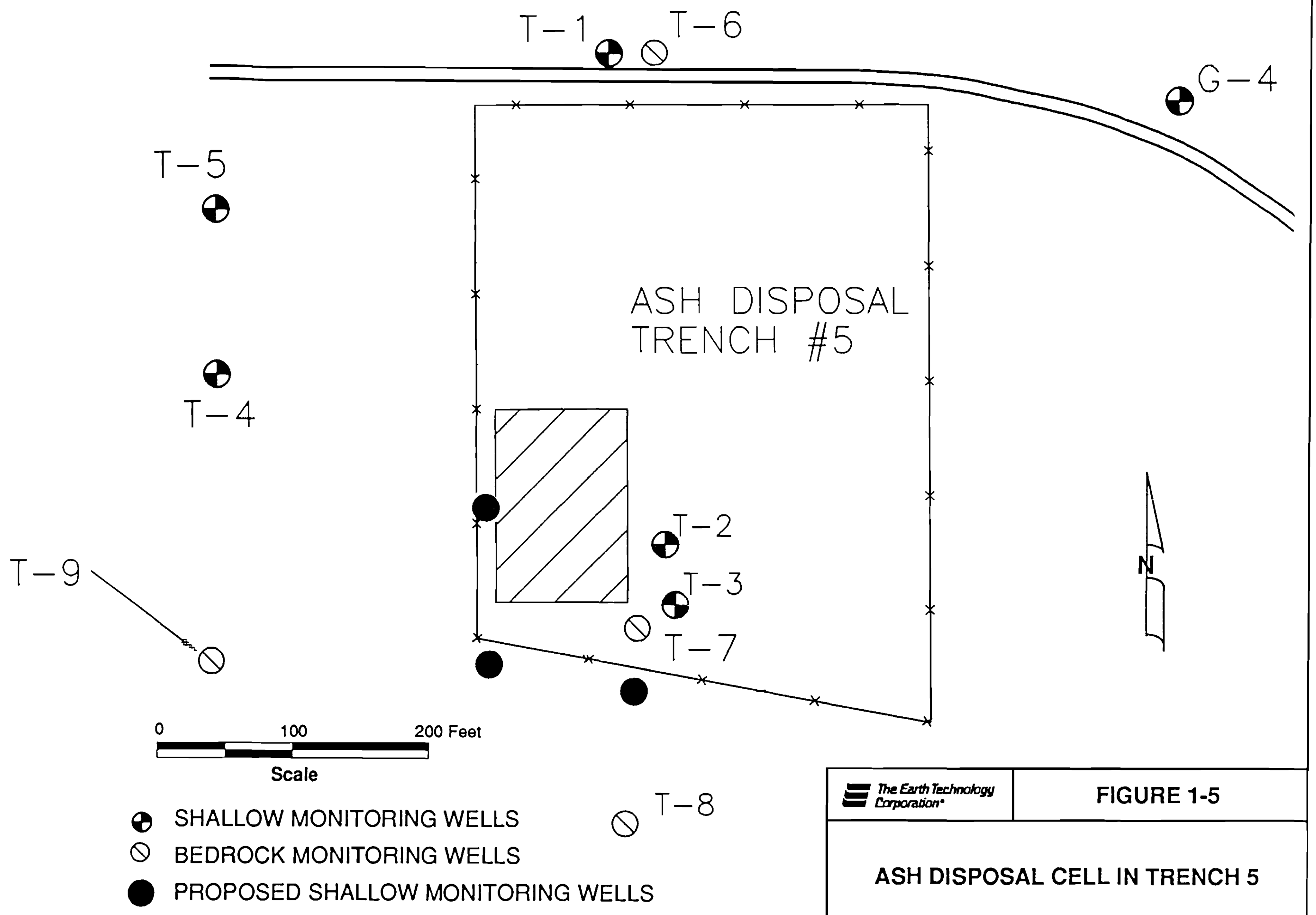

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FIGURE 1-5

ASH DISPOSAL CELL IN TRENCH 5

Known Contamination: Ash from the (1) open burning of explosive-contaminated waste, (2) EWI, and (3) CWP was placed in the Ash Disposal Cell in Trench 5. It is estimated that a maximum volume of 145 barrels of ash were placed in the trench (U.S. Army Corps of Engineers (USACOE), 1988). Assuming the barrels were 55-gallon drums and the ash had a density of 3.0 grams per cubic centimeter (g/cm^3), approximately 91,000 kilograms (kg) of ash was placed in the trench.

The open burning grounds are used to burn damaged or obsolete explosives and flash metals. No analyses of the ash generated at the open burning grounds is available, but soil samples at the open burning grounds have been collected and analyzed during two previous investigations. The first investigation conducted in 1982 by the U.S. Army Environmental Hygiene Agency (USAEHA), detected measurable concentrations of metals below RCRA limits. The second investigation, conducted in August 1986, detected elevated concentrations of barium, chromium, lead, and zinc (E&E, 1986). It is estimated that only small quantities of ash from the open burning grounds were placed in the Ash Disposal Cell in Trench 5.

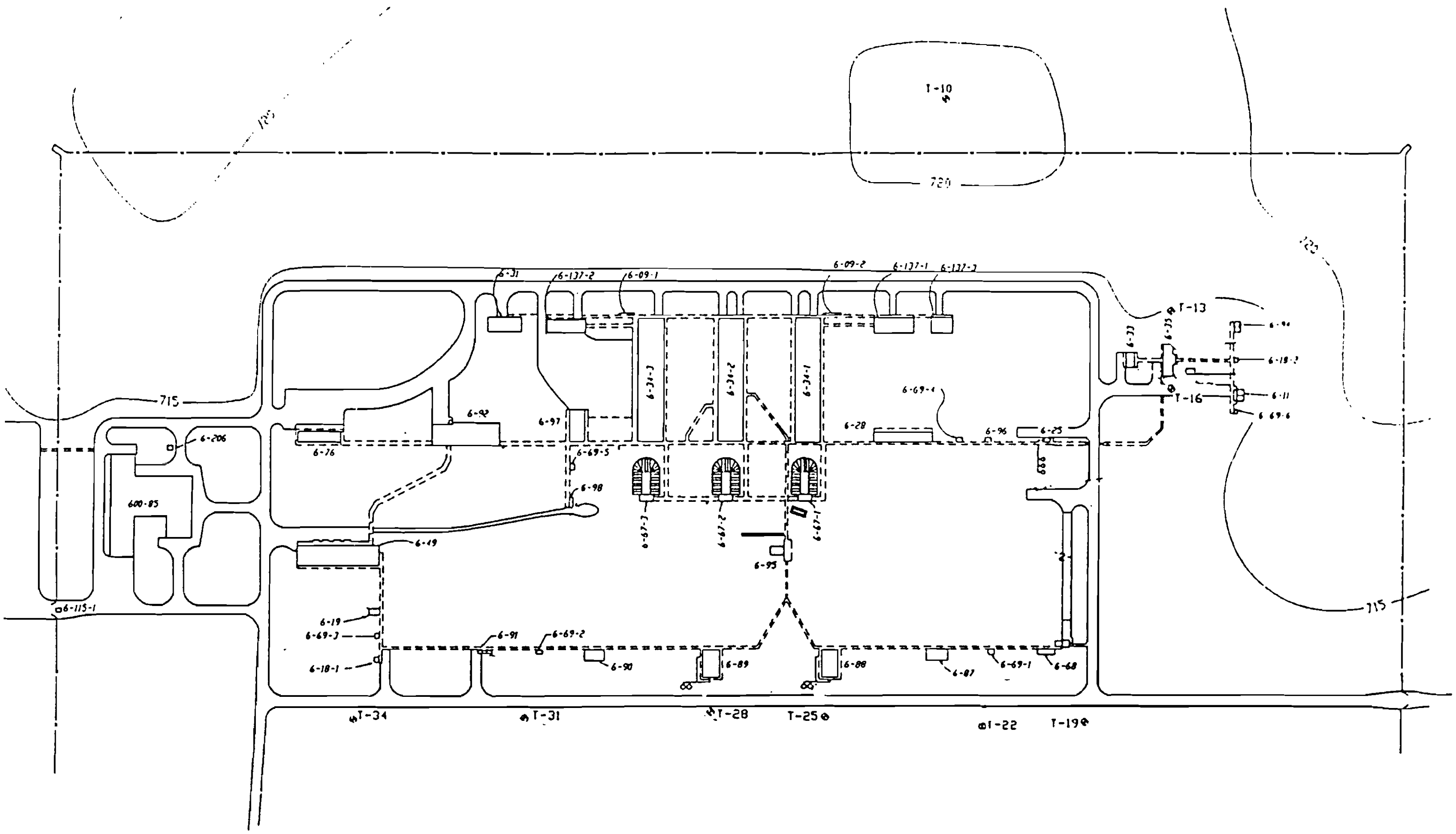
The EWI is used to incinerate bulk scrap explosives from munitions production, explosives-contaminated carbon, and explosives-contaminated diatomaceous earth. Analyses of EWI ash have been sporadically detected cyclotrimethylenetrinitramine (RDX) and trinitrotoluene (TNT). An estimated 95 barrels (USACOE, 1988) or approximately 60,000 kg of the ash in the Ash Disposal Cell in Trench 5 was derived from the EWI.

The CWP is used to burn materials which have come in contact with TNT or other explosives. Materials burned in the CWP include explosive-contaminated cardboard and paper box liners, cardboard and wooden boxes used to ship explosives, and explosives-contaminated pallets. The CWP is also used to flash empty metal projectiles, cartridge cases, and empty metal propellant cans. Analysis of typical CWP ash conducted between June 1985 and March 1987 indicate that ash from the CWP was Extraction Procedure (EP) toxic for barium, cadmium, and lead. An estimated 50 barrels (USACOE, 1988) or approximately 30,000 kg of the ash in the Ash Disposal Cell in Trench 5 was derived from the CWP.

1.6.3.2 Line 6

Site Description: Line 6 is a former detonator production facility that is currently inactive. This unit occupies approximately 30 acres near the center of the IAAP. Figure 1-6 depicts the monitoring wells completed in the shallow aquifer at Line 6. Line 6 is bounded to the north by Lines 1 and 4B, to the east by Line 3, to the south by Line 9, and to the west by the IAAP power plant and Yard J. The facility is approximately 800 feet by 1600 feet and includes approximately 34 buildings that were used in the production, storage, and shipping of detonators, relays, and hand grenade fuses.

Effluent containing explosives and lead wastes from manufacturing operations at Line 6 were placed in stainless steel tanks for desensitization prior to disposal. Desensitized water was later discharged from the tanks and allowed to percolate through limestone filters for pH adjustment before entering adjoining drainage ditches. The limestone filters and the drainage ditches were



LEGEND

ROAD
WALKWAY
FENCE
2-70-2 BUILDING #
BERM (EXPLOSION PROTECTION)
630 TOPOGRAPHIC CONTOUR
CONTOUR INTERVAL = 5 FEET

KEY

⊗ MONITORING WELL

GRAPHIC SCALE
0 100 200 300 400 FEET

N

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FIGURE 1-6

Unit Map - Line 6

subsequently removed and the unit was closed in 1989. An extensive groundwater monitoring network has been installed at the unit.

The USACOE, Omaha District, is conducting an on-going remedial action at Line 6 as part of the approved USEPA Region VII RCRA closure plan. The remedial action includes the removal of tanks, piping, and all contaminated soil associated with the wastewater treatment process. A complete description of closure activities is provided in the Closure Plan for Line 6.

A complete summary of previous investigations at Line 6 and all corresponding analytical results is provided in the IAAP RCRA Facility Assessment (RFA) (E&E, 1987) and the Work Plan for the Phase I Remedial Investigation/Feasibility Study (RI/FS) of the IAAP (Jaycor, 1992). The results of the site investigation (SI) that preceded the Phase I RI/FS are summarized in the Phase I RI/FS Work Plan. They indicate that no explosives were detected above analytical reporting limits at the unit. Several metals, however, were reported above background in soils at Line 6, including barium, chromium, lead, and nickel.

Past Waste Management Practices: Effluent containing explosives and lead wastes from manufacturing operations at Line 6 flowed through stainless steel troughs to twelve cylindrical, stainless steel underground tanks of varying capacities as listed below:

Building Number	Design Capacity (gpd)
6-18	180
6-25	360
6-35	180
6-68	540
6-88	540
6-89	900
6-91	180
Total	**2,880**

When the tanks were filled, the wastewater was chemically desensitized to render explosive constituents nonreactive. The desensitized wastewater was then discharged to limestone filter beds located adjacent to the tanks. The limestone filter beds were used to raise the pH of the desensitized wastewater before it was discharged to the surface water drainage system. The drainage system was monitored downstream from the limestone filter beds pursuant to NPDES Discharge Permit No. 1A-0003689. In addition, the IAAP included the limestone filter beds as part of the wastewater treatment system in its Part A Permit Application in November 1980 achieving interim status. The IAAP discontinued use of these limestone filter beds in May 1981. In 1984, the limestone filter bed at Building 6-88 was sampled and disposed of as hazardous waste. Operations at Line 6 were stopped in 1988.

The USEPA considers the limestone filter beds as land disposal facilities and subject to RCRA regulation. As a result, when the IAAP did not submit a Part B Permit application for these filter beds or certify compliance with applicable groundwater monitoring requirements within 12 months from the date of regulatory amendments (November 8, 1984), the IAAP lost interim status at this unit in accordance with 40 CFR Part 270.10e(5). With the loss of interim status, the Line 6 limestone filter beds were required to be closed pursuant to an approved closure plan.

Production Materials: Contaminants present in the wastewater discharged to the limestone filter beds included production materials used to manufacture detonators and materials used to desensitize the wastewater. Production materials used in the stainless steel underground tanks at Site 6 to desensitize wastewater included:

- Lead azide
- Lead styphnate
- Tetrazene
- RDX
- Barium nitrate
- Antimony sulfide.

Desensitization materials included:

- Acetic acid
- Sodium sulfate
- Sodium nitrate
- Sodium hydroxide.

Known Contamination: In October 1983, soil samples were collected at the discharge points from the limestone filter beds located at Buildings 6-25, 6-68, 6-88, and 6-89. Two of these soil samples were EP toxic for lead.

In August 1984, the limestone filter beds were removed and the excavations were filled and capped with clay. The limestone filter beds were tested for EP toxicity and one filter bed at Building 6-88 was found to be EP toxic for lead.

In August 1986, five soil samples and four sediment samples were collected within the Line 6 area and analyzed. Analytical results showed elevated concentrations of barium, lead, and zinc. Explosives were not detected.

1.6.4 PREVIOUS INVESTIGATIONS

Numerous environmental investigations have been completed at the IAAP. A summary of six pertinent investigations performed at the Ash Disposal Cell in Trench 5 and at Line 6 between 1978 and 1991, taken primarily from the June 1992 Final Work Plan Phase I RI/FS (Jaycor, 1992), is included below. These summaries are arranged chronologically, providing an overview of each investigation as well as conclusions and recommendations.

1.6.4.1 Installation Assessment (1978)

In 1978, an installation assessment of the IAAP was conducted by U.S. Army Toxic and Hazardous Materials Agency (USATHAMA). Included in that assessment were personnel interviews and a review of the records of various government agencies. The purpose of the assessment was to evaluate the use, storage, treatment, and disposal of toxic and hazardous materials at the IAAP, and to define any conditions that may adversely affect public health and welfare, or result in environmental degradation.

The assessment found no evidence of off-site migration of contamination in surface waters. Other pertinent conclusions and recommendations of this assessment are as follows:

- Although the IDA showed no evidence of contamination, there was no information available about the materials buried at the IDA early in World War II.
- Information was needed to resolve the conflict between limited geological data that tended to limit the potential for contaminant migration, and documentation that suggested that contaminant migration has occurred.
- Additional information was needed on the groundwater at the IAAP, especially near (1) potential sources of contamination and (2) the boundaries of the facility.
- A follow-on survey was recommended to better define contaminants that could migrate off site from the facility.
- It was recommended that the IAAP expand its water quality monitoring program, especially where surface water streams exit the facility.

1.6.4.2 Aerial Color Infrared Photography Interpretation (1979)

In Summer 1979, Rome Research Corporation performed an aerial infrared photography study of the IAAP in an attempt to locate stressed vegetation that could be attributed to present or past disposal activities. Pertinent to the Accelerated Groundwater Quality Assessment of the Ash Disposal Cell in Trench 5 and at Line 6, no stressed vegetation was identified in those areas.

1.6.4.3 Underground Pollution Investigation (1981)

Between October 1980 and October 1981, an underground pollution investigation was conducted at the IAAP (SCS, 1982) to investigate groundwater quality in the areas surrounding the Line 6 lead azide treatment sumps/limestone filter beds. Four monitoring wells were installed and 14 soil borings were drilled as part of this investigation. Groundwater samples were collected at the study areas. Sediment and effluent samples were also collected from the treatment sumps at Line 6. These samples were analyzed for RCRA hazardous waste criteria: ignitability, corrositivity, reactivity, and EP toxicity. The investigation produced the following pertinent conclusions and recommendations:

- Shallow groundwater contamination has not occurred in the vicinity of Line 6 treatment sumps/limestone filter beds. Based on this, contamination of water supply aquifers at these locations was not likely. There is, however, a potential for surface water contamination at the treatment sumps/limestone filter beds. As a result, surface soil samples should be taken in the drainageways downgradient from the treatment sumps/limestone filter beds and any potential migration pathways should be identified.

- Soil samples should be collected from the Line 6 treatment sumps/limestone filter beds to investigate the potential for heavy metals contamination in soils surrounding the limestone filter beds.

1.6.4.4 RCRA Facility Assessment (1986)

In 1986, an RFA was conducted at the IAAP (E&E, 1987). During the RFA, limited sampling was performed at USEPA-selected sites which were either active or former hazardous waste treatment, storage, or disposal facilities. Line 6 was sampled during this assessment. The results of the sampling at Line 6 were as follows:

- Soil and sediment samples contained elevated concentrations of barium, lead and zinc. High metals concentrations were found upgradient and downgradient of the unit.
- Groundwater samples at Line 6 contained elevated levels of heavy metals.

The following pertinent conclusions and recommendations were among the results of the RFA:

- High concentrations of heavy metals at Line 6, particularly barium, present the largest potential problem. The source of the barium has not been identified. High concentrations upgradient of potential source areas suggests that there may be multiple pathways, which are not necessarily related to groundwater flow.
- The lack of a comprehensive set of soil, surface water and groundwater samples makes an evaluation of contaminant migration impossible.
- Additional sampling at Line 6 (soil, sediment, groundwater and the IDA (sediment, groundwater) is recommended to evaluate past or present releases at these units.

1.6.4.5 Groundwater Quality Assessment (1988)

In 1988, groundwater quality assessments were conducted at the Ash Disposal Cell in Trench 5 and at Line 6 as part of the closure plan for those units (Terracon, 1989). Nine monitoring wells were installed at the Ash Disposal Cell in Trench 5 and 27 monitoring wells were installed at Line 6 (nine clusters of three monitoring wells each). In addition to the groundwater quality assessments, soil properties and aquifer characteristics were determined for the two RCRA units.

It was recommended in the results of the groundwater quality assessment that additional sampling be performed at the Ash Disposal Cell in Trench 5. This additional sampling would involve:

(1) installing and sampling shallow groundwater monitoring wells downgradient of the unit, (2) resampling three monitoring wells upgradient of the Ash Disposal Cell in Trench 5 where synthetic organic compounds were detected during the assessment, (3) and collecting soil samples for vertical permeability analysis. It was also recommended that bedrock monitoring well T30 at Line 6 be resampled and analyzed for cyanide because it was detected in that monitoring well during the assessment.

1.6.4.6 Site Investigation (1991)

In September 1990, USEPA and the U.S. Department of the Army signed a Federal Facility Agreement (FFA) under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Section 120 for the IAAP. The FFA, recognizing the recommendations and conclusions of previous environmental investigations, called for a facility-wide RI/FS to (1) determine if any release of hazardous substances at the IAAP is a threat to human health and the environment and (2) identify, evaluate, and select alternatives for remedial action to mitigate any threats to human health and the environment. The facility-wide RI/FS is currently being performed.

Prior to the RI/FS, Preliminary Assessments were conducted on 43 sites at the IAAP, 30 of which are RCRA solid waste management units (SWMUs). The Preliminary Assessments recommended that SIs be conducted at 42 of the 43 sites to determine whether or not an RI/FS is necessary for those sites.

SIs were conducted in August 1991. The objectives of the SIs were to (1) collect the data necessary to determine whether environmental contamination was present at particular sites; (2) identify and quantify any soil, sediment, groundwater or surface water contamination; and (3) evaluate the potential for contaminant migration. Together, this information was evaluated to determine which SWMUs would be recommended for the follow-on RI/FS.

SI activities included the collection of environmental samples from the IDA and Line 6. Sixteen environmental samples including: two surface soil samples, five hand-augered, subsurface soil samples, three surface water samples, and four sediment samples were collected from the IDA and analyzed for VOCs, SVOCs, explosives, and metals. The analytical results from these samples are summarized in Table 3-20 of the Work Plan for the Phase I RI/FS of the IAAP (Jaycor, 1992). Table 3-20a of the Phase I Work Plan presents those analytical results that were above evaluation criteria.

Twelve hand-augered subsurface soil samples and one groundwater sample were collected from Line 6 and analyzed for explosives and metals. The analytical results are summarized on Table 3-9 of the Work Plan for the Phase I RI/FS of the IAAP (Jaycor, 1992). Table 3-9a of the Phase I Work Plan presents those analytical results that were above evaluation criteria.

1.7 ENVIRONMENTAL SETTING

1.7.1 POPULATION

The IAAP is located in a rural area of southeastern Iowa in Des Moines County. The 1990 U.S. Census reports that Des Moines County has a population of approximately 42,614 persons. Greater than 60 percent of the county's total population (27,208 persons) lives in Burlington, the county seat. West Burlington has a population of 3,371 persons. Middletown, near the IAAP, has a population of 387 persons. Augusta, an unincorporated town south of the IAAP, has a population of 50 persons.

1.7.2 LAND USE

Des Moines County has an area of 261,760 acres (409 square miles) of land. Croplands comprise approximately 60 percent of the county. The remaining county land is divided approximately between urban use (10 percent); pasture land (eight percent); and woodland, wasteland, or idle land (22 percent). The principle farming enterprises are (1) growing soybeans and corn for grain and seed and (2) raising cattle and hogs.

The IAAP encompasses an area of 19,127 acres (30 square miles) of land. Approximately 7,500 acres of the land is forested, 7,751 acres are leased for agricultural use, and the remaining area is used for administrative and industrial operations. Approximately 20 houses located on the facility have been used for housing contract personnel and their families.

1.7.3 CULTURAL FEATURES

There are several recreational facilities located on the IAAP property and in the area immediately surrounding the IAAP. Mathes Lake (also called Long Lake) is located on IAAP property. On the water front at Mathes Lake, where Long Creek feeds into the lake, there is a small Boy Scouts of America campsite. There is also a boat ramp on the east shore of the lake that is used mainly by fishermen.

Two cemeteries are located on IAAP property: Spring Creek Cemetery is located on the west side of the facility, just east of Yard C; and Shilo Cemetery is located on the southwest side of the facility, south of Yard D.

There is a large deer population on IAAP property and in the area immediately surrounding the IAAP. Hunting is regulated at the IAAP through the use of permits.

South of the IAAP is the Skunk River (Figure 1-1). It has two boat launch access areas and one small park located on its banks, most of which are located in the town of Augusta. The Upper Augusta Access Area is located southwest of the IAAP, and the Lower Augusta Access Area is located south of the IAAP. Welter County Park is located adjacent to the Lower Augusta Access Area. The Skunk River is utilized for all types of recreation, including boating, skiing, swimming and fishing.

Several schools are located within a mile of the IAAP. Directly east of the facility are three schools: Southeastern Community College at Burlington, Buena Vista School, and Brush College School. Long Creek Church, west of the facility, is the only church near the IAAP.

There are three quarries located near the IAAP. The first is located on the west side of the facility. It is fairly large, with groundwater intercepting the low point of the quarry. The second quarry is smaller and located just outside the facility at the south entrance. No water is shown at this quarry on the USGS quadrangle map. The third quarry is located southeast of the facility. It is a relatively small quarry with a small area that is covered by water.

Approximately 3 miles west of the IAAP, in Henry County, is Geode State Park. The park is named for the geode - a hollow stone partially filled by inward projecting crystals. Lake Geode, located within the park area, is popular for fishing, boating, and swimming.

1.7.4 GEOLOGY AND HYDROGEOLOGY

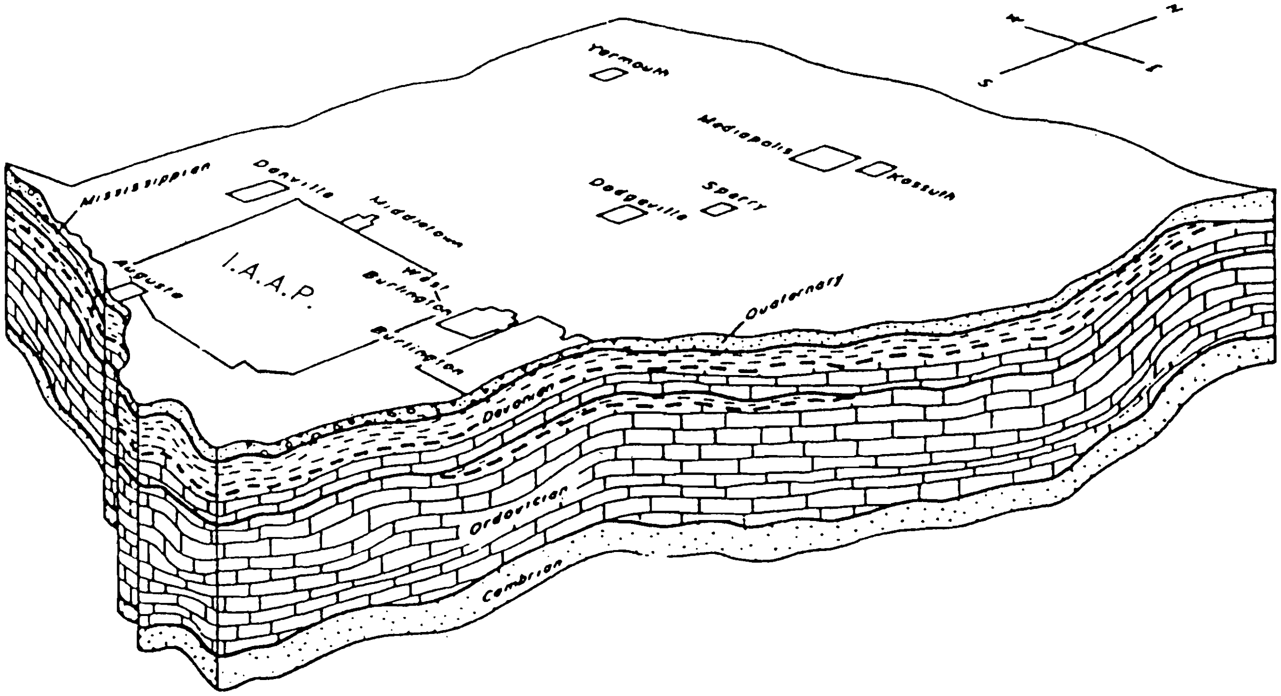
1.7.4.1 Regional Geology and Hydrogeology

Southeastern Iowa is within the Southern Iowa Till Plain Section of the Central Lowland Physiographic Province. The regional stratigraphy typically includes Pleistocene loess and till deposits overlying Paleozoic bedrock. Locally, the Pleistocene deposits are mantled by Recent alluvial deposits. Bedrock ranges from Cambrian to Pennsylvanian in age and consists entirely of sedimentary rocks. Figure 1-7 is a block diagram that illustrates these stratigraphic relationships.

The loess consists chiefly of windblown silt deposits derived from outwash plains, other unconsolidated deposits, or materials eroded from bedrock during glaciation. Loess deposits in the vicinity of the IAAP generally range from 2 to 6 feet thick (Jaycor, 1992). Loess deposits on the nearly level divides in this area range from 8 to 10 feet thick. The loess was deposited during the Wisconsinan glacial stage.

Glacial till underlies the loess. Till is an unsorted, unstratified, heterogeneous mixture of clay, silt, sand, and gravel deposited directly by a glacier without reworking by glacial meltwater or wind. The uppermost till in the vicinity of the IAAP is the Kellerville Till Member of the Glasford Formation, which was deposited during the Illinoisan glacial stage. Underlying the Kellerville is the pre-Illinoisan Wolf Creek Formation. The Wolf Creek is subdivided into three till members that include in descending chronological order, the Hickory Hill Till Member, Aurora Till Member, and Winthrop Till Member. In some locations, the pre-Illinoisan Alburnett Formation underlies the Wolf Creek.

All the till deposits are typically loam-textured with slight variation between members. The Wolf Creek also includes a number of unnamed, undifferentiated sediments that range from alluvial silts, sands, and gravels to local fine-grained swale-fill deposits and peats. The pre-Illinoisan tills are typically separated by buried soils or paleosols. The till section at the IAAP ranges up to 140 feet thick.



KEY

- ⁘ Glacial Drift
- ⁚ Sand/Sandstone
- ☰ Shale
- ▦ Limestone/Dolostone

APPROXIMATE HORIZONTAL
SCALE 1" = 30,000'

Source: Jaycor

The Earth Technology Corporation

FIGURE 1-7

Block Diagram Showing the Geology of Des Moines County

Bedrock underlying the glacial deposits is a sequence of interbedded shales, sandstones, limestones, and dolomites. The sequence is nearly 2000-feet thick and is typified by alternating intervals of relatively high and low permeability rock. Bedrock dips gently to the southwest. Localized folding in the bedrock, however, has been reported (USAEHA, 1985).

There are four principal aquifers in Des Moines County (IGS Open File Report). These include a surficial aquifer in unconsolidated Recent and Pleistocene sediments and three bedrock aquifers, one each in the Mississippian-, Devonian-, and Cambro-Ordovician sections.

The surficial aquifer at the IAAP occurs at relatively shallow depths in either glacial or alluvial deposits. It is typically perched and discontinuous. The alluvial deposits consist mainly of sands and gravels that were apparently deposited by streams. Deposits of this type are typically found within floodplains and terraces in major valleys. Similar alluvial aquifers are described in An Overview of Groundwater Quality in the Skunk River Basin. IGS Open File Report 87-3.

The loess and till deposits vary considerably in composition and, therefore, in water-bearing capacity. Generally, they are relatively impermeable materials. Typical hydraulic conductivities for the two deposits in southeastern Iowa, as estimated by the Iowa Geological Survey, are 7.3xE-06 cm/sec and 6.3 x E-09 cm/sec, respectively (USAEHA, 1985). These low hydraulic conductivities result in the loess and till being a somewhat impermeable barrier to the vertical migration of shallow groundwater.

Topography strongly controls lateral groundwater flow directions in the surficial aquifer (USAEHA, 1985 and Battelle, 1984). In general, groundwater lines are toward creeks, consistent with surface drainage patterns, and a subdued reflection of the local topography.

The Mississippian Warsaw Formation aquifer is the uppermost bedrock aquifer (Battelle, 1984). The Warsaw aquifer is composed primarily of limestone and dolomite and ranges up to 300 feet thick. The formation underlies approximately one-half of Des Moines County. Groundwater in the Warsaw flows through zones of secondary porosity, such as fractures and bedding planes. In parts of southeastern Iowa, discontinuous Pennsylvanian shales overlie the Warsaw and act as an aquitard between the Warsaw and surficial aquifers.

The shales of the Kinderhook and Maple Mill Formations separate the Mississippian Warsaw Formation aquifer from the underlying Devonian aquifer. The Devonian aquifer is within the Cedar Valley Limestone, shaley and carbonate-rich Wapsipinicon Formation, and undifferentiated dolomite. It ranges from 125 to 350 feet thick.

The dolomites and shales of the Maquoketa and Galena Formations separate the Devonian and underlying Cambro-Ordovician aquifers. The Cambro-Ordovician aquifer is within the dolomites of the Prairie du Chien and St. Lawrence Formations and sandstones of the St. Peter and Jordan Formations. It ranges from 900 to 1000 feet thick.

1.7.4.2 Site-Specific Geology and Hydrogeology

The geology at the IAAP is typical of southeastern Iowa, and includes the above mentioned alluvium, loess, and till deposits overlying bedrock. The alluvial deposits are discontinuous and generally less than 50 to 60 feet thick. The loess deposits ranges from 2 feet thick on the west side of the facility to 6 feet thick on the east. The thickness of the till varies considerably across the facility, varying from 12 feet thick on the southwest side of the facility to 85 to 140 feet thick on the north. Stream erosion has removed the till in some valleys, where the streams are now incised into the underlying bedrock. This is common on the south side of the facility.

The bedrock underlying the IAAP consists largely of Mississippian to Cambro-Ordovician carbonate rocks that are interbedded with shales and sandstones of varying thickness (Harris et al. 1964). Pennsylvanian shales are present locally (Jaycor, 1992). Bedrock at the IAAP generally strikes northwest-southeast and dips gently northeast; this contrasts with the regional southwest dip. Bedrock encountered during the drilling of bedrock monitoring wells at the IAAP includes the Mississippian Keokuk Formation and Burlington Limestone. Along with the Warsaw Formation (described above), these formations comprise the Mississippian aquifer in the area.

The Keokuk Formation as encountered at the IAAP is a light gray, cherty limestone that is approximately 70 feet thick. The upper portion of the Keokuk is dolomitic and shaley. There is an approximately 30 foot thick basal interval of alternating gray and blue cherty limestones. Although present beneath the flat upland areas of the IAAP, the Keokuk has not been encountered in valley areas to the south (USAEHA, 1985).

The underlying Burlington Limestone is very pale orange to gray in color. It is estimated to be 70 feet thick at the IAAP. It outcrops at several locations within stream valleys and is the major formation exposed in the Raider Brothers Quarry immediately southwest of the IAAP in Augusta (USAEHA, 1985).

Two of the four regional aquifers have been studied in investigations at the IAAP: the surficial aquifer and the underlying Mississippian aquifer. The water table in the surficial aquifer is quite shallow due to the relatively impermeable nature of the glacial deposits. In addition, the high percentage of clay found in the Kellersville Till impedes downward vertical flow. Measured hydraulic conductivities (from slug testing) in wells at the IAAP range from 2.3 X 10^{-5} cm/sec to 1.04 x 10^{-4} cm/sec indicating that horizontal flow in the loess and till is also quite slow (USAEHA, 1985). Groundwater in the surficial aquifer is often perched, and vertical migration and communication with the underlying bedrock aquifer is absent or very limited.

The Keokuk and Burlington formations are as one hydrogeologic unit and comprise the Mississippian or uppermost bedrock aquifer at the IAAP. Groundwater moves through fractures, or along bedding planes in these rocks, resulting in local differences in flow velocity and direction because the flow direction is partly dependent on the orientation of the fractures transmitting the groundwater. Most studies have concluded that groundwater flow follows the bedrock topography, which slopes to the southeast, reasonably consistent with regional flow patterns. Bedrock beneath the IAAP is reported to dip northeast, however, suggesting that local flow could potentially be to the northeast along bedding planes.

Recharge to the upper bedrock aquifer from precipitation is probably low due to: (1) the relatively low permeability of the materials in the surficial aquifer and (2) the possible presence of impermeable Pennsylvanian shales overlying the aquifer. In the vicinity of the IAAP, the upper bedrock aquifer appears to discharge where it comes in hydraulic contact with surface water (e.g., at the southern portions of creeks). The hydraulic conductivity of the upper bedrock aquifer is estimated to be 2.3×10^{-4} cm/sec (USAEHA, 1985).

1.7.5 TOPOGRAPHY AND SURFACE WATER FEATURES

The IAAP is located in the dissected Southern Iowa Till Plain section of the Central Lowland Physiographic Province. Evidence of continental glaciation, consisting of gently undulating terrain, is exhibited in the northern area of the facility. The central portion of the IAAP is characterized by rolling terrain dissected by a shallow drainage system, while the southern portion of the facility contains drainageways with steep slopes down to the creek beds in those areas (Terracon, 1989). Elevations at the IAAP range from 730 feet above mean sea level (MSL) in the north to 530 feet above MSL in the south (USGS, 1981 and 1964). The IAAP contains four watersheds which are described below.

1.7.5.1 Brush Creek Watershed

Brush Creek drains the central portion of the IAAP. It originates in the northern portion of the facility and flows off the facility at its southeastern boundary. Brush Creek has a drainage area of approximately 4500 acres within the facility at this southeastern boundary. Its floodplain is estimated to be 200 feet wide and is incised approximately 90 feet into bedrock at this location (USGS, 1981 and 1964; USAEHA, 1985). Brush Creek flows into the confluence of the Skunk and Mississippi Rivers approximately nine miles southeast of the facility.

1.7.5.2 Spring Creek Watershed

Spring Creek drains the eastern portion of the IAAP. It originates off the facility property just north of the Burlington Northern Railroad easement and flows off the facility at its southeastern corner. Spring Creek has a drainage area of approximately 3000 acres within the facility boundaries. The creek is intermittent and is seasonally dry within the IAAP. At the southeastern boundary of the facility, the Spring Creek floodplain is approximately 400 feet wide and is incised approximately 90 feet into bedrock at this location (USGS, 1981 and 1964; USAEHA, 1985). Spring Creek flows south-southeast off the facility directly into the Mississippi River.

1.7.5.3 Long Creek Watershed

Long Creek drains the western portion of the IAAP. It originates approximately two miles north of the northwest corner of the facility and flows off the facility at its southwestern boundary. Long Creek has a drainage area of approximately 11,500 acres within the facility boundaries.

This drainageway has been dammed near the center of the facility to create George H. Mathes Lake which encompasses approximately 83 acres. Use of the lake as a water supply for the IAAP was discontinued in January 1977. In addition to George H. Mathes Lake, there is also a smaller lake (Stump Lake) located north of Mathes Lake that encompasses seven acres. It is fed by intermittent streams and drains via intermittent streams into Long Creek.

Long Creek has incised an approximately 500 foot wide channel into bedrock at the southern boundary of the facility. It is incised approximately 120 feet into bedrock at this location. Long Creek joins the Skunk River just south of the IAAP, and Skunk Creek flows into the Mississippi River approximately 9 miles east of the facility (USATHAMA, 1980).

1.7.5.4 Skunk River

The Skunk River is located south of the IAAP. The river flows from northwest to southeast and actually borders the IAAP on its southwest boundary. It is fed by Long Creek and several intermittent streams that originate on the facility. The Skunk River is a medium-sized river that is utilized year-round for recreational purposes. Several boat launches and a park with a swimming area are located in close proximity to the facility. The Skunk River separates Des Moines County from neighboring Lee County to the south.

1.7.6 SOILS

The soils in Des Moines County consist of seven soil associations (USDA, 1979). Each association has a distinctive pattern of soils, relief, and drainage making it a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. The soils making up one association can occur in another, but in a different pattern. Table 1-2 summarizes the soil properties associated with the soil types at the IAAP. Five soil associations are present on the IAAP site. The five soil associations are:

1.7.6.1 Nodaway-Lawson-Klum Association

This association is nearly level, moderately well drained to somewhat poorly drained, loamy and silty soils on bottomland. It is found in narrow to moderately wide valleys of major and minor streams. The soils are formed in loamy and silty alluvium. Slopes generally range from 0 to 2 percent. The Nodaway-Lawson-Klum association is made up of 20 percent Nodaway and similar soils, 14 percent Lawson and similar soils, 10 percent Klum and similar soils, and 56 percent minor soils. This association makes up approximately 7 percent of the county. It is found mainly in the southwestern portion of the IAAP site, along the Skunk River and Long Creek. No figure illustrating this association is available in the soil survey of Des Moines County.

1.7.6.2 Mahaska-Taintor Association

This association is nearly level, somewhat poorly drained to poorly drained, silty soils on uplands. It is found on moderately wide or wide ridgetops characterized by a lack of well defined drainageways. The soils are formed in loess. Slopes range from 0 to 3 percent. The

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TABLE 1-2
SOIL PROPERTIES ASSOCIATED WITH SOIL TYPES AT IAAP

Soil Series	Depth (inches)	Texture		Clay (%)	Soil pH	Depth to Water Table (Feet)[1]
		USCS	USDA			
Lindley	0-11 11-60	CL-ML, CL CL	loam cl,l	18-27 25-35	4.5-7.3 4.5-6.5	>6.0
Givin	0-12 12-42	CL,ML CL,CH	sil sicl,sic	18-26 36-42	5.6-6.0 5.1-6.0	2-3 Apparent[2] Nov-Jul
Ladoga	0-11 11-39	CL,CL-ML CL,CH	sil sicl,sic	18-27 36-42	6.1-7.3 5.1-6.0	>6.0
Clinton	0-12	ML CL,CH	sil sicl,sic	16-26 36-42	5.6-7.3 6.1-7.3	>6.0
Klum	0-8 8-60	SM,ML,SC,CL SM,ML,SC,CL	fsl stratified sil-sl	5-18 5-18	6.1-7.3 6.1-7.3	3-6 Apparent[2]
Nodaway	0-60	CL,CL-ML	sil	18-28	6.1-7.3	3-5 Apparent[2]
Taintor	0-19 19-45	CL,CH CH	sicl sic,sicl	30-36 35-44	5.6-7.3 5.6-6.5	1-2 Apparent[2]
Mahaska	0-22 22-52	CL CH,MH	sicl sicl,sic	20-32 36-42	5.1-7.3 4.5-6.0	2-3 Apparent[2]
Lawson	0-34 34-60	CL,CL-ML CL	sil sicl,sil	10-20 18-30	6.1-7.8 6.1-7.8	1-3 Apparent[2]
Hedrick	0-12 12-45	CL, CL-ML CL, CH	sil sicl	16-27 27-37	5.6-7.3 5.1-6.5	>6.0

Key:

USCS = Unified Soil Classification System
USDA = U.S. Department of Agriculture Soil Conservation Service

[1] As of 10 October 1991

[2] An apparent water table is a thick zone of free water in the soil as indicated by the level of which water stands in an uncased borehole at equilibrium.

Mahaska-Taintor association is made up of about 48 percent Mahaska soils, 42 percent Taintor soils, and 10 percent minor soils. This association makes up approximately 20 percent of the county. It and the Clinton-Lindley Association are the two dominant associations found on the IAAP site. It is found mainly in the northern and central parts of the site.

1.7.6.3 Clinton-Lindley Association

This association is gently sloping to very steep, moderately well drained to well drained, loamy and silty soils on uplands and high stream benches. It is found on the narrow, rounded tops of ridges and on side slopes. It is characterized by a well developed network of drainageways. The soils formed in loess and glacial till. Slopes range from 2 to 40 percent. The Clinton-Lindley association is made up of about 45 percent Clinton soils, 25 percent Lindley soils, and 30 percent minor soils. This association makes up approximately 32 percent of the county. It and the Mahaska-Taintor Association are the two dominant associations found on the IAAP site. It is found mainly in the southern and central parts of the site.

1.7.6.4 Givin-Hedrick-Ladoga Association

This association is nearly level to moderately sloping, somewhat poorly drained to moderately well drained, silty soils on uplands. It is found on moderately wide ridgetops and short, convex or plane side slopes characterized by a well developed network of drainageways in the more sloped areas. The soils formed in loess. Slopes range from 1 to 9 percent. The Givin-Hedrick Ladoga association is made up of about 35 percent Givin soils, 25 percent Hedrick soils, 20 percent Ladoga soils, and 20 percent minor soils. This association makes up approximately 16 percent of the county and is found mainly in the northwest and central areas of the IAAP site.

1.7.6.5 Weller-Pershing-Grundy Association

This association is gently sloping to moderately sloping, moderately well drained to somewhat poorly drained, silty soils on uplands. It is found on narrow ridgetops and convex side slopes characterized by a well developed network of drainageways. The soils formed in loess. Slopes range from 1 to 9 percent. The Weller-Pershing-Grundy association is approximately 32 percent Weller soils, 19 percent Pershing soils, 11 percent Grundy soils, 38 percent minor soils. This association makes up about 3 percent of the county. It is found to be only in the southwest corner of the IAAP site.

1.7.7 METEOROLOGY

Des Moines County is cold in the winter and hot with occasional cool spells in the summer (National Climatic Center, 1979). During the winter, precipitation frequently occurs as snowstorms, and during the warm months it is chiefly rain, often heavy.

In winter, the average temperature is 25°F, and the average daily minimum temperature is 17°F. The lowest temperature on record, which occurred in Burlington in January 1977, is -23°F. In summer, the average daily maximum temperature is 83°F. The highest recorded temperature, which also occurred in Burlington, in July 1966, is 101° F.

The total annual precipitation is about 36 inches. Of this, 23 inches, or about 65 percent, usually falls in April through September. In two years out of ten, the rainfall in April through September is less than 18 inches. The heaviest recorded one-day rainfall is 3.44 inches in 1977. Thunderstorms occur on about 51 days each year, and most occur in the summer.

Average seasonal snowfall is approximately 25 inches. The greatest snow depth is 14 inches. On an average of 34 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is approximately 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 75 percent of the time in the summer and 50 percent of the time in the winter. The prevailing wind is from the south. The highest average windspeed of 12 miles per hour occurs in spring.

Tornadoes and severe thunderstorms occur occasionally. They are usually of local extent and of short duration, and the resulting damage is sparse and in narrow belts. Hail falls at times during the warmer part of the year in scattered small areas.

1.7.8 ECOLOGY

1.7.8.1 Vegetation

Des Moines County is a loess-covered glacial till plain. The soils formed under prairie and forest vegetation. The nearly level and gently sloping soils formed in loess. The native vegetation in these areas is grass. The soils in the steeper areas formed from glacial till. The native vegetation in these areas is trees. The nearly level and gently sloping soils on bottom land along the Mississippi and Skunk rivers formed in alluvium. The native vegetation in these areas is trees. The main types of prairie grasses found in this area are big bluestem and little bluestem prairie grasses. Oak, hickory, ash, elm, and maple are the main types of trees.

The IAAP site vegetation follows the same general rules as listed above; however, there is an approximate total of 13 acres containing 30 ponds and small impoundments that have some wetland vegetation along their shorelines (USACOE, 1989).

1.7.8.2 Wildlife

The IAAP has an abundance of fish and wildlife. Forest, land, fish, and wildlife management plans have been instituted to help maintain the wildlife populations while allowing consumptive and nonconsumptive recreational activities.

Long, Brush, and Spring Creeks and the Skunk River are classified by the State of Iowa as Class B (w) waters. This classification indicates they are warm water suitable for wildlife, fish, aquatic, and semiaquatic life, and secondary water uses. Species surveys in the three creeks indicate an assortment of minnows, darters, and some sucker species in the lower reaches. The upstream reaches are apparently too small to support fish species (USACOE, 1989). To maintain and improve existing fish populations, the U.S. Fish and Wildlife Service performs annual fish population surveys, creel census, data analysis, and habitat improvements throughout the IAAP. Existing fishing facilities on Mathes Lake are limited and extensive development has been deliberately avoided to preserve the quality of the lake. Species found in Mathes Lake include large mouth bass, channel catfish, black crappie, white crappie, walleye, flathead catfish, gizzard shad, bluegill, carp, black bullheads, and green sunfish. Stump Lake, the smaller lake located north of Mathes Lake, was found to contain black bullheads, yellow bullheads, large mouth bass, bluegill, and black crappie. Bluegill, northern pike, and channel catfish have been stocked since a fishkill in 1982 apparently eliminated the bluegill and crappie populations. This fishkill occurred on the upper reaches of a tributary to Long Creek. IDNR investigated the fish kill and determined the cause to be thermal conversion (Baxter, 1992). No tissue data are available.

Wildlife found at the IAAP site includes a large whitetail deer population, fox, gray squirrels, raccoons, woodchucks, coyotes, eastern cottontail rabbits, red fox, mice, moles, pocket gophers, beavers, muskrats, badgers, opossum, and mink. In an attempt to effectively manage the overpopulation of deer, limited hunting seasons have been allowed at the facility. Trapping of fur-bearing mammals is also allowed during limited times of the year.

Numerous bird species inhabit or migrate through the IAAP. Some of the most common species include the American robin, northern cardinal, blue jay, red-headed woodpecker, common crow, common grackle, mourning dove, red-winged blackbird, chipping sparrow, eastern meadowlark, American goldfinch, and turkey. Red-tailed hawks are the most common raptor species present, but bald eagles have been observed flying over the IAAP or feeding on the fish they catch in Mathes Lake. Because of its close proximity to the Mississippi River flyway, a large variety of migrating bird species may also use the IAAP environs. Water fowl commonly seen include mallards, blue-winged teals, goldeneyes, buffleheads, wood ducks, hood mergansers, green-winged teals, northern shovelers, and Canadian geese. Nest boxes have been set up on the site for wood ducks, which are common near on-site ponds and lakes (USACOE, 1989).

According to the U.S. Department of the Interior's Fish and Wildlife Service, no known endangered species reside at the IAAP. However, two federally-listed endangered animals may be found as transient species in the vicinity of the facility. These species are the bald eagle that winters along large rivers such as the Mississippi and Skunk Rivers, and the Indiana bat that has been sighted in adjacent Louisa and Van Buren Counties (USACOE, 1989).

The Iowa Department of Natural Resources has identified two state-listed threatened species that may be found at the IAAP. These species are the orangethroat darter and the yellow trout lily. The orangethroat darter is known to inhabit small headwater streams and was present in Brush and Spring Creeks during a 1987 sampling event. Although no yellow trout lilies have been observed at the IAAP, they are generally found in low woodlands along streams or on low wooded slopes and bluffs (USACOE, 1989).

2.0 DATA COLLECTION QUALITY ASSURANCE PLAN

2.1 INTRODUCTION

This Quality Assurance Plan (QAP) documents all monitoring procedures that will be performed in completing the Accelerated Groundwater Quality Assessment at the Ash Disposal Cell in Trench 5 of the IDA and Line 6 at the IAAP to ensure that all information, data, and resulting decisions are technically sound, statistically valid, and properly documented. Activities associated with the groundwater quality assessment will be implemented in conjunction with protocols set forth in RCRA Permit, USEPA ID No. IA 7213820445; Subtitle C of RCRA (42 USC Sections 6921 through 6939b); and USAEC Contract Number DAAA15-91-D-0009.

2.2 FIELD SAMPLING QUALITY ASSURANCE (QA) OBJECTIVES

The overall objectives of the field sampling portion of this QAP are to collect environmental samples which best characterize soils at the Ash Disposal Cell in Trench 5 and groundwater quality at both the Ash Disposal Cell in Trench 5 and at Line 6, and handle these samples in a manner which ensures their safe, predictable, and timely delivery to a laboratory for analysis. It is the responsibility of the Project Manager and the Field Task Manager to verify that all samples collected at the IAAP comply with field procedures outlined in this QAP.

Field sampling is scheduled to take place in Fall and Winter 1993. The individual sampling events will take place in approximately the following order:

- Determine locations for three new groundwater monitoring wells downgradient of the Ash Disposal Cell in Trench 5,
- Drill and soil sample three boreholes at the downgradient locations at the Ash Disposal Cell in Trench 5,
- Install and develop three new monitoring wells in the boreholes at the Ash Disposal Cell in Trench 5,
- Survey all new monitoring well locations and elevations, and
- Purge and sample groundwater in the new monitoring wells and selected existing monitoring wells during five rounds of groundwater sampling.

2.3 DATA QUALITY OBJECTIVES

Data quality objectives (DQOs) are qualitative and quantitative statements developed by data users to specify the quality of data from field and laboratory data collection activities to support specific decisions or regulatory actions. The DQOs describe what data are needed, why the data

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are needed, and how the data will be used to address the problem being investigated. DQOs also establish numeric limits for the data to allow the data user (or reviewers) to determine whether data collected are of sufficient quality for use in their intended application. DQOs and work plan rationale are also discussed in the QAP Section 2-11.

Qualitative or semiquantitative data collected using field instruments such as total organic vapor analyzers are considered Level I data. It can be used for the following: (1) delineation of contaminated zones, (2) gross determination of contaminants in samples, or (3) health and safety screening. Level I data can also provide information to the laboratory regarding expected concentration ranges in samples.

Quantitative data collected using field instruments designed for in situ measurements such as temperature, specific conductance, and pH meters are considered Level II data. The Level II data collection follows approved analytical procedures that do not require field laboratory support. Level II data can be used for the following: (1) site characterization, (2) evaluation of alternatives, (3) engineering design, and (4) monitoring.

Quantitative data analyzed using USEPA-accepted analytical methods such as those in SW-846, the National Pollution Discharge Elimination System (NPDES), and the Contract Laboratory Program (CLP) that provide low detection limits, a wide range of calibrated analytes, matrix recovery information, laboratory process control information, and known precision and accuracy are considered Level III data. Level III can be used for the following: (1) risk assessment, (2) site characterization, (3) evaluation of alternatives, (4) engineering design, and (5) monitoring during implementation. USEPA analytical levels are summarized in Table 2-1.

The quality of the data collected during this investigation will determine its use. Many factors relate to data quality, and sample collection methods equally as important as analytical methods. Following standardized procedures for both sample collection and analysis reduces sampling and analytical error. In addition, complete chain-of-custody (COC) documentation, and adherence to sample preservation requirements, shipping methods, and holding times further ensures sample integrity. Obtaining valid and comparable data also requires adequate QA/QC procedures and documentation, as well as established detection and control limits. A more detailed explanation of the criteria involved is presented in Section 2.15.

2.4 SITE RECONNAISSANCE, PREPARATION, AND RESTORATION

Field locations of all soil boreholes will be marked with a four-foot wooden stake and will be labeled in accordance with Installation Restoration Data Management Information System (IRDMIS) requirements. The USAEC Project Manager, TETC Project Manager, and the IAAP Point-of-Contact (POC) will approve all final monitoring well locations before drilling is begun. TETC will consult with IAAP personnel to minimize disruption of facility activities.

TABLE 2-1
SUMMARY OF ANALYTICAL LEVELS APPROPRIATE TO DATA USES

Data Uses	Analytical Level	Type of Analysis	Limitations	Data Quality
Gross Determination of Analytes; Health and Safety Screening	Level I	Total organic/inorganic vapor detection using portable instruments Field test kits	Instruments respond to naturally-occurring compounds	If instruments calibrated and data interpreted correctly, can provide indication of contamination
Site Characterization; Evaluation of Alternatives; Monitoring During Implementation	Level II	Variety of organics by GC; inorganics by AA; XRF Tentative ID; analyte-specific Detection limits vary from low ppm to low ppb	Tentative ID Techniques/instruments limited mostly to volatiles, metals	Dependent on QA/QC steps employed Data Typically reported in concentration ranges
Risk Assessment; PRP Determination; Site Characterization; Evaluation of Alternatives; Engineering Design; Monitoring During Implementation	Level III	Organics/inorganics using EPA procedures other than CLP; can be analyte-specific RCRA characteristics tests	Tentative ID in some cases Can provide data of same quality as Level IV, NS	Similar detection limits to CLP Less rigorous QA/QC
Risk Assessment; PRP Determination; Evaluation of Alternatives; Engineering Design	Level IV	HSL organics/inorganics by GC/MS; AA; ICP Low ppb detection limit	Tentative identification of Non-HSL Parameters Some time may be required for validation of packages	Goal is data of known quality Rigorous QA/QC
Risk Assessment; PRP Determination	Level V	Non-conventional parameters Method-specific detection limits Modification of existing methods Appendix 8 parameters	May require method development/modification Mechanism to obtain services requires special lead time	Method-specific

(Modified from Ref: EPA 1987b)

Field activities associated with the assessment will be coordinated with the IAAP POC. In support of the field activities, the IAAP will provide the following support items:

1. Assist TETC in locating underground utilities and issue the necessary permits to TETC for completing monitoring well installation/development.
2. Approve accumulation points on the IAAP where containerized decontamination fluids, drill cuttings, and development/purge water can be stored prior to disposal.
3. Provide TETC with existing engineering plans, drawings, diagrams, aerial photographs, etc., necessary to complete the assessment.
4. Prior to the initiation of field activities, arrange for the following to support TETC field personnel:
    - Personnel identification badges, vehicle passes, and/or entry permits,
    - A secure staging area for storing equipment and supplies,
    - A sufficient potable water supply, and
    - A set of keys for access to existing monitoring wells at the facility that will be used to complete the assessment.

All downhole drilling tools, bits, drill rods, augers, and drilling equipment will be decontaminated within the Equipment Decontamination Area before and after drilling each new monitoring well. Decontamination activities will be recorded on a Decontamination Record form (Figure 2-1).

Emergency equipment (e.g., fire extinguishers, personnel safety equipment, etc.) will be kept in plain view at each location where fieldwork is being conducted. Each work crew will be equipped with a mobile telephone to quickly alert the appropriate facility emergency service should their assistance be required.

It is an objective of the fieldwork to leave the area of investigation essentially as it was before beginning the assessment, except for the physical addition of monitoring wells and guard posts. Unused monitoring well construction materials, stakes, and flagging will be removed from the area around the Ash Disposal Cell in Trench 5 area at the conclusion of monitoring well installation and development. Borehole cuttings from hollow stem auger drilling at the Ash Disposal Cell in Trench 5 will be placed into labeled 55-gallon drums. Drums will be kept at the wellhead pending laboratory results. No disturbance of vegetation, or increases in erosion potential are anticipated as a result of this work. Any necessary restoration will include close coordination with the IAAP POC to ensure that cleanup operations are in accordance with the overall management of the facility.

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Decontamination Record

Project Name ______________________ Project Number ______________
Recorded By ______________________ Site ______________
Date ____________ Time ____________ Checked By ______________
Date ______________
Decontamination after borehole/well/sampling point ______________________

Equipment	Use	Steam/Hot Water	Detergent/Water	Potable Water	Deionized Water	Type II Water	Other Water	Methanol	Hexane	HNO_3 (Dilution)		Equip. Blank No.
Drill rig												
Drill Rods												
Augers												
Soil sampler												
Pump												
(Type)												
Bailer												

Use key : GS - Groundwater Sampling, SS - Soil Sampling, WP - Well Purging

Comments (e.g. initial decon, between which locations, or if last decon for the day)

Form F-1022
9/1/91

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FIGURE 2-1

Decontamination Record

2.5 SOIL SAMPLING

Continuous tube and Shelby tube subsurface soil samples will be collected during the drilling of three boreholes at the Ash Disposal Cell in Trench 5. Drilling will be completed with an all-terrain-vehicle hollow-stem auger drilling rig. A 5-foot long by 3-inch inside diameter (ID) continuous tube sampler will be used for collecting soil samples for chemical analysis. A 3-foot long by 3-inch ID Shelby tube sampler will be used for collecting soil samples for physical parameters. No drilling fluids will be used with these techniques unless heaving sands are encountered during soil sampling or monitoring well installation, in which case potable water may be added. If water must be added, one water sample per monitoring well will be sent to the laboratory for analysis.

2.5.1 DRILLING SUPERVISION

An experienced geologist will supervise monitoring the drilling of boreholes, and installation and development of monitoring wells during the assessment. To document these operations, the site geologist will log samples, record groundwater information, and prepare borehole logs and monitoring well construction diagrams. The site geologist will have the necessary tools and professional equipment in operable condition to efficiently perform these duties. The site geologist will be responsible for only one operating drilling rig.

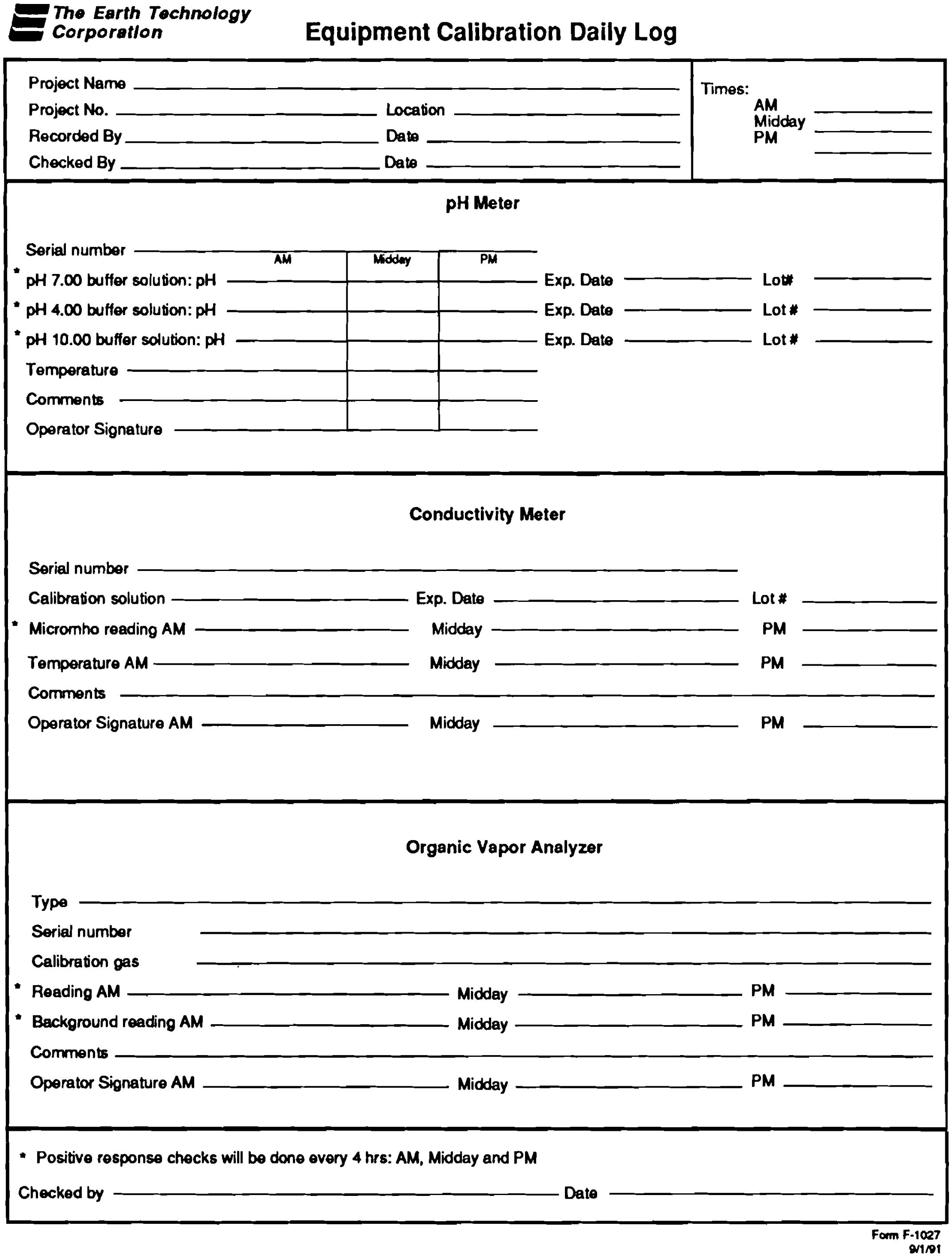
2.5.2 AIR MONITORING DURING DRILLING

Ambient air will be monitored during all borehole drilling, monitoring well installation/development, and soil and groundwater sampling. A photoionization detector (PID) will be used to monitor concentrations of total organic compounds in the breathing space at worker chest level and down the borehole immediately below the ground surface. A combustible gas indicator (CGI) will be used to monitor oxygen and explosivity in the breathing space at worker chest level and down the borehole immediately below the ground surface. Air monitoring concentrations will be recorded in the remarks column on the borehole logs. If ambient air concentrations exceed those specified in the assessment health and safety plan (Section 4), drilling will be stopped and action will be taken according to the health and safety plan.

2.5.3 EQUIPMENT CALIBRATION

The equipment used in collecting field data during the assessment will include a variety of instruments. Proper maintenance, calibration, and operation of each instrument will be the responsibility of the site geologist and other field personnel assigned to the assessment. All instruments used during the assessment will be maintained, calibrated, and operated according to the manufacturers' guidelines and recommendations.

Field instruments will be calibrated prior to use in the field as appropriate. Calibration procedures for the PID and CGI are described below. Copies of the various field instrument manuals will be on file in TETC's field office at the IAAP. A calibration record for these instruments (Figure 2-2) will be maintained in the Equipment Calibration Log by field personnel.



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Equipment Calibration Daily Log

Project Name ____________________
Project No. ____________ Location ____________
Recorded By ____________ Date ____________
Checked By ____________ Date ____________

Times:
AM ________
Midday ________
PM ________

pH Meter

Serial number ____________

	AM	Midday	PM				
* pH 7.00 buffer solution: pH				Exp. Date		Lot#	
* pH 4.00 buffer solution: pH				Exp. Date		Lot #	
* pH 10.00 buffer solution: pH				Exp. Date		Lot #	
Temperature							
Comments							
Operator Signature							

Conductivity Meter

Serial number ____________
Calibration solution ____________ Exp. Date ____________ Lot # ________
* Micromho reading AM ____________ Midday ____________ PM ________
Temperature AM ____________ Midday ____________ PM ________
Comments ____________
Operator Signature AM ____________ Midday ____________ PM ________

Organic Vapor Analyzer

Type ____________
Serial number ____________
Calibration gas ____________
* Reading AM ____________ Midday ____________ PM ________
* Background reading AM ____________ Midday ____________ PM ________
Comments ____________
Operator Signature AM ____________ Midday ____________ PM ________

* Positive response checks will be done every 4 hrs: AM, Midday and PM

Checked by ____________ Date ____________

Form F-1027
9/1/91

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FIGURE 2-2

Equipment Calibration Daily Log

These records will be subject to TETC QA audit. In addition to the instrument calibration, any notes on (1) unusual results, (2) changing of calibration standards, (3) battery charging, or (4) operation and maintenance will be included in the log.

All instruments will be stored, transported, and handled with care to preserve instrument accuracy. Damaged instruments will be taken out of service immediately and not used again until a qualified technician repairs and recalibrates the instruments.

All instruments will be thoroughly decontaminated prior to use and between sampling points, to avoid cross contamination. Instruments such as the PID, CGI, temperature, pH, and specific conductance will be wiped with a moist towel at the end of each field day. All other equipment will be scrubbed in an Alconox™ solution and rinsed with an approved potable water source. Discarded materials, including paper towels and decontamination fluids, will be accumulated and stored in appropriate receptacles for proper disposal by TETC.

Field calibration for the instruments that will be used to monitor soil sampling at the IAAP is described below.

2.5.3.1 Photoionization Detector

The PID will be calibrated in TETC's field office at the beginning of each sampling round using isobutylene as the standard calibration gas. The initial calibration will be checked at the beginning and end of each work day with the calibration gas. The instrument will be re-calibrated if it experiences abnormal perturbations or readings become erratic. Calibration and test results will be recorded on the Equipment Calibration Log.

2.5.3.2 Combustible Gas Indicator

Calibration of the CGI will be performed prior to shipment to the field. Prior to daily use, the instrument will be calibrated to fresh air for proper oxygen level indication. Oxygen alarm functions will be verified by sampling exhaled air. The meter will be checked for combustible gas response by sampling vapors from a bottle of isopropyl alcohol. Calibration and test results will be recorded on the Equipment Calibration Log.

2.5.4 SOIL SAMPLING METHODS

Subsurface soil samples will be collected for chemical analysis at 1 foot BGS, and at 10-foot intervals thereafter, beginning at 10 feet BGS and continuing to total depth in each borehole. Personnel performing soil sampling shall wear chemical-resistant gloves when obtaining soil samples. Chemical-resistant gloves shall be changed between boreholes. Subsurface soil samples will also be collected for physical analysis at the discretion of TETC geologist in accordance with American Society for Testing Materials (ASTM) Method D 1587. The analyses being performed on soil samples and the quantity of normal environmental and QA/QC samples that will be collected during the assessment are presented in Table 2-2. The sample containers, required preservation, and holding times for the analyses being performed on soil samples during the assessment are provided in Table 2-3.

TABLE 2-2
SUMMARY OF SOIL SAMPLE ANALYSES FOR THE ASH DISPOSAL CELL IN TRENCH 5

Analytical Method	Reporting Units	Number of Environmental Analyses	Trip Blanks	Field Blanks	Rinseate Blanks	Duplicate/ Replicate Analyses	Total Analyses
VOCs by Purge & Trap GC/MS	µg/g	18	3	1	1	2	25
SVOCs	µg/g	18	NA	NA	1	2	21
Explosives by HPLC	µg/g	18	NA	NA	1	2	21
Arsenic by GFAA	µg/g	18	NA	NA	1	2	21
Barium by ICAP	µg/g	18	NA	NA	1	2	21
Cadmium by ICAP	µg/g	18	NA	NA	1	2	21
Chromium by ICAP	µg/g	18	NA	NA	1	2	21
Mercury by CVAA	µg/g	18	NA	NA	1	2	21
Silver by ICAP	µg/g	18	NA	NA	1	2	21
Pesticides/PCBs by GC	µg/g	18	NA	NA	1	2	21
Sulfate by IC	µg/g	18	NA	NA	1	2	21
Nitrate by IC	µg/g	18	NA	NA	1	2	21
pH	NA	18	NA	NA	1	2	21
Soil Moisture (ASTM D2216)	Percent	3	NA	NA	NA	0	3
Atterburg Limits (ASTM D421/D422)	Percent	4	NA	NA	NA	0	4
Classification of Soil for Engineering Purposes (ASTM D2487)	USCS	4	NA	NA	NA	0	4
Particle Size Analysis (ASTM D4318)	percent	4	NA	NA	NA	0	4

Key:

CVAA = Cold Vapor Atomic Absorption
GC = Gas Chromatography
GC/MS = Gas Chromatography/Mass Spectrometer
GFAA = Graphite Furnace Atomic Absorption

HPLC = High Pressure Liquid Chromatography
IC = Ion Chromatography
ICAP = Inductively Coupled Argon Plasma
NA = Not Applicable

TABLE 2-3

ANALYSIS, CONTAINERS, VOLUME, PRESERVATION, AND HOLDING TIMES FOR SOIL SAMPLES COLLECTED AT THE ASH DISPOSAL CELL IN TRENCH 5

Parameter	Container	Volume Required	Preservation	Maximum Holding Time
VOCs by Purge and Trap GC/MS	S	2×40 mL or 2×125 mL	Cool, 4°C	14 days (7 days if not pH adjusted)
SVOCs by Purge and Trap GC/MS	G	2×8 oz	Cool, 4°C	7 days
Explosives by HPLC	G	1×4 oz	Cool, 4°C	7 days to extraction and 40 days to analysis
Arsenic by GFAA	G	1×8 oz	Cool, 4°C	6 months
Barium by ICAP	G	1×8 oz	Cool, 4°C	6 months
Cadmium by ICAP	G	1×8 oz	Cool, 4°C	6 months
Chromium by ICAP	G	1×8 oz	Cool, 4°C	6 months
Mercury by CVAA	G	1×8 oz	Cool, 4°C	28 days
Silver by ICAP	G	1×8 oz	Cool, 4°C	6 months
Pesticides/PCBs by GC	G	1×8 oz	Cool, 4°C	7 days until extraction 40 days after extraction
Sulfate by IC	G	500 mL	Cool, 4°C	28 days
Nitrate by IC	G	500 mL	Cool, 4°C	48 hours
pH	G	20 g	None Required	Analyze Immediately
Soil Moisture (ASTM D2216)	G	100 g	None Required	As soon as possible
Atterburg Limits (ASTM D421/422)	T	500 g	None Required	NA
Classification of Soil for Engineering Purposes (ASTM D2487)	T	500 g	None Required	NA
Particle Size Analysis (ASTM D4318)	T	500 g	None Required	NA

Key:

CVAA = Cold Vapor Atomic Absorption
G = Amber Glass with Teflon-Lined Cap
GC = Gas Chromatography
GC/MS = Gas Chromatography/Mass Spectrometer
GFAA = Graphite Furnace Atomic Absorption
HPLC = High Pressure Liquid Chromatography
IC = Ion Chromatography
ICAP = Inductively Coupled Argon Plasma
S = Glass Vial with Teflon-Lined Septum Cap
T = Shelby Tube

2.5.4.1 Continuous Tube Sampling

A continuous tube sampler will be used to collect soil samples for chemical analysis during the drilling of the boreholes to total depth. It is a 5-foot long by 3-inch I.D. non-rotating, split-tube sampling device that is pushed into the soil under the weight of the drilling rig and collects a continuous, relatively-undisturbed soil sample as the borehole is advanced. It is exchanged for a decontaminated, empty sampler after the borehole is advanced 5 feet. The continuous tube sampler will be used without an optional copolyester liner so that soil samples can be collected for chemical analysis and examined for soil classification.

When using the continuous tube sampler for collecting soil samples for chemical analysis, the sampler will be brought to the surface and a PID will be used to measure VOCs volatilizing from the soil in the sampler. Soil samples will then be collected in laboratory-clean glass jars, labeled, placed in self-sealing plastic bag, and stored at 4° C in a portable cooler containing ice prior to transport to the analytical laboratory for analysis. After collecting soil samples from a particular depth, the remaining soil in the sampler will then be used for soil classification and headspace analysis in the field.

2.5.4.2 Shelby Tube Sampling

A Shelby tube sampler will be used to collect undisturbed soil samples for physical analysis. Shelby tubes are thin-walled metal tubes connected to a sampler head that contains a ball check valve and ports. The Shelby tubes used in this assessment will be a 3-feet long by 3-inch I.D. galvanized tube. All tubes will be decontaminated prior to use.

The procedure for shelby tube sampling is discussed below:

1. Clean out the borehole to the sampling elevation. Remove loose material as carefully as possible to avoid disturbing the material to be sampled.

2. Place the assembled sample tube so that its bottom rests on the bottom of the hole. Place a mark on the piston rod extension at the surface as a reference.

3. Advance the sample without rotation by a continuous rapid motion of constant rate using the hydraulic drive mechanism on the drilling rig.

4. Determine the length of advancement by measuring from the reference mark.

5. Withdraw the sampler slowly and uniformly, without rotation, to its original position.

6. Separate the tube from the sampler head. The sample will be prepared for shipment to the laboratory while still intact in the sample tube. To prepare the sample for shipment, remove approximately 1 inch of soil from each end for soil classification. Fill the ends of the tube with wax added in increments to prevent the formation of voids, or with a perforated, expandable packer. The wax is used to prevent loss of water content. Both ends of the tube are capped with close-

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fitting plastic caps and secured with duct tape. The samples are then carefully packed for shipment.

2.5.5 *DUPLICATE SAMPLES & FIELD BLANKS*

The following sections define duplicate soil samples and field blanks and explains how they will be used in the assessment. The quantity of duplicate soil samples and field blanks are summarized in Table 2-3. All duplicate samples will be labeled as normal field samples (Section 2.9.1.1) so that laboratory personnel are unable to distinguish them from normal environmental samples. The numbering system for field blanks includes a number to identify the unit (5 for the Ash Disposal Cell in Trench 5), plus the letters TB for trip blanks, AB for ambient conditions blanks and RB for rinseate blanks. This is followed by a sequential number (date of collection) incremented throughout the project. As an example, 5TB1206 would be a trip blank collected at the Ash Disposal Cell in Trench 5 on December 6.

2.5.5.1 Duplicates

A sample duplicate is defined as two or more samples collected independently at a sampling location during a single act of sampling. Soil sample duplicates will be collected at the rate of one (1) soil sample duplicate for every 20 normal soil samples. Soil sample duplicates will be analyzed for all applicable analyses.

2.5.5.2 Trip Blanks

Trip blanks are defined as volatile organic analyte (VOA) sample bottles that are filled in the laboratory with ASTM Type II reagent-grade water, transported to the sampling location but never opened, and returned to the laboratory with normal environmental samples being analyzed for VOCs. One trip blank will accompany each cooler containing samples being submitted for VOC analysis.

2.5.5.3 Ambient Conditions Blank

Ambient conditions blanks are defined as samples collected by pouring ASTM Type II reagent-grade water into VOA sample containers at a sampling location. They are handled and labeled as samples and transported to the laboratory for analysis. One ambient conditions blank will be collected during the soil sampling at the Ash Disposal Cell in Trench 5.

2.5.5.4 Rinseate Blanks

Rinseate blanks are defined as samples made of ASTM Type II reagent-grade water that has been poured through or pumped through (in the case of pumps) the soil sampling device into the required sample bottle, and transported to the laboratory for analysis. One set of rinseate blanks will be collected during the soil sampling at the Ash Disposal Cell in Trench 5. The rinseate blanks will be analyzed for all analyses being performed on soil samples collected at the Ash Disposal Cell in Trench 5.

2.5.6 BOREHOLE CUTTINGS

Borehole cuttings from hollow stem auger drilling at the Ash Disposal Cell in Trench 5 will be placed into labeled 55-gallon drums. Drums will be kept at the wellhead pending laboratory results. Cuttings suspected of being contaminated will be kept segregated to the greatest extent practical. The decision to segregate cuttings will be based on elevated PID or CGI readings, or obvious staining or discoloration of the cuttings.

The analytical results from soil samples collected at the Ash Disposal Cell in Trench 5 will be used to determine whether drill cuttings can be incinerated in the CWP at the IAAP. If the analytical results prevent incineration of the drill cuttings at the CWP, then composite samples of drill cuttings will be collected and analyzed to determine disposal requirements using the Toxicity Characteristic Leaching Procedure (TCLP) found in 40 CFR Section 268. If TCLP results are used to determine disposal requirements, it is estimated that cuttings will be stored at the wellhead for 12 weeks before disposal.

TCLP results will be evaluated against USEPA threshold criteria to determine if cuttings must be classified as hazardous or non-hazardous wastes. If the cuttings are non-hazardous, they will be spread on the ground at the wellhead. If the cuttings are non-hazardous, but are significantly above established background levels, they will be disposed of in the CWP. If the cuttings are determined to be hazardous, they will be disposed of in accordance with federal and state regulations. TETC is responsible for arranging disposal of the cuttings.

2.5.7 DECONTAMINATION OF SOIL SAMPLING EQUIPMENT

Decontamination of the soil sampling equipment will be performed at a location proposed by TETC and mutually agreed upon by the IAAP and USEPA. As part of decontamination procedures, the drilling rig and associated equipment will be steam cleaned on a plastic drop cloth before and after each borehole to prevent cross contamination. At a minimum, drill bits, drill pipe, and the back and mast of the drilling rig will be steam cleaned and rinsed with potable water from an USAEC-approved source before and after each monitoring well is installed. If contaminated material remains after steam cleaning, hand brushing will be performed and the equipment steam cleaned and rinsed with potable water a second time. The soil sampling equipment will be decontaminated after every sample is collected using the following method:

1. Wash with potable water from an approved source.
2. Rinse with potable water.
3. Allow sampling equipment to air dry prior to further use. If the equipment will not be used immediately, it will be wrapped in aluminum foil and stored in plastic.

Soil sampling equipment will not be allowed to come in contact with any type of plastic because of the analyses for organic compounds. Soil sampling equipment decontaminated and not immediately reused will be wrapped in aluminum foil and stored in plastic.

Each PVC casing, screen, and cap used in the monitoring wells installed at the Ash Disposal Cell in Trench 5 will be steam cleaned and rinsed with potable water from an USAEC-approved

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source before they are lowered into the borehole. The site geologist is responsible for the supervision of all steam-cleaning procedures.

Decontamination fluids will be containerized in labeled 55-gallon drums and kept on site at the decontamination pad prior to delivery to the IAAP carbon filter treatment system. TETC is responsible for arranging disposal for all decontamination fluids associated with monitoring well installation.

2.5.8 DRILLING RECORDS

Drilling records will be kept in the daily field logbook for the assessment and on logs for each borehole. The items that will be included in the daily field logbook are described in the following sections.

2.5.8.1 Daily Logs

All information pertinent to the field program for the groundwater quality assessment will be recorded on appropriate data sheets and/or in the daily field logbook which will be a waterproof, bound book with consecutively-numbered pages. Entries in the logbook will be made in waterproof ink, and will include the following information:

- Name and address of field contact (on logbook cover)
- Names and affiliations of personnel on site
- General description of each day's field activities
- Documentation of daily weather conditions during fieldwork
- Sample locations (e.g., borehole number as description).

Entries in the logbook for each sample collected during the assessment will include the following additional information:

- Sample distribution (e.g., laboratory, hauler, etc.)
- Observations on the sample or the collection environment, if needed
- Identification of sampling device
- Any field measurements made during sample collection (e.g. air monitoring, etc.)
- Sequence of sample collection
- Type of sample matrix (e.g., soil, groundwater, etc.)
- Estimated volume of liquid samples
- Date and time of collection
- Field sample identification number
- Sampler's name
- Sample type (composite, split, etc.)
- Preservatives used.

The bottom of each page in the logbook will be signed or initialed by the person making the entries. No pages will be removed from the field logbooks for any reason. Only persons authorized by the Project Manager or the Project Manager's designee make entries in the logbook.

In addition to the information entered into the logbook, the following data sheets (described and reproduced in this section in Figures 2-1 through 2-7) must be filled out: Decontamination Record, Equipment Calibration Log, Borehole Log, Monitoring Well Construction Log, Monitoring Well Development Log, Potentiometric Level Measurement Form, and Groundwater Sampling Log.

2.5.8.2 Corrections to Documentation

All original data recorded in field logbooks and data entry sheets, on sample labels, or in COC records, will be written with waterproof ink. If an error (e.g., incorrect date or sample depth) is made on the document, corrections will be made simply by crossing a line through the error, in such a manner that the original entry can still be read, and entering the correct information. All corrections will be initialed and dated.

2.5.8.3 Photographs

Photographs, if taken, will be recorded in the appropriate logbook. Information to be recorded includes:

- Roll and frame number
- Time
- Photographer
- Location, e.g., "east side of the Ash Disposal Cell in Trench 5"
- Subject, e.g., "installation of Borehole XX"
- Significant features
- Names of any personnel included in the photograph.

2.5.8.4 Borehole Logs

The information to be recorded on a Field Borehole Log (Figure 2-3) including lithologic descriptions are listed below:

- Soil classification
- Unified Soil Classification symbol
- Secondary components and estimated percentage
- Color (Munsell)
- Plasticity
- Consistency (cohesive soil)
- Density (non-cohesive soil)
- Moisture content
- Texture/fabric/bedding and orientation
- Grain angularity

2.6 MONITORING WELL CONSTRUCTION MATERIALS AND TECHNIQUES

Monitoring well installation will include construction, wellhead completion, and development. These procedures follow methods described in the USATHAMA Geotechnical Requirements for

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Borehole Log

Project Name:		Project Number:
Borehole Location:	Borehole No.	Sheet 1 of
Drilling Agency:	Driller:	
Drilling Equipment:	Date Started:	Total Depth (feet):
Drilling Method:	Date Finished:	Depth to Bedrock (feet):
Drilling Fluid	Number of Samples:	Depth to Water (feet):
Completion Information:	Borehole Diameter (in):	Elevation and Datum:
	Logged by:	Checked by:

	Sample					Analysis	LOG		
Depth (feet)	Number	Interval	Blow Count	Recovery	Time	PID or FID (ppm) S/B*	USCS or Rock Type	**Lithologic Description**	**Remarks**
5									
10									
15									

KEY: * S/B = Sample Reading / Background Reading; NA = Not Analyzed; BZ = Breathing Zone; BG = Background; BH = Borehole Headspace

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BOREHOLE LOG	

Drilling, Monitoring Wells, Data Acquisition, and Reports (USATHAMA, 1987), the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (USEPA, 1986b), and Water Well Standards Bulletin 74-81 (CDWR, 1990). A Monitoring Well Construction Log (Figure 2-4) and Monitoring Well Development Log (Figure 2-5) will be completed for each monitoring well that is installed during the assessment.

2.6.1 CASING/SCREEN

Casing/Screen will be placed inside the hollow-stem augers. Filter pack, bentonite seal, and Portland cement/bentonite grout are then emplaced in the annulus between the borehole wall and casing/screen as the augers are withdrawn.

The monitoring well casing and screen will be constructed of 4-inch I.D., Schedule 40 PVC. All PVC casing and screen will conform to Standard 14 of the National Sanitation Foundation or the ASTM equivalent. Screens will be commercially fabricated and factory slotted. Screen size will be 0.01 inch (ten/slot) or as determined by the site geologist. Screen length will be 15 feet so as to allow for seasonal water table fluctuation.

A centralizer may be attached to the monitoring well casing depending upon the total depth of the borehole. This determination will be made in the field by the site geologist. If used, a centralizer made of PVC, PTFE, or stainless steel will be attached to the casing (not screen) so that it is above the granular filter pack and the bentonite seal.

Casing and screen sections will be flush threaded with screw joints. To prevent introduction of contaminants into the monitoring well, no glue-connected fittings will be used. Each PVC casing, screen, and the cap/plug will be steam-cleaned before lowering it into the borehole. The site geologist is responsible for the supervision of all steam-cleaning procedures.

2.6.2 GRANULAR FILTER PACK

A representative sample of the filter pack will be submitted to the USAEC Project Manager for approval prior to monitoring well installation. Once approved, the filter pack will be added to the borehole after the casing/screen is in place to allow groundwater to enter the monitoring well and stabilize the borehole wall adjacent to the screened interval. Washed and bagged, rounded No. 2 silica sand will be emplaced through a tremie pipe or poured down the annular space between the casing/screen and hollow-stem augers, depending on field conditions. The filter pack will extend from the bottom of the borehole to a maximum of 5 feet above the screen (USEPA, 1986).

The volume of sand required to fill the annular space will be calculated. If the volume required to fill the space is less than the calculated amount, bridging may have occurred. If bridging occurs, a tremie pipe will be used to break the bridging and emplace the remaining sand. The site geologist will record the start and stop times for emplacing the filter pack, depth intervals in which sand was placed, amount of sand used, and problems that arise. The site geologist will also record the type of material used for the filter pack including: trade name, source, supplier, and typical grain size distribution. A sample of sand used in the filter pack will be collected and archived as part of the project files.

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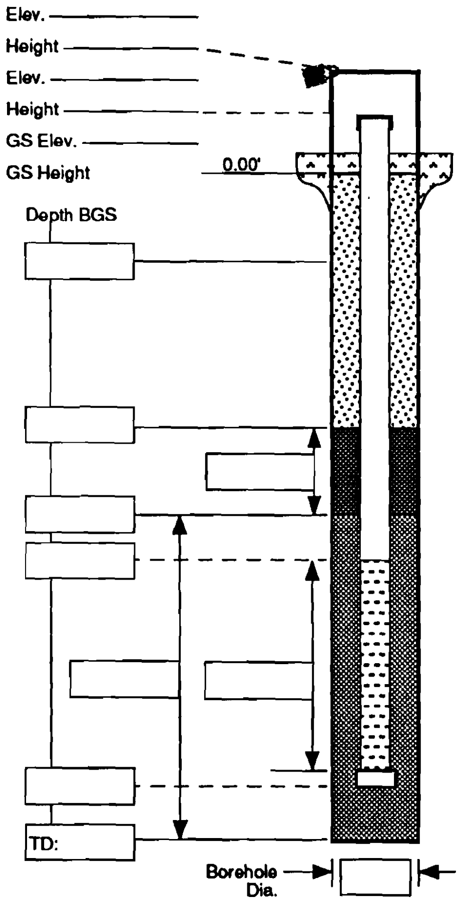
Monitoring Well Construction Log - Above Ground

Project Name:	Project Number:	Date:
Well	Well ID:	Sheet ___ of ___
Driller:	Borehole Diameter (in):	Total Depth (ft):
Drilling Agency:	Date Started:	Depth to Water (ft):
Drilling Equipment:	Date Finished:	Elevation and Datum:
Drilling Method:	Logged by:	Checked by:
Drilling Fluid:	Number of Samples:	Date:



PROTECTIVE CSG

Material / Type:

Diameter:

Depth BGS: Weep Hole (Y / N)

GUARD POSTS (Y / N)

No.: Type:

SURFACE PAD

Composition and Size:

RISER PIPE

Type:

Diameter:

Total Length (TOC to TOS):

Ventilated Cap (Y / N)

GROUT

Composition and Proportions:

Tremied (Y / N)

Interval BGS:

CENTRALIZERS

Depth(s)

SEAL

Type:

Source:

Setup / Hydration Time: Vol. Fluid Added

Tremied (Y / N)

FILTER PACK

Type:

Amt. Used:

Tremied (Y / N)

Source:

Gr. Size Dist.:

SCREEN

Type:

Diameter:

Slot Size and Type:

Interval BGS:

WELL FOOT (Y / N)

Interval BGS: Length

Bottom Cap (Y / N)

BACKFILL PLUG

Material:

Setup / Hydration Time:

Tremied (Y / N)

Form F-1024
9/1/91

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FIGURE 2-4

Monitoring Well Construction Log

WELL DEVELOPMENT LOG

Date:	Well ID:	Sample Number:	Recorded By:
Project Name:	Well Location:	Duplicate Number:	Checked By:
Project Number:	Date Well Installed:		

EQUIPMENT

pH/Conductivity/Temperature Meter #:	Purging Equipment:
PID #:	
Electric Sounder #:	

WELL DATA

Elevation:	Water Column in Well:	Total Vol. Extr.:
Well Diameter:	Borehole Diameter:	Ambient PID:
Well Depth:	Water Column in Borehole:	Well Mouth PID:
Static Water Level:	Standing Water Vol.:	Static Water Level 24 Hrs. After Development:
Screen Length:		

Ground Condition of Well:
Remarks:

PURGING

	1	2	3	4
Time				
Rate				
Temperature				
pH				
Conductivity				
Vol. Purged				
Remarks				

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FIGURE 2-5

Well Development Log

2.6.3 BENTONITE SEAL

A bentonite seal of 5-foot vertical thickness will be placed in the annular space above the filter pack to separate the permeable zone from the cement grout surface seal. The bentonite will be emplaced through a tremie pipe or poured directly into the annular space between the casing and hollow-stem augers, depending upon the conditions in the borehole. The bentonite will be pourable pellets (or granules). Five to 7 gallons of potable water from an approved source per one foot of bentonite pellets will be used to hydrate the bentonite. The bentonite will be allowed to hydrate for at least one hour. The site geologist will record the start and stop times of the bentonite seal emplacement, the depth interval of the seal, the amount of bentonite that was used, and problems that arise. The type of bentonite and the supplier will also be recorded. A sample of the bentonite will be collected and archived as part of the project files.

2.6.4 CEMENT GROUT AND PROTECTIVE CASING

The Portland cement/bentonite grout mixture will be composed of a 20:1 mixture of Type II Portland cement and pure sodium bentonite powder, measured on a dry weight basis. The final mixture will be wet enough (but not "runny") to be pumpable (maximum of 8 gallons of water per 94-pound bag of cement). The mixture will be prepared in an above-ground mixer and mechanically blended at the wellhead to produce a lump-free product. The mixed grout will be recirulcated through the grout pump prior to placement. The grout will then be pumped through a rigid side-discharging tremie pipe, such as drill rods or PVC, and placed just above the top of the bentonite seal after the bentonite seal has hydrated.

At a minimum, 10 feet of grout will remain within the hollow stem augers. Therefore, 20 feet of grout will be emplaced within the augers prior to removing 10 feet of auger flight. The grout will be pumped until 20 percent of the grout has returned to the surface. The tremie pipe and the remainder of the hollow-stem augers will then be removed, and additional grout will be added to compensate for the volume of the removed augers. For grout placement at depths less than ten feet in a dry hole, the grout may be poured in place from the ground surface. Additional grout will be placed if the grout displays settlement depression after 24 hours.

After the grout has partially set, a vented, 5-foot long black iron/steel protective casing will be emplaced in the grout. A 6-inch monitoring well protector will be used for the 4-inch PVC monitoring wells. This protective casing will extend approximately 2.5 feet below land surface. The protective casing will be set into the grout such that it will be set 2.5 feet above the ground and no more than 0.2 feet above the top of the PVC monitoring well stick-up. After the grout has completely set, depressions due to settlement will be filled in with the same grout mixture previously used. The start and stop times of the cementing, the intervals that were cemented, the amount of cement used, the mix used (gallons of water per bag of cement and the cement/bentonite ratio), any additives to the cement, and problems that arose during grouting will be recorded on the Monitoring Well Construction Log and in the field logbook.

2.6.5 MONITORING WELL PROTECTION AND MARKING

The protective casing emplaced in the Portland cement/bentonite grout will be seated in a 4 foot by 4 foot by 6-inch thick concrete surface pad. The concrete pad will be graded to slope away

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from the monitoring well. The protective casing will include a hinged cap which will be padlocked for protection and keyed for opening with one master key.

When the grout has set up around the protective casing, a 6-inch mortar collar will be placed between the inside of the protective casing and the outside of the PVC monitoring well stick-up. A hole will be drilled into the protective casing 1/8-inch above the mortar collar to allow for drainage.

The monitoring wells will be protected with 4 concrete-filled steel posts which will be installed radially around each monitoring well and extend to 3 feet above the ground surface. The posts will be installed outside of the concrete pad and will be set 2 feet below the ground surface in concrete.

After the grout and mortar collar have thoroughly set, the protective casing will be painted with orange paint. The number and date of installation of each monitoring well will be clearly marked in white paint on the monitoring well protective casing.

2.6.6 MONITORING WELL DEVELOPMENT

Monitoring well development is the process by which the aquifer's hydraulic conductivity is restored by removing drilling fluids, solids and/or other mobile particulate matter from the monitoring well. All monitoring wells installed during the assessment shall be developed no sooner than 48 hours after installation to allow the monitoring well grout to cure. All development activity will be recorded on the Monitoring Well Development Log illustrated in Figure 2-5. Two methods of monitoring well development may be used during the assessment activities at the IAAP. They are: (1) surging and bailing and (2) overpumping.

2.6.6.1 Surging and Bailing

The surging and bailing method is performed by moving a plunger up and down in the monitoring well, in a manner similar to a piston in a cylinder. A close-fitting surge block serves as the piston, and is operated in and directly above the screened portion of the monitoring well. The screen will be surged in 5-foot sections using 10 to 20 up/down cycles per section. The surge block will be removed periodically and a sediment bailer will be lowered into the monitoring well to remove accumulated sediment from the monitoring well. A bailer will then be used to ultimately remove a minimum of five times the standing water volume (SWV) which includes the volume of water in the monitoring well casing and the volume of water in the saturated portion of the filter pack. The following calculation will be used to determine the SWV.

1. Calculate the volume of water in the casing (Volume A) by measuring the total depth (TD) of the monitoring well and depth to water (DTW). Next, use the following formula:

   Volume A = (TD - DTW) * c
   where c is the conversion factor for gallons based on casing diameter; c = 0.65 for a 4-inch I.D. casing.

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2. Calculate the volume of the saturated portion of the borehole (Volume B) by measuring the TD of the borehole and DTW:

   Volume B = (TDB - DTW) * c
   where c is the conversion factor for gallons based on borehole diameter; c = 4.08 for a 10-inch diameter borehole.

3. Calculate the volume of the saturated granulated filter pack (Volume C):

   Volume C = (Volume B - Volume A) * 0.30
   where 0.30 is the assumed porosity of the granulated filter pack.

4. Calculate the SWV:

   SWV = Volume A + Volume C

The temperature, pH, and specific conductance will be monitored once before, twice during, and once after monitoring well development using a calibrated temperature/pH/conductivity meter.

The monitoring well will be considered developed when: (1) groundwater is clear to the unaided eye, (2) the thickness of sediment in the monitoring well is less than 1% of the screen length, and (3) at a minimum, five times the SWV has been removed. If the groundwater is not clear or if sediment is greater than 1% of the screen length in the monitoring well after five SWVs have been removed, then the USAEC Project Manager will be contacted for guidance.

2.6.6.2 Overpumping

As an alternative to surging and bailing the monitoring well, overpumping may be used to remove fines from the screened portion of the monitoring well. Overpumping consists of using a high-volume pump to remove water from the monitoring well at a higher rate than is required under normal circumstances. The pump must be rated to achieve the desired yield at a given depth. The pump system should include:

1. A check valve to prevent water from running back into the monitoring well when the pump is shut off.

2. Flexible discharge hose.

3. Safety cable or rope to remove the pump from the monitoring well.

4. Flow meter system (measuring bucket or inline flow meter).

5. Electric generator.

6. Ammeter, which measures current.

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The ammeter is used to gauge monitor pump performance. For instance, when the pump is becoming clogged, the current will increase due to stress on the pump. When the water level drops below the intake ports, the current will drop due to decreased resistance on the pump.

The pump will be used to remove a minimum of five times the SWV, determined by the calculations outlined above. The temperature, pH, and specific conductance will be monitored once before, twice during, and once after monitoring well development using a calibrated temperature/pH/conductivity meter.

The monitoring well will be considered developed when: (1) groundwater is clear to the unaided eye, (2) the thickness of sediment in the monitoring well is less than 1% of the screen length, and (3) at a minimum, five times the SWV has been removed. If the groundwater is not clear or if sediment is greater than 1% of the screen length in the monitoring well after five SWV have been removed, then the USAEC Project Manager will be contacted for guidance.

2.6.6.3 Development Water

Monitoring well development water will be containerized and stored at the wellhead in labeled 55-gallon drums. Labels will identify the unit, monitoring well, and date of sample collection. Disposal of development water will be based on analytical results of the subsequent groundwater sample from that monitoring well. If the sample is non-hazardous, the development water will be disposed of on site, downgradient of the unit. If the groundwater sample is above background levels, but below ARARs, or is non-hazardous, it will be transported to the carbon treatment system at IAAP, after approval by IAAP personnel.

2.6.6.4 Monitoring Well Development Equipment Decontamination

All monitoring well development equipment including bailers and pumps, will be decontaminated by flushing/pumping, potable water from an USAEC-approved source, then potable water a second time through the components. The exterior of the pump inlet hose will be steam cleaned. Monitoring well development equipment will be thoroughly decontaminated prior to use and between monitoring well locations to avoid cross contamination. All decontamination information will be recorded on the Decontamination Record (Figure 2-1).

If a rig is used to handle equipment during monitoring well development, any grease that may contact equipment going into the monitoring well must be cleaned off with Alconox™ solution, then the rig will be steam cleaned and rinsed with potable water from an USAEC-approved source.

Decontamination fluids will be containerized in labeled 55-gallon drums and kept on site at the decontamination pad prior to delivery to the IAAP carbon filter treatment system. TETC is responsible for arranging disposal for all other materials associated with monitoring well development.

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2.7 GROUNDWATER SAMPLING

The groundwater sampling program at the IAAP will include sampling monitoring wells at the Ash Disposal Cell in Trench 5 and at Line 6 one time per month for 5 consecutive months. The three newly installed shallow monitoring wells and three existing shallow monitoring wells (T-1, T-2, T-3, and G-4) shall be sampled for groundwater at the Ash Disposal Cell in Trench 5. The nine existing shallow monitoring wells at Line 6 shall be sampled for groundwater (T-10, T-13, T-16, T-19, T-22, T-25, T-28, T-31, and T-34). The analytical methods and quantity of field and QA/QC samples, broken down by location, is presented in Tables 2-4 and 2-5. Groundwater samples will be collected from the new monitoring wells to be installed at the Ash Disposal Cell in Trench 5 no sooner than 14 days following development. This will allow the groundwater in the monitoring well to return to equilibrium conditions. Groundwater samples will be collected in order from the least likely contaminated monitoring well locations to most likely contaminated monitoring well locations to lower the probability of cross contamination. Groundwater sampling methods (discussed below) follow procedures described in the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (USEPA, 1986b).

2.7.1 FIELD PARAMETERS MEASURED DURING MONITORING WELL PURGING AND GROUNDWATER SAMPLE COLLECTION

The collection of field data during the groundwater quality assessment will require a variety of field instruments. Proper maintenance, calibration, and operation of each instrument will be the responsibility of the field task manager and the instrument technicians assigned to the project. All instruments and other equipment used during the assessment will be maintained, calibrated, and operated according to the manufacturers' guidelines and recommendations.

Field instruments will be calibrated prior to use in the field as appropriate. Calibration procedures are described below. Copies of the instrument manuals will be maintained in TETC's field office at the IAAP. A record of field calibration of analytical instruments (e.g., PID, CGI, and temperature/pH/conductivity meter) will be maintained on the Equipment Calibration Log by field personnel (Figure 2-2). These records will be subject to QA audit. In addition, any notes on unusual results, changing of standards, battery charging, and operation and maintenance will be included on the Log.

All instruments will be stored, transported, and handled with care to preserve equipment accuracy. Damaged instruments will be taken out of service immediately and not used again until a qualified technician repairs and recalibrates the instruments.

All field instruments and other equipment will be thoroughly decontaminated prior to use and between sampling locations to avoid cross contamination. Instruments such as the Photovac PID and the Exotox CGI will be wiped with a moist towel at the end of each work day. Groundwater meters, such as the Hydac temperature/pH/conductivity meter, will be thoroughly rinsed with deionized water after each use. All other equipment will be scrubbed in an Alconox™ solution, rinsed with potable water from an approved source, and finally rinsed a second time with potable water. Discarded materials, including paper towels and decontamination fluids, will be accumulated and stored in appropriate receptacles for proper

TABLE 2-4A
SUMMARY OF GROUNDWATER SAMPLE ANALYSES FOR THE ASH DISPOSAL CELL AT TRENCH 5 FOR ONE ROUND OF SAMPLING

Analytical Method	Reporting Units	Number of Environmental Analyses	Trip Blanks	Field Blanks	Rinseate Blanks	Duplicate/ Replicate Analyses	Total Analyses
TOX by APT*	µg/L	4	NA	NA	0	12	16
Mercury (Total) by CVAA	µg/L	4	NA	NA	0	1	5
Mercury (Dissolved) by CVAA	µg/L	4	NA	NA	NA	1	5
2,4-D by GC	µg/L	4	NA	NA	1	1	6
Pesticides/PCBs by GC	µg/L	4	NA	NA	1	1	6
2,4,5-TP Silvex by GC	µg/L	4	NA	NA	1	1	6
SVOCs by GC/MS	µg/L	4	NA	NA	1	1	6
VOCs by Purge & Trap GC/MS	µg/L	4	2	1	1	1	9
Arsenic (Total) by GFAA	µg/L	4	NA	NA	1	1	6
Arsenic (Dissolved) by GFAA	µg/L	4	NA	NA	NA	1	5
Lead (Total) by GFAA	µg/L	4	NA	NA	1	1	6
Lead (Dissolved) by GFAA	µg/L	4	NA	NA	NA	1	5
Selenium (Total) by GFAA	µg/L	4	NA	NA	1	1	6
Selenium (Dissolved) by GFAA	µg/L	4	NA	NA	NA	1	5
Explosives by HPLC	µg/L	4	NA	NA	0	1	5
Chloride by IC	µg/L	4	NA	NA	NA	1	5
Fluoride by IC	µg/L	4	NA	NA	NA	1	5
Nitrate by IC	µg/L	4	NA	NA	0	1	5
Sulfate by IC	µg/L	4	NA	NA	0	1	5
Barium (Total) by ICAP	µg/L	4	NA	NA	0	1	5
Barium (Dissolved) by ICAP	µg/L	4	NA	NA	NA	1	5
Cadmium (Total) by ICAP	µg/L	4	NA	NA	1	1	6
Cadmium (Dissolved) by ICAP	µg/L	4	NA	NA	NA	1	5
Chromium (Total) by ICAP	µg/L	4	NA	NA	1	1	6
Chromium (Dissolved) by ICAP	µg/L	4	NA	NA	NA	1	5
Iron (Total) by ICAP	µg/L	4	NA	NA	1	1	6

*APT = Adsorption-Pyrolysis-Titrimetric

0354T.24A

TABLE 2-4A
SUMMARY OF GROUNDWATER SAMPLE ANALYSES FOR THE ASH DISPOSAL CELL AT TRENCH 5 FOR ONE ROUND OF SAMPLING

Continued

Analytical Method	Reporting Units	Number of Environmental Analyses	Trip Blanks	Field Blanks	Rinseate Blanks	Duplicate/ Replicate Analyses	Total Analyses
Iron (Dissolved) by ICAP	µg/L	4	NA	NA	NA	1	5
Manganese (Total) by ICAP	µg/L	4	NA	NA	1	1	6
Manganese (Dissolved) by ICAP	µg/L	4	NA	NA	NA	1	5
Silver (Total) by ICAP	µg/L	4	NA	NA	1	1	6
Silver (Dissolved) by ICAP	µg/L	4	NA	NA	NA	1	5
Sodium (Total) by ICAP	µg/L	4	NA	NA	0	1	5
Sodium (Dissolved) by ICAP	µg/L	4	NA	NA	NA	1	5
Coliform Bacteria by Membrane Filter	CPM	4	NA	NA	NA	1	5
Gross Alpha by proportional counting	pCi/L	4	NA	NA	1	1	6
Gross Beta by proportional counting	pCi/L	4	NA	NA	1	1	6
Radium by proportional counting	pCi/L	4	NA	NA	1	1	6
Phenols by Spectrophotometric	µg/L	4	NA	NA	1	1	6
TOC by UV	µg/L	4	NA	NA	0	12	16
Temperature field determined	°C	4	NA	NA	NA	1	5
pH lab determined	NA	4	NA	NA	NA	12	16
Specific Conductance lab determined	µmhos	4	NA	NA	NA	12	16

Key:

CPM = Counts per 100 mL
CVAA = Cold Vapor Atomic Absorption
GC = Gas Chromatography
GC/MS = Gas Chromatography/Mass Spectrometer
GFAA = Graphite Furnace Atomic Absorption

HPLC = High Pressure Liquid Chromatography
IC = Ion Chromatography
ICAP = Inductively Coupled Argon Plasma
NA = Not Applicable

*APT = Adsorption-Pyrolysis-Titrimetric

TABLE 2-4B
SUMMARY OF GROUNDWATER SAMPLE ANALYSES FOR THE ASH DISPOSAL CELL AT TRENCH 5 FOR FIVE ROUNDS OF SAMPLING

Analytical Method	Reporting Units	Number of Environmental Analyses	Trip Blanks	Field Blanks	Rinseate Blanks	Duplicate/ Replicate Analyses	Total Analyses
TOX by APT*	µg/L	20	NA	NA	0	60	80
Chromium (Dissolved) by CVAA	µg/L	20	NA	NA	NA	5	25
Mercury (Total) by CVAA	µg/L	20	NA	NA	0	5	25
2,4-D by GC	µg/L	20	NA	NA	5	5	30
Pesticides/PCBs by GC	µg/L	20	NA	NA	5	5	30
2,4,5-TP Silvex by GC	µg/L	20	NA	NA	5	5	30
SVOCs by GC/MS	µg/L	20	NA	NA	5	5	30
VOCs by Purge & Trap GC/MS	µg/L	20	10	5	5	5	45
Arsenic (Total) by GFAA	µg/L	20	NA	NA	5	5	30
Arsenic (Dissolved) by GFAA	µg/L	20	NA	NA	NA	5	25
Lead (Total) by GFAA	µg/L	20	NA	NA	5	5	30
Lead (Dissolved) by GFAA	µg/L	20	NA	NA	NA	5	25
Selenium (Total) by GFAA	µg/L	20	NA	NA	5	5	30
Selenium (Dissolved) by GFAA	µg/L	20	NA	NA	NA	5	25
Explosives by HPLC	µg/L	20	NA	NA	0	5	25
Chloride by IC	µg/L	20	NA	NA	NA	5	25
Fluoride by IC	µg/L	20	NA	NA	NA	5	25
Nitrate by IC	µg/L	20	NA	NA	0	5	25
Sulfate by IC	µg/L	20	NA	NA	0	5	25
Barium (Total) by ICAP	µg/L	20	NA	NA	0	5	25
Barium (Dissolved) by ICAP	µg/L	20	NA	NA	NA	5	25
Cadmium (Total) by ICAP	µg/L	20	NA	NA	5	5	30
Cadmium (Dissolved) by ICAP	µg/L	20	NA	NA	NA	5	25
Chromium (Total) by ICAP	µg/L	20	NA	NA	5	5	30
Iron (Total) by ICAP	µg/L	20	NA	NA	5	5	30
Iron (Dissolved) by ICAP	µg/L	20	NA	NA	NA	5	25

*APT = Adsorption-Pyrolysis-Titrimetric

TABLE 2-4B
SUMMARY OF GROUNDWATER SAMPLE ANALYSES FOR THE ASH DISPOSAL CELL AT TRENCH 5 FOR FIVE ROUNDS OF SAMPLING

Continued

Analytical Method	Reporting Units	Number of Environmental Analyses	Trip Blanks	Field Blanks	Rinseate Blanks	Duplicate/ Replicate Analyses	Total Analyses
Manganese (Total) by ICAP	µg/L	20	NA	NA	5	5	30
Manganese (Dissolved) by ICAP	µg/L	20	NA	NA	NA	5	25
Mercury (Dissolved) by ICAP	µg/L	20	NA	NA	NA	5	25
Silver (Total) by ICAP	µg/L	20	NA	NA	5	5	30
Silver (Dissolved) by ICAP	µg/L	20	NA	NA	NA	5	25
Sodium (Total) by ICAP	µg/L	20	NA	NA	0	5	25
Sodium (Dissolved) by ICAP	µg/L	20	NA	NA	NA	5	25
Coliform Bacteria by Membrane Filter	CPM	20	NA	NA	NA	5	25
Gross Alpha by proportional counting	pCi/L	20	NA	NA	5	5	30
Gross Beta by proportional counting	pCi/L	20	NA	NA	5	5	30
Radium by proportional counting	pCi/L	20	NA	NA	5	5	30
Phenols by Spectrophotometric	µg/L	20	NA	NA	5	5	30
TOC by UV	µg/L	20	NA	NA	0	60	80
Temperature field determined	°C	20	NA	NA	NA	5	45
pH lab determined	pH units	20	NA	NA	NA	60	80
Specific Conductance lab determined	µhmos	20	NA	NA	NA	60	80

Key:

CPM = Counts per 100 mL
CVAA = Cold Vapor Atomic Absorption
GC = Gas Chromatography
GC/MS = Gas Chromatography/Mass Spectrometer
GFAA = Graphite Furnace Atomic Absorption

HPLC = High Pressure Liquid Chromatography
IC = Ion Chromatography
ICAP = Inductively Coupled Argon Plasma
NA = Not Applicable

*APT = Adsorption-Pyrolysis-Titrimetric

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TABLE 2-5A
SUMMARY OF GROUNDWATER SAMPLE ANALYSES FOR LINE 6 FOR ONE ROUND OF SAMPLING

Analytical Method	Reporting Units	Number of Environmental Analyses	Trip Blanks	Field Blanks	Rinseate Blanks	Duplicate/ Replicate Analyses	Total Analyses
TOX	μg/L	9	NA	NA	1	27	37
TOC	μg/L	9	NA	NA	1	27	37
Explosives by HPLC	μg/L	9	NA	NA	1	1	11
Antimony (Total) by GFAA	μg/L	9	NA	NA	1	1	11
Antimony (Dissovled) by GFAA	μg/L	9	NA	NA	NA	1	10
Barium (Total) by ICAP	μg/L	9	NA	NA	1	1	11
Barium (Dissolved) by ICAP	μg/L	9	NA	NA	NA	1	10
Lead (Total) by GFAA	μg/L	9	NA	NA	1	1	11
Lead (Dissolved) by GFAA	μg/L	9	NA	NA	NA	1	10
Mercury (Total) by CVAA	μg/L	9	NA	NA	1	1	11
Mercury (Dissolved) by CVAA	μg/L	9	NA	NA	NA	1	10
Sodium (Total) by ICAP	μg/L	9	NA	NA	1	27	37
Cyanide by Colorimetric	μg/L	9	NA	NA	1	1	11
Sulfate by IC	μg/L	9	NA	NA	1	27	37
Nitrate by IC	μg/L	9	NA	NA	1	1	11
Ammonia by distillation	μg/L	9	NA	NA	1	1	11
pH field determined	NA	9	NA	NA	NA	27	36
Specific Conductance field determined	μmhos	9	NA	NA	NA	27	36
Temperature field determined	°C	9	NA	NA	NA	1	10

Key:

CVAA = Cold Vapor Atomic Absorption
GC = Gas Chromatography
GC/MS = Gas Chromatography/Mass Spectrometer
GFAA = Graphite Furnace Atomic Absorption

HPLC = High Pressure Liquid Chromatography
IC = Ion Chromatography
ICAP = Inductively Coupled Argon Plasma
NA = Not Applicable

TABLE 2-5B
SUMMARY OF GROUNDWATER SAMPLE ANALYSES FOR LINE 6 FOR FIVE ROUNDS OF SAMPLING

Analytical Method	Reporting Units	Number of Environmental Analyses	Trip Blanks	Field Blanks	Rinseate Blanks	Duplicate/ Replicate Analyses	Total Analyses
TOX	µg/L	45	NA	NA	5	135	185
TOC	µg/L	45	NA	NA	5	135	185
Explosives by HCLP	µg/L	45	NA	NA	5	5	55
Antimony (Total) by GFAA	µg/L	45	NA	NA	5	5	55
Antimony (Dissovled) by GFAA	µg/L	45	NA	NA	NA	5	50
Barium (Total) by ICAP	µg/L	45	NA	NA	5	5	55
Barium (Dissolved) by ICAP	µg/L	45	NA	NA	NA	5	50
Lead (Total) by GFAA	µg/L	45	NA	NA	5	5	55
Lead (Dissolved) by GFAA	µg/L	45	NA	NA	NA	5	50
Mercury (Total) by CVAA	µg/L	45	NA	NA	5	5	55
Mercury (Dissolved) by CVAA	µg/L	45	NA	NA	NA	5	50
Sodium (Total) by ICAP	µg/L	45	NA	NA	5	135	185
Cyanide by Colorimetric	µg/L	45	NA	NA	5	5	55
Sulfate by IC	µg/L	45	NA	NA	5	135	185
Nitrate by IC	µg/L	45	NA	NA	5	5	55
Ammonia by Distillation	µg/L	45	NA	NA	5	5	55
pH field determination	NA	45	NA	NA	NA	135	180
Specific Conductance field determined	µmhos	45	NA	NA	NA	135	180
Temperature field determined	°C	45	NA	NA	NA	5	50

Key:

CVAA = Cold Vapor Atomic Absorption
GC = Gas Chromatography
GC/MS = Gas Chromatography/Mass Spectrometer
GFAA = Graphite Furnace Atomic Absorption
HPLC = High Pressure Liquid Chromatography
IC = Ion Chromatography
ICAP = Inductively Coupled Argon Plasma
NA = Not Applicable

disposal by TETC. The following instruments will be used for groundwater sampling at the IAAP:

2.7.1.1 Temperature/pH/Conductivity Meter

Electronic thermometers are calibrated to National Institute of Standards and Technology (NIST) standards prior to initial use and are visually inspected at least once a year.

The pH meter is calibrated at the start and end of each sampling day with pH 4 and 7 buffers or 7 and 10 buffers, whichever is expected to bracket the pH of the actual groundwater sample. Calibration knobs are used to set the meter to read the value of the standards. The pH meter is also checked periodically during the sampling period using a pH 7 buffer. If the reading varies more than two-tenths of a unit between calibration checks, the meter will be re-calibrated.

Conductivity calibration is performed at the start of each sampling day by using KCl standard solutions supplied by the instrument manufacturer. The meter must read within ± 1 percent of full scale to be considered in calibration. Readings from conductivity meters are normally stable; thus, calibration checks are usually limited to checks at the beginning and end of the sampling day. If the calibration check at the end of the day indicates the meter is not within tolerance, the data will be flagged to note the percent difference between the meter and standard.

2.7.1.2 Photoionization Detector

The PID will be calibrated in TETC's field office at the beginning of each sampling round using isobutylene as the standard calibration gas. The initial calibration will be checked at the start and end of each day with the calibration gas. The instrument will be re-calibrated if it experiences abnormal perturbations or readings become erratic. Calibration and test results will be recorded on the Equipment Calibration Log.

2.7.1.3 Combustible Gas Indicator

Calibration of the CGI will be performed prior to shipment to the field. Prior to daily use, the instrument will be calibrated to fresh air for proper oxygen level indication. Oxygen alarm functions will be verified by sampling exhaled air. The meter will be checked for combustible gas response by sampling vapors from a bottle of isopropyl alcohol. Calibration and test results will be recorded on the Equipment Calibration Log.

2.7.1.4 Electric Tape (Water Level Sounder)

The alarm function on the water level sounder is checked by immersion in water. The length of tape is manually checked against a surveyor's steel tape annually.

2.7.2 STATIC WATER LEVEL MEASUREMENTS

Groundwater elevations will be computed each time the monitoring wells are sampled during the assessment and recorded on a Potentiometric Level Measurement Log (Figure 2-6). In this assessment, the groundwater elevations will be determined by measuring the depth to

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Potentiometric Level Measurement
(Tape, Electric Sounder)

Page 1 of ____

Project Name ______________ Project No. ______________
Location ______________
Well Designation ______ State Permit No. ______ Owner ______
Date of Completion ______ Use of Water ______ Well Depth ______
Diameter ______ Casing Type ______ Screen Type ______
Screened/Open Intervals ______________
Aquifer(s) Screened ______________
Pump Type ______________
Elevation of Ground Surface ______ Elevation of Measuring Point ______
Previous Static Level ______ Elevation Difference between Ground Surface and Measuring Point ______

Drawing of Well and Measuring Point

Date (Mo. Da. Yr)	Time (24 Hr. Clock)	Tape Reading At Measuring Point	Tape Reading at Water Mark	M.P. Correction	Instrument Correction	Water Level Below Ground Surface	Water Level Above MSL	Instrument Type And Number	Recorded by	Remarks

Comments ______________

Checked by ______________ Date ______________

Form F-1004
9/1/91

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FIGURE 2-6

Potentiometric Level Measurement

groundwater (static water level) in each monitoring well with a battery-powered Solinst sounder prior to purging and sampling the monitoring wells. The sounder has marks on it at regular intervals to indicate distance.

The measurements will be made by lowering the sounder into the monitoring well until it contacts the groundwater surface. The depth to groundwater will be measured to the nearest 0.01 foot from a clearly marked reference point on the top of each monitoring well casing. These measurements will be taken at least twice for each monitoring well; the variation between the two measurements must be less than 0.01 foot. The groundwater elevation will be this depth measurement subtracted from the elevation of the reference point on the monitoring well casing. The elevation of this reference point will be survey-established from a benchmark located on site. The sounder will be decontaminated prior to initial use and between each monitoring well to be measured.

The following monitoring wells shall be measured for static water levels at the Ash Disposal Cell in Trench 5 during each of the five rounds of ground water sampling:

- Three newly-installed shallow monitoring wells.
- All T-Series monitoring wells.
- All G-Series monitoring wells.
- All Jaycor monitoring wells.

The following monitoring wells shall be measured for static water levels at Line 6 during each of the five rounds of ground water sampling:

- All T-Series monitoring wells.
- All Z-Series monitoring wells.

2.7.3 MONITORING WELL PURGING

The water standing in the monitoring well may not be representative of in-situ groundwater quality. Therefore, it is necessary to purge the monitoring well prior to sampling to achieve a representative groundwater sample. Purging and sampling will be recorded on a Groundwater Purge and Sample Log (Figure 2-7). Before purging the monitoring well, the static water level will be measured using an electric sounder and the depth to the bottom of the monitoring well will be measured using a weighted, calibrated measuring tape.

After the static water level and monitoring well depth have been measured, a Teflon™ bailer or the dedicated bladder pumps will be used to purge water in the casing and water in the filter pack. At least five SWVs (Section 2.6.6.1 of the QAP) will be purged from the monitoring well, unless the monitoring well is purged dry before five SWVs have been achieved.

If the monitoring well is capable of yielding five SWVs, groundwater will be collected once before, twice during, and once after purging and tested for temperature, pH, and specific conductance. Samples will be measured quickly so as to have as little contact with the atmosphere as possible. Groundwater samples will be collected immediately following purging. The temperature, pH, and specific conductance will also be measured after sampling.

GROUND WATER PURGING AND SAMPLING RECORD

Date: Well ID: Sample Number: Recorded By:
Project Name: Well Location: Duplicate Number: Checked By:
Project Number:

EQUIPMENT

pH/Conductivity/Temperature Meter #: Purging Equipment:
PID #: Sampling Equipment:
Electric Sounder #:

WELL DATA

Elevation: Water Column in Well: Total Vol. Extr.:
Well Diameter: Borehole Diameter: Ambient PID:
Well Depth: Water Column in Borehole: Well Mouth PID:
Depth to Well Water: Standing Water Vol.:

Ground Condition of Well:
Remarks:

	PURGING				SAMPLING	
	1	2	3	4	1	2
Time						
Rate						
Temperature						
pH						
Conductivity						
Vol. Purged						
Remarks						

COLLECTED SAMPLES

	1	2	3	4	5	6
Sample Type						
Analytical Param						
Volume Required						
Preservation						
Field Filtered						
Time						

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FIGURE 2-7

Ground Water Purging and Sampling Record

If the monitoring well is incapable of yielding five SWVs, the monitoring well will be purged until it has been purged dry and then allowed to recover. If the monitoring well recovers rapidly, a second SWV will be purged. After the monitoring well has recovered sufficiently from the second purging, the sample will be collected. The temperature, pH, and specific conductance will also be recorded after sampling.

If recovery is very slow, a sample will be collected as soon as enough water has entered the monitoring well. The temperature, pH, and specific conductance will also be recorded after the sampling.

During purging, values for temperature, pH, and specific conductance will be recorded on the form shown on Figure 2-7. Color and any odor will be recorded under the remarks column. Values for temperature, pH, and specific conductance measured in the actual groundwater samples collected for analysis will be recorded on the form shown on Figure 2-7.

2.7.4 GROUNDWATER SAMPLE WITHDRAWAL

The groundwater sampling techniques employed will be based on the analyses to be performed on the sample. Table 2-6 lists the (1) analyses that will be performed during the assessment, (2) sample containers that will be used for each analysis, and (3) holding times for each analysis. Personnel performing groundwater sampling shall wear clean, chemical-resistant gloves when obtaining a groundwater sample. New gloves shall be used collect groundwater samples from each well. Groundwater samples will be collected using pre-cleaned, Voss disposable Teflon™ bailer. A stainless steel chain will be used to lower the bailer into the monitoring well. Groundwater samples will be collected by placing a Teflon™ sampling nipple into the bottom of the bailer and allowing the sample to flow directly into the sample container(s).

Sample bottles and caps will be rinsed three times with the sample water. After the third rinse, preservative (HCl, NHO_3, etc.), as required, will be added to the sample bottles. VOC samples will be collected in 40-mL glass bottles allowing no headspace. This will be accomplished by filling the bottle until a meniscus is over the top of the bottle, and fitting the cap securely. Headspace will be checked by inverting the bottle and tapping the top to see if any air bubbles are visible in the bottle. If an air bubble appears, the above procedure will be repeated with a new 40-ml glass bottle because the sample bottles will contain HCl as a preservative to extend the holding time of the sample.

Samples collected for all other analyses will be collected in the same manner as for VOCs, but will be placed in plastic or glass containers filled to the top. If preservatives are in the containers, they will not be allowed to overflow while filling.

The samples will be collected in order of decreasing volatilization as follows:

1. Coliform Bacteria
2. TCL VOCs
3. TOX
4. TOC
5. SVOCs
6. Explosives
7. TCL Pesticides/PCBs
8. 2,4-D
9. 2,4,5-TP Silvex
10. Phenols (Total)

TABLE 2-6
ANALYSIS, CONTAINERS, VOLUME, PRESERVATION, AND HOLDING TIMES FOR GROUNDWATER SAMPLES COLLECTED AT THE ASH DISPOSAL CELL IN TRENCH 5 AND LINE 6

Parameter	Container	Volume Required	Preservation	Maximum Holding Time
VOCs by Purge and Trap GC/MS	S	2×40 mL	Cool, 4°C; HCl to pH <2	14 days (7 days if not pH adjusted)
TOX by Adsorption-Pyrolysis-Titrimetric	G	500 mL	Cool, 4°C; 1ml of 0.1M sodium sulfite	7 days
TOC by UV	G	500 mL	Cool, 4°C; HCl or H2SO4 to <2	28 days
SVOCs by GC/MS	G	2×1 L	Cool, 4°C	7 days
Explosives by HCLP	G	2×1 L	Cool, 4°C	7 days to analysis
Antimony by GFAA	P	1×1 L	Cool, 4°C; HNO_3 to pH <2	6 months
Arsenic by GFAA	P	1×1 L	Cool, 4°C; HNO_3 to pH <2	6 months
Lead by GFAA	P	1×1 L	Cool, 4°C; HNO_3 to pH <2	6 months
Selenium by GFAA	P,G	1×1 L	HNO_3 to pH <2	6 months
Barium by ICAP	P	1×1 L	Cool, 4°C; HNO_3 to pH <2	6 months
Cadmium by ICAP	P	1×1 L	Cool, 4°C; HNO_3 to pH <2	6 months
Chromium by ICAP	P	1×1 L	Cool, 4°C; HNO_3 to pH <2	6 months
Iron by ICAP	P,G	1×1 L	HNO_3 to pH <2	6 months
Manganese by ICAP	P,G	1×1 L	HNO_3 to pH <2	6 months
Silver by ICAP	P	1×1 L	Cool, 4°C; HNO_3 to pH <2	6 months
Sodium by ICAP	P	1×1 L	Cool, 4°C; HNO_3 to pH <2	6 months
Mercury by CVAA	P	1×1 L	Cool, 4°C; HNO_3 to pH <2	28 days
Pesticides (1)/PCBs by GC	G	2×1L	Cool, 4°C; pH 5-9 for pesticides (2)	7 days until extraction 40 days after extraction
Cyanide by Colorimetric	P	1×1 L	Cool, 4°C; NaOH to pH>12; 0.6g Ascorbic Acid (3)	14 days (4)
Fluoride by IC	P	1×1 L	None Required	28 days
Chloride by IC	P	1×1 L	None Required	28 days
Sulfate by IC	P	1×1 L	Cool, 4°C	28 days
Nitrate by IC	P	1×1 L	Cool, 4°C	48 hours
Ammonia by Distillation	P	500 mL	Cool, 4°C; H_2SO_4 to pH <2	28 days

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TABLE 2-6
ANALYSIS, CONTAINERS, VOLUME, PRESERVATION, AND HOLDING TIMES FOR GROUNDWATER SAMPLES COLLECTED AT THE ASH DISPOSAL CELL IN TRENCH 5 AND LINE 6

Continued

Parameter	Container	Volume Required	Preservation	Maximum Holding Time
pH lab determined	P	250 mL	None Required	Analyze Immediately
Specific Conductance lab determined	P	250 mL	Cool, 4°C	28 days
Temperature field determined	P	250 mL	None Required	Analyze Immediately
Gross Alpha by proportional counting or scintillation	P,G	1×1 L	HNO_3 to pH <2	6 months
Gross Beta by proportional counting or scintillation	P,G	1×1 L	HNO_3 to pH <2	6 months
Radium by proportional counting or scintillation	P,G	1×1 L	HNO_3 to pH <2	6 months
Phenols by Spectrophotometric	G	500 mL	Cool, 4°C, H_2SO_4 to pH <2	28 days
Coliform Bacteria by membrane filter	P,G	100 mL	Cool, 4°C, 0.008% $Na_2S_2O_3$	6 hours
2,4-D by GC	G	1×1 L	Cool, 4°C, pH5-9	40 days after extraction
2,4,5-TP Silvex by GC	G	1×1 L	Cool, 4°C, pH5-9	40 days after extraction

Key:
CVAA = Cold Vapor Atomic Absorption
G = Amber Glass with Teflon-Lined Cap
GC = Gas Chromatography
GC/MS = Gas Chromatography/Mass Spectrometer
GFAA = Graphite Furnace Atomic Absorption
HPLC = High Pressure Liquid Chromatography
IC = Ion Chromatography
ICAP = Inductively Coupled Argon Plasma
P = Polyethylene

(1) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times must be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and 40 days after extraction.

(2) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.007% Na2S203.

(3) Should be used only in the presence of residual chlorine.

(4) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustment in order to determine if sulfide is present. If sulfide is present, it can be removed by addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.

11. Fluoride
12. Chloride
13. Sulfate
14. Nitrate
15. Ammonia
16. Total Metals
17. Dissolved Metals
18. Cyanide
19. Gross Alpha
20. Gross Beta
21. Radium

Temperature, pH, and specific conductance will be measured and recorded (Figure 2-7) before and after sampling to document the stability of the water over the sampling period. The final measurement of those parameters will be used in assessing groundwater quality.

2.7.5 Duplicate Samples & Field Blanks

The following sections define duplicate groundwater samples and field blanks and explains how they will be used in the assessment. The quantity of duplicate groundwater samples and field blanks are summarized in Table 2-3. All duplicate samples will be labeled as normal field samples (Section 2.9.1.1) so that laboratory personnel are unable to distinguish them from normal environmental samples. The numbering system for field blanks includes a number to identify the unit (5 for the Ash Disposal Cell in Trench 5 and 6 for Line 6), plus the letters TB for trip blanks, AB for ambient conditions blanks and RB for rinseate blanks. This is followed by a sequential number (date of collection) incremented throughout the project. As an example, 5TB1206 would be a trip blank collected at Line 5 on December 6.

2.7.5.1 Duplicates

A sample duplicate is defined as two or more samples collected independently at a sampling location during a single act of sampling. Groundwater sample duplicates will be collected at the rate of one (1) groundwater duplicate for every 20 normal groundwater samples. Groundwater sample duplicates will be analyzed for all applicable analyses.

2.7.5.2 Trip Blanks

Trip blanks are defined as volatile organic analyte (VOA) sample bottles that are filled in the laboratory with ASTM Type II reagent-grade water, transported to the sampling location but never opened, and returned to the laboratory with normal environmental samples being analyzed for VOCs. One trip blank will accompany each cooler containing samples being submitted for VOC analysis.

2.7.5.3 Ambient Conditions Blank

Ambient conditions blanks are defined as samples collected by pouring ASTM Type II reagent-grade water into VOA sample containers at a sampling location. They are handled and labeled as samples and transported to the laboratory for analysis. One ambient conditions blank will be collected at the Ash Disposal Cell in Trench 5 for each round of groundwater sampling.

2.7.5.4 Rinseate Blanks

Rinseate blanks are defined as samples made of ASTM Type II reagent-grade water that has been poured through or pumped through (in the case of pumps) the soil sampling device into the required sample bottle, and transported to the laboratory for analysis. One set of rinseate blanks will be collected at the Ash Disposal Cell in Trench 5 and at Line 6 for each round of groundwater sampling. The rinseate blanks will be analyzed for all analyses being performed on groundwater samples collected at the Ash Disposal Cell in Trench 5 and at Line 6.

2.7.6 MONITORING WELL PURGE WATER

Monitoring well purge water will be containerized and stored at the wellhead in labeled 55-gallon drums. Labels will identify the unit, monitoring well, and date of sample collection. Disposal of development water will be based on analytical results of the subsequent groundwater sample from that monitoring well. If the sample is non-hazardous, the purge water will be disposed of on site, downgradient of the unit. If the groundwater sample is hazardous, the purge water will be disposed of through the carbon treatment system at the IAAP, after approval by IAAP personnel.

2.7.7 GROUNDWATER SAMPLING EQUIPMENT DECONTAMINATION

All non-disposable sampling equipment, including internal components, will be thoroughly decontaminated prior to use and between sample locations to avoid cross contamination. All decontamination associated with groundwater sampling will be recorded on the Decontamination Record (Figure 2-1). All equipment used for groundwater sampling will be decontaminated as follows:

- Rinse with potable water from an USAEC-approved source
- Second rinse with potable water

Sampling equipment used to collect samples for organic analysis will not be allowed to come into contact with any type of plastic, such as plastic storage bags. Sampling equipment not immediately reused will be wrapped in aluminum foil.

Purge equipment, including bailers and pumps, will be decontaminated by flushing/pumping, potable water from an USAEC-approved source , then a second potable water rinse through the components. The exterior of the pump inlet hose will be steam cleaned.

Decontamination fluids will be containerized in labeled 55-gallon drums and kept on site at the decontamination pad prior to delivery to the IAAP carbon filter treatment system. TETC is responsible for arranging disposal for all other materials associated with groundwater sampling.

2.8 SURVEYING

The ground surface elevation and location of all newly-installed monitoring wells will be surveyed at the completion of all monitoring well installation. In addition, the elevation of the top of the monitoring well casing will be surveyed from a notch on the north side of the casing

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and determined to 0.01 foot. All measurements will be traceable to, and previously established from, a U.S. Costal and Geodetic Survey (USCGS) or U.S. Geological Survey (USGS) survey benchmark. Map coordinates will be determined by using either the Universal Transverse Mercator (UTM) on the State Planar grid to within ± 3 feet. All surveyed locations, benchmarks, and permanent markers will be recorded on both unit-specific and facility maps. All surveying will be conducted by a certified land surveyor.

2.9 SAMPLE LABELING AND CHAIN OF CUSTODY

2.9.1 SAMPLE IDENTIFICATION

Throughout the field program, consistent and thorough sample identification will be performed by field personnel. This section documents the requirements and contingencies for this procedure.

2.9.1.1 Sample Identification Code

Sample identification will be achieved through the use of a 3 part code. The first part will indicate the number of the unit, according to the following list:

Name	**Unit Number**
Ash Disposal Cell in Trench 5	5
Line 6	6

The second part will indicate the source of the sample, and will use the abbreviation system described below. Each source will be numbered, as indicated by the ''n'' in the following designations.

Location Type	**Abbreviation**
Groundwater Monitoring Well (Terracon)	TCn
Groundwater Monitoring Well (TETC)	ETn
Soil Boring	SBn

The third part will indicate the specific number of the sample obtained from the location. This numbering will begin with 01 and will increase by 1 unit each time a sample is collected from that location during this assessment, regardless of date or time. Single-digit numbers for samples obtained from a specific location will be reported with a zero preceding, such as 01.

Two examples of this numbering system are presented below:

- Third soil sample collected for analysis from soil boring number 6 at the Ash Disposal Cell in Trench 5: 5SB603

- Second groundwater sample collected for analysis from Terracon monitoring well number 10 at Line 6: 6TC1002

Each sample number along with the sample depth, date, and time the sample was obtained will be recorded in the bound logbook and written on a sample label. After collection and identification, the sample will be handled under COC procedures.

2.9.1.2 Sample Tags - Soil Samples

Sample tags for soil sample containers are illustrated in Figure 2-8. The information recorded on the sample tag will include:

- Installation where sample is being collected
- Site name
- Sample identification
- Depth of soil sample
- Date and time of sample collection
- Initials of the sampler
- Types of analyses to be conducted.

Sample tags will be affixed by the samplers to the sampler liners or other container used.

2.9.1.3 Sample Tags - Groundwater Samples

Sample tags for groundwater sample containers are illustrated in Figure 2-9. The information recorded on the sample tag will include:

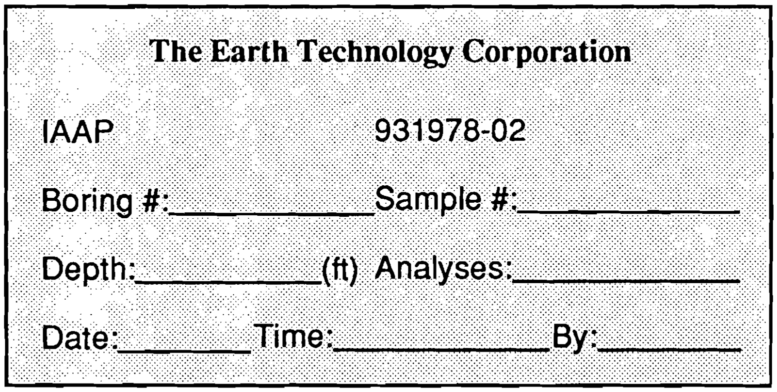
- Installation where sample is being collected
- Site name
- Sample identification
- Date and time of sample collection
- Initials of the sampler
- Preservative used (when appropriate)
- Types of analyses to be conducted.

Sample tags will be affixed by the samplers to the sample containers used.

2.9.2 SAMPLE PACKAGING, AND SHIPPING

All samples will be packaged carefully to avoid breakage or cross contamination, and will be shipped to the laboratory at proper temperatures. The following sample packaging requirements will be followed:

- Sample container tops will not be mixed. All tops will stay with the original containers.



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IAAP 931978-02

Boring #:__________ Sample #:__________

Depth:__________(ft) Analyses:__________

Date:_______ Time:__________ By:________

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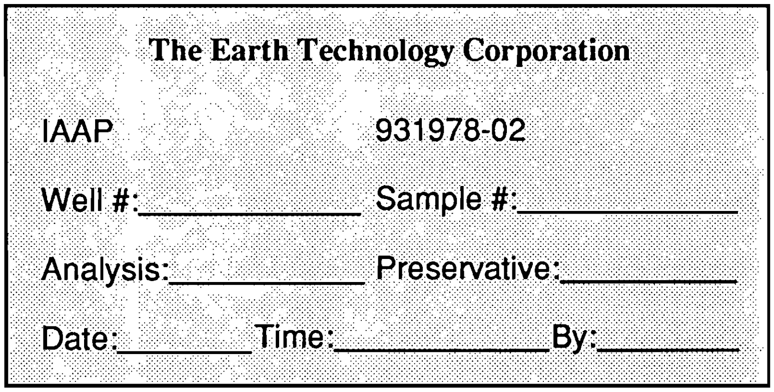
FIGURE 2-8

Soil Sample Label



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IAAP 931978-02

Well #:____________ Sample #:____________

Analysis:___________ Preservative:__________

Date:_______Time:____________By:________

The Earth Technology Corporation

FIGURE 2-9

Ground Water Sample Label

- If the sample volume level is low because of limited sample availability, the level will be marked with a grease pencil. This procedure will help the laboratory determine if any leakage occurred during shipment.
- All glass sample bottles will be wrapped in bubble pack and placed in plastic bags to minimize the potential for breakage and cross contamination during shipment. Plastic bottles will not be wrapped, but will be placed in plastic bags.
- All samples will be cooled to 4°C. The coolers will be filled with ice within Zip-lock™ bags or blue ice. One temperature blank will be added to each cooler. A temperature blank is defined as a VOA sample bottle that is filled with deionized water and sent to the laboratory with the environmental samples. The temperature will be determined immediately upon recepit at the laboratory. The bagged sample containers will be packed in vermiculite.
- Empty space in the cooler will be filled in with vermiculite. Under no circumstances will locally obtained material (sawdust, sand, etc.) be used.
- The COC record will be placed in a plastic bag and taped to the inside of the cooler lid.
- All shipping containers will be custody-sealed for shipment to the laboratory. The custody seal will be covered with filament tape wrapped around the shipping container at least twice before the sample container is shipped to the laboratory.

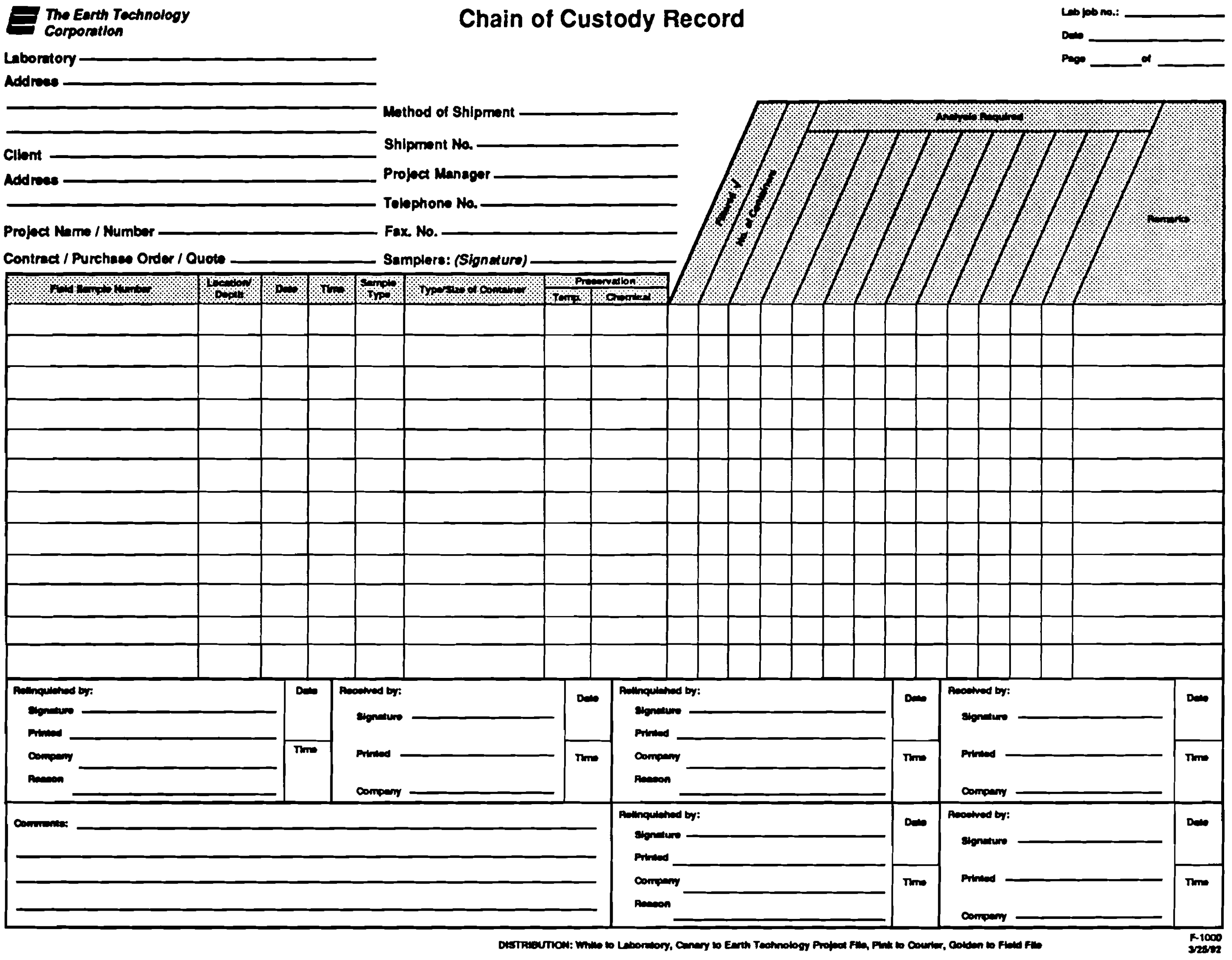
2.9.3 SAMPLE CUSTODY

In order to maintain and document sample custody, the following COC procedures will be strictly followed. A sample is considered to be under custody if:

- It is in actual possession of the responsible person,
- It is in view, following physical possession,
- It is in the possession of a responsible person and is locked or sealed to prevent tampering, or
- It is in a secure area.

2.9.3.1 Chain-of-Custody Record

Sample custody is maintained by a "COC Record" as illustrated in Figure 2-10. The custody record is completed by the individual designated by the Project Manager as being responsible for sample shipment and must be completed at the sampling location. The information recorded on this record will include the following:



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Chain of Custody Record

Lab job no.: ____________
Date ____________
Page ______ of ______

Laboratory ____________
Address ____________
____
____
Client ____________
Address ____________
____
Project Name / Number ____________
Contract / Purchase Order / Quote ____________

Method of Shipment ____________
Shipment No. ____________
Project Manager ____________
Telephone No. ____________
Fax. No. ____________
Samplers: *(Signature)* ____________

Field Sample Number	Location/ Depth	Date	Time	Sample Type	Type/Size of Container	Preservation		Filtered ✓	No. of Containers	Analysis Required											Remarks
						Temp.	Chemical														

Relinquished by: Signature ____________ Printed ____________ Company ____________ Reason ____________	Date Time	**Received by:** Signature ____________ Printed ____________ Company ____________	Date Time	**Relinquished by:** Signature ____________ Printed ____________ Company ____________ Reason ____________	Date Time	**Received by:** Signature ____________ Printed ____________ Company ____________	Date Time
Comments: ____________ ____________ ____________ ____________				**Relinquished by:** Signature ____________ Printed ____________ Company ____________ Reason ____________	Date Time	**Received by:** Signature ____________ Printed ____________ Company ____________	Date Time

DISTRIBUTION: White to Laboratory, Canary to Earth Technology Project File, Pink to Courier, Golden to Field File

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FIGURE 2-10

Chain of Custody Record

Date - Date COC was filled out

Page - Page number and total number of pages

Laboratory - Name of laboratory samples are to be shipped to

Address - Address of laboratory doing the analysis

Client - The Earth Technology Corporation

Address - 1420 King Street, Suite 600, Alexandria, VA 22314

Project Name - The project title: IAAP

Project Number - The project number: 931978-02

Method of Shipment - Print the name of the shipment company (e.g., FEDEX, courier)

Shipment Number - Consecutive number from start of project

Project Manager - Daniel Bostwick

Telephone No. - 703/549-8728

Fax No. - 703/549-9134

Samplers - Signature of person(s) collecting the samples

Field Sample Number - Write the number of the sample

Location - Print the location, or sample depth

Date, Time - Date and time sample was collected

Sample Type - Print the type of material, e.g., soil

Type/Size of Container - Print the type or size of sample container, e.g., 40 ml VOA

Type of Preservation - Print the preservation temperature (e.g., 4°C) and the preservation chemical (e.g., HNO_3 to pH < 2)

Filtered - Put a check mark if sample has been filtered in the field

Number of Containers - Number of sample containers

Analysis Required	-	Print the type of analysis required TCL VOCs (e.g., LM33)
Relinquished by	-	Signature and printed name of the person relinquishing the sample
Company	-	Print the name of the organization relinquishing the sample
Reason	-	State reason for sample transfer, e.g., transport to laboratory
Date/Time	-	Date and time at which sample custody was transferred
Received by	-	Signature and printed name of the receiving person
Company	-	Print the name of the receiving organization

Laboratory job number, laboratory sample number, and contract/PO/quote information will be completed by the laboratories.

The completed original COC form should be returned promptly to TETC by laboratory personnel upon initial receipt of the samples and completion of the form. The original form shall be a permanent part of the project records. Distribution is as follows:

White Copy	-	Project Office file
Canary	-	Testing laboratory
Pink	-	Courier or delivery service
Goldenrod	-	USAEC Project Manager

2.9.3.2 Transfer of Custody

Field personnel initially taking the sample are responsible for the care and custody of the sample(s) until it is properly transferred or delivered to laboratory personnel. All samples will be accompanied by a COC record. When transferring the possession of samples, the individuals relinquishing and receiving the samples will sign, date, and note the time on the record. The companies from which the sample is relinquished and to which it is delivered, and the reason for transfer will also be noted. This record documents the transfer of samples from the custody of the sampler to that of another person, or the laboratory.

The relinquishing individual will record specific shipping data (air bill number, office, time, and date) on the original and duplicate custody records. It is the Project Manager's responsibility to ensure that all shipping data are consistent and that they are made part of the permanent job file.

If sent by mail, the package will be sent by registered mail, with a return receipt requested. If sent by common carrier, a bill of lading will be used. Freight bills, postal service receipts, and bills of lading will be retained as part of the permanent documentation.

Sample shipment destinations will be as follows:

Sample	Type of Analysis	Ship to
Soil, groundwater	Analytical Chemistry	Pace, Incorporated (Minneapolis, MN)
Soil	Physical Tests	TETC Field and Laboratory Testing Services (Huntington Beach, CA)

2.9.4 LABORATORY OPERATIONS, PACE, INC.

All sample log-in, storage, and COC documentation are the responsibility of the sample custodian. Only the sample custodian is authorized to sign for incoming samples. The sample custodian is responsible for retaining documents of shipment, and verifying data entered into the laboratory custody records. In addition, the sample custodian will ensure that sample storage is secure and maintained at the proper temperature.

2.9.5 SAMPLE CUSTODY RECORDS

All samples shall be accompanied by a field COC record. A COC record must also be used if the laboratory relinquishes control of the samples to subcontractor laboratories or returns the samples to the originator. A laboratory COC is used to track the samples within the laboratory. All field COC records are filed permanently with the analytical data. The completed original COC will be forwarded to TETC.

2.9.6 SAMPLE HANDLING

Upon receipt of USAEC samples the sample custodian signs the field COC, logs samples in, completes a Sample Receipt Checklist, and properly stores the samples in a secure area until they are relinquished to the laboratory. A copy of the field COC, log-in, and Sample Receipt Checklist go into the lot data packets.

Laboratory COC is initiated when the neat samples, assigned to analytical lots, are transferred to an analyst for preparation or analysis. In most cases, the extraction or digestion analyst initiates a second COC with the neat samples, to the sample custodian. A copy of the neat sample COC goes into each applicable data packet along with the extract/digest COC form.

2.10 DATA COLLECTION QAP

This Sample Analysis section of the Data Collection QAP describes the QA and Quality Control (QC) procedures to be used throughout the sampling and analysis of the accelerated groundwater quality assessment at IAAP, in Middletown, Iowa.

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2.11 LABORATORY DQOs

2.11.1 PRELIMINARY LABORATORY DQOs DEVELOPMENT

Quality criteria address the following data characteristics: accuracy, precision, completeness, representativeness, and comparability.

Accuracy: Accuracy is the degree of agreement of a measurement or average of measurements with an accepted reference or "true" value, and is a measure of bias in the system.

For this project, accuracy of the measurement data will be assessed and controlled. Results for blank, standard matrix, and surrogate spikes will be the primary indicators of accuracy. These results will be used to control accuracy within acceptable limits by requiring that they meet specific criteria. As standard matrix spikes and surrogates are analyzed, target concentrations versus found concentrations will be plotted, using the method of least squares linear regression, and the slope will measure the accuracy of the method.

Acceptance limits will be based upon previously established laboratory capabilities for the control analytes using control chart techniques. In this approach, the control limits reflect the minimum and maximum recoveries expected for individual measurements for an in-control system. Recoveries outside the established limits indicate some assignable cause, other than normal measurement error, and possible need for corrective action. This includes recalibration of the instrument, reanalysis of the QC sample, reanalysis of the samples in the lot, or flagging the data as suspect if the problems cannot be resolved. For highly contaminated samples, recovery of surrogates may depend on sample homogeneity.

Precision: Precision is a measure of mutual agreement among individual measurements of the same property under prescribed similar conditions. It is independent of the error (accuracy) of the analyses and reflects only the degree to which the measurements agree with one another, not the degree to which they agree with the "true" value for the parameter measured. Precision of the measurement data for this project will be based upon duplicate/replicate analyses (replicability), control sample analyses (repeatability), and results for duplicate/replicate field samples (sampling replicability). Field duplicates/replicates are defined as two or more samples collected independently at a single sampling location during a single act of sampling. These samples are submitted blind to the laboratory. Field duplicates/replicates will number 5 percent of the original sample number or 1 per lot whichever is greater. At Trench 5, field duplicates/replicates will be collected for groundwater and soil samples and analyzed for the same parameters as the original sample. Field duplicates/replicates will be collected for groundwater samples at Line 6, and analyzed for the same parameters as the original sample.

Discretely sampled field duplicates/replicates are useful in determining sampling variability. However, greater than expected differences between replicates may occur because of inhomogeneity in the sample material. In these instances a visual examination of the sample material will be performed in order to document the reason for the difference. Field sample duplicates/replicates shall be used as a QC measure to monitor precision relative to sample collection activities. Analytical precision shall be evaluated by using duplicate spiked samples. As a part of the method approval process, percent imprecision is calculated using USAEC

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software, for method Classes 1, 1A, and 1B. On a daily basis, precision is tracked for a specific method using a range (R) control chart.

The analyst or his supervisor must investigate the cause of data outside stated acceptance limits. Follow-up action includes recalibration, reanalysis of QC samples if justified, sample reanalysis, or flagging the data as suspect if problems cannot be resolved.

Completeness: Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under correct, normal conditions.

The target value for completeness of all parameters is 100 percent. Measurement data completeness is a measure of the extent to which the database resulting from a measurement effort fulfills objectives for the amount of data required. For this program, completeness will be defined as the valid data percentage of the total tests requested.

Successful analyses are defined as those where the sample arrived at the laboratory intact, properly preserved, in sufficient quantity to perform the requested analyses, and accompanied by a completed COC. Furthermore, the sample must be analyzed within the specified holding time and in such a manner that analytical QC acceptance criteria are met.

Completeness for the entire project also involves completeness of field and laboratory documentation, whether all samples and analyses specified in the Statement of Work have been processed and the procedures specified in this document and laboratory standard operating procedures (SOPs) have been implemented.

For the project as a whole, a completeness value of 90 percent will be considered acceptable. Failure to achieve this goal may necessitate resampling and reanalysis.

Representativeness: Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

The characteristics of representativeness are usually not quantifiable. Subjective factors to be taken into account are as follows:

- Degree of homogeneity of a site
- Degree of homogeneity of a sample taken from one point in a site
- Available information on which a sampling plan is based.

Field duplication and field replication, as defined under precision, are also used to assess representativeness. Two or more samples which are collected at the same location and at the same time, are considered to be equally representative of this condition, at a given point in space and time. To maximize representativeness of results, sampling techniques, sample size, and sample locations will be carefully chosen so they provide laboratory samples representative of the site and the specific area. Properly installed monitoring wells ensure that the groundwater being sampled originates from the aquifer of concern. Care must be taken to ensure proper stabilization of measured water parameters, clarity, and color before groundwater samples are taken. Precautions, such as not operating combustion engines near a well during sampling, must be taken so that introduction of extraneous compounds does not threaten the representativeness of the samples.

Soil samples are even less homogeneous than groundwater, and thus it is important for the sampler and analyst to exercise good judgment when removing a sample. Samples exhibiting obvious stratification or lithologic changes should not be used as duplicates/replicates. Within the laboratory, precautions are taken to extract from the sample container an aliquot representative of the whole sample. For samples requiring volatiles analysis, premixing or homogenizing should be kept to a minimum.

Comparability: Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is ensured through the use of established and approved sample collection techniques and analytical methods, consistency in the basis of analysis (wet weight, volume etc.), consistency in reporting units, and analysis of standard reference materials.

Data comparability will be achieved by using standard units of measure i.e., mg/L for metals and inorganics in water samples, μg/L for organics in water, and mg/kg (dry weight) for both inorganics and organics in soil samples.

The use of standard methods to collect and analyze samples (in this case ASTM and USAEC methods), along with instruments calibrated against Standard Analytical Reference Materials (SARM) which are NIST traceable standards, will also ensure comparability.

Comparability also depends on the other data quality characteristics. Only when data are judged to be representative of the environmental conditions, and when precision and accuracy are known, can data sets be compared with confidence.

2.11.2 QUANTITATIVE LABORATORY DQOs

Project quality objectives for the various measurement parameters associated with site characterization efforts are not quantifiable for representativeness and comparability. Accuracy and precision are tracked daily through the use of USAEC required x-bar and R control charts. A completeness factor of 90 percent is acceptable.

2.12 FIELD SAMPLING PROCEDURES

Sections 2.5 through 2.9 in this QAP contains brief summaries and references for the field tasks to be performed as part of the accelerated groundwater quality assessment effort at IAAP.

2.12.1 SAMPLING PROTOCOLS

Refer to Sections 2.5 through 2.7 for more detailed descriptions of the field sampling procedures that will be used for field activities performed.

2.12.2 SAMPLE HANDLING

Preservation of samples is required to retain integrity. The most common preservation techniques include pH adjustment and temperature control. Field personnel will use USAEC container types and adhere to USAEC preservation techniques for the parameters of concern as listed in Appendix H of the 1990 USATHAMA QAP. Minimum sample volumes required for each analysis are also specified and must be observed. Pre-cleaned sample containers for groundwater samples, will be provided by the laboratory. The containers are pre-cleaned and laboratory certified (I-Chem Superfund Analyzed) with certificate of analysis. The cleaning procedure is in accordance with USAEC specifications for glassware cleaning (Appendix F of the 1990 USATHAMA QAP). The certificate of analysis will be on file at the laboratory.

The sample bottle and its original cap shall be triple rinsed with the sample water prior to filling the bottle with the sample to be analyzed. The appropriate preservative (provided by the laboratory) will be added to the bottle once the sample has been taken and the original cap will be placed securely on the container. Soil samples will consist of stainless steel sampler liners, sealed with Teflon™ paper and plastic caps. Sample containers will be packaged according to procedures outlined in Section 2.9.2. Samples are to be analyzed within the holding times defined in certified laboratory methods, and are never to exceed the prescribed holding times given in Appendix H of the 1990 USATHAMA QAP.

2.13 LABORATORY SAMPLE CUSTODY

Sample custody is described in detail in Section 2.9 in this QAP.

2.14 LABORATORY INSTRUMENT CALIBRATION

Prior to sample analysis, chemical calibration of each target analyte must be performed to ensure analytical instrumentation is functioning properly within the established sensitivity range. Protocols defining the procedures and QC measurements for instrument calibration will be in accordance with criteria specified in the 1990 USATHAMA QA Program and the individual approved methods.

Calibrations for physical and electrical measurements must be NIST traceable and records showing NIST traceability should be readily available. The calibration frequency schedule whether set by the manufacturer of the instrument, or by the laboratory, should be adhered to.

For chemical calibrations, initial calibration for the methods to be used in this project will be performed routinely by the laboratory as part of the approved analytical protocol. New initial calibrations are not required unless the instrument fails the daily calibration test procedure. The initial calibration procedure also requires the analysis of a calibration check standard (in accordance with the 1990 USATHAMA QAP, Section 8.2) before sample analysis can begin.

For Class 1, 1A and 1B methods prior to analysis, all instruments will be calibrated daily to ensure that the instrumental response has not changed significantly from the previous calibration. Analysis should be performed on the highest concentration standard. A response within the required percentage or two standard deviations of the mean response for the same concentration as determined from preperformance demonstration, performance demonstration, and prior initial/daily calibrations, indicates the instrument calibration is acceptable and sample analysis may proceed. If the response fails the percentage or two standard deviation criterion, the daily standard will be reanalyzed. Failure of the second analysis requires initial calibration to be performed as specified in the 1990 USATHAMA QAP. The laboratory will perform daily calibration for Class 2 methods at the beginning and end of the analytical sample sequence.

2.15 ANALYTICAL PROCEDURES

Analytical procedures concerning sample preparation, analysis, and reporting must be in accordance with the approved USAEC method and the guidelines given in the USATHAMA QAP. Analytical methods are given in Table 2-7 and discussed below.

2.15.1 ANALYTICAL METHODS

Standard analytical methods to be used for the sample analyses are approved by USAEC and are similar in scope to USEPA methods.

The purpose of the laboratory analyses is to identify the types and concentrations of contaminants in soil and groundwater. The analytical methods to be performed on soil and groundwater samples collected during the accelerated groundwater quality assessment at IAAP were chosen based on the site history and the contaminants which have been identified during previous investigations. The contaminants of potential concern include explosives, PCBs and various metals.

2.15.2 DETECTION LIMITS

Certified reporting limits (CRL) are required for all methods prior to sample analysis of USAEC projects to evaluate method performance. CRLs are based on all procedures and sample preparations used in the method. Therefore, if any procedure or sample preparation used in the method changes, then the method must be recertified. Analytical methods and their associated CRLs used for IAAP are listed in Table 2-7.

2.16 LABORATORY DATA REDUCTION, VALIDATION, AND REPORTING

2.16.1 DATA REDUCTION

Chemical data shall be submitted to the USAEC Chemistry Branch from the analytical laboratory in data packages. It will be the responsibility of the laboratory QAC to check the raw laboratory data for completeness and accuracy. Raw laboratory data will be transferred from the laboratory reports to the IRDMIS database for group and record checks.

It will be the responsibility of the QAC and Data Manager to ensure that all data transferred to IRDMIS are transferred correctly. All data transferred will be checked at least once for completeness and accuracy of transfer.

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TABLE 2-7A
PACE, INCORPORATED ANALYTICAL METHODS AND CRLS FOR SOIL

Method Number	Method Name	Chemical Constituent	Matrix	Units	CRL
JB06	METALS/CVAA	MERCURY	SO	μg/G	0.087000
JC02	METALS/AA	SILVER	SO	μg/G	1.010000
JD08	METALS/GFAA	ARSENIC	SO	μg/G	18.400000
JS14	METALS/ICP	BARIUM	SO	μg/G	4.870000
	METALS/ICP	CADMIUM	SO	μg/G	0.427000
	METALS/ICP	CHROMIUM	SO	μg/G	0.974000
LH04	PCBGC/ECD	DIBUTYLCHLORENDANTE	SO	μg/G	0.170000
	PCB/GC/ECD	PCB/ 1016	SO	μg/G	0.100000
	PCB/GC/ECD	PCB/ 1248	SO	μg/G	0.090000
	PCB/GC/ECD	PCB/ 1254	SO	μg/G	0.076000
	PCB/GC/ECD	PCB/ 1260	SO	μg/G	0.062000
LH19	ORGANIC/ECD	∝-BENZENE HEXACHLORIDE	SO	μg/G	0.002500
	ORGANIC/ECD	∝-CHLORDANE	SO	μg/G	0.004000
	ORGANIC/ECD	ENDOSULFAN I	SO	μg/G	0.004700
	ORGANIC/ECD	ALDRIN	SO	μg/G	0.013000
	ORGANIC/ECD	β-BENZENEHEXACHLORIDE	SO	μg/G	0.005400
	ORGANIC/ECD	ENDOSULFAN II	SO	μg/G	0.007100
	ORGANIC/ECD	DECACHLOROBIPHENYL	SO	μg/G	0.006900
	ORGANIC/ECD	2,4,5,6-TETRACHLOROMETAXYLENE	SO	μg/G	0.007100
	ORGANIC/ECD	Δ-BENZENEHEXACHLORIDE	SO	μg/G	0.022800
	ORGANIC/ECD	DIELDRIN	SO	μg/G	0.007800
	ORGANIC/ECD	ENDRIN	SO	μg/G	0.011100
	ORGANIC/ECD	ENDRIN ALDEHYDE	SO	μg/G	0.027600
	ORGANIC/ECD	ENDRIN KETONE	SO	μg/G	0.006100
	ORGANIC/ECD	ENDOSULFAN SULFATE	SO	μg/G	0.013000
	ORGANIC/ECD	V-CHLORDANE	SO	μg/G	0.021400
	ORGANIC/ECD	HEPTACHLOR	SO	μg/G	0.009600

TABLE 2-7A
PACE, INCORPORATED ANALYTICAL METHODS AND CRLS FOR SOIL

Continued

Method Number	Method Name	Chemical Constituent	Matrix	Units	CRL
LH19 (Cont.)	ORGANIC/ECD	HEPTACHLOR EPOXIDE	SO	µg/G	0.003900
	ORGANIC/ECD	LINDANE	SO	µg/G	0.020000
	ORGANIC/ECD	METHOXYCHLOR	SO	µg/G	0.211000
	ORGANIC/ECD	ppDDD	SO	µg/G	0.011200
	ORGANIC/ECD	2,2-BIS(P-CHLOROPHENYL)-1,1-DICHLOROETHENE	SO	µg/G	0.014200
	ORGANIC/ECD	2,2-BIS(P-CHLOROPHENYL)-1,1,1-TRICHLOROETHANE	SO	µg/G	0.009600
LM30	SEMIVOLATILES/GCMS	1,2,4-TRICHLOROBENZENE	SO	µg/G	0.290000
	SEMIVOLATILES/GCMS	1,2-DICHLOROBENZENE	SO	µg/G	0.320000
	SEMIVOLATILES/GCMS	1,3-DICHLOROBENZENE	SO	µg/G	0.580000
	SEMIVOLATILES/GCMS	1,4-DICHLOROBENZENE	SO	µg/G	0.170000
	SEMIVOLATILES/GCMS	2,4,5-TRICHLOROPHENOL	SO	µg/G	0.240000
	SEMIVOLATILES/GCMS	2,4,6-TRIBOMOPHENOL	SO	µg/G	0.350000
	SEMIVOLATILES/GCMS	2,4,6-TRICHLOROPHENOL	SO	µg/G	0.300000
	SEMIVOLATILES/GCMS	2,4-DICHLOROPHENOL	SO	µg/G	0.280000
	SEMIVOLATILES/GCMS	2,4-DIMETHYLPHENOL	SO	µg/G	0.330000
	SEMIVOLATILES/GCMS	2,4-DINITROTOLUENE	SO	µg/G	0.310000
	SEMIVOLATILES/GCMS	2,6-DINITROTOLUENE	SO	µg/G	0.200000
	SEMIVOLATILES/GCMS	2-CHLOROPHENOL	SO	µg/G	0.170000
	SEMIVOLATILES/GCMS	2-CHLORONAPHTHALENE	SO	µg/G	0.330000
	SEMIVOLATILES/GCMS	2-FLUOROBIPHENYL	SO	µg/G	0.180000
	SEMIVOLATILES/GCMS	2-FLUOROPHENOL	SO	µg/G	0.350000
	SEMIVOLATILES/GCMS	2-METHYLNAPHTHALENE	SO	µg/G	0.170000
	SEMIVOLATILES/GCMS	2-CRESOL	SO	µg/G	0.170000
	SEMIVOLATILES/GCMS	2-NITROANILINE	SO	µg/G	0.360000
	SEMIVOLATILES/GCMS	2-NITROPHENOL	SO	µg/G	0.260000
	SEMIVOLATILES/GCMS	2-METHYL-4,6-DINITROPHENOL	SO	µg/G	0.840000
	SEMIVOLATILES/GCMS	4-BROMOPHENYL PHENYL ETHER	SO	µg/G	0.170000

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TABLE 2-7A
PACE, INCORPORATED ANALYTICAL METHODS AND CRLs FOR SOIL

Continued

Method Number	Method Name	Chemical Constituent	Matrix	Units	CRL
LM30 (Cont.)	SEMIVOLATILES/GCMS	3-METHYL-4-CHLOROPHENOL	SO	μg/G	0.230000
	SEMIVOLATILES/GCMS	4-CHLOROPHENYL PHENYL ETHER	SO	μg/G	0.200000
	SEMIVOLATILES/GCMS	4-CRESOL	SO	μg/G	0.180000
	SEMIVOLATILES/GCMS	4-NITROPHENOL	SO	μg/G	2.500000
	SEMIVOLATILES/GCMS	ACENAPHTHENE	SO	μg/G	0.270000
	SEMIVOLATILES/GCMS	ACENAPHTHYLENE	SO	μg/G	0.270000
	SEMIVOLATILES/GCMS	ANTHRACENE	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	BIS(2-CHLOROETHYOXY)METHANE	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	BIS(2-CHLOROISOPROPYL)ETHER	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	BIS(2-CHLOROETHYL)ETHER	SO	μg/G	1.600000
	SEMIVOLATILES/GCMS	BIS(2-ETHYLHEXYL)PHTHALATE	SO	μg/G	0.190000
	SEMIVOLATILES/GCMS	BENZO[A]ANTHRACENE	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	BENZO[A]PYRENE	SO	μg/G	0.240000
	SEMIVOLATILES/GCMS	BENZO[B]FLUORANTHENE	SO	μg/G	0.730000
	SEMIVOLATILES/GCMS	BUTLYBENZYL PHTHALATE	SO	μg/G	0.200000
	SEMIVOLATILES/GCMS	BENZOIC ACID	SO	μg/G	0.920000
	SEMIVOLATILES/GCMS	BENZO[GHI]PERYLENE	SO	μg/G	0.250000
	SEMIVOLATILES/GCMS	BENZO[K]FLUORANTHENE	SO	μg/G	0.400000
	SEMIVOLATILES/GCMS	BENZYL ALCOHOL	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	CHRYSENE	SO	μg/G	0.270000
	SEMIVOLATILES/GCMS	HEXACHLOROBENZENE	SO	μg/G	0.260000
	SEMIVOLATILES/GCMS	HEXACHLOROCYCLOPENTA-DIENE	SO	μg/G	1.800000
	SEMIVOLATILES/GCMS	HEXACHLOROETHANE	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	DIBENZ[AH]ANTHRACENE	SO	μg/G	0.270000
	SEMIVOLATILES/GCMS	DIBENZOFURAN	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	DIETHYL PHTHALATE	SO	μg/G	0.350000
	SEMIVOLATILES/GCMS	DIMETHYL PHTHALATE	SO	μg/G	0.170000

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TABLE 2-7A
PACE, INCORPORATED ANALYTICAL METHODS AND CRLS FOR SOIL

Continued

Method Number	Method Name	Chemical Constituent	Matrix	Units	CRL
LM30 (Cont.)	SEMIVOLATILES/GCMS	DI-N-BUTYL PHTHALATE	SO	μg/G	0.510000
	SEMIVOLATILES/GCMS	DI-N-OCTYL PHTHALATE	SO	μg/G	0.220000
	SEMIVOLATILES/GCMS	FLUORANTHENE	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	FLUORENE	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	HEXACHLOROBUTADIENE	SO	μg/G	0.280000
	SEMIVOLATILES/GCMS	INDENO[1,2,3-C,D]PYRENE	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	ISOPHORONE	SO	μg/G	0.320000
	SEMIVOLATILES/GCMS	NAPHTHALENE	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	NITROBENZENE	SO	μg/G	0.190000
	SEMIVOLATILES/GCMS	NITROBENZENE-D5	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	N-NITROSODI-N-PROPLAMINE	SO	μg/G	1.100000
	SEMIVOLATILES/GCMS	N-NITROSODIPHENYLAMINE	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	PENTACHLOROPHENOL	SO	μg/G	0.480000
	SEMIVOLATILES/GCMS	PHENANTHRENE	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	PHENOL-D5	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	PHENOL	SO	μg/G	0.170000
	SEMIVOLATILES/GCMS	PYRENE	SO	μg/G	0.970000
	SEMIVOLATILES/GCMS	TERPHENYL-D14	SO	μg/G	0.740000
LM33	VOLATILES/GCMS	1,1,1-TRICHLOROETHANE	SO	μg/G	0.002500
	VOLATILES/GCMS	1,1,2-TRICHLOROETHANE	SO	μg/G	0.002500
	VOLATILES/GCMS	1,1-DICHLOROETHENE	SO	μg/G	0.032400
	VOLATILES/GCMS	1,1-DICHLOROETHANE	SO	μg/G	0.002500
	VOLATILES/GCMS	1,2-DICHLOROETHANE-D4	SO	μg/G	0.002500
	VOLATILES/GCMS	1,2-DICHLOROETHANE	SO	μg/G	0.002690
	VOLATILES/GCMS	1,2-DICHLOROPROPANE	SO	μg/G	0.002500
	VOLATILES/GCMS	4-BROMOFLUOROBENZENE	SO	μg/G	0.002500
	VOLATILES/GCMS	ACETONE	SO	μg/G	0.044600

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TABLE 2-7A
PACE, INCORPORATED ANALYTICAL METHODS AND CRLS FOR SOIL

Continued

Method Number	Method Name	Chemical Constituent	Matrix	Units	CRL
LM33 (Cont.)	VOLATILES/GCMS	BROMODICHLOROMETHANE	SO	μg/G	0.002500
	VOLATILES/GCMS	CIS-1,2-DICHLOROETHENE	SO	μg/G	0.002500
	VOLATILES/GCMS	CIS-1,3-DICHLOROPROPENE	SO	μg/G	0.002950
	VOLATILES/GCMS	CHLOROETHENE	SO	μg/G	0.003800
	VOLATILES/GCMS	CHLOROETHANE	SO	μg/G	0.002950
	VOLATILES/GCMS	BENZENE	SO	μg/G	0.002500
	VOLATILES/GCMS	CARBON TETRACHLORIDE	SO	μg/G	0.003110
	VOLATILES/GCMS	METHYLENE CHLORIDE	SO	μg/G	0.006160
	VOLATILES/GCMS	BROMOMETHANE	SO	μg/G	0.003100
	VOLATILES/GCMS	CHLOROMETHANE	SO	μg/G	0.035000
	VOLATILES/GCMS	BROMOFORM	SO	μg/G	0.002500
	VOLATILES/GCMS	CHLOROFORM	SO	μg/G	0.002650
	VOLATILES/GCMS	CHLOROBENZENE	SO	μg/G	0.002500
	VOLATILES/GCMS	CARBON DISULFIDE	SO	μg/G	0.014000
	VOLATILES/GCMS	DIBROMOCHLOROMETHANE	SO	μg/G	0.056600
	VOLATILES/GCMS	ETHYLBENZENE	SO	μg/G	0.002540
	VOLATILES/GCMS	TOLUENE-D8	SO	μg/G	0.002500
	VOLATILES/GCMS	TOLUENE	SO	μg/G	0.002500
	VOLATILES/GCMS	METHYL ETHYL KETONE	SO	μg/G	0.005100
	VOLATILES/GCMS	METHYL ISOBUTYL KETONE	SO	μg/G	0.018600
	VOLATILES/GCMS	2-HEXANONE	SO	μg/G	0.017600
	VOLATILES/GCMS	STYRENE	SO	μg/G	0.002500
	VOLATILES/GCMS	TRANS-1,2-DICHLOROETHENE	SO	μg/G	0.002500
	VOLATILES/GCMS	TRANS-1,3-DICHLOROPROPENE	SO	μg/G	0.002500

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TABLE 2-7A
PACE, INCORPORATED ANALYTICAL METHODS AND CRLS FOR SOIL

Continued

Method Number	Method Name	Chemical Constituent	Matrix	Units	CRL
LM33 (Cont.)	VOLATILES/GCMS	TETRACHLOROETHANE	SO	µg/G	0.011800
	VOLATILES/GCMS	TETRACHLOROETHENE	SO	µg/G	0.002500
	VOLATILES/GCMS	TRICHLOROETHENE	SO	µg/G	0.002500
	VOLATILES/GCMS	XYLENE, TOTAL COMBINED	SO	µg/G	0.007500
LW32	NITROAROMATICS/HPLC	2,4,6-TRINITROTOLUENE	SO	µg/G	0.250000
	NITROAROMATICS/HPLC	2,4-DINITROTOLUENE	SO	µg/G	0.251000
	NITROAROMATICS/HPLC	2,6-DINITROTOLUENE	SO	µg/G	0.500000
	NITROAROMATICS/HPLC	CYCLOTETRAMETHYLENETETRANITRAMINE	SO	µg/G	0.499000
	NITROAROMATICS/HPLC	RDX	SO	µg/G	0.510000
	NITROAROMATICS/HPLC	TETRYL	SO	µg/G	1.270000

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TABLE 2-7B
PACE, INCORPORATED ANALYTICAL METHODS AND CRLS FOR GROUNDWATER

Method Number	Method Name	Chemical Constituent	Matrix	Units	CRL
SB07	METALS/CVAA	MERCURY	WA	μg/L	0.740000
SD08	METALS/GFAA	ARSENIC	WA	μg/L	6.010000
	METALS/GFAA	CADMIUM	WA	μg/L	0.370000
	METALS/GFAA	LEAD	WA	μg/L	1.260000
	METALS/GFAA	SELENIUM	WA	μg/L	14.900000
	METALS/GFAA	ANTIMONY	WA	μg/L	25.500000
SS15	METALS/ICP	BARIUM	WA	μg/L	20.000000
	METALS/ICP	IRON	WA	μg/L	120.000000
	METALS/ICP	MANGANESE	WA	μg/L	5.110000
	METALS/ICP	SILVER	WA	μg/L	12.500000
	METALS/ICP	CADMIUM	WA	μg/L	5.000000
	METALS/ICP	CHROMIUM	WA	μg/L	15.000000
	METALS/ICP	SODIUM	WA	μg/L	500.000000
TT12	ANIONS/IC	NITRATE	WA	μg/L	13.800000
	ANIONS/IC	FLUORIDE	WA	μg/L	40.300000
	ANIONS/IC	CHLORIDE	WA	μg/L	268.000000
	ANIONS/IC	SULFATE	WA	μg/L	351.000000
TY03	ANIONS/SPECT	CYANIDE	WA	μg/L	8.170000
UH04	PCB/GC/ECD	DIBUTYLCHLORENDATE	WA	μg/L	0.380000
	PCB/GC/ECD	PCB 1016	WA	μg/L	0.060000
	PCB/GC/ECD	PCB 1248	WA	μg/L	0.110000
	PCB/GC/ECD	PCB 1254	WA	μg/L	0.069000
	PCB/GC/ECD	PCB 1260	WA	μg/L	0.057000
UH21	ORGANIC/ECD	α-BENZENE HEXACHLORIDE	WA	μg/L	0.043400
	ORGANIC/ECD	α-CHLORDANE	WA	μg/L	0.020200
	ORGANIC/ECD	ENDOSULFAN I	WA	μg/L	0.008560
	ORGANIC/ECD	ALDRIN	WA	μg/L	0.063800
	ORGANIC/ECD	β-BENZENEHEXACHLORIDE	WA	μg/L	0.010900
	ORGANIC/ECD	ENDOSULFAN II	WA	μg/L	0.012000
	ORGANIC/ECD	DECACHLOROBIPHENYL	WA	μg/L	0.014000
	ORGANIC/ECD	2,4,5,6-TETRACHLOROMETAXYLENE	WA	μg/L	0.076700

TABLE 2-7B
PACE, INCORPORATED ANALYTICAL METHODS AND CRLS FOR GROUNDWATER

Continued

Method Number	Method Name	Chemical Constituent	Matrix	Units	CRL
UH21 (Cont.)	ORGANIC/ECD	∆-BENZENEHEXACHLORIDE	WA	μg/L	0.048800
	ORGANIC/ECD	DIELDRIN	WA	μg/L	0.032100
	ORGANIC/ECD	ENDRIN	WA	μg/L	0.037200
	ORGANIC/ECD	ENDRIN ALDEHYDE	WA	μg/L	0.069700
	ORGANIC/ECD	ENDRIN KETONE	WA	μg/L	0.028200
	ORGANIC/ECD	ENDOSULFAN SULFATE	WA	μg/L	0.020000
	ORGANIC/ECD	V-CHLORDANE	WA	μg/L	0.045000
	ORGANIC/ECD	HEPTACHLOR	WA	μg/L	0.063100
	ORGANIC/ECD	HEPTACHLOR EPOXIDE	WA	μg/L	0.006000
	ORGANIC/ECD	LINDANE	WA	μg/L	0.042900
	ORGANIC/ECD	METHOXYCHLOR	WA	μg/L	0.267000
	ORGANIC/ECD	ppDDD	WA	μg/L	0.084800
	ORGANIC/ECD	2,2-BIS(P-CHLOROPHENYL)-1,1-DICHLOROETHENE	WA	μg/L	0.094600
	ORGANIC/ECD	2,2-BIS(P-CHLOROPHENYL)-1,1,1-TRICHLOROETHANE	WA	μg/L	0.031600
UH22	HERBICIDE/GC/ECD	2,4-D	WA	μg/L	1.050000
	HERBICIDE/GC/ECD	2,4,5-TP SILVEX	WA	μg/L	0.078400
9310	RADIONUCLIDES/COUNT	GROSS ALPHA	WA	pCi/L	*TBD
	RADIONUCLIDES/COUNT	GROSS BETA	WA	pCi/L	*TBD
9320	RADIONUCLIDES/COUNT	RADIUM	WA	pCi/L	*TBD
9132	BACTERIA/MEMBRANE FILTER	COLIFORM BACTERIA	WA	*cpm	1
9067	PHENOLS/SPECTROPHOTOMETRIC	PHENOL	WA	μg/L	*TBD
UW35	EXPLOSIVES/HPLC	246TNT	WA	μg/L	0.319000
	EXPLOSIVES/HPLC	2,6-DINITROTOLUENE	WA	μg/L	0.321000
	EXPLOSIVES/HPLC	2,6-DINITROTOLUENE	WA	μg/L	0.640000
	EXPLOSIVES/HPLC	CYCLOTETRAMETHYLENETE-TRANITRAMINE	WA	μg/L	2.290000
	EXPLOSIVES/HPLC	RDX	WA	μg/L	0.653000
	EXPLOSIVES/HPLC	TETRACENE	WA	μg/L	**TBD
	EXPLOSIVES/HPLC	TETRYL	WA	μg/L	1.290000

Key: +Counts per milliliter
*To be determined; limits are reporting limits method is not certified.
**To be determined; MDL study needed for new instrument.

2.16.2 DATA VALIDATION/REVIEW

Pace's system for ensuring valid data includes several levels of review. Each level commands specific action to prevent the unqualified release of erroneous data and to correct any problems discovered during the review process.

All analytical data generated at Pace are extensively checked for accuracy and completeness. The data validation process consists of data generation, reduction, and review, as described below. All data are ultimately compared to the criteria in the 1990 USATHAMA QAP and the specific approved USAEC method.

The analyst who generates the analytical data for a specific step in the sample processing, has the prime responsibility for the correctness and completeness of the data. All data are generated and reduced following protocols specified in Pace's SOPs. Each analyst reviews the quality of his or her work based on an established set of guidelines. The analyst reviews the data package to ensure that:

- Sample preparation information is correct and complete analysis information is correct and complete.
- The appropriate SOPs have been followed.
- Analytical results are correct and complete.
- QC samples are within established control limits.
- Special sample preparation and analytical requirements have been met.
- Documentation is complete (e.g., all anomalies in the preparation and analysis have been documented, out of control forms, if required, are complete, holding times are documented, etc.).

Upon completion of this initial review step, the analyst will sign Pace's "Data Packet Signoff Sheet". The analyst then passes the data package to technical reviewer who reviews the package for accuracy. The technical review is structured to ensure that:

- Calibration data are scientifically sound, appropriate to the method, and completely documented.
- QC samples are within established guidelines.
- Qualitative identification of sample components is correct.
- Quantitative results are correct.

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- Documentation is complete and correct (e.g., anomalies in the preparation and analysis have been documented, out-of-control forms, if required, are complete, holding times are documented, etc.).

- The data are ready for incorporation into the final report.

- The data package is complete and ready for data archive.

If no problems are found with the data package, the review is considered complete. If any problems are found with the data package, the samples are checked to the bench sheet. The process continues until no errors are found. An "Analytical Review" form will be signed by the analyst, the technical reviewer and the laboratory QAC, after the technical reviewer has examined the data package. The reviewed data are then approved for release and a final report is prepared.

Before the report is released to the client, the laboratory QAC who is responsible for interfacing directly with TETC reviews the report to ensure that the data meets the overall objectives of the project.

Each step of this review process involves evaluation of data quality based on both the results of the QC data and the professional judgement of those conducting the review. This application of technical knowledge and experience to the evaluation of the data is essential in ensuring that data of high quality are generated consistently.

In addition to the reviews discussed above, the USAEC Chemistry Branch validates the data packages. The USAEC verifies that holding times have been met, calibration checks are adequate, qualitative and quantitative results are correct, documentation is complete, and QC results are complete and accurate.

Procedures for Handling Unacceptable Data: Control charts and calibration curves will be used to review the data and identify outlying results. QC charts are prepared from spiked QC samples. Control limits are statistically calculated using USAEC required software package. Out-of-control events will be investigated by the analysts.

Results which exceed the warning limits but not the control limits alert the analyst to a potential problem. Sample results are accepted when they fall between warning limits and control limits, but the procedures and standards are checked. If the laboratory control sample exceeds the control limit, the analyst will stop work on the analysis. The analyst and QAC should investigate potential causes of the problem. After the cause is determined and corrected, samples from the original set are rerun along with duplicate spiked samples and a laboratory control sample.

All QC information will be recorded in the notebooks and printouts in the same format used for sample results. It is the analyst's responsibility to check the QC information against limits for the analysis. When an analysis of a QC sample (blank, spike, check standard, USEPA-traceable standard, replicate, or similar sample) shows that the analysis of that lot of samples is not in control, the analyst will immediately bring the matter to the attention of the QAC. The QAC

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will, if necessary, consult with TETC Analytical Task Manager to determine whether the analysis can proceed, or if selected samples should be rerun, or specific corrective action needs to be taken before analyzing additional samples. Out-of-control analyses must be documented by the supervisor. The analyst or supervisor will file an "Anomaly Report" with the QA manager.

2.16.3 DATA REPORTING

Reports from Pace shall include the following:

- A copy of the signed COC form showing date and time of sample receipt in laboratory.
- A weekly list of the chemical lots analyzed and the IRDMIS files sent to Potomac Research, Incorporated.
- A weekly list of the control charts sent to the USAEC Chemistry Branch.

2.17 INTERNAL QC FOR LABORATORY ANALYSES

Internal QC focuses on ensuring that each chemical measurement has the highest probability of exceeding method protocol in terms of precision and accuracy. QC samples such as method blanks, spikes, and duplicates are evaluated and documented on a routine basis. Spike and surrogate recoveries as appropriate are calculated, and this QC data is compared on an ongoing basis to laboratory-established control limits. SARMs should be used for spiking compounds and surrogates.

2.17.1 LABORATORY QA/QC SAMPLES

Analytical Lot: The basic unit for analytical QC is the analytical lot. The analytical lot is comprised of a maximum number of samples which are analyzed together through the rate determining step of the method, and with the manipulations common to each sample within the same time period or in continuous sequential time periods. Samples in each lot should be of similar composition and include QC samples.

Method Blank: A method blank is an artificial, matrixless sample used to monitor the system for interferences and contamination from glassware, reagents, etc. The method blank is taken through the entire sample preparation process, and is included with each lot of extractions/digestions prepared, regardless of method class.

Spikes: Depending on the method class, standard matrix spikes are analyzed with each lot. The spike levels and frequency depend on the method class and are listed in Table 11-1 of the 1990 USATHAMA QAP.

Surrogate Compounds: For method Class 1A only, the analytical process includes the addition, subsequent detection, and recovery calculations of surrogate spiking compounds. Surrogate compounds are added to every field sample at the beginning of the sample preparation, and the

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surrogate recovery is used to monitor matrix effects and sample preparation. Compounds that meet the following criteria are suitable surrogate compounds:

- Compounds not requested for analysis.
- Compounds that do not interfere with the determination of required analytes.
- Compounds that are not naturally occurring, yet are chemically similar to the required analytes.

Method of Standard Addition: The method of standard addition is used in metals analysis for samples that exhibit matrix interferences. Matrix interferences are caused by, for instance, high concentrations of analytes other than those that are being analyzed. Standard addition analysis involves adding a known concentration of each metal near the middle of the concentration range to the sample, and reanalyzing. A plot of concentration versus absorbance will give the concentration of the unknown when extrapolated back to zero absorbance. The method of standard addition shall be applied to metals analysis at the rate of 5% or 1 per lot, whichever is greater.

Reagents: Laboratory reagent water that meets the requirements of ASTM Type II water, as described in Table 5-1 of the 1990 USATHAMA QAP, is used for organic methods. ASTM Type I water will be used for inorganic methods. The resistivity of the water is measured and recorded in a logbook. Blanks are routinely analyzed for purity and accompany each lot tested.

Standard soil samples are provided by the USAEC Chemistry Branch. The quantities used will be governed by the specific method.

High-purity reagents are purchased as dictated by each test method and are documented by batch, lot number, and supplier, as well as time period of laboratory use (date opened, date depleted). SARMs should be acquired by the laboratory when analyzing samples under the USAEC program, and used whenever possible for internal QC and calibration samples.

2.18 LABORATORY PERFORMANCE AND SYSTEM AUDITS

Performance and systems audits will be used to monitor project activities to assure compliance with the QA objectives and procedures. Audits may be performed by USAEC. The 1990 USATHAMA QAP describes external and internal audits in detail. Major aspects of the audits are described below.

External Audits: External audits are conducted by the USAEC and require review of the project QAP to ensure that all procedures and practices are being followed by the laboratory. In addition, an audit checklist is completed by the USAEC representative. Audits may occur prior to analysis of field samples. Upon completion of the audit, copies of the checklist go to the following:

- USAEC Project Officer
- TETC Project Manager

- Laboratory Analytical Task Manager
- Laboratory QA Coordinator
- USAEC Chemistry Branch

Audits may also occur after the field sample analysis has begun, and any project related activity may be evaluated. Again, the project QAP will be reviewed, to ensure that all procedures and practices are being followed by the laboratory or the field team.

Internal Audits: Conducted by the laboratory QA staff, internal audits will verify that the written instructions are actually being practiced. This is accomplished through the use of a monthly or quarterly systems audit, in which a particular method is chosen and monitored through all steps of its performance. Internal audits will also verify that standards, records, magnetic tapes, etc. are being properly maintained.

Formal audit reports will be distributed to TETC Project Manager, Analytical Task Leader, and USAEC. All audit compliances and noncompliances must be documented in a bound notebook and maintained as part of the QA documentation. This information should be filed by project. At the end of the project a copy of the QA file, in addition to the data packages, shall be transmitted to the USAEC Chemistry Branch.

2.19 PREVENTIVE MAINTENANCE

The primary objective of a preventive maintenance program is to help ensure the timely and effective completion of a measurement effort by minimizing the down time of crucial sampling and/or analytical equipment due to expected or unexpected component failure. In implementing this program, efforts are focused in three primary areas: maintenance responsibilities, maintenance schedules, and adequate inventory of critical spare parts and equipment.

2.19.1 MAINTENANCE RESPONSIBILITIES

Maintenance responsibilities for laboratory equipment are assigned to the respective laboratory managers. The laboratory managers then establish maintenance procedures and schedules for each major equipment item. These are contained in the maintenance logbooks assigned to each instrument.

2.19.2 MAINTENANCE SCHEDULES

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

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2.19.3 SPARE PARTS

The respective laboratory managers are responsible for maintaining an adequate inventory of necessary spare parts. Sufficient equipment should be on hand to continue analyses in the event that an instrument encounters problems. In addition to backup instrumentation, a supply of spare parts such as gas chromatography columns, fittings, septums; atomic absorption lamps, mirrors, diaphragms; graphite furnace tubes, and other ancillary equipment should be maintained.

2.20 PROCEDURES TO ACCESS PRECISION, ACCURACY, AND COMPLETENESS

2.20.1 REPORTING PRECISION, ACCURACY, AND COMPLETENESS

This section presents the routine procedures for calculating accuracy, precision, and completeness which are discussed in detail in Section 2.11.1. Overall guidance will be obtained from the 1990 USATHAMA QAP, which dictates the use of control charts. USAEC requires specific software in order to generate these control charts. Control analytes will be compared to control limits specified in the individual approved method in order to determine the data quality.

- **Precision**: Precision will be estimated by the analysis of replicate samples and will be expressed as the Difference (R) between recoveries for two spiked QC samples (Class 1) in each lot, or between recoveries of spiked pairs (duplicates). The formula used to establish and maintain control charts for duplicates is as follows:

$$\bar{R} = \frac{\sum R}{K}$$

Where: R = Within group difference between recoveries for data pairs.
K = Cumulative number of pairs in database.

- **Accuracy**: Through the use of control charts, accuracy is calculated from the analysis of QC analytes such as surrogates or spikes, whose true values are known. These true values are compared with the found values and a percent recovery is calculated by standard USAEC formulas. Acceptable percent recoveries are given in the approved method. The calculation formula for percent recovery is:

$$\%\ spike\ recovery = \frac{found\ concentration^{(1)}}{value\ of\ spike\ added} \times 100$$

(1) Corrected for method blank contaminants

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- **Completeness:** Completeness will be reported as the percentage of all measurements whose results are judged to be valid. The following formula will be used to estimate completeness:

$$C = 100\,\frac{(V)}{(T)}$$

Where: C = Percent completeness
V = Number of measurements judged valid
T = Total number of measurements

A completeness value of 90 percent is considered acceptable.

2.21 CORRECTIVE ACTION - LABORATORY ACTIVITIES

Corrective action is dictated by the type and extent of the nonconformance. Corrective action may be initiated and carried out by nonsupervisory staff, but final approval and data review by management is necessary before reporting any information. All potentially affected data must be thoroughly reviewed for acceptance or rejection.

A nonconformance is any event whose results fall outside of established laboratory limits. Nonconformance results from a number of factors including method procedural problems, equipment malfunctions, and operator error. Regardless of the cause, any activity in the laboratory which adversely affects data quality is considered a nonconformance.

Spike recovery (accuracy) and replicability (precision) plotted on control charts are a means of determining a nonconforming situation. A single mean outside of the modified limits constitutes a nonconformance for moving averages and both duplicate spiked QC results.

Nonconformance may also be encountered in shipping and receiving. If the COC is not properly filled out, or if the samples are broken or received without required preservation, a receiving nonconformance report is filled out, and TETC Project Manager is informed. Corrective action includes correcting the COC, using alternate samples, or even resampling.

Exceeding the required holding times is another example of a nonconformance. TETC Project Manager will be informed immediately, so that resampling can be done as soon as possible.

A nonconformance/corrective action report is required to document any nonconforming situation and the corrective actions taken. The documentation must include:

- Definition of the out-of-control event and identification of all affected samples.
- Where the out-of-control incident occurred (department and test name).
- Date of occurrence.
- Corrective action taken.
- Verification of corrective action and reestablishment of control.
- Initials of operating analyst, supervisor, and laboratory QAC.

Corrective action may take several forms, but the following steps are almost always included:

1. Check the calculations.
2. Check the instrument for proper setup.
3. Reanalyze the control item.

All data generated during an out-of-control situation must be flagged, and when control has been reestablished, a decision made as to whether the data can be used or if reanalysis is required. The decision must be documented on the nonconformance/corrective action report.

2.22 QA REPORTS

Effective management of a field sampling and analytical effort requires timely assessment and review of field and laboratory activities. This will require effective interaction and feedback between the field team members, TETC Project Manager, the laboratories and the QAC.

2.22.1 QA REPORTING PROCEDURE

The laboratory Analytical Task Manager and appropriate project team members will be responsible for keeping TETC Project Manager and contractor QAC up to date regarding the status of their respective tasks so that quick and effective solutions can be implemented should any data quality problems arise.

Sampling activities will be reviewed on a daily basis by the onsite task leader to determine if the sampling QC requirements are being fulfilled, such as the proper number of blanks and duplicate samples and are taken for each parameter sampled. All data sheets and logbooks will be reviewed daily. Any needed corrective action will be initiated and documented daily.

The laboratory QAC has the responsibility of reviewing all laboratory analytical activities to ensure compliance with the QC requirements outlined in this Project QAP. This review serves as a control function in that it should be conducted frequently so deviations from method requirements will be immediately identified and corrected.

A summary report detailing the sampling and analysis status and any QA/QC problems will be prepared by the project QA coordinator after receipt of the field and laboratory reports and review of the analytical data reports, and sent to the Project Manager.

2.22.2 REPORT CONTENT

As appropriate, the required periodic reports shall contain information on the status of the project and any quality problems. This includes:

- Activities and general program status
- Calibration and QC data problems
- Unscheduled maintenance activities
- Corrective action activities
- Status of any unresolved problems
- Assessment and summary of data completeness

- Any significant QA/QC problems and recommended and/or implemented solutions not included above.

The auditor will prepare audit reports following each performance and systems audit which address the audit results and provide a qualitative assessment of overall system performance. These reports will be submitted to the laboratory QAC for laboratory audits, and to TETC Project Manager for field audits.

Problems requiring swift resolution will be brought to the immediate attention of the appropriate manager via the nonconformance reporting/corrective action scheme discussed in Section 2.21.

3.0 DATA MANAGEMENT PLAN

3.1 INTRODUCTION

This Data Management Plan (DMP) has been developed to coordinate data collection, analysis, and presentation during the groundwater quality assessment. It documents and tracks the collection of environmental samples and related information in the field, analysis of environmental samples in the laboratory, organization and validation of analytical results and related information in the USAEC IRDMIS, and presentation of results in a clear and logical format in reports. Specifically, the DMP identifies field data collection and chain-of-custody forms; summarizes data management practices that ultimately result in the IRDMIS map, geotechnical, and chemical data files; summarizes data reduction; discusses data presentation formats; and describes Interim and Final Reports that will be produced to complete the assessment.

The groundwater quality assessment will generate a significant amount of data, including the results from 2730 laboratory and 819 field analyses being performed on soil and groundwater samples collected during the assessment. Data management procedures will be established to effectively process this data such that data descriptions (e.g. sample numbers and locations, sampling procedures, and analyses) are readily accessible and accurately maintained.

Field data collection forms are described and illustrated below in Section 3.2. An overview of the IRDMIS environmental database is presented in Section 3.3. Data management, reduction, presentation, and reporting are discussed in Section 3.4 through Section 3.7, respectively.

3.2 FIELD DATA COLLECTION FORMS

To ensure the collection of all information required for the groundwater quality assessment, preprinted field data collection forms will be used in conjunction with field logbooks to record standard field tasks. The following sections describe and illustrate field data collection forms that will be used during the assessment.

3.2.1 EQUIPMENT CALIBRATION LOG

A record of the field calibration of analytical instruments used during the groundwater quality assessment will be maintained by TETC field personnel on the Equipment Calibration Log (Figure 3-1). Calibration data for the PID, CGI, and temperature/pH/conductivity meter will be maintained on this log.

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Equipment Calibration Daily Log

Project Name ____
Project No. ____ Location ____
Recorded By ____ Date ____
Checked By ____ Date ____

Times:
AM ____
Midday ____
PM ____

pH Meter

Serial number ____

	AM	Midday	PM		
* pH 7.00 buffer solution: pH				Exp. Date ____	Lot# ____
* pH 4.00 buffer solution: pH				Exp. Date ____	Lot # ____
* pH 10.00 buffer solution: pH				Exp. Date ____	Lot # ____
Temperature					
Comments					
Operator Signature					

Conductivity Meter

Serial number ____
Calibration solution ____ Exp. Date ____ Lot # ____
* Micromho reading AM ____ Midday ____ PM ____
Temperature AM ____ Midday ____ PM ____
Comments ____
Operator Signature AM ____ Midday ____ PM ____

Organic Vapor Analyzer

Type ____
Serial number ____
Calibration gas ____
* Reading AM ____ Midday ____ PM ____
* Background reading AM ____ Midday ____ PM ____
Comments ____
Operator Signature AM ____ Midday ____ PM ____

* Positive response checks will be done every 4 hrs: AM, Midday and PM

Checked by ____ Date ____

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FIGURE 3-1

Equipment Calibration Daily Log

3.2.2 DECONTAMINATION RECORD

A record of field equipment decontamination will be maintained by TETC field personnel on the Decontamination Record (Figure 3-2). The field equipment that will be decontaminated during the groundwater quality assessment includes: the drilling rig and associated equipment; field analytical instruments; soil sampling equipment; monitoring well casing, screen, caps, etc.; and groundwater purging and sampling equipment.

3.2.3 BOREHOLE LOG

A record of soil sample collection and classification, air monitoring, start/stop times, and the personnel and equipment used during the drilling of boreholes for the groundwater quality assessment will be maintained on the Borehole Log (Figure 3-3). The drilling company, driller, drilling equipment, location, and supervising geologist will be recorded in the header of the Borehole Log. The Unified Soil Classification Symbol, secondary components, color, plasticity, consistency, density, texture, grain angularity, and moisture content of the soil as well as remarks will be recorded in the body of the log.

3.2.4 SOIL SAMPLE LABEL

Soil samples collected during the groundwater quality assessment will be identified by a sample label (Figure 3-4). The following information will be recorded on the soil sample label: project name and number, borehole and sample numbers, sample depth, analyses, date, time, and initials of sampler.

3.2.5 MONITORING WELL CONSTRUCTION LOG

A Monitoring Well Construction Log will be completed for all monitoring wells installed during the groundwater quality assessment (Figure 3-5). The drilling company, driller, drilling equipment, and supervising geologist will be recorded on the header of the log. The dimensions and quantities of PVC casing and screen, granular filter pack, bentonite, grout, protective casing, etc. will be recorded in the body of log.

3.2.6 WELL DEVELOPMENT LOG

A record of development for each monitoring well installed during the groundwater quality assessment will be maintained on the Well Development Log (Figure 3-6). The equipment used to develop the monitoring well; depth to groundwater and to the bottom of the monitoring well; screen length; the volume of groundwater removed from the monitoring well; start/stop times; and groundwater temperature, pH, and specific conductance, etc. will be recorded on the log.

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Decontamination Record

Project Name ____________________ Project Number ____________

Recorded By ____________________ Site ____________

Date __________ Time __________ Checked By ____________

Date ____________

Decontamination after borehole/well/sampling point ____________________

Equipment	Use	Steam/Hot Water	Detergent/Water	Potable Water	Deionized Water	Type II Water	Other Water	Methanol	Hexane	HNO_3 (Dilution)			Equip. Blank No.
Drill rig													
Drill Rods													
Augers													
Soil sampler													
Pump													
(Type)													
Bailer													

Use key : GS - Groundwater Sampling, SS - Soil Sampling, WP - Well Purging

Comments (e.g. initial decon, between which locations, or if last decon for the day)

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FIGURE 3-2

Decontamination Record

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Borehole Log

Project Name:		Project Number:
Borehole Location:	Borehole No.	Sheet 1 of
Drilling Agency:	Driller:	
Drilling Equipment:	Date Started:	Total Depth (feet):
Drilling Method:	Date Finished:	Depth to Bedrock (feet):
Drilling Fluid	Number of Samples:	Depth to Water (feet):
Completion Information:	Borehole Diameter (in):	Elevation and Datum:
	Logged by:	Checked by:

Depth (feet)	Sample					Analysis	LOG	Lithologic Description	Remarks
	Number	Interval	Blow Count	Recovery	Time	PID or FID (ppm) S/B*	USCS or Rock Type		
5									
10									
15									

KEY: * S/B = Sample Reading / Background Reading; NA = Not Analyzed; BZ = Breathing Zone;
BG = Background; BH = Borehole Headspace

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FIGURE 3-3

BOREHOLE LOG

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IAAP 931978-02

Boring #:____________Sample #:____________

Depth:__________(ft) Analyses:____________

Date:_______Time:____________By:_________

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FIGURE 3-4

Soil Sample Label

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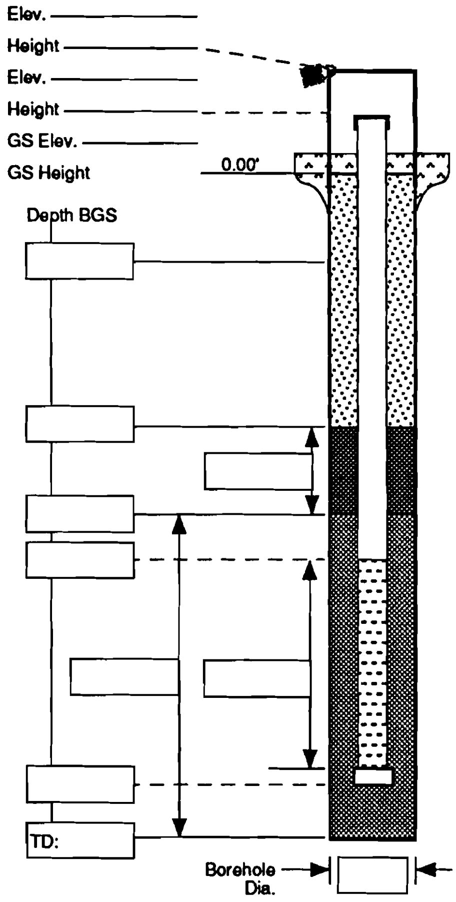
Monitoring Well Construction Log - Above Ground

Project Name:	Project Number:	Date:
Well	Well ID:	Sheet ____ of ____
Driller:	Borehole Diameter (in):	Total Depth (ft):
Drilling Agency:	Date Started:	Depth to Water (ft):
Drilling Equipment:	Date Finished:	Elevation and Datum:
Drilling Method:	Logged by:	Checked by:
Drilling Fluid:	Number of Samples:	Date:



PROTECTIVE CSG

Material / Type:

Diameter: __________

Depth BGS: __________ Weep Hole (Y / N)

GUARD POSTS (Y / N)

No.: __________ Type: __________

SURFACE PAD

Composition and Size: __________

RISER PIPE

Type: __________

Diameter: __________

Total Length (TOC to TOS): __________

Ventilated Cap (Y / N)

GROUT

Composition and Proportions: __________

Tremied (Y / N)

Interval BGS: __________

CENTRALIZERS

Depth(s) __________

SEAL

Type: __________

Source: __________

Setup / Hydration Time: __________ Vol. Fluid Added __________

Tremied (Y / N)

FILTER PACK

Type: __________

Amt. Used: __________

Tremied (Y / N) __________

Source: __________

Gr. Size Dist.:

SCREEN

Type: __________

Diameter: __________

Slot Size and Type: __________

Interval BGS: __________

WELL FOOT (Y / N)

Interval BGS: __________ Length __________

Bottom Cap (Y / N)

BACKFILL PLUG

Material: __________

Setup / Hydration Time: __________

Tremied (Y / N)

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The Earth Technology Corporation®	**FIGURE 3-5**

Monitoring Well Construction Log

WELL DEVELOPMENT LOG

Date: Well ID: Sample Number: Recorded By:
Project Name: Well Location: Duplicate Number: Checked By:
Project Number: Date Well Installed:

EQUIPMENT

pH/Conductivity/Temperature Meter #: Purging Equipment:
PID #:
Electric Sounder #:

WELL DATA

Elevation: Water Column in Well: Total Vol. Extr.:
Well Diameter: Borehole Diameter: Ambient PID:
Well Depth: Water Column in Borehole: Well Mouth PID:
Static Water Level: Standing Water Vol.: Static Water Level 24 Hrs. After Development:
Screen Length:

Ground Condition of Well:
Remarks:

PURGING

	1	2	3	4
Time				
Rate				
Temperature				
pH				
Conductivity				
Vol. Purged				
Remarks				

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FIGURE 3-6

Well Development Log

3.2.7 POTENTIOMETRIC LEVEL MEASUREMENT LOG

A record of the groundwater levels measured prior to purging and sampling monitoring wells during each round of groundwater sample collection for the groundwater quality assessment will be maintained on the Potentiometric Level Measurement Log (Figure 3-7). The depth to groundwater will be measured from the reference point in each monitoring well (top of PVC casing) and groundwater elevations will be computed by subtracting this measurement from the known elevation of the reference point.

3.2.8 GROUNDWATER PURGE AND SAMPLE LOG

A record of the temperature, pH, and specific conductance measurements collected during groundwater purging and sampling for the groundwater quality assessment will be maintained on the Ground Water Purge and Sample Log (Figure 3-8). The type of purging and sampling equipment, depth to groundwater and to the bottom of the monitoring well, and the monitoring well and borehole diameters will also be recorded on the log.

3.2.9 GROUNDWATER SAMPLE LABEL

Ground water samples collected during the groundwater quality assessment will be identified by a sample label (Figure 3-9). The following will be recorded on the groundwater sample label: project name and number, monitoring well and groundwater sample numbers, analysis, preservative, date, time, and initials of the sampler.

3.3 IRDMIS DATA MANAGEMENT PLAN

The IRDMIS computerized, environmental database will be used to manage data collected during the groundwater quality assessment. It is an interactive, electronic data management system that stores, checks, and manipulates laboratory analytical results and field data. The IRDMIS provides the advantage of electronic data management to help ensure data integrity, consistency, and completeness.

TETC and Pace, Inc. (Pace), the laboratory subcontractor for the groundwater quality assessment, will coordinate field data collection and laboratory analysis to produce the IRDMIS map, geotechnical, and chemical data files that will be used to complete the assessment.

The following sections describe the data management that will be used by TETC and Pace to produce the IRDMIS map, geotechnical, and chemical files.

3.3.1 THE MAP DATA FILE

The map data file is an integral component of IRDMIS. It will be used by the IRDMIS to ensure chemical and geotechnical data correspond to monitoring well locations at the IAAP. The

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Potentiometric Level Measurement
(Tape, Electric Sounder)

Page 1 of

Project Name ______ Project No. ______
Location ______
Well Designation ______ State Permit No. ______ Owner ______
Date of Completion ______ Use of Water ______ Well Depth ______
Diameter ______ Casing Type ______ Screen Type ______
Screened/Open Intervals ______
Aquifer(s) Screened ______
Pump Type ______
Elevation of Ground Surface ______ Elevation of Measuring Point ______
Previous Static Level ______ Elevation Difference between Ground Surface and Measuring Point ______

Drawing of Well and Measuring Point

Date (Mo. Da. Yr)	Time (24 Hr. Clock)	Tape Reading At Measuring Point	Tape Reading at Water Mark	M.P. Correction	Instrument Correction	Water Level Below Ground Surface	Water Level Above MSL	Instrument Type And Number	Recorded by	Remarks

Comments ______

Checked by ______ Date ______

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Potentiometric Level Measurement	

GROUND WATER PURGING AND SAMPLING RECORD

Date:
Well ID:
Sample Number:
Recorded By:
Project Name:
Well Location:
Duplicate Number:
Checked By:
Project Number:

EQUIPMENT

pH/Conductivity/Temperature Meter #:
Purging Equipment:
PID #:
Sampling Equipment:
Electric Sounder #:

WELL DATA

Elevation:
Water Column in Well:
Total Vol. Extr.:
Well Diameter:
Borehole Diameter:
Ambient PID:
Well Depth:
Water Column in Borehole:
Well Mouth PID:
Depth to Well Water:
Standing Water Vol.:

Ground Condition of Well:
Remarks:

	PURGING				SAMPLING	
	1	2	3	4	1	2
Time						
Rate						
Temperature						
pH						
Conductivity						
Vol. Purged						
Remarks						

COLLECTED SAMPLES

	1	2	3	4	5	6
Sample Type						
Analytical Param						
Volume Required						
Preservation						
Field Filtered						
Time						

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FIGURE 3-8

Ground Water Purging and Sampling Record

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IAAP 931978-02

Well #:__________ Sample #:__________

Analysis:__________ Preservative:__________

Date:_______ Time:__________ By:_______

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FIGURE 3-9

Ground Water Sample Label

map file will also be used to help construct groundwater level elevation and isoconcentration maps for the assessment.

TETC will coordinate with the USAEC Project Manager to obtain the existing map data file for the IAAP and identify the unique designators for each existing monitoring well that will be sampled by TETC during the assessment. If an existing monitoring well is to be sampled by TETC and it has not been recorded in the map file, TETC will request that the USAEC Project Manager assign an unique designator to be used by TETC for the IRDMIS submittals. TETC will also request unique designators for monitoring wells to be constructed by TETC during this groundwater quality assessment.

Once all the sample locations that will be used in the assessment have been identified, TETC will construct a new map file. All monitoring well locations, which are to be sampled by TETC and do not exist in the current map file, will be added to the existing map file. The coordinates used in the map file for each new monitoring well location will initially be derived from the facility map. TETC will submit this map file to USAEC and Pace. Once the new monitoring wells are installed and surveyed by TETC, a new map file containing surveyed coordinates will be submitted to USAEC.

Before any samples are sent to the laboratory for analysis, TETC field personnel will be given the complete list of monitoring well designators recorded in the new map file. These designators will be used on chain-of-custody forms that accompany all samples sent from the field to Pace. Monitoring well designators recorded in the map data file will allow Pace to perform the so-called IRDMIS group checking on chemical data files. IRDMIS group checking requires that the sample designator assigned to an analytical result corresponds to a sample location recorded in the map data file.

3.3.2 THE GEOTECHNICAL DATA FILES

The IRDMIS system requires three geotechnical data files:

- Field drilling data file
- Well construction file
- Groundwater stability data file.

The field drilling data file will record all the IRDMIS-required information pertaining to the three boreholes that will be drilled during the assessment. The well construction file will record all the IRDMIS-required information pertaining to the three monitoring wells that will be installed during the assessment. The groundwater stability data file records measurements from the ground surface to the potentiometric surface of the shallow aquifer being assessed.

TETC field personnel will be provided with pre-printed field data forms identified in Section 3.2. These forms will ensure that field personnel collect the information required for the IRDMIS geotechnical files. The field data forms will be sent from the field to TETC to construct the IRDMIS geotechnical data files.

TETC will use the IRDMIS PC Data Entry and Validation Subsystem to enter the geotechnical data from the field data forms. As an alternative, TETC will download geotechnical data from the gINT software package which is used to produce computer-based borehole logs. TETC will use the data codes identified in the IRDMIS User's Guide, Volume II, Data Dictionary.

TETC will also use the IRDMIS PC Data Entry and Validation Subsystem to perform record and group checking on all constructed geotechnical data files before submittal to the IRDMIS. When performing group checking, TETC map data file will be used. If errors are discovered during record and group checking, TETC will coordinate with the USAEC Geologist to identify correctable errors. TETC will correct these errors before submitting the geotechnical data files electronically to the IRDMIS. TETC will not address those errors identified by the USAEC Geologist as uncorrectable.

3.3.3 THE CHEMICAL DATA FILES

Pace will provide the analytical results for the groundwater quality assessment in electronic chemical data files to the IRDMIS database. These chemical data files will contain all the IRDMIS-required information that results from the analysis of all normal environmental and QA/QC samples collected during the assessment. The chemical files will fully comply with all the IRDMIS requirements with regard to analytical methods, QA/QC information, duplicate and blank sample analyses, lot size, and data reporting. Pace will use the data codes identified in the IRDMIS User's Guide, Volume II, Data Dictionary.

To construct the IRDMIS chemical data files, PACE will interface its laboratory information management system with the IRDMIS to download laboratory data and/or it will use the IRDMIS PC Data Entry and Validation Subsystem to manually enter analytical data.

PACE will use the IRDMIS PC Data Entry and Validation Subsystem to perform record and group checking on all constructed chemical data files before submittal to the IRDMIS. When performing group checking, Pace will use the map data file that TETC constructed and submitted to the IRDMIS. If errors occur during record and group checking, Pace will coordinate with the USAEC Chemistry Branch to identify correctable errors. Once Pace corrects these errors for a chemical data file, it will submit the chemical data file electronically to the IRDMIS. PACE will not address those errors identified by the USAEC Chemistry Branch as uncorrectable.

3.4 DATA REDUCTION

Data generated during the groundwater quality assessment will be reported according to accepted QA practices and data validation procedures. All data will be reported; however, treatment of duplicate measurements, identification of outlier values, and reporting of results determined to be below certified reporting limits require analysis before accepting the values for further data reduction.

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3.4.1 TREATMENT OF DUPLICATES

Duplicate measurements for a single sample will be averaged prior to further data reduction. This removes bias from the overall mean.

3.4.2 REPORTING OF OUTLIERS

Any environmental measurement program can produce numbers that lie outside the "expected" range of values. Because field variability of environmental measurements may be great, deciding whether an extreme (outlier) value is representative of actual contaminant levels may be difficult. Outlier values may be the result of:

- A catastrophic unnatural (but real) occurrence such as a spill
- Inconsistent sampling or analytical chemistry methodology
- Errors in the transcription of data values or decimal points
- True but extreme concentration measurements.

Outlier values will be corrected if the problem source can be documented. Data will be corrected, for example, if the outliers are caused by incorrect transcription, and the correct value is obtainable and documented from valid records. Also, if a documented catastrophic event or a problem in methodology occurred, data values will be reported with clear reference. Explanation and validation of outliers will accompany corrected or deleted data values; true but extreme values must not be altered or deleted.

3.4.3 REPORTING OF VALUES BELOW CERTIFIED REPORTING LIMITS

Analytical values determined to be at or below the certified reporting limit will be reported numerically (e.g. <0.1 mg/L). The data presentation procedures will cite analytical methods used including certified reporting limits.

3.5 DATA MANAGEMENT

An electronic database will be used to manage data generated during the assessment. Among the advantages of using an electronic database to manage environmental data is the ability to perform computerized error checking for data validity, consistency, and completeness. In addition to establishing data quality, an electronic database can also be used to generate (1) data tables, (2) statistical analyses, (3) graphs, and (4) maps from the qualified data, without the transcription errors normally associated with these processes.

3.6 DATA PRESENTATION

Data for the groundwater quality assessment will be arranged and presented in a clear and logical format. Tabular, graphical, and other visual displays (e.g., contaminant isoconcentration maps) will be used for organizing and evaluating such data and assisting with the decision-making process throughout the groundwater quality assessment.

3.6.1 TABLES

Tabular presentations of both raw and sorted data will be used for data presentation as discussed below. Tables of derived data will be developed and used, as necessary.

3.6.1.1 Listed (Raw) Data

Simple lists of data alone are not adequate to illustrate trends or patterns resulting from a contaminant release but provide a baseline for other presentation formats. These lists are also valuable for sample validation and auditing. Therefore, such lists will be used for reporting results during the groundwater quality assessment. Each data record will provide the following information:

- Unique sample code,
- Sampling location and sample type,
- Sampling date,
- Laboratory analysis identification number,
- Property or component measured,
- Result of analysis (e.g., concentration),
- Detection limits, and
- Reporting units.

Analytical data will generally be reduced electronically prior to report generation. Raw data will be reported in an appendix to the Interim and Final Reports. This appendix will contain exact copies of analytical results as received from the IRDMIS database.

3.6.1.2 Sorted Summary Tables

Presentation of results grouped according to data categories will be used to display trends or patterns in data. Examples of data categories include: (1) medium tested, (2) sampling date, (3) sampling location, and (4) parameter or property measured. The sample identification number will be included for data cross-referencing purposes.

3.6.1.3 Derived Data Tables

Derived data are calculated from a set of raw data. Examples include measures of central tendency, measures of statistical scattering, or the results of calculations based on indirect measurements of a physical parameter (e.g., hydraulic conductivity from a slug test). Derived data presented in tabular or graphic form will include references to the method of calculation used and location of raw data.

3.6.2 GRAPHIC PRESENTATION OF DATA

Graphic methods of data presentation often illustrate trends and patterns more clearly than tables. Graphic formats used for environmental data including bar graphs, line graphs, areal maps, and isopleth maps are discussed below.

3.6.2.1 LINE GRAPHS

Line graphs will be used to illustrate the changes in contaminant concentrations during the five rounds of groundwater sampling at the Ash Disposal Cell in Trench 5 and Line 6.

3.6.2.2 AREA MAPS

Area maps will be generated to identify the following:

- Facility location
- Unit location(s)
- Monitoring well location(s)

These maps will also identify features such as roads, buildings, boundaries, and other man-made features; as well as natural features that have an impact on the assessment.

3.6.3 TOPOGRAPHIC MAPS

Topographic maps show the relief and position of natural and man-made features of a land surface by means of contour lines. A contour line is an imaginary line that connects points of equal elevation. Surface topographic maps will be combined with area maps.

3.6.4 GEOLOGIC MAPS

Geologic maps illustrate the distribution, nature, and age relationships of soil and rock units and the occurrence of structural features. Geologic maps will be used in the groundwater quality assessment to illustrate important geological or hydrogeological data.

3.6.5 GROUNDWATER POTENTIOMETRIC SURFACE MAPS

Groundwater potentiometric surface maps are subsurface contour maps that show the elevation of a potentiometric surface of an aquifer. A potentiometric surface is an imaginary surface that represents the total head of groundwater and is defined by the level to which water will rise in a monitoring well.

3.6.6 ISOCONCENTRATION MAPS

Isoconcentration maps are contours of a particular contaminant's concentrations that are superimposed on a site map.

3.6.7 VERTICAL PROFILE OR CROSS SECTIONS

A cross section is a diagram that shows subsurface geological features transected by a vertical plane.

3.7 DATA REPORTING

3.7.1 MONTHLY PROGRESS REPORT

Monthly progress reports will be submitted to USAEC within 10 business days after the close of the month. These reports will include:

- Estimated percentage of assessment completed,
- Summaries of findings,
- Summaries of problems encountered and their resolution, and
- Projected work for the next reporting period.

3.7.2 REPORTS OF EMERGENCY AND PRIORITY SITUATIONS

When situations occur that warrant interim corrective measures, the requirements for the RCRA Contingency Plan under 40 CFR Part 264, Subpart D, will be followed. Reports will be made immediately.

3.7.3 SPECIAL INTEREST DELIVERABLES

Special interest deliverables to USAEC will be prepared during the assessment. These deliverables include:

- Sample sand pack
- Borehole logs
- Monitoring well completion logs
- Monitoring well development logs
- Soil sample location maps
- Monitoring well survey
- IRDMIS deliverables

3.7.4 REPORTS

A Draft Final and Final Groundwater Quality Assessment Work Plan will be submitted to USEPA and include a Project Management Plan, Data Collection Quality Assurance Plan, Data Management Plan, and Health and Safety Plan. A Draft Final and Final Interim Report will be

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submitted to USEPA and provide a student t-test statistical comparison of the general indicators of groundwater quality in upgradient and downgradient monitoring wells. A Draft Final and Final Report that incorporates all the analytical data collected during the groundwater quality assessment will be submitted to USEPA and provide conclusions on the groundwater quality at Trench 5 and Line 6 and recommendations for regulatory decisions about the two units.

4.0 HEALTH AND SAFETY PLAN

4.1 SITE SAFETY SUMMARY

4.1.1 ASH DISPOSAL CELL IN TRENCH 5

Site Field Activities:

- Drilling with hollow stem auger rig to install groundwater monitoring wells (Level D with upgrade to Level C). Recommended Drilling Rig Safety Guidelines are presented in Appendix B.
- Soil and groundwater sampling (Level D with upgrade to Level C).

Designated Work Zones:

- Exclusion Zone: Zone within the site, to be defined by the Site Health and Safety Officer (SHSO), where drilling and groundwater sampling will be conducted.
- Contamination Reduction Zone (CRZ): Extends out from the Exclusion Zone a Minimum of 50 feet, where possible.
- Support Zone: Area surrounding the CRZ.

Site Surveillance:

- Total Volatile Organic Vapors and Gases: Photoionization Detector continuously during drilling operations and when wells are initially opened for groundwater sampling.
- Explosivity, Percent Oxygen: EXOTOX combustible gas indicator. Continuous EXOTOX monitoring is required during drilling operations.

Personal Protective Equipment: All activities within this site will be performed using Level D or Level C protection based on the following action levels:

ASH DISPOSAL CELL IN TRENCH 5 ACTION LEVELS

Required Level of Protection	Air Monitoring Parameter		
	PID Reading	EXOTOX Explosivity	EXOTOX Percent Oxygen
D	Background to <5 ppm above background	-	-
C	5 to 50 ppm above background	-	-
Evacuate the Site	50 ppm or greater above background	20 % LEL	< 19.5% or > 22.5%

Key: PID = Photoionization Detector LEL = Lower Explosive Limit
ppm = Parts per million

4.1.2 LINE 6

Site Field Activities:	● Groundwater sampling of existing monitoring wells
Designated Work Zones:	● Exclusion Zone: Zones within the site, to be defined by the SHSO, where drilling and groundwater sampling will be conducted.
	● Contamination Reduction Zone (CRZ): Extends out from the Exclusion Zone a Minimum of 50 feet, where possible.
	● Support Zone: Area surrounding the CRZ.
Site Surveillance:	● Total Volatile Organic Vapors and Gases: Photoionization Detector when wells are initially opened for sampling.

Personal Protective Equipment: All activities within this site will be performed using Level D protection based on the following action levels:

LINE 6 ACTION LEVELS

Required Level of Protection	PID Reading
D	Background to < 5 ppm above background
C	5 to 50 ppm above background
Evacuate the Site	50 ppm or greater above background

4.2 SITE INFORMATION

4.2.1 HISTORY OF ACTIVITIES AT IOWA ARMY AMMUNITION PLANT

The IAAP is a Government Owned, Contractor Operated (GOCO) facility. Mason and Hangar, Silas Mason Company is the operating contractor. The primary mission of the IAAP is to load, assemble, and pack ammunition items, including projectiles, mortar rounds, warheads, demolition charges, anti-tank mines, anti-personnel mines, and the components of these munitions including primers, detonator, fuses, and boosters.

The IAAP was established in 1941. Munitions were produced at the facility from September 1941 until August 1945. Production of munitions was resumed in 1949 and has continued to the present. Nitrogen fertilizer was also produced at the plant from 1946 to 1950. The Atomic Energy Commission (AEC) operated facilities at the IAAP from 1947 through 1973. In 1973, the AEC facilities reverted to the U.S. Army.

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At the present time, ammunition production activities at the IAAP involve the use of explosive material and lead-based initiating compounds.

4.2.2 SITE LOCATION

The IAAP is located in southeastern Iowa, in Des Moines County. It is located approximately 10 miles west of the city of Burlington and the Mississippi River. The IAAP is a secured facility encompassing 19,127 acres in a rural setting; approximately 7,751 acres are devoted to agriculture. A regional location map of the IAAP is shown in Figure 4-1.

4.2.3 UNIT DESCRIPTIONS

4.2.3.1 The Ash Disposal Cell in Trench 5

Site Description: The Ash Disposal Cell in Trench 5 is located at the IDA near the center of the IAAP. Figure 4-2 depicts monitoring wells completed in the shallow aquifer at the Ash Disposal Cell in Trench 5. The IDA has generally been used for disposal of sanitary wastes such as plastic, tin cans, scrap lumber, waxed cardboard, and household and cafeteria waste. From November 1980 until October 1983, a portion of the Ash Disposal Cell in Trench 5 also received ash from the (1) open burning of explosive-contaminated waste, (2) EWI, and (3) CWP. When tested, the ash proved to be a RCRA hazardous waste and the disposal of the ash was discontinued at the unit. The unit was closed in 1989 in accordance with standard IAAP procedures for closure of a sanitary landfill, and a network of monitoring wells was installed. The monitoring well network, however, did not fulfill RCRA requirements for closure of the groundwater at the unit.

Past Waste Management Practices: The trench fill method of landfill operation has been employed at the IDA. In this method, an entire trench is excavated to an approximate depth of 25 feet. Refuse placement begins at the north end of a trench and progresses toward the south. Excavated material is stockpiled next to a trench and used for daily and final cover. A daily cover that is at least six-inches thick is placed over the fill from the stockpiled soil. A final cover that is at least twelve-inches thick is placed over the fill from the stockpiled soil. Materials in the trench are compacted by bulldozers and vehicle travel by trucks working the face of the trench. The final cover slopes to the south (toward natural drainage pathways) at an average grade of two percent. The Ash Disposal Cell in Trench 5 was closed in this manner.

Known Contamination: Ash from the (1) open burning of explosive-contaminated waste, (2) EWI, and (3) CWP was placed in the Ash Disposal Cell in Trench 5. It is estimated that a maximum volume of 145 barrels of ash were placed in the trench (Ref. 1). Assuming the barrels were 55-gallon drums and the ash had a density of 3.0 grams per cubic centimeter (g/cm^3), approximately 91,000 kilograms (kg) of ash was placed in the trench.

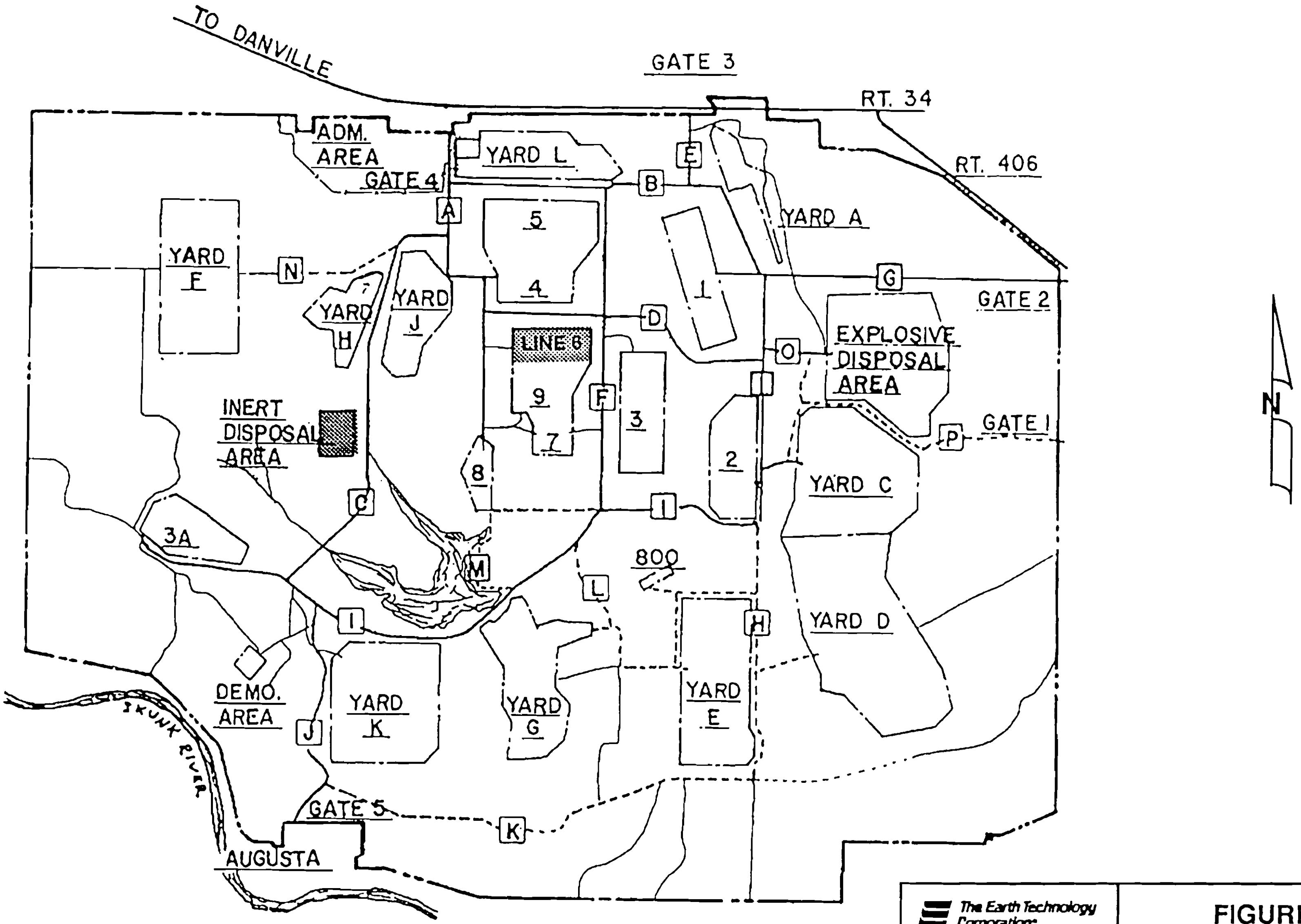

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FIGURE 4-1

IAAP FACILITY MAP

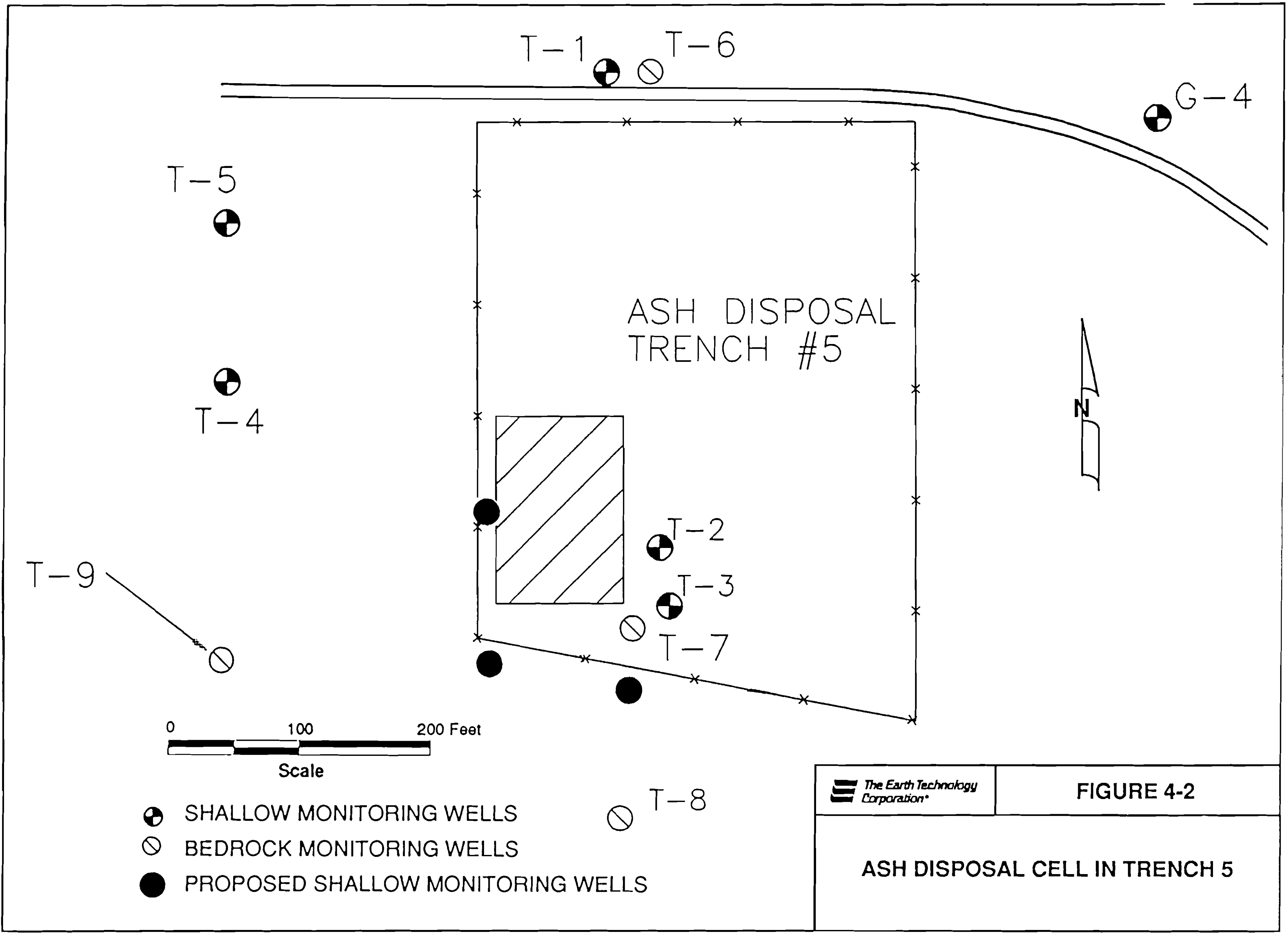

FIGURE 4-2

ASH DISPOSAL CELL IN TRENCH 5

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The open burning grounds are used to burn damaged or obsolete explosives and flash metals. No analyses of the ash generated at the open burning grounds is available, but soil samples at the open burning grounds have been collected and analyzed during two previous investigations. The first investigation, conducted in 1982 by the USAEHA, detected measurable concentrations of metals below RCRA limits. The second investigation, conducted in August 1986, detected elevated concentrations of barium, chromium, lead, and zinc (Ecology and Environment, 1986). It is estimated that only small quantities of ash from the open burning grounds were placed in the Ash Disposal Cell in Trench 5.

The EWI is used to incinerate bulk scrap explosives from munitions production, explosives-contaminated carbon, and explosives-contaminated diatomaceous earth. Analyses of EWI ash have been sporadically detected RDX and TNT. An estimated 95 barrels (Ref. 1) or approximately 60,000 kg of the ash in the Ash Disposal Cell in Trench 5 was derived from the EWI.

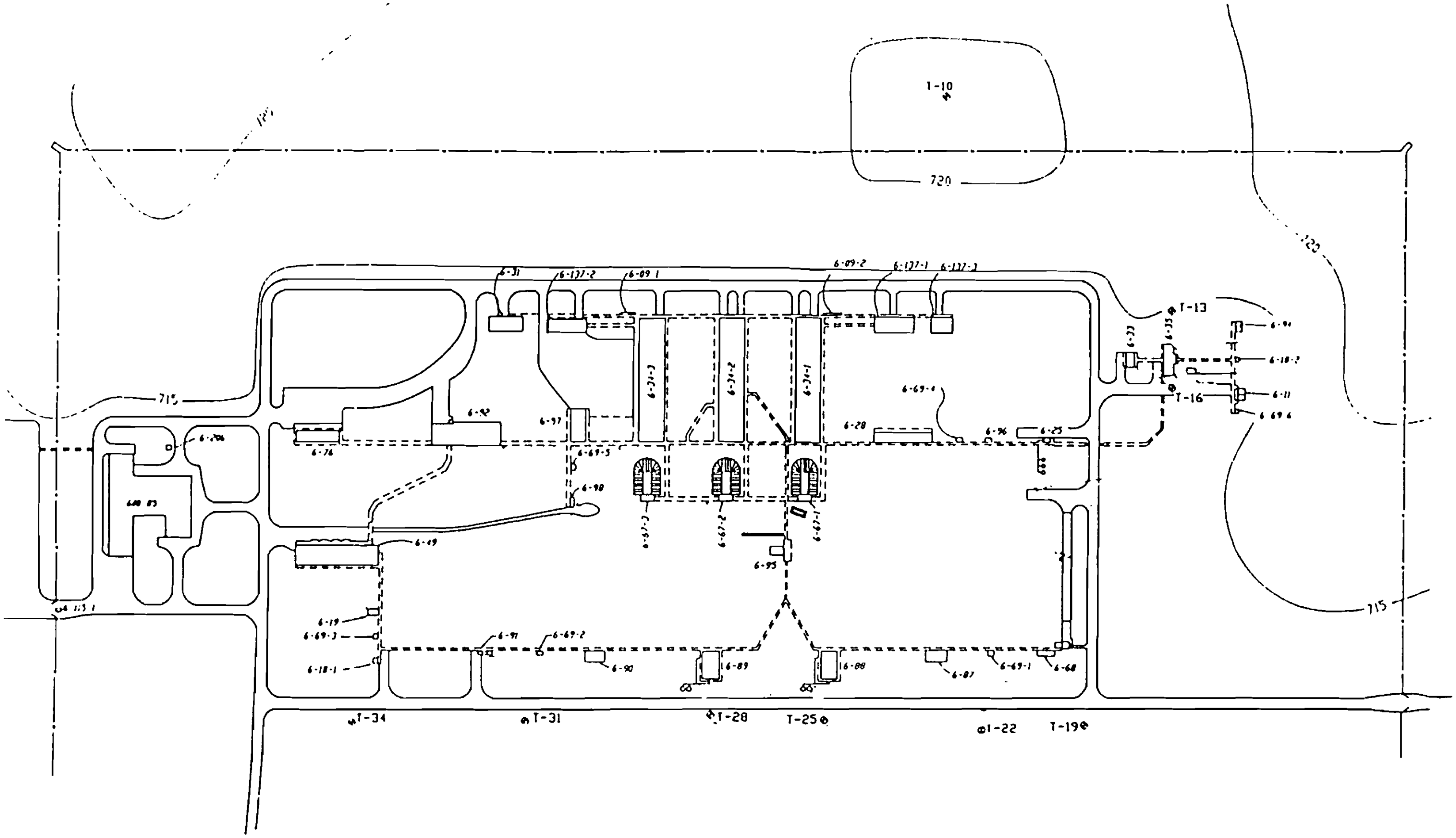
The CWP is used to burn materials which have come in contact with TNT or other explosives. Materials burned in the CWP include explosive-contaminated cardboard and paper box liners, cardboard and wooden boxes used to ship explosives, and explosives-contaminated pallets. The CWP is also used to flash empty metal projectiles, cartridge cases, and empty metal propellant cans. Analysis of typical CWP ash conducted between June 1985 and March 1987 indicate that ash from the CWP was Extraction Procedure (EP) toxic for barium, cadmium, and lead. An estimated 50 barrels (Ref. 1) or approximately 30,000 kg of the ash in the Ash Disposal Cell in Trench 5 was derived from the CWP.

4.2.3.2 Line 6

Site Description: Line 6 is a former detonator production facility that is currently inactive. This unit occupies approximately 30 acres near the center of the IAAP. Figure 4-3 depicts the monitoring wells completed in the shallow aquifer at Line 6. Line 6 is bounded to the north by Lines 1 and 4B, to the east by Line 3, to the south by Line 9, and to the west by the IAAP power plant and Yard J. The facility is approximately 800 feet by 1600 feet and includes approximately 34 buildings that were used in the production, storage, and shipping of detonators, relays, and hand grenade fuses.

Effluent containing explosives and lead wastes from manufacturing operations at Line 6 were placed in stainless steel tanks for desensitization prior to disposal. Desensitized water was later discharged from the tanks and allowed to percolate through limestone filters for pH adjustment before entering adjoining drainage ditches. The limestone filters and the drainage ditches were subsequently removed and the unit was closed in 1989. An extensive groundwater monitoring network has been installed at the unit.

The USACOE, Omaha District, is conducting an on-going remedial action at Line 6 as part of the approved EPA Region VII RCRA closure plan. The remedial action includes the removal of tanks, piping, and all contaminated soil associated with the wastewater treatment process. A complete description of closure activities is provided in the Closure Plan for Line 6.



LEGEND

ROAD

WALKWAY

FENCE

2-70-2 BUILDING

BERM (EXPLOSION PROTECTION)

670 TOPOGRAPHIC CONTOUR
CONTOUR INTERVAL = 5 FEET

KEY

⊗ MONITORING WELL

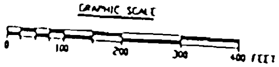


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FIGURE 4-3

Unit Map - Line 6

A complete summary of previous investigations at Line 6 and all corresponding analytical results is provided in the IAAP RCRA Facility Assessment (Ecology and Environment, 1986) and the Work Plan for the Phase I RI/FS of the IAAP (Jaycor, 1992). The results of the site investigation (SI) that preceded the Phase I RI/FS are summarized in the Phase I RI/FS Work Plan. They indicate that no explosives were detected above analytical reporting limits at the unit. Several metals, however, were reported above background in soils at Line 6, including barium, chromium, lead, and nickel.

Past Waste Management Practices: Effluent containing explosives and lead wastes from manufacturing operations at Line 6 flowed through stainless steel troughs to twelve cylindrical, stainless steel underground tanks of varying capacities as listed below:

Building Number	Design Capacity (gpd)
6-18	180
6-25	360
6-35	180
6-68	540
6-88	540
6-89	900
6-91	180
Total	**2,880**

When the tanks were filled, the wastewater was chemically desensitized to render explosive constituents nonreactive. The desensitized wastewater was then discharged to limestone filter beds located adjacent to the tanks. The limestone filter beds were used to raise the pH of the desensitized wastewater before it was discharged to the surface water drainage system. The drainage system was monitored downstream from the limestone filter beds pursuant to NPDES Discharge Permit No. 1A-0003689. In addition, the IAAP included the limestone filter beds as part of the wastewater treatment system in its Part A Permit Application in November 1980 achieving interim status. The IAAP discontinued use of these limestone filter beds in May 1981. In 1984, the limestone filter bed at Building 6-88 was sampled and disposed of as hazardous waste. Operations at Line 6 were stopped in 1988.

The EPA considers the limestone filter beds as land disposal facilities and subject to RCRA regulation. As a result, when the IAAP did not submit a Part B Permit application for these filter beds or certify compliance with applicable groundwater monitoring requirements within 12 months from the date of regulatory amendments (November 8, 1984), the IAAP lost interim status at this unit in accordance with 40 CFR Part 270.10e(5). With the loss of interim status, the Line 6 limestone filter beds were required to be closed pursuant to an approved closure plan.

Production Materials: Production materials used in the stainless steel underground tanks at Line 6 to desensitize wastewater included:

- Lead azide
- Lead styphnate

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- Tetrazene
- RDX
- Barium nitrate
- Antimony sulfide.

Desensitization materials included:

- Acetic acid
- Sodium sulfate
- Sodium nitrate
- Sodium hydroxide.

Known Contamination: In October 1983, soil samples were collected at the discharge points from the limestone filter beds located at Buildings 6-25, 6-68, 6-88, and 6-89. Two of these soil samples were EP toxic for lead.

In August 1984, the limestone filter beds were removed and the excavations were filled and capped with clay. The limestone filter beds were tested for EP toxicity and one filter bed at Building 6-88 was found to be EP toxic for lead.

In August 1986, five soil samples and four sediment samples were collected within the Line 6 area and analyzed. Analytical results showed elevated concentrations of barium, lead, and zinc. Explosives were not detected.

4.3 SITE SAFETY WORK PLAN

4.3.1 SAFETY ORGANIZATION AND RESPONSIBILITY

All personnel involved in the Accelerated Groundwater Quality Assessment at the IAAP are responsible to some extent for their own safety. Specific duties and responsibilities are discussed below. Figure 4-4 shows the safety organization for this project. Resumes of key health and safety personnel are presented in Appendix C.

- **Project Manager**: Provides subcontractor personnel with the health and safety plan before field work begins. The Project Manager supports the efforts of the SHSO. The Project Manager is responsible for the health and safety of all personnel at the site.

- **Corporate Health and Safety Officer**: Provides health and safety plans. Trains SHSOs and provides guidance. THE CORPORATE HEALTH AND SAFETY OFFICER HAS THE AUTHORITY TO IMMEDIATELY STOP ALL WORK AT THE SITE FOR HEALTH AND SAFETY REASONS.

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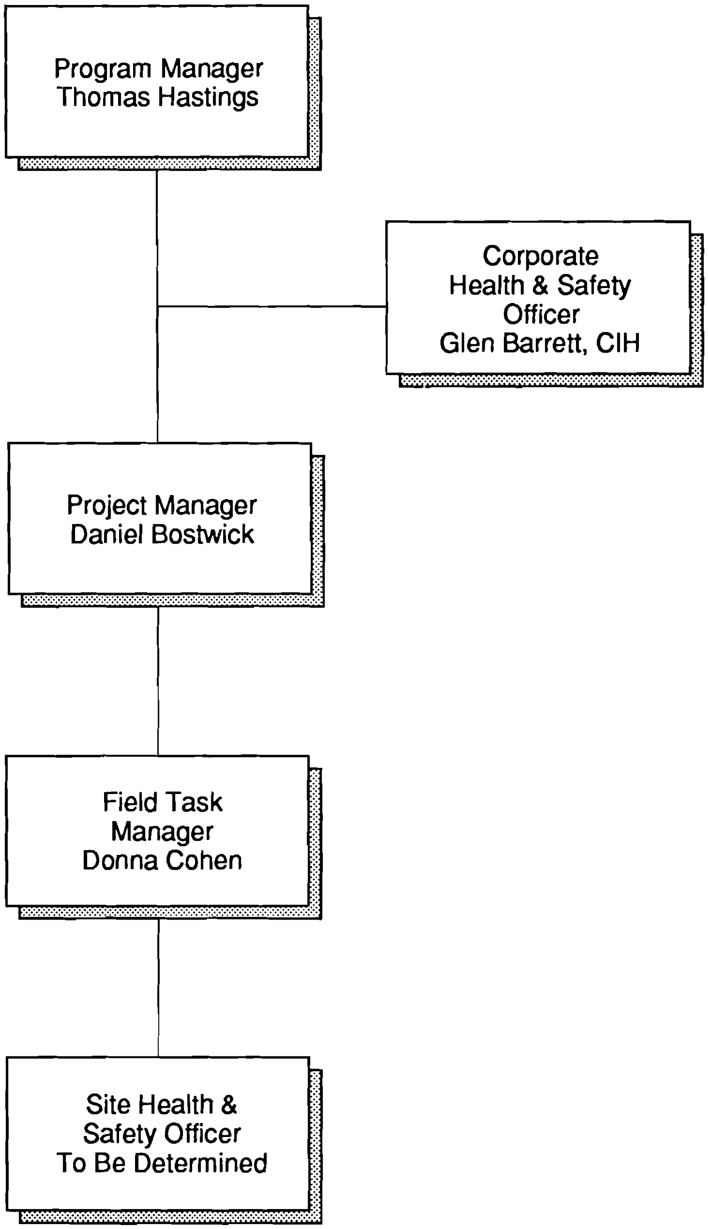

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FIGURE 4-4

Health and Safety Organization

- **Site Health and Safety Officer**: Coordinates health and safety matters within the project. Provides advice to the Project Manager regarding health and safety and recommends policies on matters not specifically addressed by the health and safety plan. Responsible for record keeping as described in Section 4.3.10. THE SITE HEALTH AND SAFETY OFFICER HAS THE AUTHORITY TO IMMEDIATELY STOP ALL WORK AT THE SITE FOR HEALTH AND SAFETY REASONS.

The SHSO is also responsible for:

- Capping wells to prevent unauthorized access.
- Ensuring all heavy machinery and equipment is locked or chained each evening upon completion of daily activities.
- Ensuring all potentially contaminated materials, such as soil cuttings, are contained prior to leaving the site each day.

4.3.2 SITE SAFETY MEETINGS

Site safety meetings involving all site personnel will occur:

- Prior to beginning field activities
- Before each work day
- When modifications are made to the site health and safety plan
- When additional staff begin field work.

The safety meetings, at a minimum, will include discussion of:

- Workers Right-to-Know
- Material Safety Data Sheets (where appropriate)
- Potential Hazards
- Health and Safety Practices
- Safe Driving Practices
- Drilling Rig Safety
- Levels of Protection
- Decontamination
- Safety Organization.

Site safety meetings are the responsibility of the SHSO. All site personnel and subcontractors are required to attend safety meetings. The SHSO will maintain a list of meeting attendees and their signatures acknowledging attendance as shown in Figure 4-5. All site personnel and subcontractors will be given a copy of the Site Health and Safety Plan and will sign the Personal Safety Certification form found in Appendix D.

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On-Site Health and Safety Meeting	
Project:	Project: No.:
Date:	Time:
Today's Work Site(s):	Type of Task(s):
Health and Safety Topics Discussed	
Chemical Hazards:	
Physical Hazards:	
Protective Clothing/Equipment:	
Decontamination Procedures:	
Monitoring Equipment:	
Action Levels:	

Emergency Procedures:

Special Equipment:

Sign Off by Meeting Attendants

______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________
______________________ ______________________

I acknowlege that I understand the topics discussed and the potential health and safety hazards associated with the fiield operations associated with this project. I will abide with the provisions of the Site Health and Safety Plan and any amendments, including topics presented during Site Safety Meetings.

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FIGURE 4-5

Daily Health and Safety Log

4.3.3 *SITE ACCESS/CONTROL*

Site access to the IAAP is through Gate 4.

To reduce the potential for migration of contamination from each site, activities will be conducted at the IAAP within three designated work zones. These zones are the:

- Exclusion Zone
- Contamination Reduction Zone (CRZ)
- Support Zone.

The three work zones are contiguous as shown in Figure 4-6; movement between these zones will be controlled at access control points.

Exclusion Zone: The Exclusion Zone is considered contaminated and is the innermost zone of the three zones. All personnel entering the Exclusion Zone must wear the prescribed level of protection for the site that is being investigated. The anticipated levels of personal protection required within the Exclusion Zone at the two sites under investigation are given in Section 4.1 Field personnel must enter the Exclusion Zone through the access control point. The Exclusion Zone will be cordoned off by the SHSO with flagging tape or another suitable indicator. This boundary is called the "hot line." The buddy system will be used within this zone. There will be no smoking, eating, drinking, or wearing of contact lenses within the Exclusion Zone.

Contamination Reduction Zone: The CRZ lies outside the Exclusion Zone and provides a transition between the contaminated zone (Exclusion Zone) and clean zone (Support Zone). The CRZ contains two contamination reduction corridors; one for equipment and one for personnel. Operations and equipment located within the CRZ will include:

- Decontamination of equipment, personnel, and samples

- Storage of equipment for emergency response including a first-aid kit, spill control equipment, and a fire extinguisher

- Sample packaging and preparation for shipment to an offsite laboratory.

The boundary between the CRZ and the Support Zone is the contamination control line. Entry into the CRZ from the Support Zone will be through an access control point. There will be no smoking, eating, drinking, or wearing of contact lenses within the CRZ.

Support Zone: The Support Zone is the outermost zone of the site and is considered a non-contaminated or clean zone. This zone includes a worker rest area and the Command Post. The Command Post will function as an administrative center which supports the following activities:

- Location of all pertinent documentation/records including the site safety plan, work plan, logbooks, and personnel records

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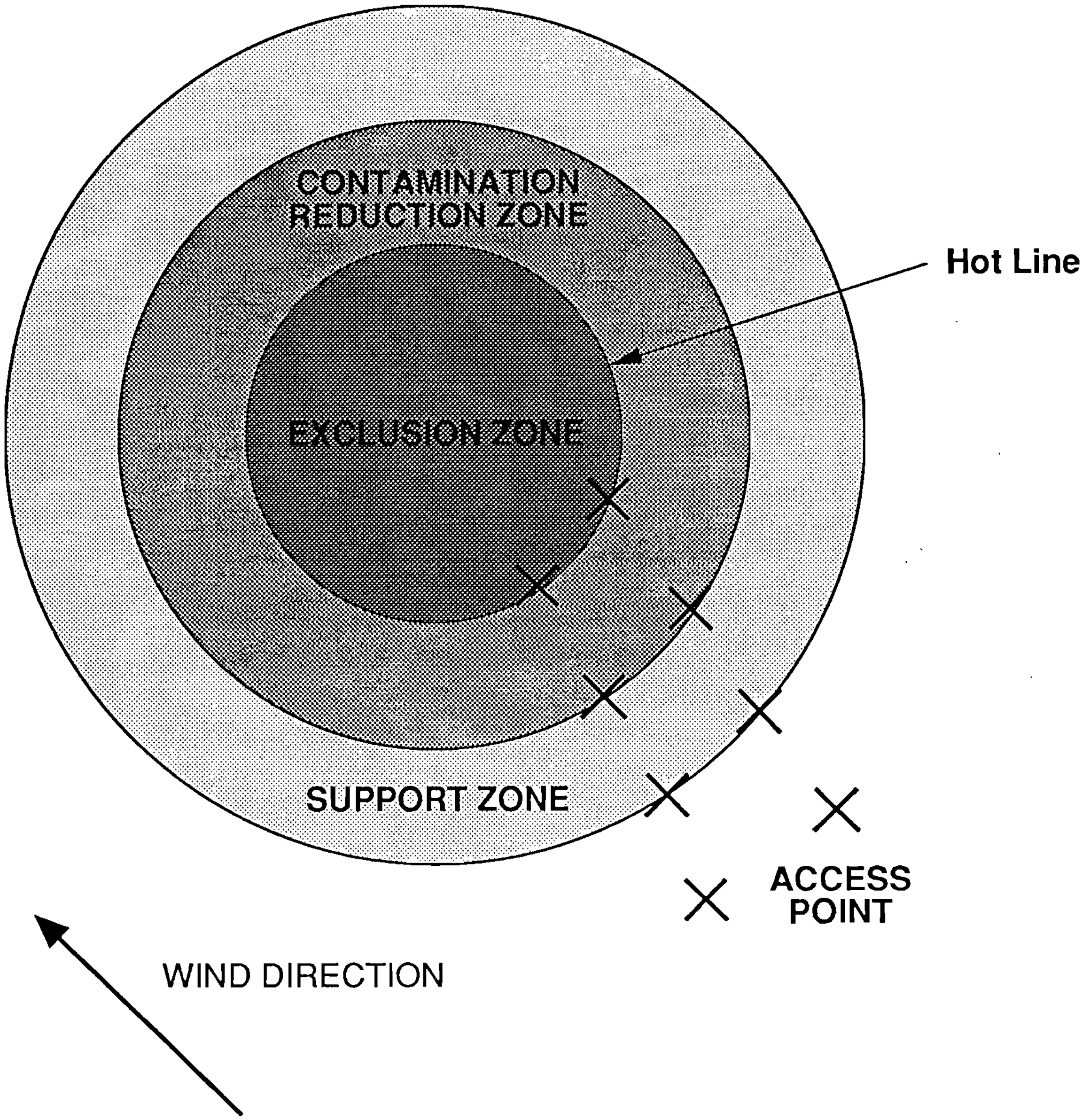

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FIGURE 4-6

Work Zones

- First aid
- Storage and maintenance of equipment and supplies.

On-site eating and drinking will be allowed only in this zone. Smoking is permitted only in areas designated by the IAAP.

4.3.4 COMMUNICATIONS

Two types of communications will be maintained. Internal site communications will include hand signals listed below. These hand signals will be reviewed each day in the site safety meetings. External communications will include a telephone.

Visual signals, including hand signals and whole body movements:

- Hand clutching throat: out of air/can't breathe
- Hands on top of head: need assistance
- Thumbs up: OK/I'm alright/I understand
- Thumbs down: No/negative
- Grip partner's wrist or both hands around partner's waist: leave area immediately.

Internal communication within the work zones are necessary for:

- Maintaining site control
- Coordinating work within all work zones
- Alerting personnel of emergencies.

External communications are necessary for:

- Coordination of emergency response
- Maintaining contact with the Command Post.

4.3.5 AIR MONITORING INSTRUMENTS

Calibration of air monitoring instruments will occur daily. Records will be kept of calibration activities including: meter serial number, calibration gas (isobutylene for the PID and isopropyl alchohol for the CGI) or calibration method, time, date, calibrating individual, and calibration adjustments.

4.3.6 PERSONAL PROTECTIVE EQUIPMENT

Drilling activities at the IAAP will be conducted utilizing Level D respiratory and skin protection. Groundwater sampling activities at the IAAP will be conducted utilizing Level D respiratory protection and Level C skin protection. An upgrade to Level C may be necessary. The requirements for levels of protection are specified in Table 4-1. Air monitoring data will

TABLE 4-1
LEVELS OF PROTECTION

Protection Level	Personal Protective Equipment
Level D	● Steel-toed boots ● Chemical-resistant gloves ● Hard hat ● Safety glasses ● Hearing protection, if required
Level C	● Saranex coveralls ● Full-face air purifying respirator (equipped with GMC-H cartridges) ● Inner and outer chemical-resistant gloves ● Chemical-resistant steel-toe boots ● Hard hat ● Hearing protection, if required

provide personnel with the necessary information for making upgrade/downgrade personal protective equipment (PPE) decisions. Air monitoring action levels for PPE are presented in the Site Summary Sheets in Section 4.1 of this document.

4.3.7 DECONTAMINATION

The need for decontamination will be minimized through work practices designed to reduce contact with hazardous substances. Decontamination of drilling rigs and heavy equipment will take place at a portable decontamination pad.

Decontamination of personnel will take place within contamination reduction corridors within the CRZ. Decontamination will be monitored by the SHSO.

4.3.7.1 Personnel Decontamination

Personnel decontamination will be accomplished through washing and rinsing, or disposal of, protective equipment in combination with sequential doffing. Decontamination will start at the first station with the most heavily contaminated items and progress to the last station with the least contaminated article. For Level D and C activities, the exact decontamination sequence will be determined by site conditions, but will be based on the sequences shown in Figure 4-7 for Level C decontamination. An explanation of the procedure follows:

Station 1: *Segregated Equipment Drop* - Deposit equipment used on sites (tools, sampling devices and containers, etc) in plastic tubs or on plastic sheeting.

Station 2: *Boot Wash* - Scrub boots with detergent/water solution.

Station 3: *Boot Rinse* - Rinse away solution from Station 2 using copious amounts of water.

Station 4: *Tape Removal* - Remove tape from boots and gloves and deposit in trash bag or plastic tub.

Station 5: *Outer Glove Removal* - remove outer gloves and deposit in trash bag or plastic tub.

Station 6: *Canister Change* - If worker leaves exclusion zone to change respirator canisters, this is the last step in the decontamination procedure. Worker's canisters are exchanged, new outer gloves donned, and joints taped. Worker returns to duty.

Station 7: *Coveralls Removal* - With assistance of helper, remove coveralls. Deposit in trash bag or plastic tub.

Station 8: *Facepiece Removal* - Remove facepiece. Deposit in plastic tub. Avoid touching face with gloves.

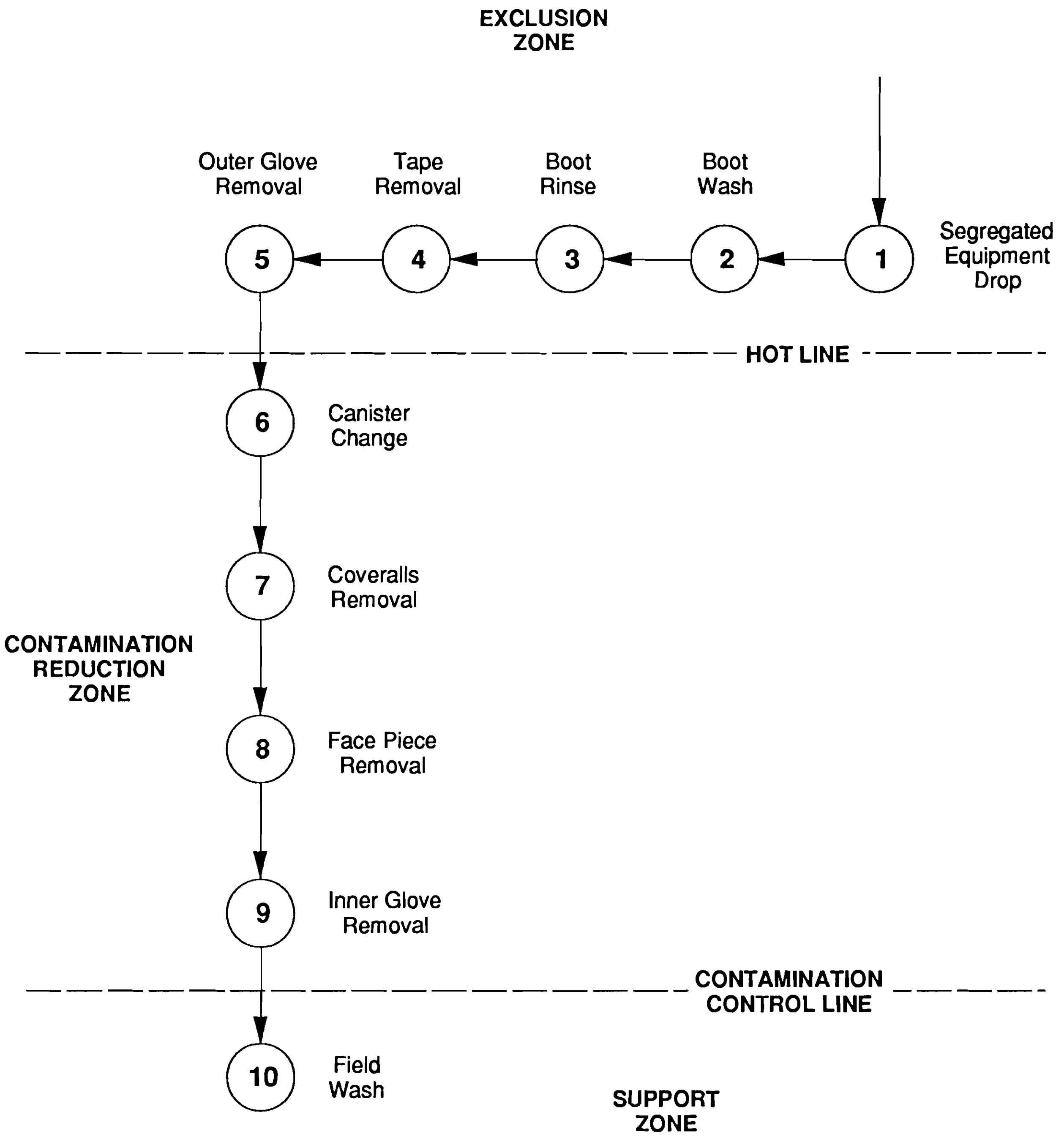

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FIGURE 4-7

Level C Decontamination Sequence

Station 9: *Inner Glove Removal* - Remove inner gloves and deposit in trash bag or plastic tub.

Station 10: *Field Wash* - Wash hands and face thoroughly with baby wipe or soap and water.

Level D decontamination may include boot and glove wash/rinse steps and a field wash.

4.3.7.2 Decontamination of Heavy Equipment

Decontamination of drilling equipment will be accomplished through scraping and removal of dirt and gross contaminants in the CRZ, if necessary, followed by steam cleaning at a portable decontamination pad at a location proposed by TETC and mutually agreed upon by the IAAP and EPA. The exact decontamination sequence will be determined by site conditions, but will be based on the sequence shown in Figure 4-8.

4.3.7.3 Decontamination of Sampling Equipment

Decontamination of sampling equipment will be accomplished by washing with detergent water, rinsing with tap water, and rinsing with distilled water. Air monitoring equipment will be protected with plastic bags or wrap when used in the Exclusion Zone.

4.3.8 MEDICAL MONITORING

TETC personnel participating in the IAAP Accelerated Groundwater Quality Assessment and drilling subcontractors receive a pre-assignment medical screening, periodic (annual) medical examinations, and a termination examination. The medical monitoring program meets the requirements of the Occupational Safety and Health Administration (OSHA) 29 CFR 1910.120.

4.3.9 PERSONNEL TRAINING

All site personnel entering an Exclusion Zone will be required to participate in an OSHA approved health and safety training program that complies with criteria set forth by 29 CFR 1910.120. This program instructs employees on general health and safety principles and procedures, proper operation of monitoring instruments, and the use of PPE.

4.3.10 RECORDS

All site personnel medical and training records and/or certificates shall be retained at the Command Post during site work. These records shall be accessible to OSHA, U.S. Army, and EPA representatives.

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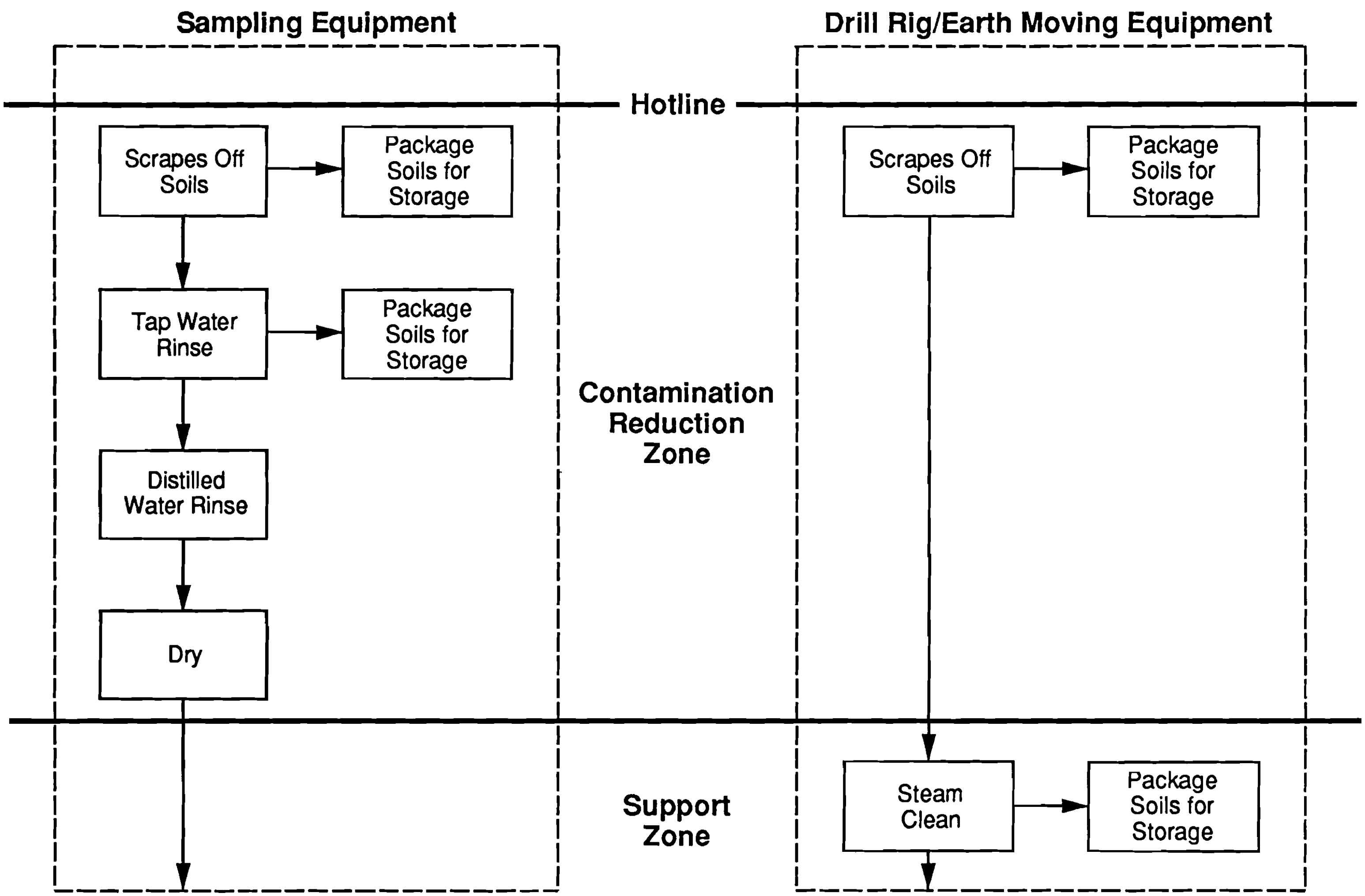

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FIGURE 4-8

Equipment Decontamination

4.3.11 CONTINGENCY/EMERGENCY RESPONSE PLAN

Emergency Coordinator: The SHSO or a designated alternate will act as Emergency Coordinator and will be responsible for initiating appropriate emergency response throughout site activities. Emergency Coordinator responsibilities include:

- Coordination with emergency medical facilities for emergency support
- Coordination with the IAAP environmental office for environmental support
- Coordination with the IAAP safety office for installation safety and security requirements
- Coordination with the IAAP and local fire departments
- Coordination with the IAAP Guards at Gate 4 ((319) 753-7434) for arranging work to be performed on Saturdays and Sundays
- Designation of onsite response teams
- Notification of offsite emergency response teams
- Emergency assessment
- Rendering first aid as necessary
- Maintaining safety equipment
- Posting emergency telephone numbers and an area map to the nearest medical facilities (Figure 4-9 and 4-10).

The only exception to this rule is any situations that are immediately dangerous to life and health.

First Aid and CPR: All TETC field personnel conducting hazardous waste operations shall be required to successfully complete a Red Cross-sponsored course, or equivalent, in first aid training and in CPR. A minimum of two TETC field personnel shall be present at each project site.

First aid kits will be 16-unit first aid kits (National Safety Council Data Sheet No. 202) or kits approved by the Corporate Health and Safety Officer and will be provided in a minimum ratio of one for each 25 persons. Each site crew will carry a first aid kit with them into the CRZ. The kit will be encased in a manner to prevent kit contamination.

Emergency Telephone List: Emergency telephone numbers as listed in Table 4-2 and Appendix E will be posted at the Command Post and will be available at the site of field activities. The emergency telephone list shall be placed in each vehicle to be used on site.

Emergency Medial Facilities: The IAAP Health Clinic shall be used for emergency care to individuals who may experience an injury or exposure on site. Figure 4-9 is a map that shows the route to the IAAP Health Clinic. This map will be placed in each vehicle to be used on site.

For injuries or exposures requiring off-site medical attention, the Burlington Medical Center (602 North 3rd Street) shall be used. The route to the Burlington Medical Center is as follows:

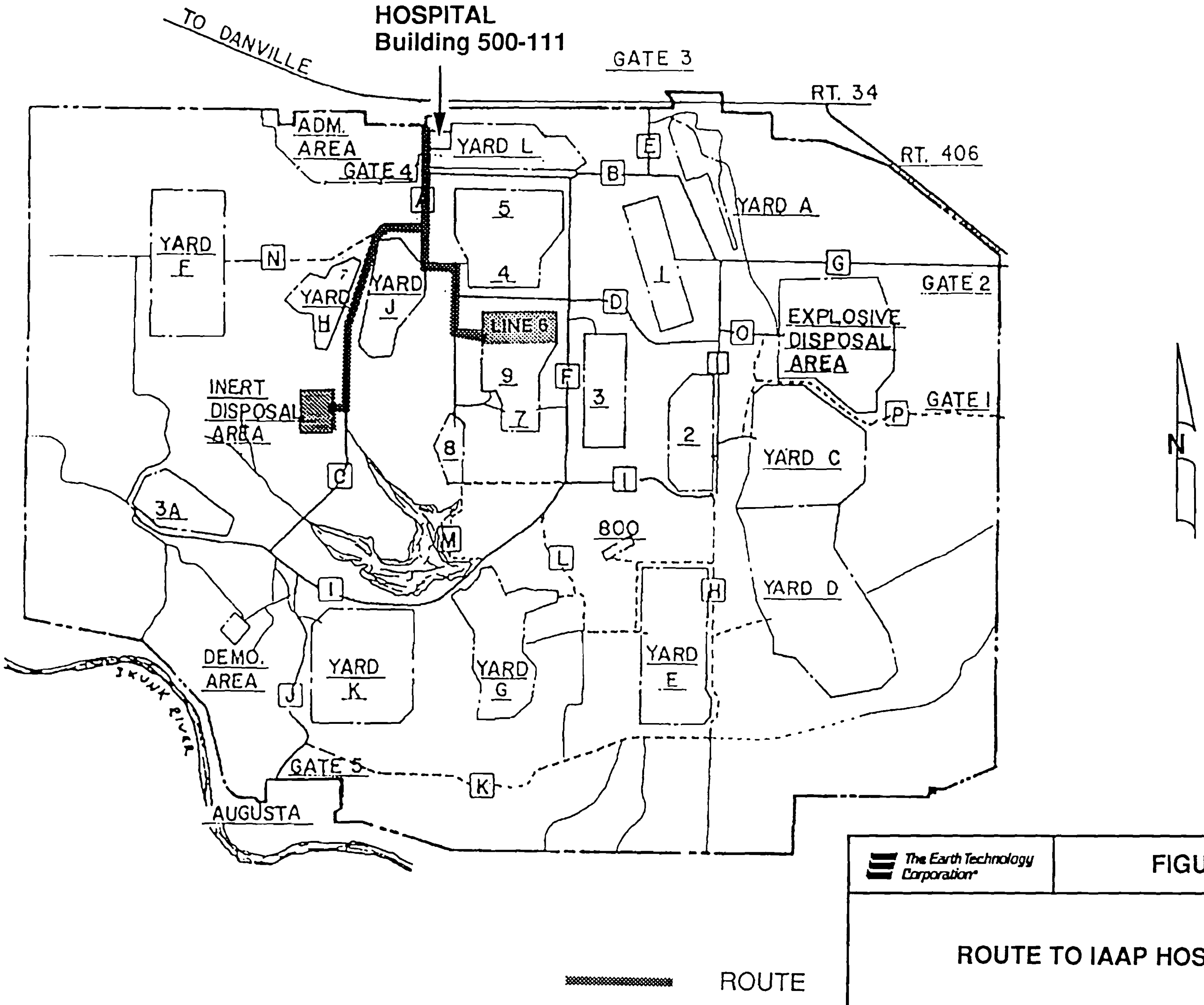

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FIGURE 4-9

ROUTE TO IAAP HOSPITAL

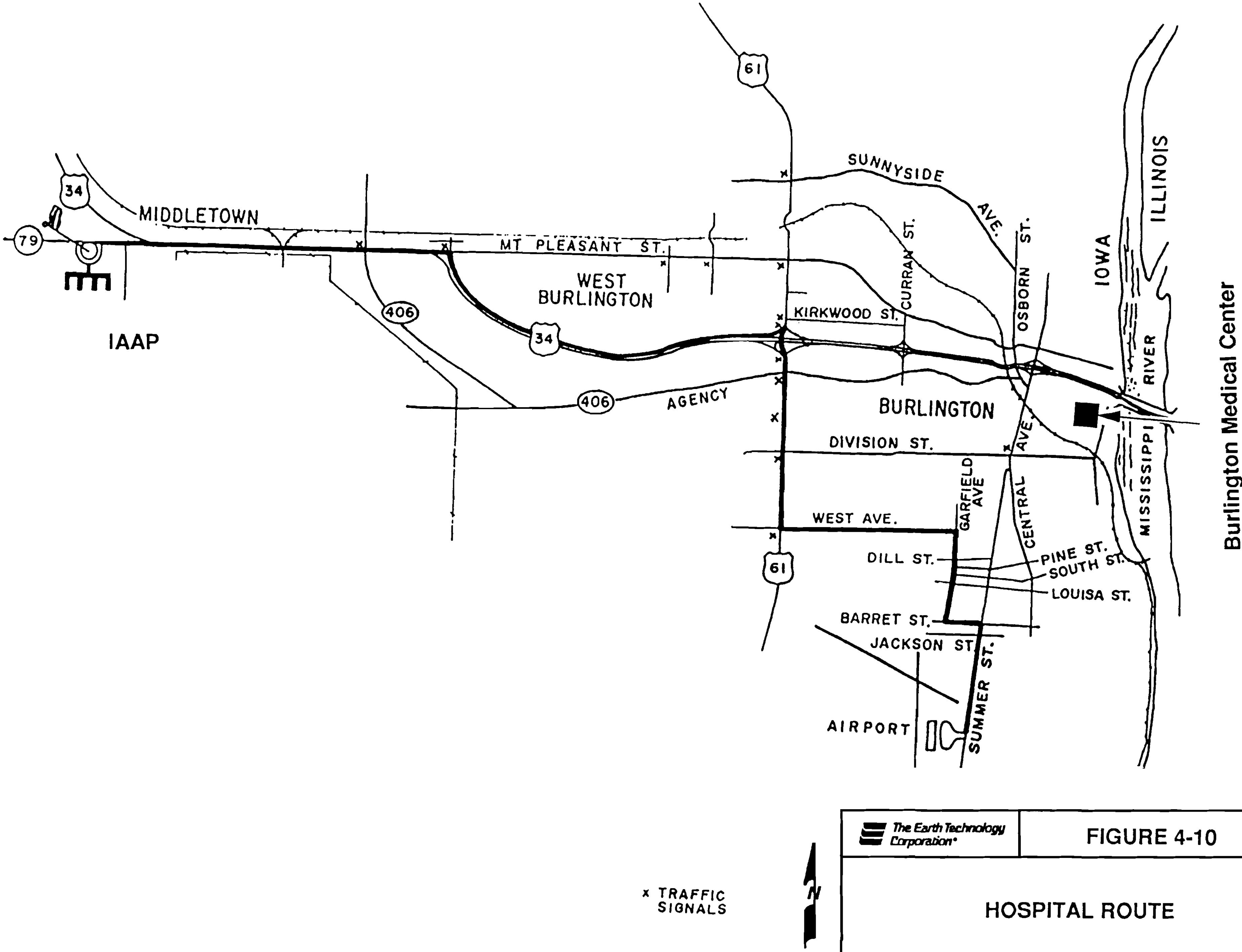

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FIGURE 4-10

HOSPITAL ROUTE

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TABLE 4-2
EMERGENCY TELEPHONE NUMBERS

Local Fire Department	(319) 753-7121
Local Paramedics	(319) 753-7121
IAAP Security	(319) 753-7960
Local Medical Care	Emergency Room (319) 753-3264 Burlington Medical Center 602 North Third Street Burlington, Iowa 52601 Emergency Room Director: Gail Boyd (319) 753-3011
Poison Control	1-800-272-6477
IAAP Emergency Response Team	(319) 753-7121
IAAP Point of Contact	Leon Baxter (319) 753-7101
TETC Office (Eastern Division)	(703) 549-8728
TETC Corporate Health and Safety Officer (Home)	Glen Barrett (703) 658-4319
TETC Senior Vice-President, WDC (Home)	Robert A. Colonna (301) 656-2155
TETC Site Health and Safety Officer (Hotel)	To Be Determined
TETC Eastern Division Deputy Health and Safety Officer (Home)	David Naleid (703) 799-2492
USAEC Project Manager	Derek Romitti (410) 671-1507
USAEC SES Branch	William Houser (410) 671-1591

- Proceed north on Texas Avenue, past the Administration Area and through Gate 4;
- Turn right (east) on Route 34;
- Follow Route 34 into Burlington;
- Turn right (south) on N. Main Street for four blocks;
- Turn right (west) onto Washington Street, follow for one block;
- Turn right again (north) onto N. 3rd Street; the Medical Center is on the right;
- Proceed to the Emergency entrance.

These written directions along with the map of the route to the Burlington Medical Center (Figure 4-10) will be placed in each vehicle to be used on site.

Response to Potential Hazards: The SHSO will designate an onsite response team to respond to minor fires, electrical fires or spills and other emergencies that do not require offsite response personnel. The SHSO will maintain communication with the onsite response team at all times during site operations. Onsite response personnel will have ready access to all fire fighting equipment, spill control equipment, and first aid supplies during site operations. Response to medical emergencies is detailed in Appendix F.

In the event of fire, spill, or other emergency that cannot be controlled by the onsite response team, all site personnel will evacuate the site and go to the Command Post. The SHSO will contact the IAAP emergency response team at (319) 753-7121 to control the hazard. The IAAP emergency response team is available 24 hours per day, seven days per week. Site personnel will wait at the Command Post for further instructions from the SHSO and/or emergency response personnel.

During an emergency, the SHSO will take all reasonable measures necessary to ensure that fires, explosions, and releases do not occur, recur, or spread to other parts of the facility. These measures will include, where applicable, stopping all site activities; collecting and containing released material; and removing or isolating containers.

Immediately after an emergency, the SHSO will provide for treating, storing, or disposing of recovered material, contaminated soil or surface water, or any other material that results from a release, fire, or explosion at the site.

The SHSO will ensure that all emergency equipment listed in this contingency plan is cleaned and fit for its intended use before site operations are resumed.

All employees should bring to the attention of the SHSO any unsafe condition, practice, or circumstance associated with or resulting from site investigations. In the case of an immediate hazard to employees or the public, any employee on the scene will take all practicable steps to eliminate or neutralize the hazard; this may include leaving the site.

In the event that any member of the field team is overcome, incapacitated, or traumatically injured while onsite, the remaining members will immediately call for assistance and then don appropriate protective equipment and make reasonable efforts to rescue the affected person. At least one person shall remain out of the problem area until help arrives. Once removed from the site, the victim will not be left unattended. If possible, limited personnel decontamination should be conducted, but not if time is critical to get the victim to medical aid.

When it is determined that the problem was due to chemical exposure, all members of the team exposed to those chemicals will proceed expeditiously, in a group, to the nearest appropriate medical facility. In those cases were personal contamination has occurred, all persons involved shall make every reasonable effort to decontaminate themselves, so there will be a minimal spread of contaminants.

All accidents and incidents that occur on site during field activities associated with this project will be promptly reported to the SSO and the Task Manager. The Task Manager will provide timely notification to the Project Manager. The supervisor of the injured employee or work crew where the accident occurred will initiate the written report. For convenience, the Injury Report form in Appendix G may be used to ensure all relevant information is recorded. The Task Manager or Project Manager may complete the "Manager" section of the Injury Report and forward the Injury Report to the Earth Technology Health and Safety Section in the Washington, D.C. office. The SSO will investigate every accident or illness and, if related to work, complete the Accident/Injury Investigation form found in Appendix G. The Corporate Health and Safety Officer will assist accident investigations and Accident Review Boards. The Task Manager will ensure the Accident Review Board recommendations are implemented.

Accidents resulting in a fatality, lost-time injury or illness, hospitalization of five or more personnel, or property damage to the government or contractor property (which occurred during the performance of the contract) equal to or exceeding $2,000 must be telephonically reported to USAEC, SES Branch (410) 671-4811, as soon as possible, but not later than 2 hours after occurrence and reported in writing within 5 days of occurrence on DA Form 285. All other accidents/incidents must be telephonically reported by USAEC, SES Branch (410) 671-4811, within 8 hours of occurrence.

Site Evacuation and Routes: An evacuation route has been established by the Corporate Health and Safety Officer. An evacuation route has been designated to move personnel away from an affected area, in a safe and efficient manner, and to establish efficient traffic patterns for fire and emergency equipment during an emergency response. The evacuation route is shown in Figure 4-11. This map shall be placed in each vehicle to be used on site.

4.3.12 HAZARD COMMUNICATION PROGRAM

A copy of the TETC Hazard Communication Program shall be kept at the Command Post. The Program shall be accessible to OSHA, U.S. Army, and EPA representatives.

4.3.13 LOGS AND REPORTS

The Field Task Manager will be responsible for keeping daily logs which shall include the following information:

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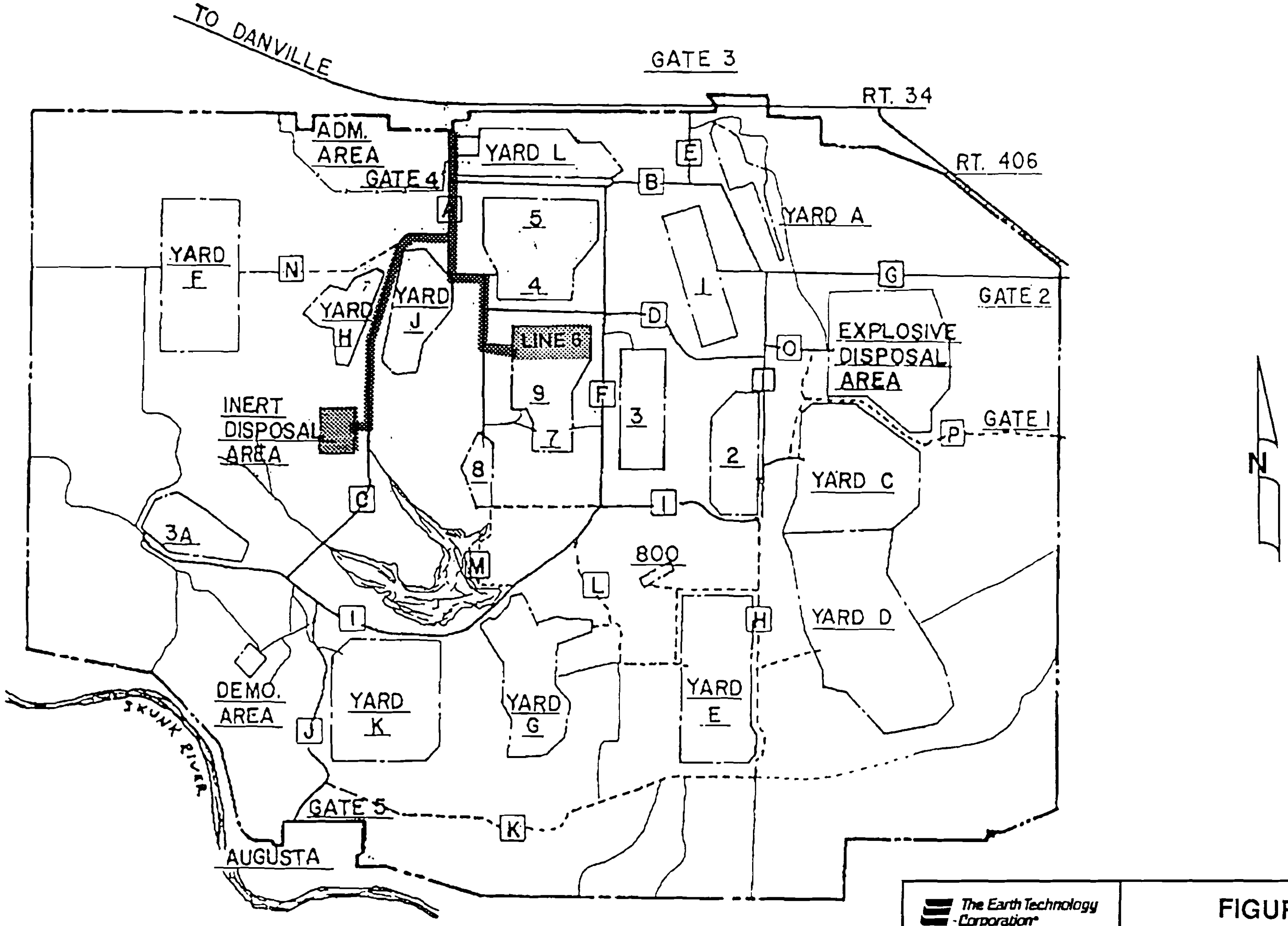

▨ ROUTE

The Earth Technology Corporation

FIGURE 4-11

EVACUATION ROUTE

- Date
- General weather conditions (temperature, wind direction, precipitation)
- Site activity
- Heavy equipment being used
- Levels of personal protection being used by onsite personnel at various tasks
- Observed safety deficiencies/incidents
- Site visitors
- Air monitoring instruments being used
- Results of air monitoring
- Accidents/illnesses.

As discussed in Section 4.3.2, the SHSO will maintain a daily log documenting the daily health and safety meeting. All TETC and subcontractor personnel will sign the log acknowledging attendance at the meeting.

4.3.14 VISITOR POLICY

Visitation to the site will be strictly controlled by the SHSO. This is to ensure that all visitors are protected from the physical and chemical hazards associated with the Accelerated Groundwater Quality Assessment. For the purpose of this health and safety plan, a visitor is anyone who is not one of the following:

- An employee of TETC or its subcontractors.
- A designated representative of the U.S. Army or the Silas Mason Company
- Routinely present at the site
- A designated participant in site operations
- Trained or medically authorized, consistent with the Health and Safety Plan.

The SHSO has the authority, using these guidelines, to determine the appropriate amount of training and PPE necessary for each visit. The SHSO oversees all site visitations to ensure that the visitor's presence complies with all government regulations and this Health and Safety Plan, and does not impede working progress at the site or endanger the health and safety of those working at the site. Any persons on site at the Ash Disposal Cell in Trench 5 or Line 6 will be given a copy of the Site Health and Safety Plan and will sign the Personal Safety Certification form found in Appendix D.

4.3.15 ONSITE/OFFSITE DELIVERIES

Outside vendors and contractors will be delivering materials to the site throughout site preparation and activities. Such personnel will be instructed in proper site entry procedures. Site personnel may be required to transport materials and supplies into the Exclusion Zone. Outside personnel will not be permitted to enter the CRZ or Exclusion Zone unless prior approval from the SHSO is obtained.

Deliveries made to the onsite area by personnel who do not meet the medical and training requirements of 29 CFR 1910.120 will be coordinated so that such delivery personnel are not

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exposed to hazardous substance concentrations above safe exposure levels or physical hazardous which may cause injury. Onsite delivery areas will be evaluated prior to allowing delivery personnel to enter the Exclusion Zone. Delivery areas and routes within the Exclusion Zone will be considered within the Support Zone during delivery, provided delivery personnel are not at risk due to potential exposure to site contaminants. Site safety personnel will accompany all delivery personnel who do not meet the requirements of 29 CFR 1910.120 during any delivery to an onsite area to ensure delivery personnel remain in the support zone.

The safety of outside vendors and contractors delivering materials to the onsite areas will be insured by the following actions:

- All work with potential for generating hazardous levels of contaminants will be halted by the SHSO or designee.
- Before entering a site, delivery personnel will be instructed regarding the potential for exposure to hazardous substances.
- Escape respirators will be provided to the delivery personnel, if appropriate, and they will be instructed in their use.
- The SHSO or designee, equipped with appropriate air monitoring equipment, will escort the delivery personnel to the delivery site, remain during the delivery and escort the vehicle and delivery personnel back to the site entrance. During this time period, the SHSO will be responsible for ensuring that all necessary safety measures are taken.
- Delivery vehicles and equipment will be decontaminated as described in Section 4.3.7, if necessary.

4.3.16 RECOMMENDED DRILLING RIG SAFETY GUIDELINES

Drilling rig maintenance and safety is the responsibility of the drilling operator. General guidelines for safety practices at the IAAP are presented in Appendix B.

4.3.17 GENERAL SAFETY PRACTICES

The following safety practices will be observed at the IAAP where exposure to potentially hazardous contaminants exists:

1. All personnel going onsite will be thoroughly briefed by the SHSO or designee on anticipated hazards, equipment requirements, safety practices, emergency procedures, and communication methods.
2. Eating, drinking, chewing gum or tobacco, and taking medication are prohibited in contaminated or potentially contaminated areas or where the possibility of the

transfer of contamination exists. Smoking or wearing contact lenses is prohibited throughout the site.

3. Thorough washing of hands is required before eating.

4. Personnel will avoid contact with potentially contaminated substances. Personnel will also avoid, whenever possible, kneeling on the ground; and leaning or sitting on drums, equipment, or the ground. Monitoring equipment will not be placed on potentially contaminated surfaces (e.g., drums, ground, etc.)

5. No beard or facial hair which interferes with a satisfactory qualitative respirator fit test will be allowed for personnel requiring respiratory protection.

6. Personnel will be familiar with and knowledgeable about standard operating safety procedures for equipment and site operations.

7. Field personnel will wear designated and approved PPE as instructed by the SHSO.

8. Proper care will be taken to avoid vehicle contamination during transport of samples to laboratories. If there is a possibility that the sample bottles, bags, or wrapping are contaminated, the laboratory will be notified.

4.4 HAZARD ASSESSMENT

Hazards associated with activities at the IAAP include physical and chemical hazards.

4.4.1 PHYSICAL HAZARDS

Physical hazards associated with work at the IAAP include:

- **Heavy Equipment**: Drilling rigs and earth moving equipment will be used at the site. Risks associated with heavy equipment use will be reduced through employing operators with proper training, confining heavy equipment use to appropriate work areas and work zones, and through preparing adequately for work assignments.

- **Underground Utilities/Overhead Power Lines**: Prior to subsurface sampling/drilling, the Ash Disposal Cell in Trench 5 and at Line 6 will be cleared by Mason-Hangar-Silas Mason for underground utilities. If underground utilities are found to be present at the Ash Disposal Cell in Trench 5, they will be visibly identified with warning tape, barriers, or spray paint. Site activities should be conducted so the underground piping or wiring systems are not disturbed. Site personnel must ensure equipment and machinery are kept clear of all overhead utilities throughout site operations. If overhead power lines are present, the drilling rig will be positioned so that a safe clearance distance between the

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overhead utility lines and the drilling rig mast is maintained (a minimum of 20 feet or the height of the mast, whichever is greater).

- Noise: Exposure to excessive noise from drilling activities can damage the hearing apparatus and cause permanent hearing loss. The drilling subcontractor shall provide TETC with established noise levels for all equipment used for drilling operations.

  When noise levels exceed 85 decibels on the A-weighted scale (85 dBA), workers are required to use appropriate hearing protection. At WRF, all personnel will wear hearing protection when normal conversation becomes difficult at distances of 3 feet or less. All Earth Technology field personnel who are medically monitored participate in a hearing conservation program. This program is mandatory for employees whose 8-hour equivalent noise exposure exceeds 85 dBA ($L_{eq} > 85$ dBA). The hearing conservation program includes the following elements.

  1. Baseline survey of noise exposures.
  2. Baseline audiometric testing.
  3. Annual audiometric testing.
  4. Annual training on the use and need for hearing protection.
  5. Distribution of hearing protectors to employees in the program.
  6. Maintenance of records.

- **Cold Stress:** Most cold-related worker fatalities have resulted from failure to escape low environmental air temperatures or from immersion in low temperature water. The single most important aspect of life-threatening hypothermia is a fall in the deep core temperature of the body. Frost-bite may also occur. These conditions are described below.

  Hypothermia: The signs and symptoms of hypothermia include shivering, dizziness, numbness, confusion, weakness, impaired judgment, impaired vision, and drowsiness. The stages are:

  - Shivering
  - Apathy
  - Loss of consciousness
  - Decreasing pulse rate and breathing rate
  - Death.

  As hypothermia progresses, the victim may move clumsily and have trouble holding things. In the later stages, he or she may stop shivering.

  If anyone exhibits the symptoms of hypothermia, call EMS. The victim of hypothermia should be removed from the cold and into dry clothing. Warm up his or her body slowly. Give nothing to eat or drink unless the victim is fully conscious.

Employees should be protected from exposure to cold so that the deep core temperature does not fall below 36°C (98.6°F.) A lower body temperature will very likely result in reduced mental alertness, reduction in rational decision making, or loss of consciousness with the threat of fatal consequences. The following work practices are mandatory and will help protect against cold stress.

- **Below 7°C (45°F)**: Workers shall be provided with warm clothing, such as mittens and heavy socks. Protective clothing may be used to provide warmth.

- **Below 4°C (40°F)**: Depending on employee comfort, clothing for warmth shall be provided in addition to protective clothing. This will include:

    1. Insulated suits, such as whole-body thermal underwear

    2. Wool socks or polypropylene socks to keep moisture off the feet if there is a potential for work activity which would cause sweating

    3. Insulated gloves

    4. Insulated boots

    5. Insulated head cover, such as knit caps.

- **Below 2°C (35°F)**:

    - If the clothing of an employee might become wet on the job site, the outer layer of the clothing must be impermeable to water.

    - If an employee's underclothing (socks, mittens, etc.) becomes wet in any way, the employee must change into dry clothing immediately. If the clothing becomes wet from sweating, the employee may finish the task which caused the sweating before changing into dry clothing.

    - Employees must be provided a warm area, warmer than 18°C (65°F) to change from work clothing into street clothing.

    - Employees must be provided a warm break area, warmer than 15°C (60°F).

- Hot liquids, such as soups, and warm, sweet drinks, etc., shall be provided in the break area. The intake of coffee shall be limited because of the attendant diuretic and circulatory effects.

- The buddy system shall be practiced at all times. Any employee observed with severe shivering shall leave the cold area immediately.

- Employees should layer their clothing, i.e., wear thinner, lighter clothing next to the body with heavier clothing layered outside the inner clothing.

- Avoid overdressing when going into warm areas or when performing activities which are strenuous. This could lead to heat stress problems.

- Employees handling volatile liquids (gasoline, hexane, alcohol, etc.) shall take special precautions to avoid spilling or splashing the liquids on clothing or gloves because of the added danger of cold injury from evaporative cooling.

Frostbite: Frostbite is the most common injury caused by exposure to cold. It happens when ice crystals form in body tissues, usually the nose, ears, chin, cheeks, fingers, or toes. This restricts blood flow to the injured parts. The effect is worse if the frostbitten parts are thawed and then frozen.

The first sign of frostbite may that the skin is slightly flushed. The skin color of the frostbitten area then changes to white or grayish yellow and finally grayish blue, as the frostbite develops. Pain is sometimes felt early on, but later goes away. The frostbitten part feels very cold and numb. The victim may not be aware of the injury.

Frostbite has degrees of tissue damage. Mild frostbite looks white or grayish, and the skin feels hard, even though the underlying tissue feels soft. In moderate frostbite, large blisters form on the surface and in the tissues underneath. The frostbitten area is hard, cold, and insensitive. If freezing is deeper than the skin, tissue damage is severe. Gangrene may result from the loss of blood supply to the area.

If anyone exhibits these symptoms, the victim should be transferred to a warm place. Put the frozen parts in warm (100-105 degrees Fahrenheit) but not hot water. Handle them gently, and do not rub or massage them. If the toes or fingers are affected, put dry, sterile gauze between them after warming them. Loosely bandage the injured parts. If the part has been thawed and refrozen, it should be rewarmed at room temperature.

- **Heat Stress**: In hot, sunny, humid environments there is a high potential for heat stress to pose a significant safety hazard to workers. This is especially true where the use of mandated protective clothing limits the body's ability to dissipate heat through the evaporation of sweat. In order to mitigate the effects of heat stress, it will be necessary to establish work routines which incorporate appropriate rest (cool down) periods to allow workers to remove protective clothing, drink fluids (vital when heavy sweating is occurring), and rest. The frequency and length of such work breaks must be determined for the individual based on factors such as ambient temperature, wind velocity, humidity, sunshine, the amount of physical labor being performed, the physical condition of the worker, and the protective clothing being worn. In any case, breaks must be sufficient to prevent workers from developing symptoms of heat stress, which can include irritability, confusion, lethargy, headache, nausea, etc.

  Workers must be encouraged to immediately report any difficulties or heat-related problems which they may experience or observe in fellow workers. Supervisors should use such information to alter the work/rest schedule to accommodate differences in workers and resolve such problems. During breaks, workers should be encouraged to drink plenty of water or other liquids to replace lost fluids and help cool off.

  Unless specifically excepted by the SSO, all onsite personnel shall use the buddy system. Buddies shall maintain visual contact with each other. Buddies must observe each other and be alert for signs of heat stress or toxic exposure, including both visual and nonvisual effects of toxic exposure, such as:

  1. Changes in complexion and skin discoloration.
  2. Changes in coordination or demeanor.
  3. Excessive salivation and pupillary response.
  4. Changes in speech pattern.
  5. Headaches, dizziness, blurred vision.
  6. Nausea, cramps.
  7. Irritation of eyes, skin, or respiratory tract.

  Anyone exhibiting symptoms should be taken immediately to the nearest medical facility, taking steps to cool the person during transportation, including removing clothing, applying cool water to the skin, placing in air conditioned space, etc.

  As the body becomes unable to effectively remove excess heat, a variety of symptoms and effects will occur. These can include the following, in order of increasing severity.

  - **Heat Cramps**: Heat cramps are caused by heavy sweating and inadequate electrolyte replacement. Signs and symptoms include muscle spasms and pain in the hands, feet, and abdomen.

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- **Heat Exhaustion**: Heat exhaustion occurs from increased stress on various body organs including inadequate blood circulation due to cardiovascular insufficiency or dehydration. Signs and symptoms include:

  1. Pale, cool, moist skin.
  2. Heavy sweating.
  3. Dizziness.
  4. Nausea.
  5. Fainting.

- **Heat Stroke**: Heat stroke is the most serious form of heat stress. Temperature regulation fails and the body temperature rises to critical levels. Immediate action must be taken to cool the body before serious injury or death occur. Competent medical help must be immediately obtained. Signs and symptoms of a true medical emergency are:

  1. Hot, usually dry, skin, often red or blotchy.
  2. Lack of or reduced perspiration.
  3. Nausea.
  4. Dizziness and confusion, disorientation.
  5. Strong, rapid pulse initially.
  6. Coma.

One or more of the following control measures can be used to help control heat stress.

1. Employees should drink plenty of water throughout the day and should increase their salt intake slightly by salting their food a little more heavily.

2. Onsite drinking water will be kept cool, 10-15°C (50-60°F), to encourage personnel to drink often.

3. A work regimen that will provide adequate rest periods for cooling down will be established, as required.

4. All personnel will be advised of the dangers and symptoms of heat stroke and exhaustion.

5. Cooling devices such as vortex tubes or cooling vests can be worn beneath protective garments.

6. Supervisors shall reinforce training daily for workers to monitor themselves and their co-workers for the effects of heat disorders and to take additional breaks, as needed.

7. All breaks are taken in a protected rest area.

8. Employees shall not conduct other tasks during rest periods.
9. Employees shall remove impermeable garments during rest periods.
10. All employees shall be informed of the importance of adequate rest, acclimatization, and proper diet in the prevention of heat stress.

4.4.2 CHEMICAL HAZARDS

In addition to the physical hazards associated with work at the IAAP, chemical hazards may exist because of potential exposure to contaminants during field activities. Potential site contaminants of concern are discussed in Section 4.2.3. Table 4-3 provides chemical hazard information for key potential contaminants.

The major routes of potential exposure include ingestion, inhalation, and skin and eye contact with contaminated soils, water, airborne particulates, or vapors and gases. Material Safety Data Sheets (MSDSs) are provided in Appendix H for chemicals of potential exposure and chemicals brought to the IAAP by TETC for the purposes of soil and groundwater sample collection.

Acetic Acid: Ingestion of acetic acid may cause severe corrosion of the mouth and gastrointestinal tract with vomiting, hematemesis, diarrhea, circulatory collapse, and uremia. Chronic exposure may cause erosion of dental enamel bronchitis, and eye irritation.

Antimony: Antimony compounds cause skin and mucous membrane irritations. Acute antimony poisoning causes weight loss, hair loss, and dry, scaly skin. Exposure also may cause acute heart, liver, and kidney congestion.

Barium: Exposure to soluble barium salts can cause upper respiratory irritation, gastrointestinal mucous spasms, slow pulse, eye irritation, skin burns, convulsive tremors, and elevated blood pressure.

Cadmium: Ingestion of cadmium and its soluble compounds causes increased salivation, choking, vomiting, abdominal pain, anemia, renal dysfunction, and diarrhea. Inhalation of cadmium dust or fumes may cause throat dryness, cough, headache, vomiting, chest pain, extreme restlessness and irritability, and pneumonitis. Cadmium is a carcinogen.

Chromium: Chromate salts (i.e., salts with chromium in the hexavalent state) are suspected human carcinogens. Inhalation may cause carcinogenic lung, nasal cavity, and paranasal sinus tumors. Exposure to trivalent chromium compounds may cause an eczema-type dermatitis.

Lead: Lead can cause acute toxicity in children with symptoms of anorexia, vomiting, malaise, and convulsions. Permanent brain damage may result in children exposed to lead. Chronic toxicity symptoms in children include weight loss, weakness and anemia.

Lead poisoning in adults may cause gastrointestinal, central nervous system and kidney disorders, and may increase blood pressure in adult males.

TABLE 4-3
PROPERTIES OF POTENTIAL CONTAMINANTS AT THE IOWA ARMY AMMUNITION PLANT

Chemical Name	Intrinsic Hazards						TLV or PEL	IDLH (mg/m^3)	LEL (%)	Odor Characteristics
	HTOX	CORR	IRR	EXPL	FLAM	CARC				
Cyclotrimethylenetrinitramine (RDX)	X			X			1.5 mg/m^3			
Acetic Acid		X	X		X		25 mg/m^3	1000		Pungent
Trinitrotoluene (TNT)	X			X	X		0.5 mg/m^3			
Lead	X		X				0.050 ppm	700		Odorless
Antimony	X			X			0.5 ppm	80		Odorless
Sodium Hydroxide		X					2 ppm(1)	250		Odorless
Cadmium	X		X			X	0.2 ppm	50		Odorless
Chromium	X		X			X	0.05 ppm(2)	30		Odorless
Barium	X						0.5 ppm	1100		Odorless
Zinc			X				10 ppm			Odorless

Key:

HTOX = Highly toxic		TLV	=	Threshold Limit Value
CORR = Corrosive		PEL	=	Permissible Exposure Limit
IRR = Irritant		IDLH	=	Immediately Dangerous to Life or Health
EXPL = Explosive		LEL	=	Lower Explosive Limit
FLAM = Flammable		mg/m^3	=	Milligrams Per Cubic Meter
CARC = Carcinogenic		ppm	=	Parts Per Million

(1) Ceiling value.

(2) TLV for water soluble CR^{6+} compounds.

RDX (Cyclotrimethylenetrinitramine): RDX exposure causes skin, eye, and mucous membrane irritation. It is poisonous by ingestion and possibly inhalation and can cause epileptic-like seizures.

Sodium Hydroxide: Sodium hydroxide is corrosive to all tissues. Ingestion of sodium hydroxide may result in vomiting, prostration, collapse, and constrictive scarring. Inhalation of the dust or concentrated mist may cause damage to the respiratory tract.

Trinitrotoluene (TNT): TNT is quantitatively the most used high explosive by the military. TNT vapors are toxic and may be absorbed through the skin and can cause headache, weakness, anemia, hallucinations, cyanosis, gastrointestinal changes, and liver injury.

Zinc: Generally, zinc and its compounds are of low toxicity. Zinc oxide dust is virtually innocuous. Ingestion of soluble zinc salts may cause nausea and vomiting.

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APPENDIX A.
RESUMES OF KEY TETC PERSONNEL FOR THE IAAP TEAM

THOMAS HASTINGS, R.E.A.

Senior Project Manager

The Earth Technology Corporation

Project Role: Program Manager

Education: M.S., Natural Resource and Environmental Management, 1977; B.S., Liberal Arts, 1975

Registration/Certification: Registered Environmental Assessor, 40-Hour OSHA Health and Safety Training, 8-Hour OSHA Health and Safety Supervisory Training

Affiliation: National Association Environmental Professionals

WORK EXPERIENCE:

Mr. Hastings has 18 years of experience in multidisciplinary environmental studies, including EISs, EAs, RCRA Facility Assessments, PA/SIs, RI/FSs, site selection investigations, and feasibility evaluations. He has managed more than 50 major environmental projects. Recent relevant experience includes:

- Acting Deputy Program Manager for a 3-year contract with USAEC for the ESPS. Responsibilities include serving as primary point of contact for any program issues identified by USAEC management. Provides overall program coordination for all delivery orders, including mobilizing corporate resources for completion of deliverables, selecting project managers, ensuring effective project support, and maintaining consistency and high quality performance on all USAEC deliverables.

- Deputy Program Manager for a 2-year contract with the Construction Engineering Research Laboratory to support the U.S. Army Environmental Policy Institute.

- Deputy Program Manager on a environmental policy support contract with ODASD(E).

- Project Manager for an environmental audit program for the U.S. DOI, Office of Construction Management.

- Project Manager for preparation of six EAs at Army Ammunition Plants.

- Project Manager for an EIS to evaluate environmental impacts of remediation alternatives developed as part of the RI/FS for at the BOMARC Missile Site.

- Senior Project Manager for RCRA Implementation Contract with the U.S. EPA Regions III, IV, VI, VIII, IX, and X.

DOUGLAS L. HAZELWOOD

Senior Project Manager

The Earth Technology Corporation

Project Role: Technical Director

Education: B.S., Environmental Engineering, 1976

Certification: 40-Hour OSHA Health and Safety Training; 8-Hour OSHA Health and Safety Supervisory Training

WORK EXPERIENCE:

Mr. Hazelwood has over 17 years of experience as a consulting environmental engineer, specializing in pollution prevention and environmental compliance programs. Relevant project experience includes:

- Senior technical lead for 5 Army Subpart X permitting projects at Open Burning/Open Detonation units nationwide under the USAEC TEPS contract.
- Project Manager for comprehensive waste minimization assessments at all DOD installations in Hawaii. Supervised team of 18 engineers during data collection and report preparation. Effort included 25 active Army, Navy, Air Force, DLA and National Guard installations.
- Senior Engineer in U.S. EPA RCRA implementation program. Reviewed over 30 Part B hazardous waste permit applications; prepared numerous design, operation, and permitting guidance manuals; trained over 1,000 federal and state permit writers nationwide in hazardous waste permitting and inspection programs.
- Deputy Program Manager for policy support contract with Office of Deputy Assistant Secretary of Defense (Environment). Directed over 30 task orders involving DOD environmental management information systems, Congressional reporting, measuring IRP progress, evaluating impacts of laws and regulations on DOD and preparing guidances for DOD components.
- Project Manager for comprehensive environmental compliance assessments at over 20 Air Force installations.
- Project Manager for Hazardous Waste Minimization studies at 23 Air Force manufacturing plants and air bases nationwide.

GLEN J. BARRETT, C.I.H.

Corporate Health & Safety Officer
The Earth Technology Corporation

Project Role: Health and Safety Officer

Education: M.S., Inorganic Chemistry, 1970; B.S., Chemistry, 1968

Registration/Certification: Industrial Hygienist, Inspector/Management Planner for Asbestos-Containing Materials, U.S. EPA Risk Assessment Guidance for Superfund Training Course

WORK EXPERIENCE:

Mr. Barrett has more than 17 years of experience in all aspects of industrial hygiene services, including health and safety program development and implementation. His expertise is in the preparation of human-health risk assessments and hazardous substance fact sheets for state hazard communication programs, health and safety training, control technology assessment, and industrial hygiene program management. He is responsible for completion of the risk assessment portion of all RIs Earth Technology completes under the IRP program, as well as development and implementation of Earth Technology's corporate health and safety program. He has managed air monitoring for major asbestos abatement projects and provided asbestos training. His relevant project experiences include:

- Managed several quantitative risk assessments for AFCEE. The risk assessments were performed using the procedures recommended by the U.S.EPA for CERCLA sites and were conducted for the following installations: March AFB, AFP 44, AFP 3, and Pease AFB.
- Managed a baseline human health risk assessment for 2 CERCLA NPL sites within U.S. EPA, Region III. Risk was quantified for current and future residential receptors, as well as future industrial workers. Risk from exposure of children to lead was quantified using an uptake/biokinetic model.
- For U.S. EPA, Region III, developed several health and safety plans for CERCLA hazardous waste sites.
- On behalf of AFCEE, developed several installation health and safety plans under the Air Force Installation Restoration Program.

DANIEL W. BOSTWICK

Senior Geologist
The Earth Technology Corporation

Project Role:	Project Manager
Education:	M.A., Geology, Pending B.S., Geology, 1979
Affiliations:	National Groundwater Association; Association of Groundwater Scientists and Engineers

WORK EXPERIENCE:

Mr. Bostwick has 11 years of professional geology experience. He is currently Project Manager for the Stage 3 RI/FS of Air Force Plant 3 in the U.S. Air Force AFCEE program. He also serves as Project Manager and has recently completed a groundwater RI/FS in the EPA ARCS Region III Superfund program. Mr. Bostwick also recently served as TETC Project Manager for a large remediation project in the ARCS program. In addition to his EPA and Air Force responsibilities, Mr. Bostwick also serves as a Project Geologist in the DOE HAZWRAP program. He also recently prepared critical sections for Deputy Assistant Secretary of Defense (Environment) (DASD(E)'s) Annual Report to Congress, describing the progress of environmental activities at DoD NPL sites throughout the country. Relevant project experience includes:

- Project Manager for the IRP Stage 3 RI/FS of Air Force Plant 3. Developed technical objectives, wrote project plans, obtained subcontractors, and manages project budget and professional staff. Designed and implemented groundwater reconnaissance survey to delineate volatile organic contamination in groundwater, used reconnaissance results to design a groundwater monitoring program, and installed and sampled monitoring wells. Currently writing the Stage 3 RI/FS report and preparing an RFI Work Plan for SWMUs at Air Force Plant 3.

- Project Manager for an ARCS groundwater RI/FS at a metals-contaminated site. Developed technical and budgetary objectives, managed project budget and professional staff, and wrote project plans. Designed downhole velocity, seismic refraction, and borehole geophysical surveys; and acquired, interpreted, and applied downhole velocity and seismic refraction data. Designed a groundwater monitoring program, installed monitoring wells, supervised monitoring residential well, surface water, and sediment sampling. Interpreted results and completed RI report. Wrote papers on aspects of this work for the 1991 Outdoor Action Conference and 1991 Focus Conference on Eastern Regional Groundwater Issues.

- Project Manager and on-site Construction Manager for an excavation, off-site treatment/disposal, and back-filling Remedial Action in the ARCS program. Supervised professional staff and subcontractors in the delineation, excavation, and removal of contaminated soil. Collected soil, groundwater, and surface water samples. Statistically analyzed soil sampling results. Supervised geotechnical testing. Coordinated community relations program.

- Prepared critical sections for DASD(E)'s Annual Report to Congress. Described the status and objectives of environmental activities at DoD NPL sites nationwide.

DONNA COHEN

Staff Geologist

The Earth Technology Corporation

Project Role: Assistant Project Manager/ Field Task Manager

Education: B.S., Geology, 1991

Affiliation: National Groundwater Association; Association of Groundwater Scientists and Engineers

WORK EXPERIENCE:

Ms. Cohen is a geologist with more than two years experience in hazardous waste site investigations that includes: project planning, site characterization, aquifer testing and analysis, data evaluation, and report writing. For the IAAP Accelerated Groundwater Quality Assessment, Ms. Cohen will be responsible for 1) preparing the Groundwater Quality Assessment Work Plan; 2) supervising soil sampling and monitoring well installation/development; 3) supervising groundwater sampling; and 4) preparing the assessment report. Other relevant experience includes:

- Assistant Project Manager for the IRP, Stage 3, RI/FS of Air Force Plant 3. Duties include: oversight of drilling and monitoring well installation, soil and groundwater sampling, single well response testing and analysis, contaminant modeling, cost tracking, Defense Priority Model (DPM) scoring, and preparation of the RI/FS report. As part of follow-on work, duties included preparing an RCRA Facility Investigation Work Plan.

- Assistant Project Manager for a groundwater RI/FS for the EPAs ARCS Region III Superfund program. Duties included: oversight of drilling and monitoring well installation, soil characterization, contaminant modeling, preparation of the risk assessment, cost tracking, and preparation of the RI report.

- Quality Assurance (QA) Manager for the FY 92 and FY 93 DPM scoring effort. Performed QA, prepared the QA Final Report submitted to the Office of the Deputy Assistant Secretary of Defense (Environment) (ODASD(E)), and presented the results to the ODASD(E).

- Researched transportation alternatives for the EIS on the Boeing Michigan Aeronautical Research Center (BOMARC) Missile Site. Duties included contacting State and County regulatory agencies for required permits and certificates of handling, determining the route to be used, and preparing the report. Other duties for this project included preparing a public hearing plan for the BOMARC Missile Site and technical editing.

JUDY A. KIRKLAND

Senior Staff Chemist
The Earth Technology Corporation

Project Role:	Analytical Task Manager
Education:	B.S. Chemistry, 1985
Affiliation:	National Organization for the Professional Advancement of Black Chemist and Chemical Engineer

WORK EXPERIENCE:

Ms. Kirkland is a chemist with more than eight years of laboratory experience. She is responsible for identifying qualified laboratories to provide analytical services for TETC on a subcontract basis. She is also responsible for validating analytical data, conducting laboratory audits, and developing quality assurance plans. Relevant project experience includes:

- IRPIMS administrator for the 1993 Stage 3 RI/FS of Air Force Plant 3. Ensured that analytical data from contract laboratories met U.S. Air Force requirements and completed the IRPIMS database and Analytical Informal Technical Information Report for the RI/FS.
- Participated in a visual site inspection during an IRP Expanded Source Investigation/RCRA Facility Assessment at Edwards AFB.
- Validated 74 soil and 104 groundwater samples, according to U.S. EPA protocols for the 1993 Stage 3 RI/FS of Air Force Plant 3.
- Validated data for 97 soil samples, according to HAZWRAP and EPA Region I guidelines, for organic and inorganic analyses as part of an RI for the Massachusetts Air National Guard RI.
- Validated data for 43 soil and groundwater samples, according to HAZWRAP Levels C and D for organic and inorganic analysis for an IRP Expanded Site Investigation as part of an RI for the California Air National Guard.
- Validated data for soil and groundwater samples, according to EPA Level C guidelines for an RI/FS of Edwards Air Force Base.

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LEONARD FRIED

Senior Staff Scientist
The Earth Technology Corporation

Project Role:	Data Manager
Education:	M.S., Artificial Intelligence, 1989 B.S., Computer Science, 1986

WORK EXPERIENCE:

Mr. Fried is an experienced software and knowledge engineer. He has several years experience in the development of knowledge-based and expert systems. Relevant project experience includes:

- Served as the Data Manager for the environmental database used to complete the 1993 March Air Force Base (AFB) RI/FS. The database exists in the U.S. Air Force Installation Restoration Program Information Management System (IRPIMS) format.

- Developed software to automate portions of the risk assessment (RA) for the 1992 Air Force Plant 44 RI/FS and 1993 March AFB RI/FS. This included software which partially automates the selection of RA chemicals of concern and produces exposure and risk tables for those chemicals of concern.

- Constructed the Automated Defense Priority Model (ADPM) for FY92 to FY94 using Arity Prolog. ADPM is an interactive knowledge-based system which implements the Defense Priority Model (DPM). The DPM is a DOD IRP site ranking model designed for the prioritization of DOD sites for environmental restoration.

- Conducted DPM training and operated the DPM hotline.

- Assisted in groundwater sampling for the Stage 3 RI/FS of Air Force Plant 3.

MICHAEL S. PHILLIPS

Staff Environmental Scientist
The Earth Technology Corporation

Project Role:	Staff Environmental Scientist
Education:	B.S., Environmental Science, 1989
Affiliation:	Society of American Military Engineers American Chemical Society

WORK EXPERIENCE:

Mr. Phillips is an environmental scientist with over five years professional experience in activities that include air dispersion modeling, air emission inventories, and RI/FSs. Relevant project experience includes:

- Measured water levels, collected groundwater samples, and performed single well response tests during the 1993 Stage 3 RI/FS of Air Force Plant 3.

- Performed oversight during off-site drilling and monitoring well installation as part of a Treatability Study at Air Force Plant 44.

- Supervised the removal of an underground storage tank and associated piping. Responsibilities included supervision of excavation activities, air monitoring, and preparation of hazardous waste manifests for off-site disposal of residuals.

- Participated in a Phase II site assessment for May Centers, Inc. Supervised the digging of test pits, drilling of soil borings, soil and groundwater sampling, and off-site disposal of drums. Mr. Phillips also worked closely with the regulators to receive emergency authorization for the disposal of the drums.

- Field team member for an air emission inventories at Fort McClellan, Fort Leonard Wood, Longhorn Army Ammunition Plant (AAP), Fort Chaffee, Fort Riley, and Kansas AAP. Responsibilities included preliminary site visits and background data collection; field site visits including source identification and emissions characterization; emissions calculation using models, established emissions factors, and engineering calculations; and report and database preparation. Other responsibilities included responding to regulatory comments and communicating with the corresponding states agencies and USAEC.

- Field Team Leader for an asbestos survey at Pease AFB. Responsibilities included locating, characterizing, and sampling asbestos in pipe insulation, ceiling tile, wall board, and floor tile.

- Participated in the air modeling of volatile organic compound dispersion from contaminated soils at multiple sites for the 1993 March AFB RI/FS risk assessment.

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APPENDIX B.
RECOMMENDED DRILLING RIG SAFETY GUIDELINES

APPENDIX B.
DRILLING EQUIPMENT OPERATIONS

1. GENERAL DRILLING PRACTICES

Prior to the start of site work, the drilling subcontractor will inspect all drilling equipment. The inspection will be documented in the field records. If field operations last longer than one week, the drilling equipment inspection must be repeated on a weekly basis.

Earth Technology will determine the location of all underground utilities before the start of drilling operations. Documentation that nearby utilities have been marked on the ground and that the drill site has been cleared shall be kept in the Earth Technology project trailer and confirmed to the drilling subcontractor.

The drilling subcontractor shall have documented safety and emergency action procedures for the equipment to be operated. The drilling contractor's employees will acknowledge in writing that they have read and understand these procedures. The drilling subcontractor shall ensure that all drilling equipment is well maintained, meets safety requirements, and is inspected daily during use. The drilling rig shall be operated by a qualified operator who can identify pending failures and supervise the driller's helper(s). Transportation of the drilling rig to the work site shall be performed by a person with the proper commercial license. The following rig maintenance and safety is the responsibility of the drilling subcontractor. The following information is provided as general guidelines for safe practices during drilling activities, and installation of monitoring wells and will be emphasized to the driller and helpers during the daily safety briefings.

1. No food or beverage will be consumed or stored in the work area.
2. Earth Technology will contact appropriate utilities agency to survey, mark and flag locations of buried utility lines.
3. Maintain orderly housekeeping on and around the drill rig.
4. Store tools, materials and supplies to allow safe handling by drill crew members. Proper storage on racks or sills will prevent spreading, rolling or sliding.
5. Avoid storage or transportation of tools, materials or supplies within or on the drill rig derrick.
6. Maintain working surfaces free of obstructions or potentially hazardous substances.
7. Store gasoline only in containers specifically designed or approved for such use.

8. Wear eye protection when chipping, chiselling or breaking material that presents risk of flying objects.

9. The departing driller should inform the oncoming driller of any special hazards or ongoing work that may affect the safety of the crew.

10. Fire fighting equipment should not be tampered with and should not be removed for other than the intended fire-fighting purposes or for servicing.

11. If lubrication fittings are not accessible with guards in place, machinery should be stopped for oil and greasing.

12. Rigging material equipment for material handling should be checked prior to use on each shift and as often as necessary to ensure it is safe. Defective rigging should be removed from service.

13. The area around the derrick ladder should be kept clear to provide unimpeded access to the ladder.

14. Work areas and walkways should not be obstructed.

15. The rotary table of the rig floor shall be kept free of obstructions and free of undue accumulation of oil, water, ice, or circulating fluids.

16. Make certain that all personnel are wearing hearing and sight protection.

2. MOVING RIG TO DRILLING LOCATION

17. Inspect the route of travel before moving drill rig off-road. Note rocks, trees, erosion, and uneven surfaces.

18. Remove all passengers from the cab before moving drill rig onto rough or sloped terrain. The operation and transportation of the drill rig must be by a qualified and licensed individual.

19. Engage multiple drive power trains (when available) on rig vehicle when mobilizing off-road.

20. Travel directly up or down grade on slopes when feasible. Avoid off-camber traverse approaches to drill sites.

21. Approach changes in grade squarely to avoid shifting loads or unexpected unweighting.

22. Use a spotter (person at grade) to provide guidance when vertical and lateral clearance is questionable.

23. Use hand brakes and block rigwheels when grades are steep.

24. Lower rig mast before moving rig.

25. Secure all loads to rig prior to off-road mobilization.

26. Earth Technology will use geophysical techniques, or equivalent, to locate buried utility lines.

27. Stabilize and level each work site prior to drill set-up.

3. RAISING MAST

28. Locate visually overhead and buried utilities prior to drilling operations.

29. Treat overhead electrical lines as if they were energized and maintain at least 40 feet clearance.

30. Earth Technology will contact appropriate utilities agency to manipulate and deactivate overhead service in areas that interfere with drilling operations. Do not attempt to handle utilities.

31. To the greatest extent possible, the terrain should be level (a minimum of 10 feet on each side of the drilling rig) and the condition of the ground such that unexpected movement of the drilling rig is unlikely. If the slope of the terrain is hazardous, the USAEC Project Manager and the USAEC SES Branch will be contacted for the selection of a safe drilling site.

32. The derrick must not be raised until the rig has been blocked, leveled, and chocked.

33. Note wind speed and direction to prevent overhead utility lines from contacting rig derrick. Allow at least 20 feet clearance between rig mast and utility lines.

4. HOISTING OPERATIONS

34. Drillers should never engage the rotary clutch without watching the rotary table and ensuring it is clear of personnel and equipment.

35. Unless the draw works is equipped with an automatic feed control, the brake should not be left unattended without first being tied down.

36. Drill pipe or casing should not be picked up suddenly.

37. Drill pipe should not be hoisted until the driller is sure that the pipe is latched in the elevator, or the derrick man has signaled that he may safely hoist the pipe.

38. During instances of unusual loading of the derrick or mast, such as when making an unusually hard pull, only the driller should be on the rig floor and no one should be on the rig or derrick.

39. The brakes on the draw works of every drilling rig should be tested by each driller, when he comes on shift, to determine whether they are in good order. The brakes should be thoroughly inspected by a competent individual each week.

40. A hoisting line with a load imposed should not be permitted to be in direct contact with any derrick member or stationary equipment, unless it has been specifically designed for line contact.

41. Workers should never stand near the well bore whenever any wire line device is being run.

42. Hoisting control stations should be kept clean and controls labeled as to their functions.

43. Inspect wire, rope, hoisting hardware, swivels, hooks, bearings, sheaves, guides, rollers, clutches, brakes for the following:

    - abrasions
    - breaks
    - wear
    - fatigue
    - corrosion
    - jamming
    - kinking

44. Avoid the suspension of loads when hoist is unattended.

45. Prevent hoisting loads directly over field personnel.

46. Restrict hoisting operations during unfavorable environmental conditions such as rain or high winds.

47. Maintain safe hand distance from hoisting equipment (e.g., wire rope, hooks, pinch points) when slack is reduced.

5. RIDING HOISTING EQUIPMENT

Under no circumstances will personnel be permitted to ride the traveling block or elevators, nor will the cat line be used as a personnel carrier.

6. CAT LINE OPERATIONS

48. Only experienced workers will be allowed to operate the cat head controls. The kill switch must be clearly labeled and operational prior to operation of the cat line.

49. The cat head area must be kept free of obstructions and entanglements.

50. The operator should not use more wraps than necessary to pick up the load. More than one layer of wrapping is not permitted.

51. Personnel should not stand near, step over, or go under a cable or cat line which is under tension.

52. Employees rigging loads on cat lines should:

    - Keep out from under the load
    - Keep fingers and feet where they will not be crushed
    - Be sure to signal clearly when the load is being picked up
    - Use standard visual signals only and not depend on shouting to coworkers
    - Make sure the load is properly rigged, since a sudden jerk in the cat line will shift or drop the load.

7. PIPE HANDLING

53. Pipe should be loaded and unloaded, layer by layer, with the bottom layer pinned or blocked securely on all four corners. Each successive layer should be effectively blocked or chocked.

54. Workers should not be permitted on top of the load during loading, unloading, or transferring of pipe or rolling stock.

55. Employees should be instructed never to try to stop rolling pipe or casing; they should be instructed to stand clear of rolling pipe.

56. Slip handles should be used to lift and move slips. Employees should not be permitted to kick slips into position.

57. When pipe is being hoisted, personnel should not stand where the bottom end of the pipe could whip and strike them.

58. Pipe stored in racks, catwalks, or on flatbed trucks should be chocked to prevent rolling.

8. DERRICK OPERATIONS

59. The derrick climber should be used whenever climbing the derrick. Personnel on the derrick should be tied off, or otherwise protected from falling when working in an unguarded elevated position.

60. All stands of pipe and drill collars racked in a derrick should be secured with rope or otherwise adequately secured.

61. Tools, derrick parts, or materials of any kind should not be thrown from the derrick.

62. The elevators must be properly clamped onto all pipe joints prior to the driller engaging the load.

9. MAKING AND BREAKING JOINTS

63. Tongs should be used for the initial making up and breaking of the joint. The rotary table should not be used for the initial breaking of a joint.

64. Employees making or breaking joints should not be permitted to stand within the arc of the tong handles when the tong pull line is under tension. Employees should handle the tongs only by the appropriate handles.

65. Employees should be trained in the safe use of spinning chains. Spinning chains should not be handled near the rotary table while it is in motion.

10. DRILLING OPERATIONS

66. Begin auger borings slowly with the drive engine operating at low speed.

67. Establish a communication system between driller, helper and geologist for responsibilities during drilling operations.

68. Engage auger to power coupling as recommended by manufacturer.

69. Restrict contact with power coupling or auger during rotation.

70. Prevent placing hands or feet under auger during rotation.

71. Prevent placing hands or feet under auger sections during hoisting over hard surfaces.

72. Avoid the removal of spoil cuttings with hands or feet.

73. Assure drill rig is in neutral and the augers are not rotating before cleaning augers.

74. All personnel working in and around the drill rig must be informed of the location of the kill switch.

APPENDIX C.
RESUMES OF KEY HEALTH & SAFETY PERSONNEL

APPENDIX C.
RESUMES OF KEY HEALTH AND SAFETY PERSONNEL

The resumes of key TETC Health and Safety personnel for the Accelerated Groundwater Quality Assessment at IAAP are presented below:

GLEN J. BARRETT, C.I.H.

Corporate Health & Safety Officer
The Earth Technology Corporation

Project Role: Health and Safety Officer

Education: M.S., Inorganic Chemistry, 1970; B.S., Chemistry, 1968

Registration/Certification: Industrial Hygienist, Inspector/Management Planner for Asbestos-Containing Materials, U.S. EPA Risk Assessment Guidance for Superfund Training Course

WORK EXPERIENCE:

Mr. Barrett has more than 17 years of experience in all aspects of industrial hygiene services, including health and safety program development and implementation. His expertise is in the preparation of human-health risk assessments and hazardous substance fact sheets for state hazard communication programs, health and safety training, control technology assessment, and industrial hygiene program management. He is responsible for completion of the risk assessment portion of all RIs Earth Technology completes under the IRP program, as well as development and implementation of Earth Technology's corporate health and safety program. He has managed air monitoring for major asbestos abatement projects and provided asbestos training. His relevant project experiences include:

- Managed several quantitative risk assessments for AFCEE. The risk assessments were performed using the procedures recommended by the U.S.EPA for CERCLA sites and were conducted for the following installations: March AFB, AFP 44, AFP 3, and Pease AFB.

- Managed a baseline human health risk assessment for 2 CERCLA NPL sites within U.S. EPA, Region III. Risk was quantified for current and future residential receptors, as well as future industrial workers. Risk from exposure of children to lead was quantified using an uptake/biokinetic model.

- For U.S. EPA, Region III, developed several health and safety plans for CERCLA hazardous waste sites.

- On behalf of AFCEE, developed several installation health and safety plans under the Air Force Installation Restoration Program.

DAVID S. NALEID

Project Engineer

The Earth Technology Corporation

Project Role:	Deputy Health and Safety Officer
Education:	B.S., Chemical Engineering, 1977
Professional Affiliation:	American Institute of Chemical Engineers

WORK EXPERIENCE:

Mr. Naleid is a chemical engineer with expertise in hazardous waste management and minimization, and remedial investigations/feasibility studies. Relevant project experience includes:

- Participated in the remedial investigation of AFP 44 by establishing geophysical survey grids, collecting surface soil samples, and packaging samples for shipment. Also assisted in costing, design, and installation of soil vapor extraction bench-scale systems for treatability studies at three sites at AFP 44. After systems were installed, he helped to start-up and operate systems during the studies. Collected samples for system optimization data.

- Developed Feasibility Studies of remedial alternatives for hazardous waste sites at the March Air Force Base, California, Air National Guard Base in Burlington, Vermont, the Air Force Plant 3 in Tulsa, Oklahoma and the Boeing Michigan Aeronautical Research Center (BOMARC) Missile Site near McGuire Air Force Base, New Jersey. Developed and screened remedial alternatives. Also, calculated capital, operating and maintenance costs and performed sensitivity analysis on the various alternative costs.

- Participated in the Remedial Investigation/Feasibility Study of Air Force Plant 3 in Tulsa, Oklahoma. Tasks included a geophysical survey to locate underground obstacles at borehole sites, a soil-gas survey along a 5,000 foot abandoned fuel line to delineate any leakage, and subsurface sampling of soil and groundwater to define boundaries and concentration levels. Assisted in the installation of boreholes and groundwater monitoring wells for plume delineation, both laterally and vertically, contaminant definition and concentration.

- Assisted with design, installation, and start-up of a groundwater treatment system at Pease Air Force Base in Portsmouth, New Hampshire. The system included a combination vapor/groundwater extraction component and a treatment component. Treatment was achieved with activated carbon adsorption units for removal of volatile compounds from the vapor and an air stripper for the groundwater.

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APPENDIX D.
PERSONAL SAFETY CERTIFICATION

APPENDIX D.
PERSONAL SAFETY CERTIFICATION

Project Name:	Accelerated Groundwater Quality Assessment of the Ash Disposal Cell in Trench 5 and Line 6 at the Iowa Army Ammunition Plant
Project Number:	931078
Client:	Army Environmental Center
Project Manager:	Daniel Bostwick
Site Safety Officer:	To Be Assigned

1. I acknowledge that I have reviewed the Site Health and Safety Plan and any Addendums for the above listed project and I have read and understand the potential health and safety hazards associated with the project.

2. I acknowledge that I have been properly trained in the use and type of personal protective equipment selected for this project and am appropriately certified to do so.

3. I will abide by the provisions of this Site Health and Safety Plan and any Addendums.

(Site Health and Safety Officer) (Date)

(Project Manager) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

(Other) (Date)

APPENDIX E.
EMERGENCY EQUIPMENT AND EMERGENCY TELEPHONE NUMBERS

APPENDIX E.
EMERGENCY EQUIPMENT

- Spill dike (case)
- Disposal bags (case)
- Shovel (1)
- First aid kit (1 per 25 workers, minimum)
- Eyewash (1 per 25 workers, minimum)
- Fire extinguisher (1)
- Mobile Phones (1, minimum)

EMERGENCY TELEPHONE NUMBERS

Local Fire Department	(319) 753-7121
Local Paramedics	(319) 753-7121
IAAP Security	(319) 753-7960
Local Medical Care	Emergency Room (319) 753-3264 Burlington Medical Center 602 North Third Street Burlington, Iowa 52601 Emergency Room Director: Gail Boyd (319) 753-3011
Poison Control	1-800-272-6477
IAAP Emergency Response Team	(319) 753-7121
IAAP Point of Contact	Leon Baxter (319) 753-7101
TETC Office (Eastern Division)	(703) 549-8728
TETC Corporate Health and Safety Officer (Home)	Glen Barrett (703) 658-4319
TETC Senior Vice-President, WDC (Home)	Robert A. Colonna (301) 656-2155
TETC Site Health and Safety Officer (Hotel)	To Be Determined
TETC Eastern Division Deputy Health and Safety Officer (Home)	David Naleid (703) 799-2492
USAEC Project Manager	Derek Romitti (410) 671-1507
USAEC SES Branch	William Houser (410) 671-1591

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APPENDIX F.
RESPONSE TO MEDICAL EMERGENCIES

APPENDIX F.
RESPONSE TO MEDICAL EMERGENCIES

INHALATION

1. Workers wearing proper respiratory protective equipment should remove the victim from the contaminated atmosphere.

2. If the victim is not breathing, administer mouth-to-mouth resuscitation or cardiopulmonary resuscitation (CPR) immediately.

3. Seek medical assistance.

EYE CONTACT

1. Do not rub eyes.

2. Flood eyes with emergency solution of water. Hold the eye open and flood so that all surfaces are thoroughly washed.

3. Continue washing for 15 minutes while seeking medical assistance.

SKIN EXPOSURE

1. Wash skin with soap and water for a minimum of 15 minutes. All contaminated parts of the body, including hair, should be thoroughly decontaminated.

2. If clothing is contaminated, it should be removed in such a way to minimize further contact with the contaminant.

3. Seek medical assistance.

COLD STRESS

Types of Cold Stress

1. Hypothermia
   - shivering
   - dizziness
   - numbness
   - confusion
   - weakness
   - impaired judgment
   - impaired vision

- drowsiness

2. Frostbite
    - slightly flushed skin (onset of frostbite)
    - pain
    - white, grayish yellow, or grayish blue skin (developing frostbite)
    - coldness or numbness of the body part
    - blisters

First Aid

1. Move victim to a warm place.
2. Warm the victim (for hypothermia) or the frostbitten body parts slowly.
3. Seek medical assistance.

HEAT STRESS

Types and Symptoms of Heat Stress

1. Heat Cramps
    - muscular pains or spasms (usually involve abdominal or leg muscles)

2. Heat Exhaustion
    - cool, pale and moist skin
    - heavy sweating
    - dilated pupils
    - headache
    - nausea
    - dizziness
    - vomiting
    - body temperature nearly normal

3. Heat Stroke
    - hot, red skin
    - very small pupils
    - very high blood pressure

First Aid

1. Move victim to a cool place.
2. Remove excess clothing.
3. Pour water on the victim.
4. If conscious, offer the victim water or gatorade.
5. Seek medical assistance.

APPENDIX G.
HEALTH AND SAFETY FORMS

The Earth Technology Corporation

INJURY REPORT

This is an official document to be initiated by the employee's supervisor. Please answer all questions completely. This report must be forwarded to the Health and Safety office within 24 hours of the injury.

Injured's name__________ Sex______ S.S. No.______ Birthdate______

Home address__________ City______ State____ Zip____ Phone______

Job title__________ Employee's section______ Hire date______ Hourly wage______

SUPERVISOR

Date of incident__________ Time______ Time reported______ To Whom?______

Client name__________ Client address__________ Time shift began______

Exact location of incident__________ Did employee leave work? ☐ No ☐ Yes When______

Has employee returned to work? ☐ No ☐ Yes When______ Did employee miss a regularly scheduled shift? ☐ No ☐ Yes

Doctor/Hospital name__________ Address__________

Witness name(s)__________ Statements attached? ☐ No ☐ Yes

Nature of injury__________ Exact body part__________

Medical attention__________

Job assignment at time of accident__________

Describe incident__________

____

What caused the accident?__________

hat corrective action has been taken to prevent recurrence?__________

____

____

Supervisor/Foreman__________ __________ __________

(Print) Signature Date

MANAGER

Comments on incident and corrective action__________

____

____

Manager's name__________ __________ __________

(Print) Signature Date

HEALTH & SAFETY

Concur with action taken? ☐ No ☐ Yes Remarks__________

____

____

____

OSHA Classification:

☐ Incident only ☐ First aid ☐ No lost workdays ☐ Lost workdays ☐ Restricted activity ☐ Fatality

Days away from work__________ Days restricted work__________ Total days charged__________

Name__________ __________ __________

(Print) Signature Date

The Earth Technology Corporation

ACCIDENT/INJURY INVESTIGATION

Must be completed within 72 hours

1. Date______________________ Section____________________ Date of Accident/Injury____________________

Employee Name____

Supervisor Name____

Job Number/Name____

Location of Accident/Injury____

2. Accident/Injury Classification

Injury		Vehicle		DOT	
☐	Near Miss	☐	Chargeable	☐	DOT Vehicle
☐	First Aid	☐	Non-Chargeable	☐	DOT Reportable
☐	OSHA Recordable	☐	Not at Fault	General Liability	☐
☐	Lost Workday				

3. Description (Provide facts, describe how incident occurred, provide diagram (on back) or photos)

____

____

____

4. Analysis 1 (What unsafe acts or conditions contributed to the incident?)

____

____

____

5. Analysis 2 (What systematic or management deficiencies contributed to incident?)

____

____

____

6. Corrective action(s) (List corrective action items, responsible person, schedule completion date)

____

____

____

7. Witnesses (Attach statements or indicate why unavailable)

____

____

____

8. Investigated by ____________________ ____________________ ____________________

Print Name Signature Date

Manager ____________________ ____________________ ____________________

Print Name Signature Date

(Attach additional pages if needed)

APPENDIX H.
MATERIAL SAFETY DATA SHEETS

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 327
Acetic Acid

Issued: 11/75 **Revision: E, 9/92**

Section 1. Material Identification 39

Acetic Acid (CH_3COOH) Description: Derived by fermentative oxidation of ethanol, liquid and vapor phase oxidation of petroleum gases with a catalyst, hydration of acetic anhydride, or by reacting methyl alcohol with carbon monoxide in presence of a catalyst. Occurs naturally in wines, aged cheese, orange juice, and vinegar (3 to 6%). Glacial acetic acid is the concentrated form and is diluted with water to form varying concentrations. Used in production of inorganic and organic acetates and organic esters, in dyeing, pharmaceuticals, canning, food processing, pigment production, and in textile printing; as a food additive, latex coagulant, oil well acidizer, and a solvent for gums, resins, and volatile oils.

Other Designations: CAS No. 64-19-7, Aci-Jel, ethanoic acid, ethylic acid, glacial acetic acid, methane carboxylic acid, pyroligneous acid, vinegar acid.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Acetic acid is highly corrosive and can seriously damage living tissue. Prolonged inhalation of even low acetic acid percentages such as found in vinegar (3 to 6 %) can cause severe irritation of mucous membranes. Concentrated acetic acid is highly flammable while concentrations below 50% are nonflammable. Reaction with water releases heat and irritating vapors.

R 2
I 2-3*
S 2-3*
K 1-2*
* Applies to glacial acetic acid

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HMIS
H 3†
F 2
R 1
PPE‡
† Chronic effects
‡ Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Acetic acid. Glacial acetic acid is 99.8%. Impurities include trace amounts of chloride, lead, iron, sulfate, and sulfur dioxide.

1991 OSHA PEL
8-hr TWA: 10 ppm (25 mg/m^3)

1990 IDLH Level
1000 ppm

1990 NIOSH RELs
TWA: 10 ppm (25 mg/m^3)
STEL: 15 ppm (37 mg/m^3)

1992-93 ACGIH TLVs
TWA: 10 ppm (25 mg/m^3)
STEL: 15 ppm (37 mg/m^3)

1990 DFG (Germany) MAK
TWA: 10 ppm (25 mg/m^3)
Category I: Local irritants
Peak Exposure Limit: 20 ppm, 5 min momentary value, 8/shift

1985-86 Toxicity Data*
Human, skin: 50 mg/24 hr caused mild irritation.
Man, unreported route, LD_{Lo}: 308 mg/kg; toxic effects not yet reviewed
Human, oral, TD_{Lo}: 1470 µg/kg caused functional changes in the esophagus and bleeding in the small & large intestine.
Human, inhalation, TC_{Lo}: 816 ppm/3 min caused olfactory and eye effects with respiratory changes.
Rat, oral, LD_{50}: 3530 mg/kg; no toxic effect noted
Rabbit, eye (open patch test): 50 µg caused severe irritation.

* See NIOSH, *RTECS* (AF1225000, % not specified; synonyms include *vinegar* and *glacial acetic acid*), (AF1300000, 25 to 80%), (AF1340000, 80 to 100%) for additional irritation, mutation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: 244 °F, 118 °C (760 mm Hg); 176 °F, 80 °C (202 mm Hg)
Melting Point: 62 °F (16.6 °C), *congeals at 6.8 °F (-14 °C)*
Water Solubility: Soluble, *releases heat & toxic vapors*
Other Solubilities: Soluble in ethanol, ether, glycerol, glycerine, acetone, benzene, and carbon tetrachloride. Insoluble in carbon disulfide.
Vapor Pressure: 11 mm Hg at 68 °F (20 °C)
Density of Saturated Air (Air = 1): 1.02

Molecular Weight: 60.05
Density: 1.0492 at 68 °F (20/4 °C)
pH: 1 M (2.4), 0.1 M (2.9), 0.01 M (3.4)
Viscosity: 1.22 cP at 68 °F (20 °C)
Refraction Index: 1.3715 at 68 °F (20 °C)
Wt/Gal: 8.64 lb/gal at 68 °F (20 °C)
Evaporation Rate: 0.24 g/m^2/s at 25 °C and wind at 4.5 m/s

Appearance and Odor: Colorless, hygroscopic liquid or crystals with a pungent (vinegar) odor. The odor threshold = 0.037 to 0.15 ppm.

Section 4. Fire and Explosion Data

Flash Point: 103 °F (39 °C) OC	Autoignition Temperature: 800 to 916 °F (426 to 516 °C)	LEL: 5.4 % v/v	UEL: 16% v/v at 212 °F (100 °C)

Extinguishing Media: Concentrations below 50% are nonflammable. Greater than 50% poses a fire hazard directly and by releasing flammable hydrogen gas from contact with many metals. Fight fire with dry chemical, carbon dioxide, water spray, or 'alcohol-resistent' foam.
Unusual Fire or Explosion Hazards: Burning Rate = 1.6 mm/min. Container may explode in heat of fire. Concentrated acetic acid poses an explosion hazard indoors, outdoors, and in sewers. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing provides only limited protection. If possible without risk, remove container from fire area. If impossible, apply cooling water to sides of containers until well after fire is out. Stay away from ends of tanks. Withdraw immediately if you hear a rising sound from venting safety device or notice any tank discoloration due to fire. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Acetic acid contracts slightly upon freezing and releases heat and toxic, irritating vapors when mixed with water. It is stable at room temperature in closed containers as long as temperatures are kept above freezing; even a slight contraction can cause the container to burst. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Attacks some forms of plastics, rubber, and coatings. Other incompatibles include: acetaldehyde, 5-azidotetrazole, 2-aminoethanol, ammonium nitrate, bromine trifluoride, chromic acid, chlorine trifluoride, chlorosulfonic acid, diallyl-methyl carbinol + ozone, ethylenediamine, hydrogen peroxide, sodium peroxide, potassium hydroxide, sodium hydroxide, potassium permanganate, nitric acid + acetone, oleum, perchloric acid, phosphorus trichloride, potassium *t*-butoxide, phosphorus isocyanate, and *n*-xylene. It can attack a wide variety of metals to release hydrogen gas. **Conditions to Avoid:** Contact with heat, ignition sources, carbonates, hydroxides, oxides, phosphates, and other incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of acetic acid can produce carbon dioxide (CO_2), carbon monoxide (CO), and toxic, irritating vapors.

S n 6: Health Hazard Data

arcinogenicity: The IARC,[164] NTP,[169] and OSHA[164] do not list acetic acid as a carcinogen. **Summary of Risks:** Splashes of low acetic acid oncentrations as found in vinegar (4 to 10%) are painful to the eye and vapors are irritating to the respiratory tract. The skin is only mildly affected y low concentrations; above 50% irritation becomes severe and leads to corrosion and blistering. Vapor from concentrated acid (glacial) is extremely irritating and can cause bronchial constriction. Delayed breathing difficulties may occur. Chronic exposure causes continued inflammation of the respiratory tract, erosion of tooth enamel and darkening and thickening of the skin (usually hands). **Target Organs:** Eyes, teeth, skin, espiratory system, (blood & kidney injury evident from ingestion only). **Primary Entry Routes:** Inhalation, skin and eye contact, ingestion. **Medical Conditions Aggravated by Long-Term Exposure:** Skin and respiratory disorders. **Acute Effects:** Exposure to ~ 10 ppm for 8 hr has caused eye, nose, and throat irritation; 50 ppm caused intensive eye watering and 100 ppm caused serious lung irritation and is intolerable to most individuals. Splashes to the eyes are very painful, resulting in blood build up in the conjunctiva and possible injury to epithelium or permanent opacification of the cornea. Acute skin contact with dilute solutions is only mildly irritating; concentrated solutions are highly corrosive causing redness, blistering and severe burns. Ingestion is unlikely in an industrial setting but if it occurs, as little as 1 mL of the concentrated acid (*glacial*) can cause perforation of the esophagus. Other ingestion symptoms include upper digestive tract ulcerations, bloody vomitus, diarrhea, shock, free hemoglobin in the blood (due to red blood cell destruction), defective urination, uremia (accumulation in the blood of constituents usually excreted in the urine), circulatory distress, and death due to coma. **Chronic Effects:** Vapor inhalation of 200 ppm for an unspecified number of years caused edema (fluid buildup) around the eyelids, lymph node enlargement, blood buildup in the conjunctiva, inflammation of the pharynx, respiratory passages, and mucous membranes, and tooth enamel erosion. Workers have complained of digestive disorders including heartburn and constipation. Repeated skin contact causes dryness and cracking and eventually, thickening and darkening of the skin. Cuts and abrasions heal slowly.

FIRST AID **Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center and unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not induce vomiting!* **Note to Physicians:** Treatment is symptomatic and supportive.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel must protect against inhalation and skin/eye contact. Shut off all ignition sources. Use water spray to reduce vapor and dilute spills to nonflammable mixtures (< 50% acetic acid); do not get water inside container. Contain any wastewater. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable container. Neutralize any residue by wiping up with sodium bicarbonate or soda ash solutions. For large spills, dike far ahead for reclamation or disposal. Report any release in excess of 5000 lb. Follow applicable OSHA regulations (29 CFR 1910.120). **Ecotoxicity Values:** Mosquito fish, TLm = 251 ppm/24 hr; fathead minnow, LC_{50} = 315 mg/L/1 hr, 122 mg/L/24 hr & 88 mg/L/96 hr; bluegill, TLm = 75 mg/L/96 hr. **Environmental Degradation:** If released on land, acetic acid will spread on the surface and penetrate the soil at a rate dependant on soil type and water content. In water, it is readily degradable and dilute solutions will neutralize to acetate salts. Acetic acid shows *no* potential for bioaccumulation. **Disposal:** Neutralize with crushed limestone, soda ash, or lime; mix with a flammable solvent, and burn in an incinerator with an afterburner. Contact ur supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

A Designations	**OSHA Designations**
Listed as a RCRA Hazardous Waste (40 CFR 261.21): Characteristic of ignitability	Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed	
SARA Toxic Chemical (40 CFR 372.65): Not listed	

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 5000 lb (2270 kg) [* per CWA, Sec. 311 (b)(4)]

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For <250 ppm, use any supplied-air respirator (SAR) operated in continuous-flow mode or any powered, air-purifying respirator with appropriate organic vapor cartridges. For <500 ppm, use any chemical cartridge respirator with a full facepiece and organic vapor cartridges, any SCBA or SAR with a full facepiece. For <1000 ppm, use any SAR with a full facepiece operated in pressure-demand or other positive pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Butyl rubber and Teflon with breakthrough times (BT) >8 hr, polyethylene and Neoprene with BT >4 hr, and Viton are suitable materials for PPE. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove acetic acid from your shoes and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in glass or stainless steel containers, polyethylene carboys, or polyethylene-lined drums. Keep in a dry area above freezing pt. (62 °F/16.6 °C) and away from ignition sources or oxidizers. Outside or detached storage is preferred. Periodically inspect containers. Install Class 1, Group D electrical equipment. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the skin, eyes, teeth, and respiratory tract.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Acetic acid solution, > 10% but < than 80%, by mass; Acetic acid, glacial or Acetic acid solution, > 80% acid by mass.
DOT Hazard Class: 8
ID No.: UN2790, UN2789
DOT Packing Group: II
DOT Label: Corrosive
Special Provisions: A3, A6, A7, A10, B2, T8

Packaging Authorizations
a) Exceptions: 173.154
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger Aircraft or Railcar: 1L
b) Cargo Aircraft Only: 30 L

Vessel Stowage Requirements
a) Vessel Stowage: A
b) Other: 112; 12, 21, 48

MSDS Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 149, 153, 159, 162, 163, 164, 167, 168, 171, 174, 176

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, CIH, MPH; **Medical Review:** AC Darlington, MPH, MD

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Material Safety Data Sheets Collection:

Sheet No. 70
Antimony Metal/Powder

Issued: 9/80 **Revision: A, 11/89**

Section 1. Material Identification 30

Antimony Metal/Powder Description: A naturally occurring ore found in sulfides, oxides, complex lead, silver, copper, and mercury sulfides. Prepared in the laboratory by reducing Sb_2O_3 with KCN. Used in manufacturing bullets, bearing metal, hard lead, blackening iron, coating metals, white metal, thermoelectric piles, storage batteries, cable sheaths, type metal, and alloys (Britannia or Babbitt metal). Pure antimony compounds are used as catalysts in organic synthesis, abrasives, plasticizers, pigment, and flameproofing compounds; also used in manufacturing paints, enamels, matches, glass, pharmaceuticals, explosives, and tartar emetic.
Other Designations: Stibium; antimony regulus; Sb; CAS No. 7440-36-0.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

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Section 2. Ingredients and Occupational Exposure Limits

Antimony, ca 99%

OSHA PEL	**ACGIH TLV, 1989-90**	**NIOSH REL, 1987***	**Toxicity Data†**
8-hr TWA: 0.5 mg/m³ (as Sb)	TLV-TWA: 0.5 mg/m³ (as Sb)	10-hr TWA: 0.5 mg/m³	Rat, intraperitoneal, LD_{50}: 100 mg/kg Rat, oral, LD_{50}: 100 mg/kg

* NIOSH has proposed a 10-hr TWA of 0.5 mg/m³ with an action level at 0.25 mg/m³. The TLV was established at a level to prevent irritation and systemic effects.
† See NIOSH, *RTECS* (CC4025000), for additional data with references to toxic effects.

Section 3. Physical Data

Boiling Point: 2975 °F (1635 °C)
Melting Point: 1166.9 °F (630.5 °C)
Vapor Pressure: 1 mm Hg at 1627 °F (886 °C)
Molecular Weight: 121.76 g/mol
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 6.68 at 77 °F (25 °C)
Water Solubility: Insoluble
Mohs Hardness: 3.0 to 3.5

Appearance and Odor: A brittle, flaky, crystalline solid with a lustrous blue-white color; however, a noncrystalline form is also known. The powder form is dark gray, lustrous.

Section 4. Fire and Explosion Data

Flash Point: None reported	**Autoignition Temperature:** Cloud,* 788 °F (420 °C); dust layer,* 626 °F (330 °C)	**LEL:** Dust cloud explosion, 0.42 oz/ft³	**UEL:** None reported

Extinguishing Media: Dry chemical powder.
Unusual Fire or Explosion Hazards: Antimony bulk metal is combustible in air at *high temperature*. When ignited it burns with a brilliant flame, giving off dense, white antimony trioxide (Sb_2O_3) fumes. When exposed to heat or ignition sources, powdered antimony is a moderate fire and explosion hazard. Particle size and dispersion in air determine reactivity.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Personal protective clothing and eye protection are essential.

* Ninety-one percent of dust goes through a 74-µm sieve. A 1.92-J spark can ignite an antimony dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Antimony metal (bulk) is stable in dry air at room temperature in closed containers. It slowly tarnishes in moist air. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Antimony is not very reactive with cold, dilute acids, but it reacts readily with aqua regia and hot, concentrated sulfuric acid. Powdered antimony* also reacts with hot, concentrated hydrochloric acid (HCl). On contact with acid, it emits toxic antimony trihydride (SbH_3) fumes; electrolysis of acid sulfides and stirred antimony halide yields explosive antimony. Antimony can react vigorously or violently with oxidizing agents such as nitrate salts, halogens, nitric acid, perchloric acids, chlorine trifluoride (ClF_3), potassium permanganate ($KMnO_4$), ammonium nitrate (NH_4NO_3), bromine trinitride (BrN_3), bromine trifluoride (BrF_3), chlorine monoxide (ClO), chlorine trifluoride (ClF_3), potassium nitrate (KNO_3), sodium nitrate ($NaNO_3$), and potassium oxide (K_2O_2).
Conditions to Avoid: Nascent hydrogen can react with Sb, or its alloys with Mg or Zn, to form antimony trihydride, a colorless, highly toxic gas (causing headache, nausea, vomiting, abdominal pain, hemolysis (separation of hemoglobin from red blood corpuscles), hematuria (blood in the urine), and death) with a disagreeable odor (0.1-ppm TLV).
Hazardous Products of Decomposition: Thermal oxidative decomposition of antimony can produce toxic SbH_3 fumes.

* Powdered antimony reacts more vigorously than the bulk material and forms dangerous mixtures with oxidizing agents. Heating further increases its reactivity.

No. 70 Antimony Metal/Powder 11/89

[illegible]tion 6—Health Hazard Data

[illegible]cinogenicity: Neither the NTP, IARC, nor OSHA lists antimony as a carcinogen. However, its ore is a suspected carcinogen in antimony trioxide production. Antimony trioxide is prepared in the laboratory by a volatilization process involving antimony trichloride ($SbCl_3$) and water.
Summary of Risks: An irritant to mucous membranes, eyes, and skin. Exposures to dust/powder can cause eye inflammation (conjunctivitis), nasal irritation (rhinitis - perforation of the nasal septum), chronic dermatitis ranging from mild rashes to blemishes resembling chicken pox, and muscle pain and weakness. Some sources refer to antimony as a human poison by an unspecified route. Exposure to antimony may result in "metal fume fever," a flu-like syndrome with fever, fatigue, cough, and muscle ache.
Medical Conditions Aggravated by Long-Term Exposure: Chronic inhalation of subtoxic doses of dust or fume above the TLV may result in chemical pneumonia, intraalveolar lipid deposits, liver and cardiac involvement, and possible kidney disease.
Target Organs: Skin, eyes, mucous membranes, respiratory system, and cardiovascular system.
Primary Entry: Inhalation (dust and fume), ingestion.
Acute Effects: Acute ingestion may cause violent vomiting, diarrhea, slow pulse and low blood pressure, shallow breathing, and death.
Chronic Effects: Chronic exposures lead to dizziness, dry throat, sleeplessness, anorexia, and nausea.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
Skin: After rinsing affected area with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: ***Contact physician!*** Never give anything by mouth to an unconscious or convulsing person. Give 1 to 2 glasses of water to dilute, although vomiting may be spontaneous after ingestion.
After first aid, get appropriate in-plant, paramedic, or community medical attention and support.
Physician's Note: If indicated, intravenous gastric lavage chelation therapy with BAL (British Anti-Lewsite) for 10 days is recommended.

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Spill/Leak: Notify safety personnel of powder spills. Small spills can be removed by vacuuming or wet sweeping to minimize airborne dust. Cleanup personnel should use protective equipment.
Disposal: Return scrap metal to your supplier. Unsalvageable waste may be buried in an approved secure landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, Sec. 307(a)]
ARA Extremely Hazardous Substance (40 CFR 355): Not listed
isted as a SARA Toxic Chemical (40 CFR 372.65)

Section 8—Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Wear a NIOSH-approved respirator if necessary. Follow OSHA respirator regulations (29 CFR 1910.134). Respirators should be available for nonroutine or emergency use for concentrations above the TLV: high-efficiency dust respirators for concentrations below 5 mg/m^3 and self-contained or air-supplied respirators with full facepiece for concentrations above 5 mg/m^3.
Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.
Ventilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9—Special Precautions and Comments

Storage Requirements: Store in a dry, well-ventilated, low fire-risk area. Avoid heat and direct sunlight.
Engineering Controls: Avoid breathing dust or fumes. Practice good housekeeping and cleaning techniques to prevent dust accumulation and to minimize airborne particulates. Minimize skin contact by using barrier creams, rubber gloves and aprons, and good personal hygiene. Keep antimony dust off clothing. Provide preplacement and periodic medical examinations for those workers exposed regularly to antimony, with emphasis on the skin, mucous membranes, and the pulmonary, cardiac, and reproductive systems. Provide suitable training to those working with antimony. Monitor the workplace. Keep records.

Transportation Data (49 CFR 172.102)

IMO Shipping Name: Antimony compounds, inorganic, n.o.s.
IMO Hazard Class: 6.1
IMO Label: Poison/St. Andrews Cross (Stow away from foodstuffs)
IMDG Packaging Group: I, II, III

MSDS Collection References: 1, 2-12, 24, 26, 27, 31, 37, 38, 41, 81, 84, 87, 89, 90, 91, 100, 109
Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Hardies, MD F7

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Material Safety Data Sheets Collection:

Sheet No. 119
Barium Carbonate

Issued: 10/83 Revision: A, 8/90

Section 1. Material Identification

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R	0	Genium	
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K	0		-

Barium Carbonate ($BaCO_3$) Description: Found in nature as the mineral witherite. Prepared commercially by reacting sodium carbonate or carbon dioxide with barium sulfide. Used in rodenticides, ceramics, paints, enamels, marble substitutes, and rubber; in manufacturing of paper, electrodes, barium salts, optical glasses; as an analytical reagent; in the treatment of brines in chlorine-alkali cells to remove sulfates; and in radiation-resistant glass for color television tubes.
Other Designations: CAS No. 0513-77-9; carbonic acid, barium salt.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[7] for a suppliers list.

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* Sec. 8

Cautions: *Barium carbonate is a poison by ingestion!* Inhalation may result in bronchial irritation. Excessive exposures may cause baritosis (a benign pneumoconiosis).

Section 2. Ingredients and Occupational Exposure Limits

Barium carbonate, ca 100%

1989 OSHA PEL	1989-90 ACGIH TLV	1985-86 Toxicity Data*
0.5 mg (Ba)/m³	0.5 mg (Ba)/m³	Human, oral, TD_{Lo}: 11 mg/kg ingested produces gastrointestinal effects (ulceration or bleeding from the stomach)
	1988 NIOSH REL	Rat, oral, LD_{50}: 418 mg/kg; no toxic effect noted
	None established	Rat, inhalation, TC_{Lo}: 3130 µg/m³ inhaled in a 24-hr period within 16 weeks prior to mating produces maternal effects (oogenesis, ovaries, Fallopian tubes)

* See NIOSH, *RTECS* (CQ8600000), for additional reproductive and toxicity data.

Section 3. Physical Data

Boiling Point: 2372 °F (1300 °C) (decomposes)
Melting Point: 1492 °F (811 °C)
Molecular Weight: 197.35
Specific Gravity: 4.43
Water Solubility: 0.002 g/100 cc at 20 °C
Appearance and Odor: White to greyish-white fine granular powder. Odorless.

Section 4. Fire and Explosion Data

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

Extinguishing Media: Since barium carbonate is noncombustible, use extinguishing media appropriate to the surrounding fire. Use water spray to wet down material and to avoid a dust problem.
Unusual Fire or Explosion Hazards: There is no special or unusual fire or explosion hazard associated with this material. However, thermal oxidative decomposition of barium carbonate can produce barium oxide. The barium oxide produced is a strongly alkaline material and exothermic (heat producing) upon contact with water. Hot barium oxide can react directly with oxygen to give off a peroxide (BaO_2) which can be a fire and explosion risk with organic materials.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Barium carbonate is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Barium carbonate is incompatible with 2-furanpercarboxylic acid and bromine trifluoride. It is acid soluble with emission of carbon dioxide.
Hazardous Products of Decomposition: Thermal oxidative decomposition of barium carbonate can produce barium oxide (Sec. 4) and carbon dioxide.

tion 6: Health Hazard Data

Carcinogenicity: The NTP, IARC, and OSHA do not list barium carbonate as a carcinogen.
Summary of Risks: Barium carbonate may be irritating to the skin, eyes, nose, throat, and lungs and may cause baritosis if inhaled. Unlike the insoluble barium (sulfate) used in medical testing, barium carbonate is a human poison by ingestion. The human systemic effects by ingestion include stomach ulcers, muscle weakness, paresthesias (tingling sensation on the skin), and paralysis. It can adversely affect the gastrointestinal system and musculature (including the heart muscle). Experimental studies show reproductive effects in laboratory animals. In rats it impairs the function of the male and female gonads.
Medical Conditions Aggravated by Long-Term Exposure: None reported. However, anyone with a chronic pulmonary disorder should be advised to minimize inhalation contact with any chemical irritants.
Target Organs: Respiratory tract by inhalation; gastrointestinal system and muscles including heart by ingestion.
Primary Entry Routes: Ingestion, inhalation.
Acute Effects: Acute effects of skin or eye contact are primarily limited to irritation. Inhalation may be irritating and may cause cough or shortness of breath, as well as x-ray changes. Systemic effects of ingestion may include salivation, nausea, vomiting, colic (severe crampy abdominal pain), diarrhea, internal gastrointestinal bleeding, dyspnea (shortness of breath), paresthesia, muscular spasm or paralysis, hypokalemia (potassium deficiency in the blood), hypertension (increased blood pressure), and bradycardia (slow pulse).
Chronic Effects: None reported.
FIRST AID
Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of low-pressure running water for at least 15 min.
Skin: *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Contact a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: Precipitate ingested soluble barium compounds as benign insoluble barium sulfate using an Epsom ($MgSO_4$) or a Glauber's ($NaSO_4$) salt solution. Dilute copiously with water or milk. Evacuate via nasogastric aspiration or induction of emesis. Monitor electrolytes, especially potassium (treat for hypokalemia), electrocardiogram and rhythm, and acid/base status. Induce brisk diuresis. Calcium gluconate may be helpful for muscle spasms. Provide oxygen by nasal cannula or mask and other supportive treatment for symptoms as clinically indicated.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spills and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and skin or eye contact. Avoid creating airborne dust situations. Remove spills by vacuuming or wet sweeping. Place spilled material in containers with covers for disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations that promote worker safety and productivity. Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.(103)
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in closed containers in a dry, well-ventilated area away from acids and oxidizing agents. Protect containers from physical damage.
Engineering Controls: Avoid breathing dust. Keep dust off clothing and follow good personal hygiene procedures. Use good housekeeping practices and sound cleaning techniques to prevent dust accumulation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation.
Other Precautions: Provide preplacement and periodic medical examinations with emphasis on the skin, eye, heart, and lung (including chest x-ray and pulmonary function studies).

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Barium compounds, n.o.s.
IMO Hazard Class: 6.1
IMO Label: Poison/St. Andrew Cross
IMDG Packaging Group: I, II, III
ID No.: UN1564

MSDS Collection **References:** 1, 2, 4-7, 10, 12, 14, 26, 34, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 136, 139
Prepared by: MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

No. 23

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
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SCHENECTADY, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

CADMIUM METAL
Revision B

Date December 1980

SECTION I. MATERIAL IDENTIFICATION

MATERIAL NAME: CADMIUM METAL
DESCRIPTION: Silver-white, malleable elemental metal
OTHER DESIGNATIONS: Cadmium Anodes, Cd, GE Material B10C11, ASTM B440, CAS #007 440 439
MANUFACTURER: Available from many suppliers, including:

ASARCO Inc.
120 Broadway
New York, NY

Telephone: (801) 262-2459 (Emergency Phone)

SECTION II. INGREDIENTS AND HAZARDS

SECTION II. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Cadmium	>99.8	8-hr TWA fume 0.1 mg/m^3 } * dust 0.2 mg/m^3 } or 0.05 mg/m^3**
*Current OSHA TLV as developed by ANSI. **ACGIH TLV (1980) for fume, salt or dust. NIOSH has recommended a 10-hr TWA of 0.04 mg/m^3 with a 15 minute ceiling of 0.2 mg/m^3. TLV was set at level to prevent systemic effects of chronic cadmium poisoning. The massive metal is usually safe unless metal fume is formed (heating) or soluble cadmium compounds are formed (acid reaction or corrosion).		Human, inhalation TCLo 88 µg/m^3/8.6 yrs (systemic effect) Rat, intramuscular TDLo 14 mg/kg (carcinogenic effects)

SECTION III. PHYSICAL DATA

Boiling point at 1 atm, deg C (F)	767 (1415)	Specific gravity (H_2O=1)	8.6
Vapor pressure at 394 C, mm Hg	1	Melting point, deg C	320.9
Solubility in water	Insoluble	Atomic weight	112.41
Viscosity @ 340 C, cp	2.37	Brittle temperature, deg C	80

Appearance and Odor: Silvery white, bluish, lustrous metal; no odor.

SECTION IV. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
Not applicable	570 C* 250 C* (Cloud) (dust layer)	Dust Cloud*	--	--

Extinguishing Media: CO_2 or dry chemical type; sand can be used.
Cd dust will burn with evolution of CdO fumes; it is a weak fire and explosion hazard.
Firefighters must wear self-contained breathing apparatus and full protective clothing.

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*Through 74 µm sieve; cloud can be ignited by 4.0J spark.

SECTION V. REACTIVITY DATA

Massive metal is stable at room conditions when dry; when, at red heat it oxidizes in air to CdO. Finely powdered metal can be pyrophoric. Heat treatment, welding, or soldering of cadmium metal and cadmium coatings will produce toxic CdO and Cd metal fumes.

The sulfide, carbonate and hydroxide are insoluble in water while the halides, nitrate and sulfate are relatively soluble. Cd forms a variety of soluble complexes such as cyanide & amines. Soluble in acids. Resistant to alkalies. Tarnishes in moist air.

Ammonium nitrate & powdered Cd may yield an explosive reaction. It is incompatible with strong oxidizing agents, elemental sulfur, selenium, tellurium, and hydrazoic acid. Nitryl fluoride passed over a mildly warm Cd metal can produce incandescence.

NO. 23

SECTION VI. HEALTH HAZARD INFORMATION

TLV (See Sect. II)

Exposures to cadmium dust/fume can result in pulmonary irritation, dermatitis, or allergic sensitization. Pneumonitis can occur after excessive inhalation at 0.5 to 2.5 mg/m³. Fatal pulmonary edema†(delayed effects) can result from levels which provide insufficient discomfort for warning; for example, at or above 5 mg/m³ for 8 hrs or at 40-50 mg/m³ for 1 hr. Symptoms of overexposure can be a dry, burning throat, headache, muscle aches, cough, chest tightness and pain, nausea, chills and fever. Chronic exposure, low level fume, may lead to emphysema, anemia, kidney damage, anosemia, and yellow rings around the necks of teeth. Cadmium can be toxic by ingestion.

FIRST AID:

Eye Contact: Flush with running water for 15 minutes, including under eyelids.

Skin Contact: Wash contact area well with soap and water.

Inhalation: Remove victim to fresh air. Restore breathing if required; have trained person administer 60-100% oxygen. Contact physician or hospital.

Ingestion*: Contact physician for gastric lavage followed by saline catharsis. (If physician not readily available, give 2-3 glasses water to drink and induce vomiting.)

Obtain medical assistance for treatment, observation, and support as needed.

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*Chelating agents used by physicians in cadmium poisoning: Calcium disodium edetate or pencillamine. †Latent period of up to 12 hours.

SECTION VII. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of spills. Clean-up personnel need protection against inhalation of dust or fumes. Pick up material using vacuum or wet mopping or sweeping to avoid dusting.

DISPOSAL: Recover scrap metal and store in closed container for salvage. When possible, return cadmium materials to supplier for reclamination. Incineration can be a cause of air pollution; proper scrubber needed. Conc. soluble Cd waste can be precipitated with lime and collected by filtration. Effluent is treated further as needed to reduce Cd conc. to compliance levels. Cadmium compound containing waste (EPA number D006 under RCRA) to be disposed in an approved chemical landfill of the California Class I type. Follow Federal, State and Local regulations. Toxic to fish. (Conc. greater than 0.001 mg/L; depends on pH).

SECTION VIII. SPECIAL PROTECTION INFORMATION

Provide efficient local exhaust ventilation to meet TLV requirements in the workplace. Approved respirator protection required when heating, grinding, and for operations where dust and/or fume exposure may occur. A self-contained or air supplied respirator can be used up to 2 mg/m³ with a full face piece above 0.4 mg/m³. (Above 2 mg/m³ a positive pressure mode or auxillary air supply is needed, respectively.)

Wear rubber gloves, chemical goggles and/or face shield and protective coveralls. Special work clothing and laundering recommended. Change work clothing daily; shower after work.

Provide periodic medical examinations for those regularly exposed, including chest x-ray, vital capacity, and urinalysis. Preclude from exposure those individuals with lung, liver, kidney, and blood ailments until approved by physician.

SECTION IX. SPECIAL PRECAUTIONS AND COMMENTS

Store in a dry, low fire-risk area; avoid storage conditions where corrosion can occur. Keep powdered metal in closed containers, protected from physical damage. Use good housekeeping practices to prevent accumulation of dust; use good cleaning techniques, such as vacuuming to keep airborne particulate at a minimum. Use nonsparking tools where cadmium particulate is found.

Use good hygienic practice in handling cadmium and its compounds. No eating or smoking in work areas.

Toxic effects of Cd are influenced by the presence or absence of other elements, such as Zn & Se. As an elemental material, cadmium is not degradable; but it can be isolated as insoluble salts in secure landfills.

DATA SOURCE(S) CODE: 1-12, 19, 20, 24-27, 31, 37-40

APPROVALS: MIS CRD	
Industrial Hygiene and Safety	12-9-80
MEDICAL REVIEW: 16 Dec. 1980	

GENIUM PUBLISHING

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Material Safety Data Sheets Collection:

Sheet No. 744
Potassium Chromate

Issued: 7/91

Section 1. Material Identification

Potassium Chromate (K_2CrO_4) Description: Derived by roasting powdered chromite with potash and limestone, then treating the cinder with hot potassium sulfate solution, followed by leaching. Also obtained by reaction of potassium bichromate with potassium hydroxide. Used in photography (sensitizer for gelatin coatings), textile printing pads, metal finishing and chrome plating; in manufacturing and packing the cement and glue used in shoes, furniture, and packaging materials; as a corrosion inhibitor in batteries, radiator coolants, internal combustion and gas turbine engines, refrigerator and air-conditioning systems, and water-cooled nuclear reactors; and as a mordant in dyeing, an analytical reagent, and a fungicide in aqueous wood preservatives.
Other Designations: CAS No. 7789-00-6; bipotassium chromate; chromate of potash; chromate of potassium; dipotassium chromate; dipotassium monochromate; neutral potassium chromate; potassium chromate (VI); potassium chromate, yellow; Tarapacaite.*
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*⁽⁷³⁾ for a suppliers list.

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Cautions: A highly corrosive, powerful oxidizer, potassium chromate can be severely toxic by inhalation, ingestion, and skin contact.

Section 2. Ingredients and Occupational Exposure Limits

Potassium chromate, ca 100%

1990 OSHA PEL
Ceiling: 0.1 mg (CrO_3)/m³

1990 IDLH Level
30 mg/m³ (as CrO_3)/m³

1990-91 ACGIH TLV
TWA: 0.5 mg (Cr)/m³

1990 NIOSH REL
TWA: 0.025 mg/m³ (Cr(VI))
Ceiling: 0.05 for 15 min

1985-86 Toxicity Data*
Human, estimated lethal dose: 1 to 10 g
Dog, intravenous, LD_{Lo}: 2900 µg/kg; no toxic effects noted
Dog, subcutaneous, LD_{Lo}: 19 mg/kg; toxic effects not yet reviewed

* See NIOSH, *RTECS* (GB2940000), for additional toxicity data.

Section 3. Physical Data

Melting Point: 1787 °F (975 °C)
Heat of Fusion: 6920 cal/g/mol
Vapor Pressure: 0
Index of Refraction: ß 1.74
pH: Aqueous solution is alkaline
Molecular Weight: 194.2
Density/Specific Gravity: 2.73 at 64.4 °F (18 °C)
Water Solubility: Soluble; 69.9 g/100 cc in water at 68 °F (20 °C), 79.2 g/100 cc in water at 212 °F (100 °C)
Appearance and Odor: Odorless, lemon-yellow rhombic crystals.

Section 4. Fire and Explosion Data

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

Extinguishing Media: Potassium chromate may burn, but it does not readily ignite. For small fires, use dry chemical, carbon dioxide (CO_2), water spray, or foam. For large fires, use water spray, fog, or foam. Cool containers with a water spray to the side until fire is well out. If possible without risk, move containers from hazard area. Do not scatter material with more water than needed to put out fire. Dike fire control water for later disposal.
Unusual Fire or Explosion Hazards: Potassium chromate becomes a possible explosion hazard when shocked, heated, or exposed to hydrazine. Fire may increase in intensity if potassium chromate contacts combustibles.
Special Fire-fighting Procedures: Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Avoid breathing dusts or vapors. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Potassium chromate is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. It is important to keep containers tightly closed.
Chemical Incompatibilities: Potassium chromate violently decomposes hydrazine and is incompatible with readily oxidizable materials such as organic material, paper, wood, sulfur, aluminum, and plastics.
Conditions to Avoid: Avoid contact with hydrazine and combustibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of potassium chromate can produce toxic fumes of potassium oxide (K_2O).

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC lists chromium and many of its compounds as carcinogens, with the qualification that they have not yet reviewed potassium chromate. In general, hexavalent chromium compounds are established as bronchogenic (lung) carcinogens. However, there is some controversy regarding potassium chromate. NIOSH states that potassium chromate is not a carcinogen.
Summary of Risks: Potassium chromate is corrosive to skin and mucous membranes and is toxic by inhalation and ingestion of small amounts. Symptoms range from respiratory and gastrointestinal (GI) tract irritation to severe corrosion and, in some cases, kidney, liver, and blood damage.
Medical Conditions Aggravated by Long-Term Exposure: Pulmonary conditions such as asthma, certain skin conditions, allergies, chromate sensitization.

Continue on next page

Section 6. Health Hazard Data, *continued*

T ret Organs: Eye, skin, and respiratory, digestive, hepatic (liver), renal (kidney), and hematopoietic (blood) systems.
ary Entry Routes: Inhalation, ingestion, and skin contact.
Acute Effects: Inhalation may cause severe irritation or corrosion of the mucous membranes of the nose, throat, airways, and lungs. Skin contact can result in irritant or allergic contact dermatitis (rash) or penetrating ulcers. Eye contact can cause conjunctivitis (inflammation of the lining of the eye) or burns. Ingestion can be highly corrosive to the esophagus and stomach and can cause severe poisoning. Systemic effects from absorption by any route may include kidney failure (acute tubular necrosis with uremia), liver damage, hemolysis (destruction of red blood cells), and other changes in the blood (e.g., alterations of white blood count: leukocytosis, leukopenia, or monocytosis). Shock or death may result.
Chronic Effects: Possible effects of chronic exposure may include ulceration or perforation of the nasal septum (tissue separating the nostrils). rhinitis (runny nose), pharyngitis (sore throat), penetrating skin ulcers, allergic sensitization, and possibly lung cancer.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Do not break open blisters or remove skin. Wash affected area with soap and water. If clothing sticks to skin after flooding with water, *do not* remove it. Have victim medically evaluated.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Encourage blowing of nose, coughing up, and spitting out any retained particulate matter.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious and alert* person drink a glass of milk (or, if unavailable, water). *Do not induce vomiting!* If vitamin C is available, give a high dose (5 to 10 g) as soon as possible.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Promptly treat systemic absorption with 5 to 10 g of ascorbic acid (acts as a reducing agent). Emesis is contraindicated. For ingestion, consider gastric lavage, followed by charcoal. Monitor renal, hepatic, cardiovascular, and pulmonary function. Hemodialysis may be indicated if renal failure develops.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel. Isolate hazard area, deny entry, and stay upwind. If possible without risk, stop leak. For small spills, take up with sand, vermiculite or other absorbent, or noncombustible material and place in suitable containers for later disposal. For large spills, dike far ahead of liquid spill for later disposal. In case of water spill, add sodium bisulfite and neutralize with agricultural lime. Cover powder spill with an impermeable plastic sheet or tarp to minimize spreading. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Transport: Chromium is transported from soil through runoff and leaching of water. Water runoff can remove chromium ions and bulk precipitates of chromium and deposit them on a different soil or body of water. Chromium released into the soil can enter the atmosphere by way of aerosol formation. Once in the atmosphere, chromium particles may remain for extended periods of time and be transported great distances by wind currents and diffusion forces.
Environmental Degradation: Ecotoxicity values for *Daphnia magna* (Cladoceran), EC$_{50}$ (median effective concentration producing an effect in 50% of test organisms in water): 19.2 and 7.39 μg/l for 48 and 96 hr, respectively.
Soil Absorption/Mobility: Chromates do not readily bond to soil; up to 300 ppm were found in column studies from all different soil types.
Disposal: Anion exchanges or ferric salt and sodium bicarbonate precipitate chromium. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
CRA Hazardous Waste (40 CFR 261.33): Not listed
isted as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 10 lb (4.54 kg) [* per Clean Water Act, Sec. 311(b)(4)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed
OSHA Designation*
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

* Listed as CrO$_3$

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. There are no specific NIOSH recommendations for potassium chromate. However, consider recommendations for chromic acid and chromates (as CrO$_3$; *MSDS Collection*, No. 5). For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent all skin contact.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below applicable levels (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Remove this material from your shoes and equipment. Launder contaminated clothing before wearing. Provide covered containers for work clothing removed at end of shift or after a contamination incident. Store until taken for disposal.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in a cool, dry, well-ventilated area away from reducing materials. Keep containers tightly closed.
Engineering Controls: Avoid dust inhalation and skin contact. Use appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Post signs where chromates are used and limit access to these areas to trained personnel only. Process enclosures may be useful in containing chromates and preventing dust dispersion. Practice good personal hygiene and housekeeping procedures.
Other Precautions: Consider preplacement and periodic medical exams of exposed workers that emphasize changes in mucous membranes and monitoring for malignancies of the upper respiratory tract, blood, liver, kidneys and chronic skin disorders. Baseline may include CXR, PFT, CBC, LFTs, BUN and creatinine and U/A.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Potassium chromate
DOT Hazard Class: ORM-E
DOT Label: None
Note: Potassium chromate is subject to specific packaging requirements in 49 CFR 173.510

***MSDS Collection* References:** 73, 101, 103, 124, 126, 127, 132, 136, 140, 142, 153
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS 151

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Material Safety Data Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification 32

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

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

Section 2. Ingredients and Occupational Exposure Limits

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

1989 OSHA PELs (Lead, inorganic compounds)
8-hr TWA: 50 $\mu g/m^3$
Action Level TWA*: 30 $\mu g/m^3$

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

1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)
TLV-TWA: 150 $\mu g/m^3$

1988 NIOSH REL
10-hr TWA: <100 $\mu g/m^3$

1985-86 Toxicity Data†
Human, inhalation, TC_{Lo}: 10 $\mu g/m^3$ affects gastrointestinal tract and liver
Human, oral, TD_{Lo}: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, TD_{Lo}: 790 mg/kg affects multigeneration reproduction

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

Section 3. Physical Data

Boiling Point: 3164 °F (1740 °C)
Melting Point: 621.3 °F (327.4 °C)
Vapor Pressure: 1.77 mm Hg at 1832 °F (1000 °C)
Viscosity: 3.2 cp at 621.3 °F (327.4 °C)
Molecular Weight: 207.20
Specific Gravity (20 °C/4 °C): 11.34
Water Solubility: Relatively insoluble in hot or cold water*
Appearance and Odor: Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

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

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

Section 5. Reactivity Data

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

Section 6. Health Hazard Data

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

Continue on next page

Section 6. Health Hazard Data, *continued*

rget Organs: Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects: An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
Chronic Effects: Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.
FIRST AID
Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
Inhalation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Physician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
Ventilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.(103)
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

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

Transportation Data (49 CFR 172.102)
IMO Shipping Name: Lead compounds, soluble, n.o.s.
IMO Hazard Class: 6.1
ID No.: UN2291
IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)
IMDG Packaging Group: III

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

R

Chemical Name or Synonym	CAS No.
R 12	75-71-8
R 22	75-45-6
R 875	357-56-2
R-(-)-AMPHETAMINE	156-34-3
R-326	136-45-8
R-PENTINE	542-92-7
RACE-ACETYLMETHADOL HYDROCHLORIDE	509-74-0
RACEMIC LACTIC ACID	50-21-5
racemic-DESOXYNOR-EPHEDRINE	300-62-9
RACEPHEN	60-13-9
RACUMIN	5836-29-3
RADIOSTOL	50-14-6
RADSTERIN	50-14-6
RAMIZOL	61-82-5
RANEY CATALYST #2813	37187-84-1
RAPHETAMINE	300-62-9
RAPIDASE 2M	9000-92-4
RAT & MICE BAIT	81-81-2
RAT-A-WAY	81-81-2
RAT-A-WAY	117-52-2
RAT-B-GON	81-81-2
RAT-GARD	81-81-2
RAT-NIP	7723-14-0
RATAFIN	117-52-2
RATS-NO-MORE	81-81-2
RATSUL SOLUBLE	129-06-6
RAUCUMIN 57	5836-29-3
RAVONAL	71-73-8
RCRA WASTE NUMBER P001	81-81-2
RCRA WASTE NUMBER P010	7778-39-4
RCRA WASTE NUMBER P030	57-12-5
RCRA WASTE NUMBER P037	60-57-1
RCRA WASTE NUMBER P042	51-43-4
RCRA WASTE NUMBER P051	72-20-8
RCRA WASTE NUMBER P105	26628-22-8
RCRA WASTE NUMBER U010	50-07-7
RCRA WASTE NUMBER U041	106-89-8
RCRA WASTE NUMBER U058	50-18-0
RCRA WASTE NUMBER U060	72-54-8
RCRA WASTE NUMBER U075	75-71-8
RCRA WASTE NUMBER U081	120-83-2
RCRA WASTE NUMBER U106	606-20-2
RCRA WASTE NUMBER U122	50-00-0
RCRA WASTE NUMBER U129	58-89-9
RCRA WASTE NUMBER U213	109-99-9
RCRA WASTE NUMBER U223	584-84-9
RCRA WASTE NUMBER U226	71-55-6
RCRA WASTE NUMBER U232	93-76-5
RCRA WASTE NUMBER U238	51-79-6
RCRA WASTE NUMBER U240	94-75-7
* RDX	121-82-4
RECTHORMONE TESTOSTERONE	57-85-2
RED ARSENIC GLASS	12044-79-0
RED IRON ORE	1317-60-8
RED IRON OXIDE	1309-37-1
RED LEAD CHROMATE	18454-12-1
RED ORPIMENT	12044-79-0
RED OXIDE	1309-37-1
RED OXIDE OF MERCURY	21908-53-2
RED POTASSIUM CHROMATE	7778-50-9
RED PRECIPITATE	21908-53-2
RED URANIUM OXIDE	1344-58-7
RED-AL	22722-98-1
REDDON	93-76-5
REDDOX	93-76-5
REED AMINE 400	2008-39-1
REED LV 2,4-D	25168-26-7
REED LV 400 2,4-D	25168-26-7
REED LV 600 2,4-D	25168-26-7
REFINED SOLVENT NAPHTHA	8032-32-4
REFINED SOLVENT NAPHTHA	64475-85-0
REFREGERANT 12	75-71-8
REFRIGERANT 12/114	57197-42-9
REFRIGERANT 22	75-45-6
REGLON	85-00-7
REGLONE	85-00-7
REGLOX	85-00-7
REICHSTEIN'S SUBSTANCE H	50-22-6
REICHSTEIN'S SUBSTANCE M	50-23-7
RELUTIN	630-56-8
RENAGLADIN	51-43-4
RENALEPTINE	51-43-4

RDX

CAS No.	Genium MSDS No.	DOT ID No.	OSHA PELs (Subpart Z) TWA ppm	OSHA TWA mg/m3	OSHA STEL/Ceiling ppm	OSHA STEL/Ceiling mg/m3	ACGIH TLVs TWA ppm	ACGIH TWA mg/m3	ACGIH STEL/Ceiling ppm	ACGIH STEL/Ceiling mg/m3	RCRA Hazardous Waste No.	RCRA Code	CERCLA RQ (Pounds)	SARA 311/312 codes	SARA TPQ (Pounds)	SARA Toxic	CAA	CWA	Carcinogen IARC	Carcinogen NTP	Carcinogen OSHA	Proc. Safety	MA	NJ	CA Prop 65
121-44-8	392	1296	10	41	15	62	10	40	15	60			5000	123			A						Y	Y	
121-45-9		2329	2.	10			2	10						1 3									Y	Y	
121-46-0																							Y		
121-54-0																									
121-66-4																			3				Y		
121-69-7	347	2253	5	25	10	50	5	25	10	50				123		Y	A						Y	Y	
121-73-3																		Y					Y		
121-75-5		2783		10				5					100										Y	Y	
121-82-4		72		1.5				1.5															Y	Y	
122-09-8											P046	H	5000												
122-10-1		3018																						Y	
122-14-5		3018													500								Y	Y	
122-20-3																							Y		
122-34-9																							Y		
122-39-4	461			10				10						1									Y		
122-51-0		2524																					Y	Y	
122-52-1		2323																						Y	
122-59-8														1					2B						
122-60-1	595		1	6.1			1	8						1									Y		Y
122-66-7											U109	T	10	12		Y	A	Y		A			Y	Y	Y
122-82-7																							Y		
122-98-5																							Y		
123-00-2		1760																					Y	Y	
123-04-6																		Y					Y		
123-05-7		1191																					Y	Y	
123-07-9																							Y		
123-15-9		2367																					Y	Y	
123-17-1																							Y		
123-18-2																							Y		
123-19-3	810	2710	50	233			50	235						1 3									Y	Y	
123-20-6		2838																					Y	Y	
123-23-9		2135																						Y	
123-31-9	635	2662		2				2						12	500/10000	Y	A		3					Y	
123-33-1											U148	T	5000												
123-38-6		1275												1 3		Y	A						Y	Y	
123-42-2	353	1148	50	238			50	240						13									Y	Y	

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Material Safety Data Sheets Collection:

Sheet No. 3
Sodium Hydroxide

Issued: 10/77 Revision: C, 11/91

Section 1. Material Identification 36

R 0 NFPA
I 2
S 4
K 0

0
3 1
W
Alkali

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

Sodium Hydroxide (NaOH) Description: Derived by electrolysis of sodium chloride brines, by reacting calcium chloride with sodium carbonate, or by electrolytic production using the diaphragm cell. Sodium hydroxide often contains as impurities minimal amounts of sodium chloride, sodium carbonate, sodium sulfate, sodium chlorate, iron, or nickel. Used to hydrolyze fats and form soaps; in making plastics to dissolve casein; in treating cellulose to make rayon and cellophane; in explosives, dyestuffs, electrolytic extraction of zinc, reclaiming rubber, tin plating, oxide coating, etching and electroplating, laundering and bleaching, pulp and paper manufacture; in vegetable oil refining; in peeling of fruits and vegetables in the food industry; and in veterinary medicine as a disinfectant.
Other Designations: CAS No. 1310-73-2; Aetznatron; caustic soda; Collo-Grillrein; Collo-Tapette; Feurs Rohp; Lewis-Red Devil Lye; soda, hydrate; soda lye; sodium hydrate.
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*[73] for a suppliers list.

Cautions: Sodium hydroxide is moderately toxic by ingestion and inhalation and can be seriously corrosive to eyes, skin, and mucous membranes.

Section 2. Ingredients and Occupational Exposure Limits

Sodium hydroxide, ca 100%

1990 OSHA PEL
Ceiling: 2 mg/m³

1990 IDLH Level
250 mg/m³ (solution mists)

1991-92 ACGIH TLV
Ceiling: 2 mg/m³

1990 DFG (Germany) MAK
2 mg/m³

1990 NIOSH REL
Ceiling: 2 mg/m³

1985-86 Toxicity Data*
Rabbit, oral, LD_{Lo}: 500 mg/kg; no toxic effect noted
Rabbit, skin: 500 mg applied over 24 hr causes severe irritation
Mouse, intraperitoneal, LD_{50}: 40 mg/kg; toxic effects not yet reviewed

* See NIOSH, *RTECS* (WB4900000), for additional irritation, mutation, and toxicity data.

Section 3. Physical Data

Boiling Point: 2534 °F (1390 °C)
Melting Point: 605 °F (318.4 °C)
Vapor Pressure: 1 mm Hg at 1362 °F (739 °C)
pH (0.5% solution): 13
Molecular Weight: 40.01
Specific Gravity: 2.13 at 77 °F (25 °C)
Water Solubility: 1 g/0.9 ml water, 1 g/0.3 ml boiling water
Other Solubilities: 1 g/7.2 ml alcohol, 1 g/4.2 ml methanol, soluble in glycerol; insoluble in acetone and ether

Appearance and Odor: Odorless, hydroscopic (readily absorbs water) white flakes, cake, lumps, chips, pellets, or sticks.

Section 4. Fire and Explosion Data

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

Extinguishing Media: Although noncombustible as a solid, when in contact with moisture or water sodium hydroxide can generate enough heat to ignite surrounding combustibles. If possible without risk, remove containers from area. Use extinguishing agents suitable for surrounding fire. For small fire, use dry chemical, carbon dioxide (CO_2), or regular foam. Avoid water spray since water reacts with sodium hydroxide to generate substantial heat. If you must use water, be sure it is as cold as possible. For large fires, use fog or regular foam.
Unusual Fire or Explosion Hazards: Sodium hydroxide may melt and flow when heated.
Special Fire-fighting Procedures: Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Also, wear fully protective clothing. Structural firefighters' protective clothing provides limited protection. Apply cooling water to fire-exposed sides of container until fire is well out. *Do not* splatter or splash this material. Stay away from ends of tanks. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Sodium hydroxide is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Violent polymerization can occur when in contact with acrolein or acrylonitrile. Since sodium hydroxide readily absorbs water and carbon dioxide from air, keep containers tightly closed.
Chemical Incompatibilities: Sodium hydroxide generates large amounts of heat when in contact with water and may steam and splatter. It reacts with mineral acids to form corresponding salts; reacts with weak-acid gases like hydrogen sulfide, sulfur dioxide, and carbon dioxide; ignites when in contact with cinnamaldehyde or zinc; and has exploded when exposed to a mixture of chloroform and methane. Sodium hydroxide can be very corrosive to metals such as aluminum, tin, and zinc as well as to alloys such as steel, and may cause formation of flammable hydrogen gas. An increase in temperature and pressure occurs in closed containers when sodium hydroxide is mixed with: acetic anhydride, glacial acetic acid, chlorohydrin, chlorosulfonic acid, ethylene cyanohydrin, glyoxal, oleum, 36% hydrochloric acid, 48.7% hydrofluoric acid, 70% nitric acid, or 96% sulfuric acid.
Conditions to Avoid: Avoid generation of sodium hydroxide dusts, and contact with water, metals, and the chemicals listed above.
Hazardous Products of Decomposition: Thermal oxidative decomposition of sodium hydroxide can produce toxic sodium oxide (Na_2O) and sodium peroxide (Na_2O_2) fumes.

Section 6. Health Hazard Data

Carcinogenicity: In 1990 reports, the IARC, NTP, and OSHA do not list sodium hydroxide as a carcinogen (see Chronic Effects).
Summary of Risks: Sodium hydroxide is toxic by inhalation of dusts or mists, ingestion, or direct skin or eye contact. Damage is immediate and without prompt medical attention can become permanent. This strong, corrosive alkali dissolves any living tissue it contacts.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Eyes, digestive tract, respiratory system, and skin.
Primary Entry Routes: Ingestion, inhalation, and skin and eye contact.

Continue on next page

ction 6. Health Hazard Data, *continued*

Acute Effects: Ingestion causes immediate burning of mouth, esophagus, and stomach; painful swallowing; excessive salivation; edematous (excess fluid in surrounding tissue) lips, chin, tongue, and pharynx covered with exudate (fluid oozed from swollen tissue); esophageal edema (swelling from fluid buildup in esophagus walls that can prevent all swallowing within hours); possibly edematous, gelatinous, and necrotic (localized tissue death) mucous membranes; vomiting (sometimes coffee grounds like material due to digestive hemorrhage); and rapid, faint pulse; and cold, clammy skin. Death results commonly from shock, asphyxia (oxygen loss due to interrupted breathing), or pneumonia by the second or third day after ingestion. Dust inhalation can cause many small burns, temporary hair loss (in nasal passages since sodium hydroxide breaks down keratin), and possibly pulmonary edema (fluid in lungs). Skin contact causes slippery, soapy feeling that is not usually painful for 3 min after contact—even though skin damage begins immediately. It causes burns, keratin (hair and nails) destruction, and intracellular edema (excess fluid in skin cells), with damage progressing to severe burns, tissue corrosion, deep ulcerations, and permanent scarring if not immediately washed off. The cornea begins to corrode on contact. Disintegration and sloughing of conjunctival and corneal epithelium may progress to temporary or permanent corneal opacification (cloudiness, becoming impervious to light) or symblepharon (adhesion of lid to eyeball).

Chronic Effects: Dermatitis may result from repeated exposure to dilute solutions. Cases of squamous cell carcinoma (malignant tumors of epithelial origin) of the esophagus are reported 12 to 42 years after sodium hydroxide ingestion, although it is unclear whether the cancer results from scar formation caused by tissue destruction or directly from the chemical's possible carcinogenicity.

FIRST AID: Emergency personnel should protect against contamination.

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of cold water until transported to an emergency medical facility. *Do not* allow victim to keep eyes tightly shut. *Warning!* Although splashed directly in only one eye, sodium hydroxide may affect the other eye's sight if prompt medical attention is not received. Consult a physician immediately.

Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. *Be aware* that this substance can become very hot when in contact with water. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious and alert* person drink 1 to 2 glasses of water, followed by vinegar or fruit juice to neutralize the poison. *Do not induce vomiting!*

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

Note to Physicians: Perform endoscopy in all suspected cases of sodium hydroxide ingestion. Perform blood analysis to determine if dehydration, acidosis, or other electrolyte imbalances have occurred.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate hazard area, deny entry, and stay upwind of spills. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Use water spray to disperse vapors, but do not spray directly on spills. For small dry spills, avoid excess dust generation by carefully scooping or vacuuming (with appropriate filter) into a suitable container (above 60 °C sodium hydroxide corrodes steel) for later disposal. For large dry spills, cover with plastic sheet or other impermeable layer and contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).

Environmental Transport: Sodium hydroxide is not mobile in solid form, although it absorbs moisture very easily. Once liquid, sodium hydroxide leaches rapidly into soil, possibly contaminating water sources.

Environmental Degradation: Ecotoxicity values: TLm, mosquito fish, 125 ppm/96 hr (fresh water); TLm, bluegill, 99 mg/48 hr (tap water).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.22): Characteristic of corrosivity
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable
Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 311 (b)(4)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
SARA Toxic Chemical (40 CFR 372.65): Not listed

OSHA Designations

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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.

Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Select the respirator based on its suitability to provide adequate worker protection for the given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

Other: Wear impervious gloves, boots, aprons, and gauntlets to prevent any skin contact.

Ventilation: Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.(103)

Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Avoid physical damage to containers. Store in dry, well-ventilated area away from water, acids, metals, flammable liquids, and organic halogens. Keep containers tightly closed since sodium hydroxide can decompose to sodium carbonate and carbon dioxide upon exposure to air. Since corrosion occurs easily above 140 °F (60 °C), do not store or transport sodium hydroxide in aluminum or steel containers at temperatures near this level. Store containers in rooms equipped with trapped floor drains, curbs, or gutters.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control hazardous contaminants and to maintain concentrations at the lowest practical level.

Other Precautions: Consider preplacement and periodic medical examinations of exposed workers that emphasize eyes, skin, and respiratory tract. Consider a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Inform employees of the possible hazards in using sodium hydroxide.

Transportation Data (49 CFR 172.101, .102)

DOT Shipping Name: Sodium hydroxide; dry, solid, flake, bead *or* granular
DOT Hazard Class: Corrosive material
ID No.: UN1823
DOT Label: Corrosive
DOT Packaging Exceptions: 173.244
DOT Packaging Requirements: 173.245b

IMO Shipping Name: Sodium hydroxide, solid
IMO Hazard Class: 8
ID No.: UN1823
IMO Label: Corrosive
IMDG Packaging Group: II

MSDS Collection **References:** 26, 38, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 140, 143, 146, 148, 149, 153, 159, 161, 163

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** ER O'Connor, MS

Chemical Name or Synonym	CAS No.
TITANIUM OXIDE (TIO2)	13463-67-7
TITANIUM OXO(SULFATO)	13825-74-6
TITANIUM SULFATE	13825-74-6
TITANIUM SULFATE (1:2)	13825-74-6
TITANIUM SULFATE (H2SO4.XTI)	18130-44-4
TITANIUM TETRACHLORIDE	7550-45-0
TITANIUM TETRAPROPOXIDE	3087-37-4
TITANIUM TETRAPROPYLATE	3087-37-4
TITANIUM TRICHLORIDE	7705-07-9
TITANIUM(4) SULFATE	13825-74-6
TITANIUM(IV) CHLORIDE	7550-45-0
TITANIUM(IV) OXIDE	13463-67-7
TITANIUM(IV) SULFATE	13825-74-6
TITANOUS CHLORIDE	7705-07-9
TITONIUM(III) CHLORIDE	7705-07-9
TMA	75-50-3
TMAN	552-30-7
TMEDA	110-18-9
TMG	1445-79-0
TML	75-74-1
TMPEA	54-04-6
TMS	75-76-3
TMS CHLORIDE	75-77-4
TMTD	137-26-8
TNM	509-14-8
TNT	118-96-7
TNTAZB	29306-57-8
TOBRAMYCIN SULFATE	49842-07-1
TOCP	78-30-8
TOFURON	3588-53-7
TOKAMINA	51-43-4
TOKOPHARM	59-02-9
TOLUEEN-DIISOCYANAAT	584-84-9
TOLUEN-DIISOCIANATO	584-84-9
TOLUENE	108-88-3
TOLUENE 2,6-DIISOCYANATE	91-08-7
TOLUENE DIISOCYANATE	584-84-9
TOLUENE DIISOCYANATE (MIXED ISOMERS)	26471-62-5
TOLUENE HEXAHYDRIDE	108-87-2
TOLUENE SULFONIC ACID	104-15-4
TOLUENE SULFONIC ACID	25231-46-3
TOLUENESULFONIC ACID (MORE THAN 5% FREE SULFURIC ACID)	25231-46-3

Chemical Name or Synonym	CAS No.
TOLUENE TRICHLORIDE	98-07-7
TOLUENE, 2,4-DINITRO-	121-14-2
TOLUENE, 3,4-DINITRO-	610-39-9
TOLUENE, 3-NITRO-ALPHA,ALPHA,ALPHA-TRIFLUORO-	98-46-4
TOLUENE, 3-NITRO-ALPHA,ALPHA,ALPHA-TRIFLUORO-	98-46-4
TOLUENE, 3-NITRO-α,α,α-TRIFLUORO-	98-46-4
TOLUENE, AR,AR-DINITRO-	25321-14-6
TOLUENE, M-CHLORO-	108-41-8
TOLUENE, O-NITRO-	88-72-2
TOLUENE, P,ALPHA-DICHLORO-	104-83-6
TOLUENE, P-CHLORO-	106-43-4
TOLUENE, P-ISOPROPYL-	99-87-6
TOLUENE, α,α,α-TRICHLORO-	98-07-7
TOLUENE, α,α-DICHLORO-	98-87-3
TOLUENE, α-CHLORO-P-NITRO-	100-14-1
TOLUENE-2,4-DIISOCYANATE	584-84-9
TOLUENE-2,6-DIAMINE	823-40-5
TOLUENE-2,6-DIISOCYANATE	91-08-7
TOLUENE-2-AZONAPHTHOL-2	2646-17-5
TOLUENE-3,4-DIAMINE	496-72-0
TOLUENE-4-SULFONIC ACID	104-15-4
TOLUENE-AR,AR'-DIAMINE	25376-45-8
TOLUENE-AR,AR-DIAMINE	25376-45-8
TOLUENEDIAMINE	25376-45-8
TOLUENEDIAMINE	30143-13-6
TOLUENEDIISOCYANATE (MIXED ISOMERS)	26471-62-5
TOLUENESULFONIC ACID	104-15-4
TOLUENESULFONIC ACID (CONTAINING MORE THAN 5% SULFURIC ACID)	25231-46-3
TOLUENESULFONIC ACID MONOHYDRATE	104-15-4
TOLUENESULFONIC ACID, PARA-	104-15-4
TOLUIDINE, PARA-	106-49-0
TOLUILENODWUIZOCYJANIAN	584-84-9
TOLUOL	108-88-3
TOLUYLENE-2,4-DIISOCYANATE	584-84-9
TOLYL CHLORIDE	25168-05-2
TOLYLENE-2,6-DIISOCYANATE	91-08-7
TOLYLENE-2,4-DIISOCYANATE	584-84-9
TOLYLENEDIAMINE	25376-45-8
TONEDRON	51-57-0
TONKA BEAN CAMPHOR	91-64-5
TONOGEN	51-43-4
TOP FLAKE	7647-14-5

CAS No.	Genium MSDS No.	DOT ID No.	OSHA PELs (Subpart Z)				ACGIH TLVs				RCRA Hazardous Waste		CERCLA RQ (Pounds)	SARA 311/312 codes	SARA TPQ (Pounds)	SARA Toxic	CAA	CWA	Carcinogen			Proc. Safety	MA	NJ	CA Prop 65
			TWA		STEL/Ceiling		TWA		STEL/Ceiling																
			ppm	mg/m3	ppm	mg/m3	ppm	mg/m3	ppm	mg/m3	No.	Code							IARC	NTP	OSHA				
117-39-5																									
117-51-1																									
117-52-2		3027																					Y	Y	
117-79-3														12		Y			3	A			Y	Y	Y
117-80-6		2781											1					Y						Y	
117-81-7	414			5		10		5		10	U028	T	100	12		Y	A		2B	A			Y	Y	Y
117-84-0											U107	T	5000	2		Y							Y	Y	
118-52-5	766			0.2		0.4		0.2		0.4				1				Y					Y		
118-74-1		2729									U127	ET	10	12		Y	R	Y	2B	A			Y	Y	Y
118-83-2		2307																						Y	
118-92-3																									
TNT 118-96-7		209		0.5				0.5									R						Y	Y	
119-34-6																		Y	3				Y		
119-36-8	722																								
119-38-0		2992													500								Y	Y	
119-42-6																							Y		
119-64-2																									
119-90-4											U091	T	100	12		Y	A			A			Y		Y
119-93-7	819										U095	T	10			Y	A		2B	A			Y	Y	Y
119-94-8		2753																						Y	
120-12-7													5000	1		Y			3					Y	
120-22-9																									
120-36-5																									
120-58-1											U141	T	100	2		Y			3				Y	Y	Y
120-62-7																							Y		
120-71-8														12		Y			2B	A			Y	Y	Y
120-80-9			5	23			5	20						1		Y	A		3				Y	Y	
120-82-1	365	2321			C5	C37			C5	C40			100	12		Y	A	Y					Y	Y	
120-83-2											U081	T	100	12		Y		Y						Y	
120-92-3	570	2245																					Y	Y	
120-94-5																							Y		
121-14-2	811	1600									U105	ET	10	12		Y	A						Y	Y	Y
121-17-5		2307																						Y	
121-21-1		9184											1											Y	
121-29-9		9184											1											Y	
121-43-7		2416																					Y	Y	

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Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 45

ZINC OXIDE
(Revision A)
Issued: December 1978
Revised: February 1986

SECTION 1. MATERIAL IDENTIFICATION 19

MATERIAL NAME: ZINC OXIDE

DESCRIPTION: Fine metal oxide used as a pigment, filler, or reinforcing agent. An aerosol fume is formed when zinc metal is volatilized.

OTHER DESIGNATIONS: Flowers of Zinc, Zinc White, Chinese White, ZnO, CAS #1314-13-2

SUPPLIERS: Available from several suppliers, including:
Madison Industries, Inc., Old Waterworks Road, Old Bridge, NJ 08857; Telephone (201) 727-2225

HMIS
H: 0
F: 0
R: 0
PPE: *
* See Sect. 8

Not Found

R 0
I 2
S 1
K -

SECTION 2. INGREDIENTS AND HAZARDS

	%	HAZARD DATA
ZINC OXIDE, ZnO Purity level may vary with grade. Typical impurities include lead and/or cadmium (normally <0.1%). Consult supplier's specification for impurity levels.	>99	See Note for TLV and PEL information Rat, Inhalation, LCLo: 400 mg/m^3

NOTE: Current (1985-86) ACGIH TLV and OSHA PEL:

	TLV	PEL
DUST:	10 mg/m^3 (Total Dust)	None Established
FUME:	5 mg/m^3	5 mg/m^3

NIOSH recommends (1975 criteria document) a 10-hr TWA of 5 mg/m^3 with a 15 mg/m^3 ceiling limit for dust and fumes.

SECTION 3. PHYSICAL DATA

Melting Point ... ca 3587°F (1975°C) (Sublimes)
Specific Gravity ... 5.68
Solubility in Water @ 29°C ... 0.00016 gm/100cc
Vapor Pressure at 20°C ... Not Applicable
Molecular Weight ... 81.37

Appearance and odor: White or yellowish white powder. No odor.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
Not Applicable	Not Applicable	Not Applicable		

EXTINGUISHING MEDIA: Zinc oxide is noncombustible. Use extinguishing agents that are suitable for dousing the surrounding fire. If practical, wet down powder with water spray to reduce dusting and fume formation.

Fire fighters should wear self-contained breathing apparatus and fully protective gear for protection against dust and/or fumes that may be generated in a fire situation.

SECTION 5. REACTIVITY DATA

Zinc oxide is stable under normal conditions of handling and use. It does not polymerize. It is practically insoluble in water but is soluble in acids and alkalies and absorbs carbon dioxide from moist air.
When heated to elevated temperatures, zinc oxide sublimes to produce toxic fumes. (Also note that zinc metal burns at elevated temperatures in air to produce zinc oxide fume).
Zinc oxide and magnesium react explosively when heated. Mixtures of chlorinated rubber and zinc oxide can explode violently when heated to 419°F (215°C).

No. 45 2/86 ZINC OXIDE (Rev. A)

SECTION 6. HEALTH HAZARD INFORMATION TLV

Zinc oxide dust is considered to be of low toxicity and is classified by the ACGIH as a nuisance particulate. However, inhalation of zinc oxide fume causes a condition known as "zinc fume fever" (ZFF). ZFF is characterized by flulike symptoms with "metallic taste," coughing, weakness, fatigue, muscular pain, and nausea, followed by fever and chills. Onset of symptoms occurs about 4 to 12 hours after exposure. A tolerance to zinc oxide fume may be acquired but is lost within a day or two after exposure ceases. Zinc oxide fume has also been reported to cause gastrointestinal disturbances. Although zinc oxide is not known to be a skin irritant, under poor personal hygienic conditions contact with zinc oxide has been reported to cause dermatitis ("oxide pox").

Zinc oxide has not been identified as a known or suspected carcinogen by the IARC, NTP, or OSHA.

FIRST AID: EYE CONTACT: Flush well with running water to remove particles. Get medical attention if irritation persists.* SKIN CONTACT: Wash contaminated area thoroughly with mild soap and water. Seek medical attention if irritation persists.* INHALATION: Remove victim from exposure. Provide bed rest and aspirin. Contact physician. (Recovery is generally complete in 24 to 48 hours.) INGESTION: Give victim a large quantity of water to drink. Contact physician or poison control center for instructions.

*GET MEDICAL ATTENTION = In plant, paramedic, community.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Collect spilled material in a way that will minimize excessive generation of dust such as vacuuming (with absolute filter) or wet sweeping. If dusting occurs, cleanup personnel should wear appropriate respiratory protective equipment.

DISPOSAL: Reclaim material when possible. Unsalvageable waste may be buried in an approved sanitary landfill. Follow Federal, state, and local regulations.

Zinc oxide is not listed as a hazardous waste in 40 CFR 261.33. It has not been assigned a reportable spill quantity in 40 CFR 117.3.

SECTION 8. SPECIAL PROTECTION INFORMATION

Use general and/or local exhaust ventilation to maintain dust and fume levels below the TLV and PEL. Where concentrations exceed these limits, workers should wear NIOSH-approved respirators with protection factors suitable for the exposure concentration. High-efficiency particulate (dust/fume) filter respirators are suitable for ZnO fume exposures up to 50 mg/m^3 (250 mg/m^3 with full facepiece). Respirator usage must be in accordance with OSHA requirements (29 CFR 1910.134). Wear dustproof safety goggles where the possibility of eye contact exists. Gloves should be worn if prolonged or repeated contact is likely. Wear protective clothing (apron, coveralls, etc.) as required by the work situation to prevent gross contamination of skin and clothing.

Eyewash stations and washing facilities should be readily accessible to workers handling this material. Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a dry location. Protect containers from physical damage. Use with adequate ventilation. Maintain good housekeeping procedures to prevent accumulation of dust (avoid generating dust during cleaning).
Follow good personal hygiene practice. Wash thoroughly after handling. Launder contaminated clothing before reuse.
Individuals with preexisting pulmonary disease may be more susceptible to the effects of zinc oxide fume.
Avoid dust and fume inhalation.
Welding galvanized metal will generate zinc oxide fumes.

DOT Classification: Not listed in DOT Hazardous Material Tables (49 CFR 172.101 and 172.102).

Data Source(s) Code: 2, 4, 5, 12, 14, 19, 20, 25, 27, 49, 55, 61, 62, 82. CV

Approvals JO Accrocco, 6/86
Indust. Hygiene/Safety DJW 6/86
Medical Review July 86

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Material Safety Data Sheets Collection:

Sheet No. 7
Nitric Acid

Issued: 10/88 **Revision: D, 9/92**

Section 1. Material Identification

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Nitric Acid (HNO_3) Description: A solution of nitrogen dioxide in water commercially available in many concentrations. Derived by oxidation of ammonia by catalytic process (heated platinum catalyst); or by direct synthesis, combining atmospheric nitrogen and oxygen in an electric arc (an expensive process, thus largely abandoned). HNO_3 is usually found in conjunction with nitrogen dioxide, which is considered more hazardous. Used in fertilizer production (ammonium nitrate), in photoengraving, steel etching, explosives (TNT, nitroglycerin, trinitrophenol); manufacture of metallic nitrates, sulfuric acid, aqua regia and oxalic acid, jewelry, various dyes and dyestuffs, pharmaceuticals; as a laboratory reagent, in metallurgy (*mainly* as a pickling agent) and the printing industy.
Other Designations: CAS No. 7697-37-2, aqua fortis, aqua regia, azotic acid, engravers nitrate, hydrogen nitrate, red fuming nitric acid (RFNA), white fuming nitric acid (WFNA).
Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for suppliers list.

Cautions: Nitric acid is a corrosive, strong oxidizer that causes irritation or severe burns to the skin, eyes, and respiratory tract. Exposures to high levels of the concentrated acid can be fatal. Increases the flammability of combustibles. Use extreme caution when handling HNO_3.

R	2	HMIS			NFPA
I	4	H	3*	*Fuming* nitric acid	0 3 1 OX
S	4	F	0		
K	0	R	1		
		PPE**			
R	2	HMIS			
I	4	H	3*	> *40%* nitric acid	0 3 0 OX
S	4	F	0		
K	0	R	1		
		PPE**			
R	2	HMIS			
I	3	H	3*	≤ *40%* nitric acid	0 3 0 –
S	3	F	0		
K	0	R	0		
		PPE**			

* Chronic effects ** See Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Nitric acid, various %. Commercially available in nearly all concentrations; most common are 56 and 68%. RFNA (85%), WFNA (97.5%).

1991 OSHA PELs
8-hr TWA: 2 ppm (5 mg/m^3)
15-min STEL: 4 ppm (10 mg/m^3)

1990 IDLH Level
100 ppm

1990 NIOSH REL
8-hr TWA: 2 ppm (5 mg/m^3)
15-min STEL: 4 ppm (10 mg/m^3)

1992-93 ACGIH TLVs
TWA: 2 ppm (5.2 mg/m^3)
STEL: 4 ppm (10 mg/m^3)

1990 DFG (Germany) MAK
2 ppm (5 mg/m^3)
Category I: local irritants
Peak Exposure Limit: 2 ppm
5 min momentary value, 8 per shift

1985-86 Toxicity Data*
Man, unreported route, LD_{Lo}: 110 mg/kg; toxic effects not yet reviewed
Rat, oral, TD_{Lo}: 5275 g/kg administered from 1 to 21 days of pregnancy caused post-implantation mortality and specific developmental abnormalities of the musculoskeletal system.
Rat, inhalation, LC_{50}: 67 ppm (NO_2)/4 hr; toxic effects not yet reviewed

* See NIOSH, *RTECS* [QU5775000 (nitric acid), QU5900000 (RFNA), QU6000000 (WFNA)], for additional reproductive and toxicity data.

Section 3. Physical Data

Boiling Point: 186.8 °F (86 °C)
Melting Point: -43.6 °F (-42 °C)
Vapor Pressure: 67% HNO_3 = 6.8 mm Hg at 68 °F (20 °C); 95 to 98% = 113 at 100.4 °F (38 °C)
Saturated Vapor Density (Air = 1.2 kg/m^3): 1.212 kg/m^3 or 0.0757 lb/ft^3 (67 % HNO_3)
pH: 1
Molecular Weight: 63.02
Density: 1.50269 at 77/39.2 °F (25/4 °C)
Water Solubility: Soluble (releases heat)
Ionization Potential: 11.95 eV

Appearance and Odor: Transparent, clear to yellow, fuming liquid with an acrid, suffocating odor which darkens to a brownish color on aging and exposure to light. "Fuming" nitric acid is red-brown in color.

Section 4. Fire and Explosion Data

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

Extinguishing Media: For small fires (< 40% HNO_3), use dry chemical, carbon dioxide (CO_2), water spray, or regular foam. For large fires, use water spray, fog, or regular foam. For small fires (> 40% HNO_3), use water spray, dry chemical, or soda ash. For large fires, flood area with water (*do not* get inside HNO_3 containers). Apply water from as far a distance as possible.
Unusual Fire or Explosion Hazards: HNO_3 is noncombustible but is an oxidizer which increases fire involving combustibles and can initiate an explosion. It releases flammable hydrogen gas in contact with many metals.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighters' protective clothing is not effective for fires involving nitric acid. Acid-resistant clothing is needed. Apply cooling water to sides of containers until well after fire is out. Stay away from ends of tanks. For massive fire in cargo area, use monitor nozzles or unmanned hose holders; if impossible, withdraw from area and let fire burn. *Do not* release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Nitric acid decomposes in air and in contact with light and organic matter. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Nitric acid reacts explosively with combustibles, organics or readily oxidizable materials such as wood, turpentine, metal powder and hydrogen sulfide, carbides, cyanides, and alkalies; causes spattering with strong bases; is corrosive to paper, cloth and most metals (except aluminum, gold, platinum, thorium, and tantalum. Will also attack some forms of plastics, rubber, and coatings. There are at least 150 chemicals and chemical combinations which are incompatible with nitric acid. HNO_3 reacts with water to produce heat and toxic corrosive fumes. Refer to *Genium* references 126 and 159 for further detail. **Conditions to Avoid:** Avoid exposure to moisture, heat, and incompatibles.
Hazardous Decomposition Products: Thermal oxidative decomposition of HNO_3 produces nitrogen peroxide and toxic, irritating nitrogen oxides.

Section 6. Health Hazards Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list nitric acid as a carcinogen.
Summary of Risks: Nitric acid is very corrosive to the skin, eyes, digestive and respiratory tract or any tissue it comes in contact with. 58 to 68% (nitric acid) vapors are moderately irritating and can't be tolerated at high concentrations. 95% (nitric acid) vapors cause severe irritation at very low levels and the liquid causes 2nd and 3rd degree burns on short contact with skin or eyes. Vapor inhalation may cause pulmonary edema (fluid in lungs) leading to death. HNO_3 vapor or mist can slowly corrode teeth when chronically exposed. **Medical Conditions Aggravated by Long-Term Exposure:** Chronic respiratory diseases. **Target Organs:** Eyes, skin, respiratory tract, teeth.

Continue on next page

No. 7 Nitric Acid 9/92

Section 6 - Health Hazard Data, continued

P[illegible]ry Entry Routes: Inhalation, ingestion, skin and eye contact. **Acute Effects:** Inhalation symptoms may take several hours and include throat and nose irritation, cough, chest pain, difficulty breathing, salivation, giddiness, nausea, muscular weakness, ulceration of nasal mucous membranes, pulmonary edema, and chemical pneumonia. Skin contact is moderately irritating to severely corrosive depending on % of nitric acid. Burns may penetrate deeply causing ulcers. Skin may be stained yellowish brown. Dilute solutions cause irritation and tend to harden the epithelium (outer skin layer) without destroying it. HNO_3 liquid causes yellow discoloration of the eyes and severe burns which may result in permanent damage, i.e., sight loss. Ingestion produces immediate pain and digestive tract burns followed by throat swelling, convulsions, risk of stomach perforation (causing a rigid abdomen) and possible coma. **Chronic Effects:** Repeated inhalation of low concentrations may cause chronic bronchitis, tooth erosion, and/or appetite loss. Repeated exposure to $NO_{(x)}$ such as produced by thermal decomposition of HNO_3 is implicated in chronic lung diseases.

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing (*do not force removal if stuck to skin*). Rinse with flooding amounts of water for at least 15 min. Apply a 5% triethanolamine solution to affected area. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute followed by lime milk or milk of magnesia. Do not induce vomiting. *Do not* give sodium bicarbonate or attempt to neutralize the acid.

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

Note to Physicians: Observe for several hours since symptoms such as pulmonary edema may be delayed.

Section 7 - Spill, Leak, and Disposal Procedures

Spill/Leak: Immediately notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Cleanup personnel should wear fully-encapsulating vapor-protective clothing. Use water spray to cool and disperse vapor. Keep combustibles away from spilled material. For small spills, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in dry containers for disposal. For large spill, flush with water to containment area and neutralize with agricultural (slaked) lime, sodium bicarbonate, crushed limestone, soda ash, or lime. Report any release in excess of 1000 lb. Control runoff and dike for disposal. Follow applicable OSHA regulations (29 CFR 1910.120).

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a SARA Toxic Chemical (40 CFR 372.65)

Listed as a SARA Extremely Hazardous Substance (40 CFR 355), TPQ: 1000 lb

Listed as a RCRA Hazardous Waste (40 CFR 261.22): No. D001, Characteristic of corrosivity

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

OSHA Designations

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

Listed as a Process Safety Hazardous Chemical (29 CFR 1910.119), TQ: 500 lb

Section 8 - Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For < 50 ppm, use any supplied-air respirator operated in a continuous-flow mode. For < 100 ppm, use any supplied-air respirator or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear acid-proof gloves, boots, aprons, and gauntlets to prevent skin contact. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103) **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in aluminum, stainless steel, or glass containers on a cement floor in a cool, dry, well-ventilated area away from incompatibles (Sec. 5). Dike around storage tanks with large kirbs or stills to retain the acid in event of leakage. Keep neutralization agents on hand and install a fire hydrant in storage area. (See NFPA Code 43A). **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. **Administrative Controls:** Consider preplacement and periodic medical exams of exposed workers that emphasize the eyes, skin, respiratory tract and teeth. Pulmonary function tests (FEV< FVC) are helpful. Educate workers about the hazardous properties of nitric acid.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: *, †, ‡, §, ¥, ψ, ϕ
DOT Hazard Class: 8

ID No.: UN1826 (*†), UN1796 (‡§), UN2031 (¥ψ), UN2032 (ϕ)
DOT Packing Group: I (†§¥ϕ), II (*‡ψ)

DOT Packaging Label: Corrosive (*‡¥ψ), Corrosive, Oxidizer (†§), Corrosive, Oxidizer, Poison (ϕ)
Special Provisions (172.102): B2, T12, T27 (*); T12, T27 (†); B2, T12, T27 (‡); T12, T27 (§); B12, B53, T9, T27 (¥); B2, B12, B53, T9, T27(ψ); 2, B9, B32, B74, T38, T43, T45(ϕ)

* Nitrating acid mixtures spent, < 50% HNO_3
† Nitrating acid mixtures spent, > 50% HNO_3
‡ Nitrating acid mixtures, < 50% HNO_3
§ Nitrating acid mixtures, > 50% HNO_3
¥ Nitric acid other than red fuming, > 70% HNO_3
ψ Nitric acid other than red fuming, < 70% HNO_3
ϕ Nitric acid, red fuming.

Packaging Authorizations
a) **Exceptions:** None
b) **Non-bulk Packaging:** 173.158 (*†‡§¥ψ), 173.227 (ϕ)
c) **Bulk Packaging:** 173.242 (*‡ψ), 173.243 (†§¥), 173.244(ϕ)

Quantity limitations
a) **Passenger Aircraft or Railcar:** Forbidden
b) **Cargo Aircraft Only:** 30L (*‡ψ), 2.5L (†§¥), Forbidden (ϕ)

Vessel Stowage Requirements
a) **Vessel stowage:** D
b) **Other:** 40(*); 40, 66, 89 (†); 40 (‡); 40, 66, 89 (§); 110, 111 (¥); 110, 111 (ψ); 40, 66, 74, 89, 90, 95 (ϕ)

***MSDS Collection* References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 136, 139, 140, 148, 149, 153, 159, 162, 163, 164, 167, 168, 171, 174, 175

Prepared by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** W Silverman, MD

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Material Safety Data Sheets Collection:

Sheet No. 9
Sulfuric Acid, Concentrated

Issued: 10/77 Revision: D, 9/92

Section 1. Material Identification 39

Sulfuric Acid Concentrated (H_2SO_4) Description: Prepared by the "Cat-Ox" process; by the contact process (vanadium pentoxide catalyst) with sulfur, pyrite (FeS_2), hydrogen sulfide, or sulfur-containing smelter gases; and from gypsum (calcium sulfate). Sulfuric acid is by far the most widely used industrial chemical. Its uses include: in the manufacture of fertilizers, chemicals, nitrate explosives, parchment paper, glue, dyes and pigments; as an etchant, a lab reagent, an electrolyte in lead/acid batteries, a dehydrating agent in the manufacture of ethers and esters, and an alkylation catalyst; in the purification of petroleum, the refining of mineral and vegetable oils, the leather industry, the carbonization of wool fabrics, the recuperation of fatty acids from soapworks waste water, the production of rayon and film, the extraction of uranium from pitchblende, and pickling of metal; in electroplating baths, gas drying and nonferrous metallurgy; and to obtain glucose by the hydrolysis of cellulose.

Other Designations: CAS No. 7664-93-9, battery acid, BOV, Caswell No 815, dipping acid, electrolyte acid, hydrogen sulfate, matting acid, oil of vitriol, sulphuric acid, vitriol brown oil.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Handle concentrated sulfuric acid with extreme caution because it is corrosive to all body tissues. Vapor inhalation can cause severe lung damage. Skin or eye contact can produce severe burns; blindness may result.

R 1
I 3
S 4
K 0

NFPA

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

Section 2. Ingredients and Occupational Exposure Limits

Sulfuric acid concentrated, 93-98% sulfuric acid; remainder is water. Impurities include nonvolatiles, 0.02-0.03 ppm; SO_2, 40-80 ppm; iron, 50-100 ppm; nitrate, 5-20 ppm.

1991 OSHA PEL
8-hr TWA: 1 mg/m³

1990 IDLH Level
80 mg/m³

1990 NIOSH REL
TWA: 1 mg/m³

1992-93 ACGIH TLVs
TWA: 1 mg/m³
STEL: 3 mg/m³

1990 DFG (Germany) MAK
TWA: 1 mg/m³
Category: Local irritants
Peak: 2 mg/m³, 5 min, momentary value †, 8 peaks per shift

1985-86 Toxicity Data*
Human, inhalation, TC_{Lo}: 3 mg/m³ for 24 weeks; toxic effects not yet reviewed.
Man, unreported route, LD_{Lo}: 135 mg/kg; toxic effects not yet reviewed.
Rat, oral, LD_{50}: 2140 mg/kg, toxic effects not yet reviewed.
Rabbit, eye: 100 mg rinse produced severe irritation.

* See NIOSH, *RTECS* (WS5600000), for additional toxicity data.
† The momentary value is a level which the concentration should never exceed.

Section 3. Physical Data

Boiling Point: 554 °F (290 °C); decomposes at 644 °F (340 °C) into sulfur trioxide and water.
Melting Point (100%): 50.65 °F (10.36 °C)
Vapor Pressure: <0.001 mm Hg at 20 °C
Saturated Vapor Density (air = 1.2 kg/m³): 1.2 kg/m³, 0.075 lbs/ft³
pH: 1 N sol = 0.3, 0.1 N sol = 1.2, 0.01 N sol = 2.1
Molecular Weight: 98.08
Density/Specific Gravity (96-98%): 1.841
Water Solubility: Soluble; reacts!*
Other Solubilities: Ethyl alcohol
Odor Threshold: 0.150 ppm

Appearance and Odor: Colorless (pure) to dark brown (impure), odorless, dense, oily liquid. Pure compound is a solid below 51 °F (11 °C).

* Sulfuric acid reacts violently with water with the evolution of heat. *Always add the acid to water or other diluent, not the water to acid!*

Section 4. Fire and Explosion Data

Flash Point: Not combustible	**Autoignition Temperature:** None reported	**LEL:** None reported	**UEL:** None reported

Extinguishing Media: Use extinguishing media appropriate to surrounding fire. Only use water if absolutely necessary and use with great caution. Water applied directly to sulfuric acid results in violent heat liberation and splattering of the material. Use water spray only to keep fire-exposed containers cool. **Unusual Fire or Explosion Hazards:** Sulfuric acid, a strong dehydrating agent, reacts with organic materials and produces enough heat ignition, chars wood, and may cause ignition of finely divided materials on contact. Reaction with metals may produce highly flammable, hydrogen gas. **Special Fire-fighting Procedures:** Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing is *not* effective. Stay away from ends of tanks. Do not release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Sulfuric acid is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include acetic acid; acetone cyanohydrin; (acetone + nitric acid); (acetone + potassium dichromate); acetonitrile; acrolein; acrylonitrile; acrylonitrile + water; (alcohol + hydrogen peroxide); allyl alcohol; allyl chloride; ammonium hydroxide; 2-amino ethanol; ammonium; triperchromate; aniline; (bromates + metals); bromine pentafluoride; *n*-butyraldehyde; carbides; cesium acetylene carbide; chlorates; (chlorates + metals); chlorine trifluoride; chlorosulfonic acid; cuprous nitride; diisobutylene; (dimethylbenzylcarbinol + hydrogen peroxide); epichlorohydrin; ethylene cyanohydrin; ethylene diamine; ethylene glycol; ethylene imine; fulminates; hydrochloric acid; hydrogen; iodine heptafluoride; (indene + nitric acid); iron; isoprene; lithium silicide; mercuric nitride; mesityl oxide; powdered metals; (nitric acid + glycerides); *p*-nitrotoluene; pentasilver trihydroxydiaminophosphate; perchlorates; perchloric acid; (permanganates + benzene); (1-phenyl-2-methylpropyl alcohol + hydrogen peroxide); phosphorus; phosphorus isocyanate; picrates; potassium *tert*-butoxide; potassium chlorate; (potassium permanganate + potassium chloride); (potassium permanganate + water); beta-propiolactone; propylene oxide; pyridine; rubidium acetylene carbide; silver permanganate; sodium; sodium carbonate; sodium chlorate; sodium hydroxide; steel; styrene monomer; (toluene + nitric acid); vinyl acetate; and water. **Conditions to Avoid:** Water, combustibles, heat, ignition sources, and other incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative decomposition of sulfuric acid can produce sulfur oxides.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list sulfuric acid as a carcinogen. However, a number of studies have associated exposures to sulfuric acid or to acid mists in general with laryngeal cancer. In 50 confirmed cases there was an approximately four-fold increased risk among highly exposed individuals relative to matched controls. It is not known if sulfuric acid can act as a direct carcinogen, as a promoter, or in combination with other substances.(167) **Summary of Risks:** Concentrated sulfuric acid is a severe respiratory tract, skin, and eye irritant.

Continue on next page

Section 6. Health Hazard Data, *continued*

posure can result in severe burns, tissue damage, scarring, functional inhibition, and blindness if splashed in the eye. Although ingestion is unlikely, it may cause severe injury and death. **Medical Conditions Aggravated by Long-Term Exposure:** Chronic respiratory, gastrointestinal, nervous, skin or eye diseases. **Target Organs:** Respiratory system, eyes, skin, and teeth. **Primary Entry Routes:** Inhalation, skin and eye contact. **Acute Effects:** Vapor or mist inhalation causes coughing, sneezing, nose irritation and nose bleeds, reflex bronchospasm, shortness of breath, pulmonary edema (fluid in lungs), emphysema, and permanent changes in pulmonary function. Ingestion causes corrosion of the mucous membranes of mouth, throat, and esophagus; and epigastric pain with nausea and vomiting of mucoid and "coffee ground" material. Skin contact produces severe burns; initially the zone of contact is bleached and turns brown prior to the formation of a clearly defined ulcer. These wounds are slow in healing and may cause extensive scarring that results in functional inhibition. If burns are extensive, the outcome may prove fatal. Circulatory collapse with clammy skin, weak and rapid pulse, shallow respirations, and scanty urine may follow ingestion or skin contact. Circulatory shock is often the immediate cause of death. Eye contact produces deep corneal ulceration, kerato-conjunctivitis, palpebral lesions, and possible blindness. **Chronic Effects:** Chronic effects may include dental erosion, conjunctivitis, tracheobronchitis, emphysema, stomatitis (inflammation of the mouth mucous membranes), gastritis (inflammation of stomach mucous membranes), and dermatitis. **FIRST AID Eyes:** *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult an ophthalmologist immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Use a 2% sodium bicarbonate solution to further neutralize any H_2SO_4 on the skin. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have that *conscious and alert* person drink 1 to 2 glasses of water or milk to dilute. *Do not* induce vomiting! Do not attempt to neutralize the acid with sodium bicarbonate. **Note to Physicians:** Monitor arterial blood gases, chest x-ray, and pulmonary function tests if respiratory tract irritation or respiratory depression is evident. Treat dermal irritation or burns with standard topical therapy.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of spill, evacuate all unnecessary personnel, remove all ignition sources, and provide adequate ventilation. Cleanup personnel should wear fully-encapsulating, vapor-protective clothing to protect against inhalation and skin or eye contact. Keep water and combustibles away from release. Stop or control leak if this can be done without undue risk. Neutralize small spills with sodium bicarbonate or a mixture of soda ash/slaked lime (50/50) and place into sealed containers for disposal. If a neutralizing agent is not available, absorb spilled sulfuric acid with vermiculite, dry sand, or earth. *Never* use organic material (e.g., sawdust) to absorb spill. For large spills, dike far ahead to contain for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120). Report any release in excess of 1000 lbs. **Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Neutralize waste water pH between 5.5 and 8.5. Follow applicable Federal, state, and local regulations.

Aquatic Toxicity: LC_{50} (saltwater, prawns): 42.5 ppm for 48 hrs; lethal (freshwater, bluegill): 24.5 ppm/24 hr.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.33): Characteristic of corrosivity
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 1000 lb (454 kg) [* per CWA, Sec. 311(b)(4)]
Listed as a SARA Extremely Hazardous Substance (40 CFR 355), TPQ: 1000 lbs.
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

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

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For concentrations < 25 mg/m³ use any powered, air-purifying respirator with acid gas cartridge(s) in combination with a high-efficiency particulate filter. For concentrations < 50 mg/m³, use any chemical cartridge respirator with a full facepiece and acid gas cartridge(s) in combination with a high-efficiency particulate filter. For concentrations < 80 mg/m³, use any supplied air-respirator with a full facepiece and operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. If respirators are used, OSHA requires a respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. H_2SO_4 has a minor to moderate effect on neoprene or rubber.(131) **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103) **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes and launder before reuse. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in clearly labelled, steel containers in a cool [below 50 °F (10 °C)], dry, well-ventilated location on an acid-resistant cement floor and away from direct sunlight, combustibles, and other reactive materials. Separate from carbides, chlorates, fulminates, nitrates, picrates, and powdered metals. Protect storage containers against damage and water. Use non-sparking tools near sulfuric acid carboys, drums, tank cars, or metal storage tanks because of the possible production of hydrogen during storage. Use hand pumps for the decanting and emptying of carboys. **Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. Total enclosures of processes and the mechanization of handling procedures are the most effective measures to prevent contact with sulfuric acid. Protect electrical installations against the corrosive action of acid vapors. **Administrative Controls:** Consider preplacement and periodic physical examinations with emphasis on the respiratory tract (including pulmonary function tests), skin, eyes, and teeth.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Sulfuric acid
DOT Hazard Class: 8
ID No.: UN1830
DOT Packaging Group: II
DOT Label: Corrosive
Special Provisions (172.102): A3, A7, B2, B83, B84, N34, T9, T27

Packaging Authorizations
a) Exceptions: 173.154
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity Limitations
a) Passenger, Aircraft, or Railcar: 1L
b) Cargo Aircraft Only: 30L

Vessel Stowage Requirements
a) Vessel Stowage: C
b) Other: 14

***MSDS Collection* References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 131, 132, 139, 140, 148, 149, 153, 159, 163, 164, 167, 171, 174, 180
Prepared by: MJ Wurth, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MPH

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Material Safety Data Sheets Collection:

Sheet No. 30A
Hydrochloric Acid

Issued: 10/77 Revision: C, 9/92

Section 1. Material Identification 39

Hydrochloric Acid (HCl) Description: An aqueous solution of hydrogen chloride. Derived by dissolving hydrogen chloride gas in water at various concentrations. Hydrochloric acid is also formed as a byproduct from oxychlorination and/or oxyhydrochlorination of organic materials. Used in metal pickling and cleaning (boiler and heat exchange equipment scale removal), ore reduction, processing (corn syrup, hydrolyzing starch), dye and dye intermediate production, electroplating, leather tanning, in fertilizer, artificial silk, and paint pigment production, refining soaps and edible fats and oils, petroleum extraction, toilet bowl cleaners; as an alcohol denaturant, a chemical intermediate and solvent in organic synthesis, and in the photographic, textile, and rubber industries.

Other Designations: CAS No. 7647-01-0, Caswell No. 486, chlorohydric acid, Muriatic acid, spirits of salt.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

Cautions: Hydrochloric acid is highly corrosive and causes serious skin and eye burns as well as acute and chronic respiratory problems.

R	1
I	4
S	4
K	0

NFPA
0
3 0
-

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

Section 2. Ingredients and Occupational Exposure Limits

Hydrochloric acid; ~38% (commercial), 20% ("azeotrope"). Trace impurities include ammonia, arsenic, iron, sulfate, free Cl-, and heavy metals.

1991 OSHA PEL
Ceiling: 5 ppm (7 mg/m^3)

1990 IDLH Level
100 ppm

1990 NIOSH REL
Ceiling: 5 ppm (7 mg/m^3)

1992-93 ACGIH TLV
Ceiling: 5 ppm (7.5 mg/m^3)

1990 DFG (Germany) MAK
Ceiling: 5 ppm (7 mg/m^3)
Category 1: local irritants
Peak Exposure Limit: 10 ppm, 5 min momentary value/8 per shift

1985-86 Toxicity Data*
Human, inhalation, LC_{Lo}: 1300 ppm/30 min; toxic effects not yet reviewed
Rabbit, oral, LD_{50}: 900 mg/kg; toxic effects not yet reviewed
Rat, inhalation, TC_{Lo}: 450 mg/m^3/1 hr (1 day prior to pregnancy) produced fetotoxicity (except death) & specific developmental abnormalities (homeostasis).
Rabbit, eye: 100 mg rinse caused mild irritation.

*See NIOSH, *RTECS* (MW4025000), for additional irritation, reproductive, and toxicity data.

Section 3. Physical Data

Boiling Point: -120.64 °F (-84.8 °C)*
Vapor Pressure: 4 atm at 64 °F (17.8 °C)
Vapor Density (Air = 1): 1.257
Surface Tension: 23 at 244.68 (118.16 °C)
Molecular Weight: 36.46
Odor Threshold: 0.1 to 5 ppm
Ionization Potential: 12.74 eV
Freezing Point: 1.1 °F (-17.14 °C) for 10.81%, -51.16 °F (-46.2 °C) for 31.24%
Density: 1.194 at -14.8 °F (-26 °C)
Water Solubility: Soluble, 823 g/L at 32 °F (0 °C); 561 g/L at 140 °F (60 °C).
Other Solubilities: Soluble in alcohol, benzene, and ether; insoluble in hydrocarbons.
pH: 1N (0.1), 0.1N (1.1), 0.01N (2.02), 0.001N (3.02), 0.0001N (4.01)
Refraction Index (1N solution): 1.34168 at 64.4 °F (18 °C/D)

Appearance and Odor: Colorless liquid that fumes in air and has a strong pungent odor. Can be slightly yellow from traces of iron, chlorine, or organic matter. Forms a constant boiling azeotrope at 20 % HCl, 108.58 °C and 760 mm Hg.

* Decomposes at 3239.6 °F (1782 °C).

Section 4. Fire and Explosion Data

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

Extinguishing Media: Use extinguishing agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: *Extreme heat or contact with many metals liberates hydrogen gas which has explosion limits of 4 to 75%.
Special Fire-fighting Procedures: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing is *ineffective* for fires involving hydrochloric acid. Stay away from ends of tanks. Cool tanks with water spray until well after fire is out. *Do not* release runoff from fire control methods to sewers or waterways.

Section 5. Reactivity Data

Stability/Polymerization: Hydrochloric acid has high thermal stability (decomposes at 3239.6 °F/1782 °C). Hazardous polymerization does not occur unless exposed to aldehydes or epoxides.
Chemical Incompatibilities: Polymerizes on contact with aldehydes or epoxides; attacks most metals (except mercury, silver, gold, platinum, tantalum, and some alloys), some plastics, rubber, and coatings; reacts explosively with alcohols + hydrogen cyanide, potassium permanganate, tetraselenium tetranitride; ignites on contact with fluorine, hexalithium disilicide, metal acetylides or carbides (cesium acetylide, rubidium acetylide); and is incompatible with acetic anhydride, 2-amino ethanol, ammonium hydroxide, calcium phosphide, chlorosulfonic acid, 1,1-difluoroethylene, ethylene diamine, ethylene imine, oleum, perchloric acid, ß-propiolacetone, propylene oxide, sodium hydroxide, silver perchlorate + carbon tetrachloride, sulfuric acid, uranium phosphide, acetate, calcium carbide, magnesium bromide, mercuric sulfate, and chlorine + dinitroaniline.
Conditions to Avoid: Avoid contact with incompatibles.
Hazardous Products of Decomposition: Thermal oxidative decomposition of HCl produces toxic chloride fumes and explosive hydrogen gas.

Section 6. Health Hazard Data

Carcinogenicity: The IARC,(164) NTP,(169) and OSHA(164) do not list HCl as a carcinogen.
Summary of Risks: HCl is a highly corrosive liquid and depending on concentration and duration of exposure, symptoms range from irritation to ulcerations and permanent injury. **Target Organs:** Eyes, skin, respiratory tract, and liver (in animals). **Primary Entry Routes:** Inhalation, skin and eye contact. **Medical Conditions Aggravated by Long-Term Exposure:** Respiratory disorders.

Continue on next page

Section 6. Health Hazard Data, *continued*

Acute Effects: Inhalation of vapors or mists is corrosive to the respiratory tract and can cause tracheal and bronchial epithelium necrosis (tissue death), cough, choking, ulceration. Liquid aspiration can cause pulmonary edema, lung collapse, emphysema and damage to the pulmonary blood vessels. Skin contact with HCl solutions causes burns and ulcerations. Permanent eye damage may result from splashes. Ingestion is unlikely but if it occurs, symptoms include gray tongue color, corrosion of mucous membranes, esophagus, and stomach, nausea, vomiting, intense thirst, diarrhea, difficulty swallowing, circulatory collapse and possible death. **Chronic Effects:** Repeated or prolonged exposure can cause dermatitis, conjunctivitis, gastritis, photosensitization, tooth erosion, and repeated exposure to mists from heated-metal pickling solutions can cause nose and gum bleeds, ulceration of oral or nasal mucosa, and "renders facial skin so tender that shaving is painful."(133)

FIRST AID

Eyes: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately. **Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Treat skin with a 5% triethanolamine solution. For reddened or blistered skin, consult a physician. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have that *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting!

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

Note to Physicians: Consider a chest x-ray in acute overexposure. Gastric lavage with 5% sodium bicarbonate may be helpful.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Neutralize spills with crushed limestone, soda ash, lime, or sodium bicarbonate. After neutralizing, take up small spills with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers for disposal; flush large spills to containment area and reclaim (if possible) or await disposal. Follow applicable OSHA regulations (29 CFR 1910.120). **Environmental Transport:** In soil, HCl will infiltrate moving faster in the presence of moisture. It may dissolve some soil matter, particularly those of a carbonate base will be neutralized to some degree and will be transported to groundwater. **Ecotoxicity Values:** Chronic plant toxicity = 100 ppm; injurious to irrigatable crops at 350 mg/L; trout, LC_{100}, 10 mg/L/24 hr shrimp, LC_{50}, 100 to 330 ppm/starfish, LC_{50}, 100 to 330 mg/L/48 hr; shore crab, LC_{50}, 240 mg/L/48 hr. **Disposal:** Neutralize to between 5.5 & 8.5 before disposal. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.23, *0.01N solution or higher*): No. D002, Characteristic of corrosivity
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 5000 lb (2270 kg) [* per CWA, Sec. 311 (b)(4)]
SARA Extremely Hazardous Substance (40 CFR 355), TPQ: Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

OSHA Designations

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

Section 8. Special Protection Data

Goggles: Wear chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy. **Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. For < 50 ppm, use a cartridge respirator with acid gas cartridges, or any supplied-air respirator (SAR) or SCBA. For < 100 ppm, use any chemical cartridge respirator with a full facepiece and cartridge that protects against HCl inhalation, or any SAR or SCBA with a full facepiece. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas. **Other:** Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Polycarbonate, butyl rubber, polyvinyl chloride, and chlorinated polyethylene are recommended materials for PPE. Polyvinyl alcohol is not recommended. **Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103) **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Prevent physical damage to containers. Store in a cool, dry, well-ventilated area on a cement floor away from direct sunlight and heat sources. Use decanting pumps or pouring frames to minimize spillage during loading and unloading operations.

Engineering Controls: To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control airborne contaminants and to maintain concentrations at the lowest practical level. HCl should be manufactured in closed systems. Pay close attention to leak detection. Aqueous scrubbers are used to control hydrogen chloride emissions from vent stacks and other sources. Workers shouldn't enter tanks previously containing HCl until they have been cleaned.

Administrative Controls: Consider preplacement and periodic medical exams of exposed workers with emphasis on the eyes, skin, and respiratory tract. Pulmonary function tests (FEV, FVC) are useful in determining lung disorders. Conduct difficult operations in fume hoods.

Transportation Data (49 CFR 172.101)

DOT Shipping Name: Hydrochloric acid, solution
DOT Hazard Class: 8
ID No.: UN1789
DOT Label: Corrosive
DOT Packing Group: II
Special provisions (172.102): A3, A6, B2, B15, N41, T9, T27

Packaging Authorizations
a) Exceptions: 173.154
b) Non-bulk Packaging: 173.202
c) Bulk Packaging: 173.242

Quantity limitations
a) Passenger, Aircraft, or Railcar: 1 L
b) Cargo Aircraft Only: 30 L

Vessel Stowage Requirements
a) Vessel Stowage: C
b) Other: 8

***MSDS Collection* References:** 26, 73, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 149, 153, 159, 163, 164, 167, 168, 171, 174, 180
Prepared by: M Gannon, BA; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MPH, MD

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Material Safety Data Sheets Collection:

Sheet No. 420
Acetone Solvent Blend

Issued: 4/79 Revision: A, 9/91

Section 1. Material Identification 35

Acetone Solvent Blend Description: A mixture of acetone and isopropanol. Used as a solvent for fats, oils, waxes, rubber, plastics, varnishes, gums, resins and rubber cements.
Other Designations: Acetone, CAS No. 0067-64-1; isopropyl alcohol, CAS No. 0067-63-0.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

R 1
I 1
S 2
K 3

NFPA
3
1 0
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HMIS
H 1
F 3
R 0
PPG†
† Sec. 8

Cautions: Acetone solvent blend is a skin, eye, and mucous membrane irritant. It may be narcotic in high concentrations.

Section 2. Ingredients and Occupational Exposure Limits

Acetone, >60%
Isopropanol, 10 to 30%

1990 OSHA PELs
Acetone: 8-hr TWA: 750 ppm, 1800 mg/m^3
15-min STEL: 1000 ppm, 2400 mg/m^3
Isopropyl alcohol: 8-hr TWA: 400 ppm, 980 mg/m^3
15-min STEL: 500 ppm, 1225 mg/m^3

1990-91 ACGIH TLVs
Acetone: TWA: 750 ppm, 1,780 mg/m^3
STEL: 1000 ppm, 2400 mg/m^3
Isopropyl alcohol: TWA: 400 ppm, 985 mg/m^3
STEL: 500 ppm, 1,230 mg/m^3

1990 NIOSH RELs
Acetone: TWA: 250 ppm, 590 mg/m^3
Isopropyl alcohol: 400 ppm, 980 mg/m^3

1985-86 Toxicity Data*
Acetone: Man, oral, TD_{Lo}: 2857 mg/kg
Man, inhalation, TD_{Lo}: 440 µg/m^3/6 min
Isopropyl alcohol: Man, oral, LD_{Lo}: 5272 mg/kg
Human, oral, LD_{Lo}: 3570 mg/kg; toxic effects include central nervous system, pulmonary, and gastrointestinal

Calculated TLV for Acetone (70%) Isopropanol (30%) Mixture: 596 ppm

* See NIOSH, *RTECS* (AL3150000, NT8050000) for additional toxicity data on acetone and isopropyl alcohol, respectively.

Section 3. Physical Data

Boiling Point: 133 to 181 °F (56 to 83 °C) at 1 atm
Vapor Pressure: ca 225 mm Hg at 77 °F (25 °C)
Vapor Density (air = 1): ca 2
Density/Specific Gravity (20 °C/20 °C): 0.79
Water Solubility: Completely soluble
%Volatile by Volume: ca 100*
Appearance and Odor: A clear, colorless liquid with an acetone odor.

* Acetone solvent blend is a very volatile liquid that increases fire/explosion risk, especially at elevated temperatures.

Section 4. Fire and Explosion Data

Flash Point: 0 to 53 °F (-17.8 to 11.7 °C), CC	**Autoignition Temperature:** >750 °F (399 °C)*	**LEL:** 2.0% v/v	**UEL:** 12.0% v/v

Extinguishing Media: Alcohol foam, dry chemical, or carbon dioxide (CO_2). Use smothering effect to extinguish fire. Waterspray may be ineffective for extinguishing, but it is useful in cooling fire-exposed containers, in reducing fire intensity, and for diluting and flushing solvent.
Unusual Fire or Explosion Hazards: Acetone solvent blend is an OSHA Class 1B liquid. Fire and explosion hazards exist when this material is exposed to heat or ignition sources. Vapors may travel to an ignition source and flash back.
Special Fire-fighting Procedures: Isolate hazard area and deny entry. Stay upwind. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode, and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

* An estimated value.

Section 5. Reactivity Data

Stability/Polymerization: Acetone solvent blend is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Acetone solvent blend is incompatible with strong oxidizing agents, strong acids, and strong alkalies.
Conditions to Avoid: Avoid heat and ignition sources.
Hazardous Products of Decomposition: Thermal oxidative decomposition of acetone solvent blend can produce carbon monoxide.

No. 420 Acetone Solvent Blend 9/91

Section 6. Health Hazard Data

inogenicity: In 1990 reports, the IARC, NTP, and OSHA do not list acetone solvent blend as a carcinogen.
mary of Risks: Excessive vapor inhalation can cause mucous membrane and respiratory tract irritation. Eye contact can cause severe irritation. Prolonged or repeated skin contact can defat skin. It may be narcotic in high concentrations.
Medical Conditions Aggravated by Long-Term Exposure: None reported.
Target Organs: Skin, eyes, respiratory system, and central nervous system (CNS).
Primary Entry Routes: Inhalation, skin contact.
Acute Effects: Symptoms include respiratory tract irritation, nasal irritation, conjunctiva irritation, cough, headache, fatigue, dizziness, narcosis, and even asphyxiation. Skin contact causes dryness, irritation, and mild dermatitis. Ingestion produces gastrointestinal (GI) tract irritation and nausea. Injury to the kidneys is associated with ingestion of isopropyl alcohol and could potentially occur with significant ingestions of acetone solvent blend. Aspiration of vomitus into the lungs is a hazard and can result in severe illness or even death.
Chronic Effects: None reported.

FIRST AID

Eyes: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
Skin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
Inhalation: Remove exposed person to fresh air and support breathing as needed.
Ingestion: Never give anything by mouth to an unconscious or convulsing person. If a small amount is ingested, have that *conscious and alert* person drink 1 to 2 glasses of water. Consult a physician.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Accidental or intentional ingestion may result in a state of intoxication difficult to distinguish from ethanol ingestion. Serum acetone and alcohol levels may be necessary to diagnose and monitor such a patient's status. In severe intoxication, arterial blood gases and pH, blood electrolytes, liver function studies, a baseline creatinine, blood counts, and urinalysis may be indicated. Watch for deteriorating CNS and respiratory function.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of large spills, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide maximum, explosion-proof ventilation. Cleanup personnel should protect against inhalation and skin or eye contact. For small spills, 1) absorb liquid with a noncombustible, absorbent material, and dispose; or 2) absorb on paper and burn. For large spills, dike far ahead to contain and collect for recycle or disposal. Use nonsparking tools to place waste liquid or absorbent in closable containers for disposal. Keep waste out of sewers, watersheds, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
Environmental Degradation: When released on soil, acetone solvent blend probably both volatilizes and leaches into the ground and probably biodegrades. If released into water, it probably also biodegrades.
Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

EPA Designations

Listed as a RCRA Hazardous Waste (40 CFR 261.21): Ignitable Waste
Acetone is listed as a RCRA Hazardous Waste (40 CFR 261.33)
Acetone is listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Acetone and isopropyl alcohol are listed as SARA Toxic Chemicals (40 CFR 372.65)

OSHA Designations

Acetone and isopropyl alcohol are listed as Air Contaminants (29 CFR 1910.1000, Table Z-1-A)

Section 8. Special Protection Data

Goggles: Wear protective eyeglasses or chemical safety goggles where necessary, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
Respirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
Other: Wear impervious natural rubber gloves, boots, aprons, and gauntlets to prevent skin contact.
Ventilation: Provide general and local explosion-proof exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
Safety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
Contaminated Equipment: Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

Storage Requirements: Store in a clean, cool, well-ventilated area away from heat and ignition sources, oxidizing agents, strong acids, and bases. Protect containers from physical damage. Emptied containers may still be hazardous from residual liquid or vapors. Store and handle as an OSHA Class 1B flammable liquid.
Engineering Controls: Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Make sure all engineering systems are of maximum explosion-proof design. Acetone solvent blend presents a dangerous fire and explosion hazard; perform all work operations involving it carefully and in a way that prevents exposing liquid or its vapor to ignition sources. To prevent static sparks, electrically ground and bond all containers and pipelines used in shipping, transferring, reacting, production, and sampling operations. Consider automatic sprinkler systems for fire protection in work areas.

Transportation Data (49 CFR 172.101, .102): See acetone and isopropyl alcohol (*MSDS Collection*, Nos. 300 and 324)

MSDS Collection **References:** 1, 2, 26, 38, 73, 84-94, 100, 101, 103, 116, 117, 120, 122, 124, 126, 132, 136, 138, 143, 146, 148, 159
Prepared by: M Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD ; **Edited by:** JR Stuart, MS

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FFFFFFFFFF   III    SSSSSS   HH    HH   EEEEEEE   RRRRR
FFFFFFFFFF   III  SS      SS HH    HH   EEEEEEE   RR  RR
FFF          III   SS        HH    HH   EE        RR   RR
FFFFFFFF     III      SS     HHHHHHHH   EEEEEEE   RRRRR
FFFFFFFF     III         SS  HHHHHHHH   EEEEEEE   RRRR
FFF          III         SS  HH    HH   EE        RR RR
FFF          III  SS     SS  HH    HH   EEEEEEE   RR  RR
FFF          III    SSSSS    HH    HH   EEEEEEE   RR   RR

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          MMM MMM  SS        DD   DD   SS
          MM M MM    SSS     DD   DD     SSS
          MM   MM       SS   DD   DD        SS
          MM   MM  SSSSS     DDDDDD      SSSSS
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10/15/88 029308-01

	CAT NBR	DESCRIPTION
1.	SB105	BUFFER PAC PH4 7 10 3X1PT/PK

IMPORTANT SAFETY INFORMATION -- DO NOT DISCARD.

PLEASE ROUTE TO COMPANY SAFETY OFFICER.

IF NAME AND/OR ADDRESS HAVE CHANGED, CONTACT YOUR FISHER SALES REPRESENTATIVE OR YOUR LOCAL FISHER BRANCH.

FISHER SCIENTIFIC HAS A COMPLETE LINE OF SAFETY PRODUCTS AND INFORMATION FOR THE LABORATORY. CONTACT YOUR LOCAL FISHER BRANCH FOR FILMS, BROCHURES, CATALOGS AND PRODUCTS.

THE EARTH TECHNOLOGY CORP
300 N. WASHINGTON ST
ALEXANDRIA   VA 22314

P O NUMBERS

1. 7

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TB '75

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BUFFER SOLUTIONS
BUFFER SOLUTIONS
BUFFER SOLUTIONS

MATERIAL SAFETY DATA SHEET

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CHEMICAL DIVISION
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SUBSTANCE IDENTIFICATION

SUBSTANCE: **BUFFER SOLUTIONS**

TRADE NAMES/SYNONYMS: PH 6.0 (CONC), (SO-B-106); PH 6, (SO-B-104); PH 7 (CONC) (SO-B-109); PH 7, (SO-B-108); PH 7 (YELLOW), (SO-B-107); PH 7.4, (SO-B-110), PH 8, (SO-B-112); PH 6.4-6.5, (SO-B-122); PH 7.2 (0.2M), (SO-P-74); PH 7.2 APHA, (SO-P-341); OHS03513

CERCLA RATINGS (SCALE 0-3): HEALTH=2 FIRE=0 REACTIVITY=0 PERSISTENCE=0

COMPONENTS AND CONTAMINANTS

PERCENT: COMPONENT: SODIUM PHOSPHATE, DIBASIC 7558-79-4
NA2-H-P-O4

PERCENT: COMPONENT: POTASSIUM PHOSPHATE, MONOBASIC 7778-77-0
K-H2-P-O4

PERCENT: COMPONENT: POTASSIUM PHOSPHATE, DIBASIC 7758-79-4
K2-H-P-O4

EXPOSURE LIMITS:
NONE FOR ALL COMPONENTS

PHYSICAL DATA

DESCRIPTION CLEAR, COLORLESS LIQUID (RED, YELLOW OR BLUE FOR COLOR CODED SOLUTIONS) : BOILING POINT. APPROXIMATELY 100 C

MELTING POINT APPROXIMATELY 0 C. VAPOR PRESSURE: 14 MMHG (WATER)

EVAPORATION RATE. (ETHER=1) >1 PH: 6-8 SOLUBILITY IN WATER: SOLUBLE

VAPOR DENSITY: 0.7 (WATER)

2OFL?

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD:
NEGLIGIBLE FIRE AND EXPLOSION HAZARD WHEN EXPOSED TO HEAT OR FLAME.

FIREFIGHTING MEDIA
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR FOAM
(1984 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.3).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR ALCOHOL FOAM
(1984 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.3).

FIREFIGHTING
NO ACUTE HAZARD. MOVE CONTAINER FROM FIRE AREA IF POSSIBLE. AVOID BREATHING VAPORS OR DUSTS, KEEP UPWIND.

TOXICITY

SODIUM PHOSPHATE, DIBASIC: 500 MG/24 HOURS SKIN-RABBIT MILD IRRITATION; 500 MG/24 HOURS EYE-RABBIT MILD IRRITATION; 1000 MG/KG INTRAPERITONEAL-RAT LDLO; 1000 MG/KG SUBCUTANEOUS-RAT LDLO; 1000 MG/KG INTRAMUSCULAR-RAT LDLO; 298 MG/KG INTRAVENOUS-DOG LDLO; 1075 MG/KG INTRAVENOUS RABBIT LDLO;
CARCINOGEN STATUS: NONE FOR ALL COMPONENTS.
THESE BUFFER SOLUTIONS CONTAINING SODIUM PHOSPHATE, DIBASIC, POTASSIUM PHOSPHATE, MONOBASIC AND POTASSIUM PHOSPHATE, DIBASIC ARE SKIN, EYE AND MUCOUS MEMBRANE IRRITANTS.

HEALTH EFFECTS AND FIRST AID

INHALATION:
IRRITANT.

ACUTE EXPOSURE- INHALATION OF VAPORS OF SODIUM PHOSPHATE, DIBASIC, POTASSIUM PHOSPHATE, MONOBASIC AND POTASSIUM PHOSPHATE, DIBASIC MAY CAUSE RESPIRATORY TRACT IRRITATION AND COUGHING.

CHRONIC EXPOSURE- PROLONGED OR REPEATED EXPOSURE TO VAPORS OF SODIUM PHOSPHATE, DIBASIC, POTASSIUM PHOSPHATE, MONOBASIC AND POTASSIUM PHOSPHATE, DIBASIC MAY CAUSE RESPIRATORY TRACT IRRITATION.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. MAINTAIN AIRWAY AND BLOOD PRESSURE AND ADMINISTER OXYGEN IF AVAILABLE. KEEP AFFECTED PERSON WARM AND AT REST. ADMINISTRATION OF OXYGEN SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
IRRITANT.

ACUTE EXPOSURE- CONTACT WITH SODIUM PHOSPHATE, DIBASIC MAY CAUSE STRONG

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IRRITATION, ERYTHEMA, PAIN AND BLISTERS.
CONTACT WITH POTASSIUM PHOSPHATE, MONOBASIC AND POTASSIUM PHOSPHATE, DIBASIC MAY CAUSE LOCAL IRRITATION.

CHRONIC EXPOSURE- PROLONGED OR REPEATED EXPOSURE TO SODIUM PHOSPHATE, DIBASIC, POTASSIUM PHOSPHATE, MONOBASIC AND POTASSIUM PHOSPHATE, DIBASIC MAY CAUSE DERMATITIS.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
IRRITANT.
ACUTE EXPOSURE- DIRECT CONTACT WITH SODIUM PHOSPHATE, DIBASIC MAY CAUSE IRRITATION, PAIN AND CORNEAL INJURY.
DIRECT CONTACT WITH POTASSIUM PHOSPHATE, MONOBASIC AND POTASSIUM PHOSPHATE, DIBASIC MAY CAUSE IRRITATION.

CHRONIC EXPOSURE- PROLONGED OR REPEATED EXPOSURE TO SODIUM PHOSPHATE, DIBASIC, POTASSIUM PHOSPHATE, MONOBASIC AND POTASSIUM PHOSPHATE, DIBASIC MAY CAUSE CONJUNCTIVITIS.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:
IRRITANT.
ACUTE EXPOSURE- INGESTION OF SODIUM PHOSPHATE, DIBASIC MAY CAUSE ABDOMINAL PAIN, NAUSEA, VOMITING, DIARRHEA, SHOCK, HYPOTENSION, SLOW PULSE, CYANOSIS, COMA AND CONVULSIONS.
INGESTION OF POTASSIUM PHOSPHATE, MONOBASIC AND POTASSIUM PHOSPHATE, DIBASIC MAY CAUSE NAUSEA, VOMITING AND DIARRHEA.

CHRONIC EXPOSURE- CHRONIC INTOXICATION BY SODIUM PHOSPHATE, DIBASIC, POTASSIUM PHOSPHATE, MONOBASIC AND POTASSIUM PHOSPHATE, DIBASIC HAS NOT BEEN REPORTED IN HUMANS.

FIRST AID- DILUTE THE ALKALI BY GIVING WATER OR MILK IMMEDIATELY AND ALLOW VOMITING TO OCCUR. EXAMINE VICTIM FOR POSSIBLE CORROSIVE INJURY TO MOUTH AND THROAT AND IRRIGATE AFFECTED AREAS WITH 1% ACETIC ACID UNTIL ALKALI IS COMPLETELY NEUTRALIZED. DO NOT USE GASTRIC LAVAGE OR EMESIS. GET MEDICAL ATTENTION IMMEDIATELY. (DREISBACH, HANDBOOK OF POISONING, 11TH ED.). ADMINISTRATION OF ACETIC ACID SHOULD BE PERFORMED BY QUALIFIED MEDICAL PERSONNEL.

ANTIDOTE:
NO SPECIFIC ANTIDOTE. TREAT SYMPTOMATICALLY AND SUPPORTIVELY.

REACTIVITY

REACTIVITY:
STABLE UNDER NORMAL TEMPERATURES AND PRESSURES.

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INCOMPATIBILITIES:
SODIUM PHOSPHATE, DIBASIC:
MAY BE CORROSIVE TO METALS.

POTASSIUM PHOSPHATE, MONOBASIC AND DIBASIC:
NO KNOWN INCOMPATIBILITIES.

DECOMPOSITION:
THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE TOXIC OXIDES OF PHOSPHORUS AND TOXIC SODIUM OXIDE.

POLYMERIZATION.
NOT KNOWN TO OCCUR.

CONDITIONS TO AVOID

NONE REPORTED.

SPILL AND LEAK PROCEDURES

OCCUPATIONAL SPILL:
NO SPECIAL PRECAUTIONS INDICATED.

PROTECTIVE EQUIPMENT

VENTILATION:
PROVIDE GENERAL DILUTION VENTILATION.

RESPIRATOR.
NONE REQUIRED.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SUBSTANCE.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SUBSTANCE.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF OR DUST-RESISTANT SAFETY GOGGLES AND A FACESHIELD TO PREVENT CONTACT WITH THIS SUBSTANCE.

WHERE THERE IS ANY POSSIBILITY THAT AN EMPLOYEE'S EYES MAY BE EXPOSED TO THIS SUBSTANCE, THE EMPLOYER SHALL PROVIDE AN EYE-WASH FOUNTAIN WITHIN THE IMMEDIATE WORK AREA FOR EMERGENCY USE.

AUTHORIZED - ALLIED FISHER SCIENTIFIC
CREATION DATE: 11/09/85 REVISION DATE: 11/14/85

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BUFFER SOLUTIONS PH 9.0 TO 11.0

BUFFER SOLUTIONS PH 9.0 TO 11.0
BUFFER SOLUTIONS PH 9.0 TO 11.0

MATERIAL SAFETY DATA SHEET

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SUBSTANCE IDENTIFICATION

SUBSTANCE: **BUFFER SOLUTIONS PH 9.0 TO 11.0**

TRADE NAMES/SYNONYMS: PH 9.0, (SO-B-114); PH 9.0 BORATE (CONC), (SO-B-139); PH 10.0 (CONC), (SO-B-141); PH 10.0 BLUE, (SO-B-115); PH 10.0, (SO-B-116); PH 11.0 (CONC), (SO-B-142)

CERCLA RATINGS (SCALE 0-3): HEALTH=U FIRE=U REACTIVITY=U
NFPA RATINGS (SCALE 0-4): HEALTH=U FIRE=U REACTIVITY=U

COMPONENTS AND CONTAMINANTS

PERCENT: >1	COMPONENT: SODIUM CHLORIDE CAS 7647-14-5	NA-CL
PERCENT: >1	COMPONENT: SODIUM TETRABORATE CAS 1303-96-4	
PERCENT >1	COMPONENT: POTASSIUM CHLORIDE CAS 7447-40-7	K-CL
PERCENT >1	COMPONENT: SODIUM GLYCINATE CAS 6000-44-8	

EXPOSURE LIMITS:
NONE ESTABLISHED

PHYSICAL DATA

DESCRIPTION: CLEAR, COLORLESS LIQUID (RED, YELLOW OR BLUE FOR COLOR CODE)

BOILING POINT: APPROX 100 C

MELTING POINT: APPROX 0 C

SPECIFIC GRAVITY: 1-1.13

5w/a
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VAPOR PRESSURE. <4 MMHG (WATER)   EVAPORATION RATE: (ETHER = 1) >1 (TTE)

PH: 9-11   SOLUBILITY IN WATER: MISCIBLE   VAPOR DENSITY: 0.7 (WATER)

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD:
NEGLIGIBLE FIRE AND EXPLOSION HAZARD WHEN EXPOSED TO HEAT OR FLAME.

FLASH POINT WILL NOT BURN

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR FOAM
(1984 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.3).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR ALCOHOL FOAM.
(1984 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.3).

FIREFIGHTING:
NO ACUTE HAZARD. MOVE CONTAINER FROM FIRE AREA IF POSSIBLE. AVOID BREATHING VAPORS OR DUSTS, KEEP UPWIND.

TOXICITY

SODIUM CHLORIDE. 50 MG/24 HOURS SKIN-RABBIT MILD IRRITATION; 100 MG/24 HOURS EYE-RABBIT SEVERE IRRITATION; 3000 MG/KG ORAL-RAT LD50; 4000 MG/KG ORAL-MOUSE LD50, 3500 MG/KG SUBCUTANEOUS-RAT LDLO; REPRODUCTIVE EFFECTS DATA (RTECS); CARCINOGEN STATUS: NONE.
SODIUM BORATE: 1000 MG/KG ORAL-INFANT LDLO; 709 MG/KG ORAL-MAN LDLO; 2660 MG/KG ORAL-RAT LD50; 2000 MG/KG ORAL-MOUSE LD50; MUTAGENIC DATA (RTECS), REPRODUCTIVE EFFECTS DATA (RTECS); CARCINOGEN STATUS: NONE.
POTASSIUM CHLORIDE: 3020 MG/KG ORAL-RAT LD50; 2500 MG/KG ORAL-GUINEA PIG LD50; 500 MG/24 HOURS EYE-RABBIT SEVERE IRRITATION; MUTAGENIC DATA (RTECS); CARCINOGEN STATUS: NONE.
SODIUM GLYCINATE: 564 MG/KG INTRAVENOUS-MOUSE LD50; CARCINOGEN STATUS: NONE.

HEALTH EFFECTS AND FIRST AID

INHALATION
IRRITANT.
  ACUTE EXPOSURE
    SODIUM CHLORIDE: INHALATION OF CRYSTALS OR POWDER MAY PRODUCE IRRITATION AND COUGHING.
    SODIUM BORATE: BORATES ARE IRRITATING TO THE MUCOUS MEMBRANES. ABSORPTION THROUGH THE MUCOUS MEMBRANES MAY RESULT IN TOXIC EFFECTS OF SKIN EXCORITATIONS, FEVER AND ANURIA.
    POTASSIUM CHLORIDE: MAY CAUSE NAUSEA, VOMITING, FEVER, HEADACHE, HYPOTENSION, WEAKNESS AND FATIGUE.
    SODIUM GLYCINATE: NO HUMAN DATA AVAILABLE. ESTIMATED TO BE MODERATELY TOXIC - SEE TOXICOLOTY SECTION.

  CHRONIC ESPOSURE

SODIUM CHLORIDE: MAY CAUSE MUCOUS MEMBRANE IRRITATION.
SODIUM BORATE: PROLONGED ABSORPTION MAY CAUSE ANOREXIA, WEIGHT LOSS, VOMITING, MILD DIARRHEA, SKIN RASH, ALOPECIA, CONVULSIONS AND ANEMIA.
POTASSIUM CHLORIDE: MAY CAUSE MUCOUS MEMBRANE IRRITATION.
SODIUM GLYCINATE: NO HUMAN DATA AVAILABLE. SEE ESTIMATE IN ACUTE EXPOSURE PARAGRAPH.
SEE MUTAGNEIC DATA AND ANIMAL REPRODUCTIVE EFFECTS DATA REFERENCE(S) IN TOXICITY SECTION.

FIRST AID: REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. MAINTAIN AIRWAY AND BLOOD PRESSURE AND ADMINISTER OXYGEN IF AVAILABLE. KEEP AFFECTED PERSON WARM AND AT REST. ADMINISTRATION OF OXYGEN SHOULD BE PERFORMED BY QUALIFIED PERSONNEL. GET MEDICAL ATTENTION IMMEDIATELY.

SKIN CONTACT:
CORROSIVE/SENSITIZER.
ACUTE EXPOSURE- DIRECT CONTACT MAY DISSOLVE THE SKIN, FORMING ULCERS WITH HARD EDGES, WHICH HEAL SLOWLY.

CHRONIC EXPOSURE- REPEATED OR PROLONGED EXPOSURE MAY CAUSE SENSITIZATION DERMATITIS OR SEVERE ECZEMATOUS DERMATITIS WITH EDEMA AND SLOW HEALING ULCERS.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

EYE CONTACT:
IRRITANT.
ACUTE EXPOSURE
SODIUM CHLORIDE: SOLID PARTICLES MAY CAUSE REDNESS, PAIN AND IRRITATION.
SODIUM BORATE: BORATES MAY BE IRRITATING TO THE EYES.
POTASSIUM CHLORIDE: DIRECT CONTACT MAY CAUSE REDNESS AND IRRITATION.
SODIUM GLYCINATE: NO HUMAN DATA AVAILABLE.

CHRONIC EXPOSURE
SODIUM CHLORIDE: MAY CAUSE CONJUNCTIVITIS.
SODIUM BORATE: MAY CAUSE CONJUNCTIVITIS.
POTASSIUM CHLORIDE: MAY CAUSE CONJUNCTIVITIS.
SODIUM GLYCINATE: NO DATA AVAILABLE.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION
NEPHROTOXIN.
ACUTE EXPOSURE
SODIUM CHLORIDE: INGESTION OF LARGE DOSES MAY CAUSE NAUSEA, VOMITING, MUSCULAR TWITCHING, RIGIDITY, CONVULSIONS AND PROSTRATION. IN INFANTS THIS CAN PROGRESS TO COMA, CONVULSIONS AND DEATH. DEHYDRATION AND CONGESTION OCCUR IN MOST INTERNAL ORGANS, PARTICULARLY THE MENINGES AND BRAIN.
SODIUM BORATE: CAUSES NAUSEA, VOMITING, BLOODY DIARRHEA, EPIGASTRIC

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PAIN AND HEMORRHAGIC GASTRITIS FOLLOWED BY WEAKNESS, LETHARGY, HEADACHE, RESTLESSNESS, TREMORS AND TWITCHING OF FACIAL MUSCLES AND EXTREMITIES, INTERMITTENT CONVULSIONS AND CENTRAL NERVOUS SYSTEM DEPRESSION. ERYTHRODERMA WITH DESQAMATION, EXCORIATIONS, BLISTERING, BULLAE AND LESIONS MAY OCCUR. RASHES ARE TYPICALLY LOCATED ON THE PALMS, SOLES OF FEET, BUTTOCKS AND SCROTUM. THE PHARYNX AND TYMPANIC MEMBRANES MAY ALSO BE AFFECTED. POISONING RESULTS IN SHOCK WITH COLD, CLAMMY SKIN, CYANOSIS, HYPOTENSION AND THREADY PULSE, COMA AND DEATH. KIDNEY INJURY IS INDICATED BY OLIGULRIA, ALBUMINURIA OR ANURIA. LIVER DAMAGE IS RARE BUT MAY OCCUR. OTHER SYMPTOMS MAY INCLUDE ACIDOSIS, INTRAVASCULAR COAGULATION AND FEVER. BRONCHOPNEUMONIA, MENINGITIS OR OTHER INFECTIONS MAY BE FATAL.

POTASSIUM CHLORIDE: CAUSES NAUSEA, VOMITING, SORE THROAT, ABDOMINAL PAIN AND DIARRHEA.

SODIUM GLYCINATE: NO HUMAN DATA AVAILABLE.

FIRST AID- IF VICTIM IS CONSCIOUS, GIVE HIM LARGE QUANTITIES OF WATER, TO DILUTE THE ALKALI. DO NOT INDUCE VOMITING.

REACTIVITY

REACTIVITY:
STABLE UNDER NORMAL PRESSURES UP TO THE BOILING POINT, 100 C.

INCOMPATIBILITIES:
SODIUM CHLORIDE:
METALS: MANY METALS ATTACKED BY SODIUM CHLORIDE.
BUILDING MATERIALS: ATTACKED BY SODIUM CHLORIDE.

SODIUM BORATE:
ACIDS: INCOMPATIBLE.

SODIUM GLYCINATE:
NONE KNOWN.

WATER: WATER-REACTIVE MATERIALS, SUCH AS OLEUM, SODIUM METAL.

DECOMPOSITION:
THERMAL DECOMPOSITION PRODUCTS MAY INCLUDE CORROSIVE HYDROCHLORIC ACID AND SODIUM OXIDE WHICH CAN REACT WITH WATER OR STEAM TO PRODUCE HEAT, HYDROGEN AND FLAMMABLE VAPORS. IF HEATED TO DRYNESS, AND RESIDUE IS HEATED FURTHER, MAY YIELD CARBON MONOXIDE AND DIOXIDE GASES, AND LEAVE A CAUSTIC RESIDUE.

POLYMERIZATION:
WILL NOT OCCUR.

* * *

CONDITIONS TO AVOID

AVOID HEATING TO THE BOILING POINT, 100 C. AVOID CONTACT WITH OR STORAGE WITH INCOMPATIBLE MATERIALS, INCLUDING THOSE LISTED IN THE INCOMPATIBLILITIES SECTION.

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SPILL AND LEAK PROCEDURES

OCCUPATIONAL SPILL:
WEAR PERSONAL PROTECTIVE EQUIPMENT. ABSORB SMALL SPILLS WITH VERMICULITE, SCOOP UP, AND PLACE IN SUITABLE E.G., PLASTIC CONTAINER, CLOSE TIGHTLY AND LABEL 'CORROSIVE'. DIKE LARGE SPILLS AS CLOSE TO SPILL AS PRACTICAL TO MINIMIZE ENVIRONMENTAL CONTAMINATION. PUMP INTO SUITABLE CONTAINERS, CLOSE TIGHTLY, AND LABEL 'CORROSIVE'. KEEP OUT OF SEWERS AND WATER SOURCES.

PROTECTIVE EQUIPMENT

VENTILATION:
PROVIDE GENERAL DILUTION VENTILATION.

RESPIRATOR:
ROUTINE LEVELS- USE MIST RESPIRATOR

HIGH LEVELS- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE.

FIREFIGHTING- SELF-CONTAINED BREATHING APPARATUS WITH A FULL FACEPIECE OPERATED IN PRESSURE-DEMAND OR OTHER POSITIVE-PRESSURE MODE.

CLOTHING:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE CLOTHING AND EQUIPMENT TO PREVENT ANY POSSIBILITY OF SKIN CONTACT WITH THIS SOLUTION.

GLOVES:
EMPLOYEE MUST WEAR APPROPRIATE PROTECTIVE GLOVES TO PREVENT CONTACT WITH THIS SOLUTION. PREFERRED MATERIALS: NATURAL, NEOPRENE AND NITRILE RUBBERS, AND PVC PLASTIC.

EYE PROTECTION:
EMPLOYEE MUST WEAR SPLASH-PROOF SAFETY GOGGLES TO PREVENT ANY POSSIBILITY OF CONTACT WITH THIS SOLUTION. DO NOT WEAR CONTACT LENSES WHEN WORKING WITH CHEMICALS.

AUTHORIZED - ALLIED FISHER SCIENTIFIC
CREATION DATE: 09/26/85 REVISION DATE: 10/29/85

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**BUFFER SOLUTIONS (PH 3.00, 4.00, 5.00)

**BUFFER SOLUTIONS (PH 3.00, 4.00, 5.00)
**BUFFER SOLUTIONS (PH 3.00, 4.00, 5.00)

MATERIAL SAFETY DATA SHEET

FISHER SCIENTIFIC
CHEMICAL DIVISION
1 REAGENT LANE
FAIR LAWN NJ 07410
(201) 796-7100

EMERGENCY CONTACTS:
GASTON L. PILLORI
(201) 796-7100

SUBSTANCE IDENTIFICATION

CAS-NUMBER NOT LISTED

SUBSTANCE: **BUFFER SOLUTIONS (PH 3.00, 4.00, 5.00)**

MOLECULAR FORMULA: MIXTURE

CERCLA RATINGS (SCALE 0-3) HEALTH=0 FIRE=0 REACTIVITY=0 PERSISTENCE=0
NFPA RATINGS (SCALE 0-4): HEALTH=0 FIRE=0 REACTIVITY=0

COMPONENTS AND CONTAMINANTS

PERCENT: <0.1	COMPONENT: HYDROCHLORIC ACID CAS# 7647-01-0
PERCENT: >1	COMPONENT: POTASSIUM HYDROGEN PHTHALATE CAS# 877-24-7
PERCENT: 0.04	COMPONENT: FORMALDEHYDE CAS# 50-00-0
PERCENT 0.05	COMPONENT: SODIUM HYDROXIDE CAS# 1310-73-2
PERCENT 99	COMPONENT: WATER

OTHER CONTAMINANTS: NONE

EXPOSURE LIMITS:
NONE THAT AFFECT THE PROPOSED APPLICATION

PHYSICAL DATA

DESCRIPTION: CLEAR COLORLESS LIQUID (MAY BE COLOR CODED ACCORDING TO PH

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AND MAY VARY WITH MANUFACTURER)

BOILING POINT: 212 F (100 C)   MELTING POINT: 32 F (0 C)

SPECIFIC GRAVITY: 1.0   VAPOR PRESSURE: 14 MMHG @ 20 C (H2O)

EVAPORATION RATE: (ETHER=1) >1 (TTE)   PH: 3, 4, OR 5

SOLUBILITY IN WATER: COMPLETE   VAPOR DENSITY: 0.7 (WATER)

FIRE AND EXPLOSION DATA

FIRE AND EXPLOSION HAZARD:
NEGLIGIBLE FIRE AND EXPLOSION HAZARD WHEN EXPOSED TO HEAT OR FLAME.

FLASH POINT: NOT APPLICABLE

FIREFIGHTING MEDIA:
DRY CHEMICAL, CARBON DIOXIDE, WATER SPRAY OR FOAM
(1984 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.3).

FOR LARGER FIRES, USE WATER SPRAY, FOG OR ALCOHOL FOAM
(1984 EMERGENCY RESPONSE GUIDEBOOK, DOT P 5800.3).

FIREFIGHTING:
NO ACUTE HAZARD. MOVE CONTAINER FROM FIRE AREA IF POSSIBLE. AVOID BREATHING VAPORS OR DUSTS; KEEP UPWIND.

TOXICITY

CARCINOGEN STATUS: NONE.
POTASSIUM HYDROGEN PHTHALATE IS AN EYE, SKIN, AND MUCOUS MEMBRANE IRRITANT.

HEALTH EFFECTS AND FIRST AID

INHALATION:

ACUTE EXPOSURE- POTASSIUM HYDROGEN PHTHALATE MAY CAUSE IRRITATION.

CHRONIC EXPOSURE- POTASSIUM HYDROGEN PHTHALATE MAY CAUSE IRRITATION.

FIRST AID- REMOVE FROM EXPOSURE AREA TO FRESH AIR IMMEDIATELY. IF BREATHING HAS STOPPED, GIVE ARTIFICIAL RESPIRATION. KEEP AFFECTED PERSON WARM AND AT REST. GET MEDICAL ATTENTION.

SKIN CONTACT:

ACUTE EXPOSURE- POTASSIUM HYDROGEN PHTHALATE MAY CAUSE SKIN IRRITATION.

CHRONIC EXPOSURE- POTASSIUM HYDROGEN PHTHALATE MAY CAUSE DERMATITIS.

FIRST AID- REMOVE CONTAMINATED CLOTHING AND SHOES IMMEDIATELY. WASH AFFECTED

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AREA WITH SOAP OR MILD DETERGENT AND LARGE AMOUNTS OF WATER UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION.

EYE CONTACT:

ACUTE EXPOSURE- POTASSIUM HYDROGEN PHTHALATE MAY CAUSE IRRITATION REDNESS AND PAIN.

CHRONIC EXPOSURE- POTASSIUM HYDROGEN PHTHALATE MAY CAUSE CONJUNCTIVITIS.

FIRST AID- WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER, OCCASIONALLY LIFTING UPPER AND LOWER LIDS, UNTIL NO EVIDENCE OF CHEMICAL REMAINS (APPROXIMATELY 15-20 MINUTES). GET MEDICAL ATTENTION IMMEDIATELY.

INGESTION:

ACUTE EXPOSURE- POTASSIUM HYDROGEN PHTHALATE MAY CAUSE NAUSEA, VOMITING, AND DIARRHEA.

FIRST AID- IF VICTIM IS CONSCIOUS, IMMEDIATELY GIVE 2 TO 4 GLASSES OF WATER, AND INDUCE VOMITING BY TOUCHING FINGER TO BACK OF THROAT. GET MEDICAL ATTENTION IMMEDIATELY.

REACTIVITY

REACTIVITY:
STABLE UNDER NORMAL PRESSURES UP TO THE BOILING POINT, 100 C.

INCOMPATIBILITIES:
WATER-REACTIVE SUBSTANCES, EXAMPLES FOLLOW: OLEUM, SODIUM.

DECOMPOSITION:
BOILING TO DRYNESS RELEASES A SMALL AMOUNT OF HYDROGEN CHLORIDE GAS AND A TRACE OF FORMALDEHYDE.

POLYMERIZATION:
WILL NOT OCCUR.

****

CONDITIONS TO AVOID

AVOID CONTACT WITH OR STORAGE WITH INCOMPATIBLE MATERIALS, INCLUDING THOSE LISTED IN THE REACTIVITY SECTION.

****

SPILL AND LEAK PROCEDURES

OCCUPATIONAL SPILL:
PROVIDE VENTILATION. ABSORB WITH VERMICULITE OR OTHER SUITABLE MATERIAL. PLACE IN A SUITABLE CONTAINER (PLASTIC OR METAL), FOR LATER DISPOSAL. KEEP OUT OF SEWERS AND WATER SOURCES.

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PROTECTIVE EQUIPMENT

VENTILATION:
PROVIDE GENERAL DILUTION VENTILATION.

RESPIRATOR:
NONE REQUIRED.

CLOTHING:
PROTECTIVE CLOTHING REQUIRED AS NECESSARY TO AVOID REPEATED OR PROLONGED CONTACT WITH THIS SOLUTION.

GLOVES.
PROTECTIVE GLOVES ARE REQUIRED AS NECESSARY TO PREVENT REPEATED OR PROLONGED CONTACT WITH SOLUTION.

EYE PROTECTION:
EMPLOYEE MUST WEAR CHEMICAL SAFETY GOGGLES (PREFERRED MATERIALS: POLYETHYLENE, VITON OR SARANEX) AS NECESSARY TO AVOID ANY POSSIBILITY OF CONTACT WITH SOLUTION. DO NOT WEAR CONTACT LENSES WHEN WORKING WITH CHEMICALS.

AUTHORIZED - ALLIED FISHER SCIENTIFIC
CREATION DATE: 09/19/85 REVISION DATE: 09/24/85

ALCONOX POWDER DETERGENT

Material Safety Data Sheet

Required under USDL Safety and Health Regulations for Shipyard Employment (29 CFR 1915)

U.S. Department of Labor

Occupational Safety and Health Administration

OMB No 1218-0074
Expiration Date 05/31/86

04-322-4

PREPARED 1/2/85

Section I

Manufacturer's Name: ALCONOX, INC.

Emergency Telephone Number: (212) 473-1300

Address (Number, Street, City, State, and ZIP Code):
215 PARK AVENUE SOUTH
NEW YORK, N.Y. 10003

Chemical Name and Synonyms: N.A.

Trade Name and Synonyms: ALCONOX

Chemical Family: ANIONIC DETERGENT

Formula: N.A.

Section II - Hazardous Ingredients

Paints, Preservatives, and Solvents	%	TLV (Units)	Alloys and Metallic Coatings	%	TLV (Units)
Pigments NONE			Base Metal NONE		
Catalyst NONE			Alloys NONE		
Vehicle NONE			Metallic Coatings NONE		
Solvents NONE			Filler Metal Plus Coating or Core Flux NONE		
Additives NONE			Others NONE		
Others NONE					

Hazardous Mixtures of Other Liquids, Solids or Gases	%	TLV (Units)
NONE		

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Section III - Physical Data

Boiling Point (°F)	N.A.	Specific Gravity (H_2O=1)	N.A.
Vapor Pressure (mm Hg)	N.A.	Percent Volatile by Volume (%)	N.A.
Vapor Density (AIR=1)	N.A.	Evaporation Rate (________=1)	N.A.

Solubility in Water: APPRECIABLE

Appearance and Odor: WHITE POWDER INTERSPERSED WITH CREAM COLORED FLAKES - ODORLESS

Section IV - Fire and Explosion Hazard Data

Flash Point (Method Used): NONE	Flammable Limits: N.A.	Lel: N.A.	Uel: N.A.

Extinguishing Media: WATER, CO_2, DRY CHEMICAL, FOAM, SAND/EARTH

Special Fire Fighting Procedures: FOR FIRES INVOLVING THIS MATERIAL, DO NOT ENTER WITHOUT PROTECTIVE EQUIPMENT AND SELF CONTAINED BREATHING APPARATUS

Unusual Fire and Explosion Hazards: NONE

ALCONOX POWDER
04-322-4
04-322-5B, 5C & 5D

Section V - Health Hazard Data

Threshold Limit Value

NO DATA AVAILABLE - TREAT AS NUISANCE DUST

Effects of Overexposure

PROLONGED EXPOSURE TO DUST MAY IRRITATE MUCOUS MEMBRANES

Emergency First Aid Procedures

EYES - FLUSH WITH PLENTY OF WATER FOR 15 MINUTES, SKIN-FLUSH WITH PLENTY OF WATER. INGESTION - DRINK LARGE QUANTITIES OF WATER TO DILUTE MATERIAL. GET MEDICAL ATTENTION FOR DISCOMFORT.

Section VI - Reactivity Data

Stability	Unstable		Conditions to Avoid NONE
	Stable X		

Incompatability (Materials to Avoid) AVOID STRONG ACIDS

Hazardous Decomposition Products MAY RELEASE CO_2 GAS ON BURNING

Hazardous Polymerization	May Occur		Conditions to Avoid NONE
	Will Not Occur X		

Section VII - Spill or Leak Procedures

Steps to be Taken in Case Material is Released or Spilled MATERIAL FOAMS PROFUSELY, SHOVEL AND RECOVER MUCH AS POSSIBLE. RINSE REMAINDER TO SEWER. MATERIAL IS COMPLETELY BIODEGRADABLE.

Waste Disposal Method SMALL QUANTITIES MAY BE DISPOSED OF IN SEWER. LARGE QUANTITIES SHOULD BE DISPOSED OF ACCORDING TO LOCAL REQUIREMENTS FOR NON-HAZARDOUS DETERGENT

Section VIII - Special Protection Information

Respiratory Protection (Specify Type) DUST MASK

Ventilation	Local Exhaust NORMAL	Special N.A.
	Mechanical (General) N.A.	Other N.A.

Protective Gloves USEFUL - NOT REQUIRED	Eye Protection USEFUL - NOT REQUIRED

Other Protective Equipment

NOT REQUIRED

Section IX - Special Precautions

Precautions to be Taken in Handling and Storing

SHOULD BE STORED IN A DRY AREA TO PREVENT CAKING

Other Precautions

NO SPECIAL REQUIREMENTS OTHER THAN THE GOOD INDUSTRIAL HYGIENE AND SAFETY PRACTICES EMPLOYED WITH ANY INDUSTRIAL CHEMICAL.

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U.S. DEPARTMENT OF LABOR
Occupational Safety and Health Administration

MATERIAL SAFETY DATA SHEET

Form Approved
OMB No. 44-R1387

13-382-10D
13-382-10E
13-382-10F

Required under USDL Safety and Health Regulations for Ship Repairing, Shipbuilding, and Shipbreaking (29 CFR 1915, 1916, 1917)

MARKING PEN

SECTION I

MANUFACTURER'S NAME Berol USA, Division of Berol Corporation	EMERGENCY TELEPHONE NO. (203) 744-0000
ADDRESS (Number, Street, City, State, and ZIP Code) Eagle Road, Danbury, CT 06810	
CHEMICAL NAME AND SYNONYMS Xylene based marker ink	TRADE NAME AND SYNONYMS Berol© LIQUID TIP 1100/6100 Series
CHEMICAL FAMILY Aromatic hydrocarbon	FORMULA Proprietary

SECTION II - HAZARDOUS INGREDIENTS

PAINTS, PRESERVATIVES, & SOLVENTS	%	TLV (Units)	ALLOYS AND METALLIC COATINGS	%	TLV (Units)
PIGMENTS Oil soluble dyestuffs	10		BASE METAL		
CATALYST			ALLOYS		
VEHICLE			METALLIC COATINGS		
SOLVENTS Xylene CAS #1330-20-7	85		FILLER METAL PLUS COATING OR CORE FLUX		
ADDITIVES			OTHERS		
OTHERS Phenolic resin	5				

HAZARDOUS MIXTURES OF OTHER LIQUIDS, SOLIDS, OR GASES	%	TLV (Units)

SECTION III - PHYSICAL DATA

BOILING POINT (°F.) Xylene	281-284°	SPECIFIC GRAVITY (H_2O=1)	0.880
VAPOR PRESSURE (mm Hg.) 68°F (20°C)	6	PERCENT, VOLATILE BY VOLUME (%)	85
VAPOR DENSITY (AIR=1)	3.7	EVAPORATION RATE (Butyl Acetate =1)	0.59
SOLUBILITY IN WATER	Negligible		
APPEARANCE AND ODOR	Aluminum barrel; nylon cap, wool felt nib. Ink has aromatic odor.		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (Method used) Tag closed cup 80°F	FLAMMABLE LIMITS	Lel 1.0	Uel 7.0

EXTINGUISHING MEDIA
Exclude air - use foam, CO_2 dry chemicals.

SPECIAL FIRE FIGHTING PROCEDURES
Do not use water, exclude air.

UNUSUAL FIRE AND EXPLOSION HAZARDS
Vapor forms explosive mixture with air between upper & lower explosion limits.

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(Continued on reverse side)

Form OSHA-20
Rev. May 72

1166 F - BROWN
1168 F - BLUE
1169 F - RED
1170 F - YELLOW
1171 F - GREEN
1172 F - PURPLE
1173 F - BLACK
1174 F - ORANGE
6166 F - BROWN
6168 F - BLUE
6169 F - RED
6170 F - YELLOW
6171 F - GREEN
6172 F - PURPLE
6173 F - BLACK
6174 F - ORANGE

SECTION V - HEALTH HAZARD DATA

THRESHOLD LIMIT VALUE	100 ppm
EFFECTS OF OVEREXPOSURE	Anesthesia; headache, nausea, dizziness, etc.
	Ink is moderately irritating to skin & eyes.
EMERGENCY AND FIRST AID PROCEDURES	Remove victim & restore breathing if required.
	Remove from skin with diluted commercial bleach (1% Sodium Hypochlorite).
	Flush eyes with water.

SECTION VI - REACTIVITY DATA

STABILITY	UNSTABLE		CONDITIONS TO AVOID
	STABLE	X	
INCOMPATABILITY (Materials to avoid)	N/A		
HAZARDOUS DECOMPOSITION PRODUCTS	Carbon monoxide		
HAZARDOUS POLYMERIZATION	MAY OCCUR		CONDITIONS TO AVOID
	WILL NOT OCCUR	X	

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED	Avoid open flame or spark sources.
WASTE DISPOSAL METHOD	Remove cap & allow to evaporate in a well ventilated area.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (Specify type)	N/A		
VENTILATION	LOCAL EXHAUST	SPECIAL	
	MECHANICAL (General)	OTHER	
PROTECTIVE GLOVES		EYE PROTECTION	
OTHER PROTECTIVE EQUIPMENT			

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING	Avoid open flames & spark sources. Avoid excessive heat.
OTHER PRECAUTIONS	Hazardous materials as per 49 CFR 172.101 - Xylene (Xylol)
	Hazard class (49 CFR 172.101) - Flammable liquid

Scott Specialty Gases
ROUTE 611 NORTH, PLUMSTEADVILLE, PA 18949 (215) 766-8861

Electronics Group
2330 HAMILTON BOULEVARD, P.O. BOX 640, SOUTH PLAINFIELD, N.J. 07080 (201) 754-7700

REGIONAL PHONE NUMBERS

PA (215) 766-8861	CA (714) 887-2571	MI (313) 589-2950	TX (713) 644-4820
NJ (201) 754-7700	CA (415) 059-0162	CO (303) 442-4700	MA (617) 245-0707

MATERIAL SAFETY DATA SHEET

SECTION I - MATERIAL IDENTIFICATION

CHEMICAL NAME: Isobutylene in Air

SUPPLIER: Scott Specialty Gases, Inc.

CHEMICAL FORMULA: C_4H_{10}/Air

ADDRESS: 2330 Hamilton Blvd., South Plainfield, NJ 07080

CHEMICAL FAMILY: Alkene in gas mixture

In Case of Emergency, call (908) 754-7700

DATE PREPARED: 4/23/92

OTHER DESIGNATIONS: None

SECTION II - HAZARDOUS INGREDIENTS

COMPONENT	CAS #	CONCENTRATION	EXPOSURE LIMITS (PPM) ACGIH TLV	 OSHA PEL	 OTHER
Isobutylene	115-11-7	100 ppm	None established		
r	25635-88-5	Balance	None established		

SECTION III - PHYSICAL DATA

BOILING POINT (°C): -194.4

SPECIFIC GRAVITY $(H_2O = 1)$ @ 20°C: 0.88

VAPOR PRESSURE @ 20°C: N/A

PERCENT, VOLATILE BY VOLUME (%): 100%

VAPOR DENSITY (AIR = 1): 1.2 kg/m^3

EVAPORATION RATE (___ = 1): N/A

SOLUBILITY IN WATER 20°C: Insoluble

APPEARANCE AND ODOR: Colorless gas with a possible slight olefinic odor.

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT AND METHOD	FLAMMABLE LIMITS	LEL	UEL
Nonflammable	N/A		

EXTINGUISHING MEDIA: Use what is appropriate for surrounding fire

SPECIAL FIRE FIGHTING PROCEDURES: Wear self-contained breathing apparatus and full protective clothing. Use water spray to keep fire exposed cylinders cool.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Compressed air at high pressures will accelerate the burning of flammable materials.

SECTION V - REACTIVITY DATA

STABILITY: Stable under normal storage conditions.

INCOMPATIBILITY (MATERIALS TO AVOID): None

HAZARDOUS DECOMPOSITION PRODUCTS: None

HAZARDOUS POLYMERIZATION: Will not occur.

SECTION IV - HEALTH HAZARD DATA

ROUTES OF ENTRY: Inhalation

EFFECTS OF OVEREXPOSURE: **(ACUTE)**: The concentration of isobutylene in this mixture should not present any symptoms of toxicity. **(CHRONIC)**: None **(MEDICAL CONDITIONS AGGRAVATED BY OVEREXPOSURE)**: None

CARCINOGENICITY - NTP? NO IARC MONOGRAPHS? NO OSHA REGULATED? NO

EMERGENCY AND FIRST AID: **Inhalation** - Immediately remove victim to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen.

SECTION VII - SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN: Evacuate and ventilate area. Remove leaking cylinder to exhaust hood or safe outdoors are if this can be done safely.

WASTE DISPOSAL METHOD: Return cylinders to supplier for proper disposal with any valve outlet plugs or caps cured and valve protection cap in place. Allow gas to discharge at a slow rate to the atmosphere in an unconfined area or exhaust hood.

SECTION VIII - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION (SPECIFY TYPE): Use a self-contained breathing apparatus in case of emergency or non-routine use.

VENTILATION: Provide adequate general and local exhaust ventilation.

OTHER PROTECTIVE EQUIPMENT: Wear safety goggles, rubber gloves, and safety shoes. A safety shower and eyewash station should be readily available.

SECTION IX - SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Store in well ventilated areas only. Keep valve protection cap on cylinders when not in use and secure cylinder when using to protect from falling. Use suitable hand truck to move cylinders.

OTHER PRECAUTIONS: Protect containers from physical damage. Do not deface cylinders or labels. Move cylinder vith adequate hand truck. Cylinder should be refilled by qualified producers of compressed gases. Shipment of a ompressed gas cylinder which has not been filled by the owner or with his written consent is a violation of federal law (49 CFR).

Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 187

SODIUM SULFITE, ANHYDROUS

Issued: June 1986

SECTION 1. MATERIAL IDENTIFICATION 20

MATERIAL NAME: SODIUM SULFITE, ANHYDROUS

DESCRIPTION: Inorganic Salt

OTHER DESIGNATIONS: Sulfurous Acid, Disodium Salt, Na_2SO_3, CAS #7757-83-7

MANUFACTURER/SUPPLIER: Available from several suppliers, including:
Mallinckrodt, PO Box 5439, St. Louis, MO 63147; Telephone: 800-325-7155

HMIS
H: 1
F: 0
R: 1
PPE*
*See sect. 8

Not Found

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	HAZARD DATA
Sodium Sulfite * Decomposition products (see sects. 4 and 5) may contain sulfur dioxide. ACGIH (1985-86) TLV is 2 ppm or 5 mg/m^3.	99	No TLV Established.* Rat, Oral, LD_{50}: >1000 mg/kg

SECTION 3. PHYSICAL DATA

Boiling Point, 1 atm, deg F ... Decomposes
Vapor Pressure, 25°C, mm Hg ... Not Applicable
Vapor Density (Air = 1) ... Not Applicable
Solubility in Water @ 33.4°C, g/100g Solvent ... 28

Specific Gravity, 15.4°C ... 2.63
Melting Point, Decomposes @ ... 302°F (150°C)
Evaporation Rate ... Not Applicable
Volatiles, % ... Low
pH (1% Aqueous Solution) ... 9.6-9.8
Molecular Weight ... 126.04

Appearance and odor: A free-flowing white powder or crystalline solid. Odorless.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits In Air	LOWER	UPPER
Noncombustible	Not Applicable	% by Volume	Not Applicable	Not Applicable

EXTINGUISHING MEDIA: Dry chemical, carbon dioxide, foam, water or water spray. Noncombustible. Use a smothering technique to extinguish fire and any media suitable for extinguishing surrounding fire.
Decomposition of sodium sulfite at 1112°F (600°C) forms sodium sulfate (Na_2SO_4) and sodium sulfide (Na_2S); at 1652°F (900°C) it yields sulfur dioxide (SO_2).
SPECIAL FIRE-FIGHTING PROCEDURES: Fire fighters should use self-contained breathing apparatus and fully protective clothing, particularly when products of decomposition are formed in enclosed areas.

SECTION 5. REACTIVITY DATA

CHEMICAL INCOMPATIBILITIES: Sodium sulfite, anhydrous, is a stable material in weathertight closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.
It is incompatible with oxidizing agents and acids. It will release sulfur dioxide, which is toxic and corrosive, when in contact with mineral acids.
Addition of water may cause an exothermic reaction. Anhydrous sulfite does not oxidize as rapidly as the hydrated sulfite.

Products of thermal-oxidative degradation can include sulfur dioxide.

No. 187 4/86 SODIUM SULFITE

SECTION 6. HEALTH HAZARD INFORMATION

Sodium sulfite is not listed as a carcinogen by the NTP, IARC, or OSHA.

SUMMARY OF RISKS: Based on animal studies, inhalation of sodium sulfite dust or solutions may cause irritation to the mucous membranes of the nose, throat, and upper respiratory tract. Heating this material releases sulfur dioxide (SO_2), which is irritating to the mucous membranes. Repeated or prolonged skin contact may cause irritation. Eye contact may cause irritation. Ingestion may irritate the gastrointestinal tract by the liberation of sulfurous acid; large doses may lead to violent colic, diarrhea, or circulatory and central nervous system disturbances. TARGET ORGANS: Gastrointestinal tract. PRIMARY ENTRY: Inhalation, ingestion. ACUTE EFFECTS: Eye, skin, respiratory, and gastrointestinal irritation. CHRONIC EFFECTS: Unknown

FIRST AID: EYE CONTACT: Flush thoroughly with running water, including under eyelids, for 15 minutes. Get medical help.* SKIN CONTACT: Remove contaminated clothing. Flush affected area with water; wash with soap and water. Get medical help.* INHALATION: Remove victim to fresh air. Restore and/or support breathing as required. Get medical help.* INGESTION: Rinse mouth with water. Give victim 2 to 3 glasses of water to drink to dilute the material. Induce vomiting. Never give anything by mouth to an unconscious or convulsing victim. Get medical help.*

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Seek prompt medical assistance for further treatment, observation, and support after first aid, if indicated.

SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel of spills. Provide adequate ventilation. Remove sources of heat. Cleanup personnel should use protection against inhalation of dust and contact with material. Contain spill and scoop up for recovery or disposal and place into appropriate retaining container. Avoid creating dust. Thoroughly vacuum the area of trace residues or flush trace residues with much water (small amounts of water may cause an exothermic reaction). Do not flush to sewers or open waterways. Avoid contact with acids.

DISPOSAL: Reclaim for salvage or reuse. Neutralization with acid will release sulfur dioxide (SO_2) gas.

SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Wear chemical safety goggles.

GLOVES: Wear rubber gloves (cotton gloves are adequate for dry material), boots, apron, and other protective clothing suitable for use conditions to prevent contact with skin.

RESPIRATOR: Use a NIOSH-approved respirator for emergencies or when concentrations of dust are unknown. Use an appropriate respirator for sulfur dioxide should this gas be released.

VENTILATION: Provide general or local (hood) exhaust ventilation sufficient to minimize employee exposure where use conditions generate airborne dust or decomposition products.

Contact lenses pose a special hazard; soft lenses absorb irritants, and all lenses concentrate them.

SPECIAL CONSIDERATION: Remove soiled clothing and launder it before reuse. Eyewash stations, safety showers, and washing facilities should be accessible in areas of use and handling.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store sodium sulfite, anhydrous, in weathertight containers in a cool, dry, well-ventilated area away from oxidizing agents, acids, and sources of heat. Protect containers from physical damage.

OTHER PRECAUTIONS: Avoid breathing the dust of this material or its contact with skin, eyes, or clothing. Do not ingest it. Wash hands thoroughly after handling this material and before eating. Use good housekeeping techniques and follow good personal hygiene practices. Do not handle sodium sulfite with bare hands. Eating, drinking, and smoking should be prohibited in areas of its use or handling.

Data Source(s) Code: 1-12, 14, 31, 34, 81, 82, 84. CK

Approvals 11/86.

Indust. Hygiene/Safety 9-86

Medical Review Oct 86

MATERIAL SAFETY DATA SHEET

GENIUM PUBLISHING CORPORATION
1145 CATALYN ST., SCHENECTADY, NY 12303 USA (518) 377-8854

From Genium's MSDS Collection, to be used as a reference.

MSDS # 324
ISOPROPYL ALCOHOL
Revision D
Issued: October 1982
Revised: September 1985

SECTION 1. MATERIAL IDENTIFICATION

18

MATERIAL NAME: ISOPROPYL ALCOHOL
OTHER DESIGNATIONS: Isopropanol, 2-Propanol, sec-Propyl Alcohol, Dimethyl Carbinol, Isohol, Petrohol, IPA, C_3H_8O, CAS # 0067 63 0
MANUFACTURER/SUPPLIER: Available from several sources, including:
Allied Corporation
PO Box 2064R
Morristown, NJ 07960 (201) 455-4400 - (800) 631-8050

3
1 0

SECTION 2. INGREDIENTS AND HAZARDS

SECTION 2. INGREDIENTS AND HAZARDS	%	HAZARD DATA
ISOPROPYL ALCOHOL	ca 100	8-hr TWA: 400 ppm or 980 mg/m^3*
		Human, Eye: 20 ppm Primary irritation dose
		Human, Inhalation: 400 ppm: IRR
		Man, Oral LDLo: 8600 mg/kg
		Rat, Oral: 5840 mg/kg

* Current OSHA PEL and ACGIH TLV (1985-86).
The ACGIH STEL is 500 ppm, 1225 mg/m^3.
NIOSH has recommended a 15-minute ceiling of 800 ppm.

NOTE: NTP and IARC list CAS #0067-63-0," isopropyl alcohol manufacture (strong acid process)" as a human carcinogen. We believe this refers to the process and not necessarily the product. Check with your suppliers.

SECTION 3. PHYSICAL DATA

Boiling point, 1 atm	180°F, (82°C)	Specific gravity (H_2O-1)	0.786
Vapor pressure @ 20°C, mmHg	33	Melting point	-127.3°F (-88.5°C)
Vapor density (Air=1)	2.07	% Volatile by volume, 20°C	ca 100
Viscosity, 20°C, cps	2.4	Evaporation rate (CCl_4=1)	2.6
Solubility in water	Completely soluble	Molecular weight	60.11

APPEARANCE & ODOR: Clear, colorless liquid with a slight non-residual alcohol type odor. Threshold odor concentration, 100% recognition by test panel, is 28.2 ppm.

SECTION 4. FIRE AND EXPLOSION DATA

Flash Point and Method	Autoignition Temp.	Flammability Limits in Air	Lower	Upper
53°F (11.7°C) closed cup	750°F (399°C)	% by volume	2.0	12.0

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, alcohol foam. Use water spray to cool fire-exposed tanks/containers. A fine water mist may be used to smother fire or to disperse vapors. Do not use a solid stream of water since the stream will scatter and spread the fire.
Isopropyl alcohol is an OSHA Class IB flammable liquid. It is a dangerous fire hazard and a moderate explosion hazard when exposed to heat, flames or oxidizers. At 20°C, the vapor space (saturated) above isopropyl alcohol contains about 4.3 volume % of vapor. Vapors are heavier than air and may travel a considerable distance to an ignition source and flashback. Firefighters should wear self-contained breathing apparatus and full protective clothing when fighting fires involving this material.

SECTION 5. REACTIVITY DATA

This material is stable in closed containers at room temperature under normal storage and handling conditions. It does not polymerize. Isopropyl alcohol is incompatible with acetaldehyde, chlorine, ethylene oxide, hydrogen-palladium combination, hydrogen peroxide-sulfuric acid combination, potassium tert-butoxide, hypochlorous acid, isocyanates, nitroform, phosgene, oleum, perchloric acid, and strong oxidizing agents. Do not store isopropyl alcohol in aluminum containers.

Thermal-oxidative degradation products can include carbon monoxide.

Revised 9/85
MSDS # 324, Issued 10/82 ISOPROPYL ALCOHOL (Rev. D)

SECTION 6. HEALTH HAZARD INFORMATION

TLV 400 ppm (see Section 2)

At 400 ppm, vapors of isopropanol (IPA) may cause mild irritation of the eyes, nose, and throat. Prolonged exposures above the TLV may cause nausea, headache, and mild narcosis. The liquid is irritating to the eyes and produces intense stinging and burning. If not promptly removed, IPA may cause eye damage. Repeated or prolonged contact with the skin may cause irritation and dermatitis. While toxic skin absorption is unlikely it should be considered in meeting the TLV. Ingestion of IPA will cause burning of the gastrointestinal tract, nausea, vomiting, bleeding, CNS depression, hemolysis, and pulmonary damage. Ingestion of as little as 10 ml may cause serious injury, while ingestion of 100 ml can be fatal. The single lethal dose for an adult is approximately 250 ml. The TLV for this material is set on the basis of eye, nose, and throat irritation. IPA has good warning properties.

FIRST AID: EYE CONTACT: Flush eyes, including under eyelids, with running water for at least 15 minutes. Get medical attention (Inplant, community, paramedic). SKIN CONTACT: Flush exposed area with water while removing contaminated clothing. Get medical attention if irritation persists. INHALATION: Remove victim to fresh air. Restore and/or support breathing as required. Get medical help. INGESTION: Give victim milk or water. Induce vomiting by sticking finger to back of throat. Contact a physician or Poison Control Center. Never give anything by mouth to a person who is unconscious or is having convulsions.

SECTION 7. SPILL, LEAK AND DISPOSAL PROCEDURES

Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Evacuate all personnel from area, except for those involved in clean-up. Remove leaking container to safe place if feasible. Clean-up personnel need protection against liquid contact and vapor inhalation. Absorb small spills with paper towels, evaporate flammable alcohol in exhaust hood and burn dry paper. Contain large spills and collect liquid, if feasible, or absorb with vermiculite or sand. Place waste or absorbent into closed container (using non-sparking tools) for disposal. Water spray can be used to dilute and flush spill if necessary, but do not flush to water course or to sewer or enclosed area.

DISPOSAL: Burn waste liquid in an approved incinerator or dispose of via licensed waste disposal company. Absorbed liquid can be landfilled. Follow Federal, State and Local regulations.

AQUATIC TOXICITY TLm 96: 1000-100 ppm.

SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation (explosion proof) to meet TLV requirements. For emergency or nonroutine exposures where the TLV may be exceeded, use an appropriate NIOSH approved respirator. Fume hoods should have a minimum face velocity of 100 lfm. All electrical service in use or storage areas should have an explosion-proof design. Wear impervious gloves and safety glasses to prevent contact with the skin and eyes. If repeated or prolonged contact with liquid or mist is likely, wear protective clothing including boots, apron, and face-shield or splash goggles. Remove contaminated clothing immediately and do not reuse until it has been properly laundered.

Eye wash stations and safety showers should be available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb and all lenses concentrate irritants.

SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store in closed containers in a cool, dry, well-ventilated area away from oxidizers, heat, sparks, and open flame. Protect containers from physical damage.

Use only with adequate ventilation. Avoid inhalation of vapor and repeated or prolonged contact with the skin.

Remove contaminated clothing immediately. Wash thoroughly after handling.

Ground and bond containers and equipment when transferring or pouring liquid. Use non-sparking tools.

Do not eat or smoke in areas where this material is being used or handled.

DOT CLASSIFICATION: Flammable liquid. DOT I.D. NO.: UN1219

DATA SOURCE(S) CODE (See Glossary) 1-12, 19, 20, 23, 26, 31, 34, 37, 39, 43, 47, 59, 79.R.

APPROVALS	J.O. Accrocco, 11/85
INDUST. HYGIENE/SAFETY	DJW 11-85
MEDICAL REVIEW:	Dec. 85

JOA 5/851M

GENIUM PUBLISHING

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                DOD Hazardous Materials Information System
                              DoD 6050.5-L
                             AS OF May 1993
SC: 6810
IIN: 002002574
anufacturer's CAGE: 1B464
art No. Indicator: A
art Number/Trade Name: POTASSIUM CHLORIDE P-217,P-330
===========================================================================
                          General Information
===========================================================================
tem Name: POTASSIUM CHLORIDE,ACS
anufacturer's Name: FISHER SCIENTIFIC, CHEMICAL DIV.
anufacturer's Street: 1 REAGENT LANE
anufacturer's P. O. Box:
anufacturer's City: FAIR LAWN
anufacturer's State: NJ
anufacturer's Country: US
anufacturer's Zip Code: 07410
anufacturer's Emerg Ph #: 201-796-7100 OR 201-796-7523
anufacturer's Info Ph #: 201-796-7100
Distributor/Vendor # 1:
Distributor/Vendor # 1 Cage:
Distributor/Vendor # 2:
Distributor/Vendor # 2 Cage:
Distributor/Vendor # 3:
Distributor/Vendor # 3 Cage:
Distributor/Vendor # 4:
Distributor/Vendor # 4 Cage:
Safety Data Action Code:
Safety Focal Point: D
Record No. For Safety Entry: 002
Tot Safety Entries This Stk#: 004
Status: SE
Date MSDS Prepared: 03APR89
Safety Data Review Date: 22FEB91
Supply Item Manager: CX
MSDS Preparer's Name:
Preparer's Company:
Preparer's St Or P. O. Box:
Preparer's City:
Preparer's State:
Preparer's Zip Code:
Other MSDS Number:
MSDS Serial Number: BJPCM
Specification Number: O-C-265
Spec Type, Grade, Class:
Hazard Characteristic Code: N1
Unit Of Issue: BT
Unit Of Issue Container Qty: 5 LBS
Type Of Container: BOTTLE
Net Unit Weight: 5.0 LBS
NRC/State License Number:
Net Explosive Weight:
Net Propellant Weight-Ammo:
Coast Guard Ammunition Code:
```

Ingredients/Identity Information

opr ary: NO
gr ient: POTASSIUM CHLORIDE
gr dient Sequence Number: 01
rcent: 100
gredient Action Code:
gr dient Focal Point: D
OSH (RTECS) Number: TS8050000
S Number: 7447-40-7
H PEL: NOT ESTABLISHED
G H TLV: NOT ESTABLISHED
her Recommended Limit: NONE SPECIFIED

Physical/Chemical Characteristics

pearance And Odor: ODORLESS, COLORLESS TO WHITE CRYSTALS/GRANULAR POWDER
T A STRONG SALINE TASTE
iling Point: 2732F,1500C
lting Point: 1418F,770C
p r Pressure (MM Hg/70 F): N/R
p r Density (Air=1): N/R
ecific Gravity: 1.984
composition Temperature: UNKNOWN
a oration Rate And Ref: N/R
lubility In Water: 23.8 % @ 20C
rcent Volatiles By Volume: N/R
s c ity: N/R
I:
dioactivity:
r (Radioactive Matl):
g etism (Milligauss):
rrosion Rate (IPY): UNKNOWN
t-ignition Temperature: N/R

Fire and Explosion Hazard Data

a h Point: NONE
ash Point Method: N/R
wer Explosive Limit: N/R
r Explosive Limit: N/R
t nguishing Media: USE WATER FOG, CARBON DIOXIDE, FOAM, OR DRY CHEMICAL.
R LARGER FIRE, USE WATER SPRAY,FOG OR ALCOHOL FOAM.
ecial Fire Fighting Proc: NO ACUTE HAZARD. MOVE CONTAINER FROM FIRE IF
SIBLE.AVOID BREATHING VAPORS OR DUSTS. KEEP UPWIND.
usual Fire And Expl Hazrds: NEGLIGIBLE FIRE HAZARD WHEN EXPOSED TO HEAT
R FLAME.

Reactivity Data

t bility: YES
o d To Avoid (Stability): HIGH TEMPERATURES AND FLAMES
aterials To Avoid: BROMINE TRIFLUORIDE: MAY REACT VIOLENTLY.SULFURIC ACID
ND TASSIUM PERMANGANATE:POSSIBLE EXPLOSION.
a ardous Decomp Products: TOXIC AND CORROSIVE FUMES OF CHLORIDES
a ardous ~~Poly Occur: NO~~

Revised 6/18/91

Material Safety Data Sheet

for

Portland Cement

Section I-Identity

Manufacturer's name and address: Holnam Inc.
6211 Ann Arbor Road
Dundee, MI 48131

Emergency Telephone Number: 313-529-2411

Chemical Name and Synonyms: Portland Cement (CAS #65997-15-1)

Trade name and synonyms: Hydraulic Cement, Types I, II, and III

Section II-Chemical Data

Chemical family: Calcium Salts

Formula: Portland cement consists of finely ground portland cement clinker mixed with a small amount of calcium sulfate to control set. Portland cement clinker is a sintered material produced by heating to high temperature (greater than 1200 degrees celsius) a mixture of substances such as limestone and shale from the earth's crust. The substances manufactured are essentially hydraulic calcium silicates contained in a crystalline mass, not separable into the individual components.

Substances similar to the following are known to be present in portland cement:

$3CaO.SiO_2$	(CAS # 12168-85-3)
$2CaO.SiO_2$	(CAS # 10034-77-2)
$3CaO.Al_2O_3$	(CAS # 12042-78-3)
$4CaO.Al_2O_3.Fe_2O_3$	(CAS # 12068-35-8)
$CaSO_4.XH_2O$	(CAS # 13397-24-5)

Small amounts of CaO, MgO. K_2SO_4. Na_2SO_4 may also be present.

Section III-Hazardous Ingredients

Ingredients: Portland cements are listed by OSHA in 29 CFR 1910.1000. Table Z-1-A. and require material safety data sheets (FR. January 19. 1989). MSHA (30 CFR 55.5.-1. Ref. 2. ACGIH TLV's for 1973. Appendix E) and ACGIH (TLV's for 1984-5. Appendix D) list portland cements as nuisance dusts. Portland cements are NOT listed by NTP, IARC, or OSHA as carcinogens. However, since portland cement is manufactured from raw materials mined from the earth (limestone, marl, sand, shale, clay, etc.) and process heat is provided by burning fossil fuels, trace, but detectable, amounts of naturally occurring, and possibly harmful, elements may be found during chemical analysis. Under ASTM standards, portland cement may contain .75 percent insoluble residue. A fraction of these residues may be free crystalline silica.

Section IV-Physical Data

Boiling Point: Not applicable, portland cement is a powdered solid.

Vapor Pressure: Not applicable, portland cement is a powdered solid.

Vapor Density: Not applicable, portland cement is a powdered solid.

Solubility in Water: Slight (0.1-1.0%)

Specific Gravity: (H_2O=1) 3.15

Evaporation Rate: Not applicable, portland cement is a powdered solid.

Appearance and Odor: Gray or white powder; no odor.

Melting Point: Not applicable.

Section V-Fire and Explosion Hazard Data

Flash Point: Portland cements are noncombustible and not explosive.

Flammable or Explosive Limits: Not Applicable.

Extinguishing Media: Not applicable.

Special Firefighting Procedures: Not applicable.

Unusual Fire and Explosion Hazards: None.

Lower Explosive Limit: Not applicable.

Upper Explosive Limit: Not applicable.

Section VI-Health Hazard Data

ACGIH Threshold Limit Value (1988-89):	Total dust containing no asbestos and less than 1% silica - 10 mg/m^3
OSHA PEL (Transitional):	Total dust - 50 million particles/ft^3
OSHA PEL (Final):	Total dust - 10 mg/m^3 Respirable Dust - 5 mg/m^3

Effects of Overexposure:

Acute: Wet cement, especially as an ingredient in plastic (unhardened) concrete, mortar or slurries, can dry the skin and cause caustic burns. Direct contact with the eyes can cause irritation. Inhalation can irritate the upper respiratory system.

Chronic: Cement dust can cause inflammation of the lining tissue of the interior of the nose and inflammation of the cornea. Hypersensitive individuals may develop an allergic dermatitis. [Cement may contain trace (less than 0.05%) amounts of chromium salts or compounds including hexavalent chromium, or other metals found to be hazardous or toxic in some chemical forms. These metals are mostly present as trace substitutions within the principal minerals.]

Emergency and First Aid Procedures: Irrigate eyes immediately and repeatedly with water and get prompt medical attention. Wash exposed skin areas with soap and water. Apply sterile dressings. If ingested, consult a physician immediately. Drink water.

Section VII-Reactivity Data

Stability: Product is stable. Keep dry until used.

Incompatibility: Aluminum powder and other alkali and alkaline earth elements will react in wet mortar or concrete, liberating hydrogen gas.

Hazardous Decomposition Products: None

Hazardous Polymerization: Will not occur.

Section VIII-Spill Procedures

Steps to be taken in case material is spilled: Use dry cleanup methods that do not disperse the dust into the air. Avoid breathing the dust. Emergency procedures are not required.

Disposal Method: Small amounts of material can be disposed of as common waste or returned to the container for later use if it is not contaminated. Large volumes may require special handling.

Section IX-Special Protection Information

Respiratory Protection: In dusty environments, the use of a MSHA/NIOSH-approved respirator is recommended.

Ventilation: Local exhaust can be used to control airborne dust levels.

Eye Protection: Use tight fitting goggles in dusty environments.

Skin Protection: Use barrier creams, impervious, abrasion- and alkali-resistant gloves, boots and protective clothing to protect the skin from prolonged contact with wet cement in plastic concrete, mortar or slurries. Immediately after working with cement or cement-containing materials, workers should shower with soap and water. Precautions must be taken. Cement burns with little warning—little heat is sensed.

Section X-Abbreviations

ACGIH	American Conference of Governmental Industrial Hygienists
ASTM	American Society for Testing and Materials
CAS	Chemical Abstract Service
CFR	Code of Federal Regulations
ft^3	Cubic foot
IARC	International Agency for Research on Cancer
m^3	Cubic meter
mg	Milligram
MSHA	Mine Safety and Health Administration
NIOSH	National Institute for Occupational Safety and Health
NTP	National Toxicology Program
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
TLV's	Threshold Limit Values

Note: This material safety data sheet attempts to describe as accurately as possible the potential exposures associated with normal cement use. Health and safety precautions in this data sheet may not be adequate for all individuals and/or situations. Users have the responsibility to evaluate and use this product safely and to comply with all applicable laws and regulations.

SECTION XI - REGULATORY INFORMATION

Federal EPA

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) requires notification of the National Response Center of release of quantities of Hazardous Substances equal to or greater than the reportable quantities (RQs) in 40 CFR 302.4.

Components present in this product at a level which could require reporting under this statute are:

None

Superfund Amendments and Re-Authorization Act of 1986
SARA Title III

Requires emergency planning based on Threshold Planning Quantities (TPQs) and release reporting based on Reportable Quantities (RQs) in 40 CFR 338 (used for SARA 302, 304, 311, and 312).

Components present in this product at a level which could require reporting under this statute are:

None

Superfund Amendments and Re-Authorization Act of 1986
SARA Title III

Requires submission of annual reports of release of toxic chemicals that appear in 40 CFR 372 (for SARA 313). This information must be included in all MSDSs that are copied and distributed for this material.

Components present in this product at a level which could require reporting under this statute are:

None

Material Safety Data Sheet

FINISHED PROFILE, BAR STOCK, DUCT, ANGLE, JOINING STRIP, and PIPE MADE FROM RIGID PVC and CPVC THERMOPLASTIC

SECTION I

Manufacturer's Name Harvel Plastics	**Telephone Number** (215) 252-7355 FAX: (215) 253-4436	**Address** P.O. Box 757, Easton, PA 18042
Chemical Family Ethene, chloro- (homopolymer and chlorinated)	**Formula** Mixture of PVC or CPVC polymer with functional additives.	**Trade Designation**
Chemical Name/Synonyms Polyvinyl chloride, PVC and chlorinated polyvinyl chloride, CPVC.	**NFPA 704**[1] Health: 2 Flammability: 1 Reactivity: 0 Special: None	**HMIS**[2] Health: 0 Flammability: 1 Reactivity: 0

Hazard Code Key: 0 = Insignificant; 1 = Slight; 2 = Moderate 3 = High; 4 = Extreme

[1] National Fire Protection Ass'n. [2] National Paint and Coatings Ass'n.

SECTION II— HAZARDOUS INGREDIENTS

All ingredients are bound-up in the manufacturing process and are not expected to create any hazard in handling or use. Finished goods (e.g., rigid pipe, bar stock, duct, angle, joining strip, or profile) are inert.

SECTION III—PHYSICAL DATA (Typical data, not specifications)

Boiling Point Not applicable (NA)	**Melting Point** NA	**Specific Gravity** (H_2O = 1) 1.35-1.55
Solubility in Water Insoluble	**% Volatile by Weight** NA	**Vapor Density** (Air = 1) NA
Vapor Pressure (mm Hg) NA	**pH** NA	**Particle Size** NA

Appearance and Odor

Rigid pipe, bar stock, duct, angle, joining strip, or profile. No odor.

SECTION IV—FIRE AND EXPLOSION HAZARD DATA

Flashpoint Not applicable to solid products	**Ignition Temperature** PVC: >730°F (>388°C) CPVC: >830°F (>433°C)	**Flammable Limits in Air** (% by volume) Lower: NA Upper: NA

Extinguishing Media

Water. ABC dry chemical. AFFF. Protein type air foams. Carbon Dioxide may be ineffective on larger fires due to a lack of cooling capacity which may result in reignition.

Special Firefighting Procedure

Wear positive pressure self-contained breathing apparatus (SCBA). Personnel not having suitable respiratory protection must leave the area to prevent significant exposure to toxic combustion gases from any source. In enclosed or poorly ventilated areas, wear SCBA during cleanup immediately after a fire as well as during the attack phase of firefighting operations.

Unusual Fire and Explosion Hazards

None known.

SECTION V—HEALTH HAZARD DATA

Threshold Limit Value

None established.

Effects of Overexposure

There are no significant health hazards from vinyl compound at ambient temperature.

Inhalation of decomposition or combustion products, especially hydrogen chloride, will cause irritation of the respiratory tract, eyes and skin. Depending on the severity of exposure, physiological response will be coughing, pain and inflammation. Individuals with bronchial asthma and other types of chronic obstructive respiratory diseases may develop bronchspasm if exposure is prolonged.

Emergency and First Aid Procedure

If irritation persists from exposure to decomposition products, remove the affected individual from the area. Provide protection before reentry.

SECTION VI—REACTIVITY DATA

Stability	**Hazardous Polymerization**
Stable	Will not occur.

Hazardous Decomposition Products

CO, CO_2 hydrogen chloride and small amounts of benzene and aromatic and aliphatic hydrocarbons. CPVC may also contribute small amounts of chloroform and carbon tetrachloride.

Incompatibility (materials to avoid)

See Pages 7-10 for chemical resistance information about Harvel thermoplastic pipe.

Material Safety Data Sheet (continued)

SECTION VII—SPILL OR LEAK PROCEDURE

Steps to be taken in case material is released or spilled. Material is inert. Place into a container for reuse or disposal.

Waste Disposal Method

Dispose of waste in accordance with federal, state and local regulations. For waste disposal purposes these products are not defined or designated as hazardous by current provisions of the Federal Resources Conservation and Recovery Act (RCRA) 40CFR261.

SECTION VIII—SPECIAL PROTECTION INFORMATION

Ventilation

Provide efficient exhaust at all operations capable of creating fumes or vapors. Cutting or sawing, machining, heat welding, thermofolding and other operations involving heat sufficient to result in degradation should be examined to ensure adequate ventilation.

Respiratory Protection

Not normally required.

-If overheating results in decomposition resulting in smoke or fumes, a NIOSH/MSHA approved combination high efficiency particulate filter with organic vapor cartridge can be used. Gross decomposition may require the use of a positive pressure self-contained breathing apparatus.

Protective Equipment

Wear safety glasses.

SECTION IX—SPECIAL PRECAUTIONS

-Certain operations, such as the installation of piping systems, may require the use of solvent cements. The user must obtain and comply with all safety precautions recommended by solvent cement manufacturers. See Pages 61 thru 65 for solvent cementing guidelines. - Avoid continued or prolonged breathing vapors produced by overheating.

SECTION X—TRANSPORTATION

For domestic transportation purposes, these products are not defined or designated as a hazardous material by the U.S. Department of Transportation under Title 49 of the Code of Federal Regulations, 1983 Edition.

- DOT Proper Shipping Name: Not applicable
- DOT Hazard Class: Not hazardous
- DOT Label: None required
- UN/NA Hazard No.: Not applicable

USER'S RESPONSIBILITY

A bulletin such as this cannot be expected to cover all possible individual situations. As the user has the responsibility to provide a safe workplace, all aspects of an individual operation should be examined to determine if, or where, precautions, in addition to those described herein, are required. Any health hazard and safety information contained herein should be passed on to your customers or employees, as the case may be. Harvel Plastics must rely on the user to utilize the information we have supplied to develop work practice guidelines and employee instructional programs for the individual operation.

DISCLAIMER OF LIABILITY

As the conditions or methods of use are beyond our control, we do not assume any responsibility and expressly disclaim any liability for any use of this material. Information contained herein is believed to be true and accurate but all statements or suggestions are made without warranty, expressed or implied, regarding accuracy of the information, the hazards connected with the use of the material or the results to be obtained from the use thereof. Compliance with all applicable federal, state and local laws and regulations remains the responsibility of the user.

ASTM Test Methods

C 177-85 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus, **04.06,08.01,14.01**

D 149-81 Test Methods for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies, **08.01,09.02,10.02**

D 150-81 Test Methods for A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials, **08.01,09.02,10.02,10.03**

D 256-84 Test Methods for Impact Resistance of Plastics and Electrical Insulating Materials, **08.01,09.02**

D 570-81 Test Method for Water Absorption of Plastics, **08.01**

D 635-81 Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position, **08.01**

D 638-84 Test Method for Tensile Properties of Plastics **08.01**

D 648-82 Test Method for Deflection Temperature of Plastics Under Flexural Load, **08.01**

D 695-85 Test Method for Compressive Properties of Rigid Plastics **08.01**

D 696-79 Test Method for Coefficient of Linear Thermal Expansion of Plastics, **08.01,14.01**

D 790-84a Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials, **08.01**

D 791 Discontinued—Replaced by E 308

D 792-66 (1979) Test Methods for Specific Gravity and Density of Plastics by Displacement, **08.01**

D 1784-81 Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds, **08.02,08.04**

D 2240-86 Test Method for Rubber Property—Durometer Hardness, **08.02,09.01**

D 2766-83 Test Method for Specific Heat of Liquids and Solids, **05.02**

D 3915-80 Specification for Poly (Vinyl Chloride) (PVC) and Related Plastics Pipe and Fitting Compounds, **08.03,08.04**

E 84-84 Test Method for Surface Burning Characteristics of Building Materials, **04.07**

E 162-83 Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source, **04.07**

E 308-85 Method for Computing the Colors of Objects [illegible] 14.02

In-Situ Inc.

210 South Third Street
P O Box I
Laramie, Wyoming 82070-0920 USA

307 742-8213 800 446-7488
FAX: 307 742-6225
TWX: 910/949-4944 (INSITU LRME)

PRODUCT SAFETY DATA SUMMARY

Date: January 14, 1991 **Supercedes:** none

Product Name: In-Situ, Inc. Hermit Data Loggers

Product Model: SE1000B, SE1000C, SE2000 Environmental Data Loggers

Hazard Class/Division: UN3091

Product Hazard: Lithium Oxyhalide Primary Battery Pack; pack comprised of 5DD cells

Chemistry System: Lithium/Bromine Chloride in Thionyl Chloride
Chemical Formula: $Li/BrCl$ in $SOCl_2$

I. Toxic, Caustic or Irritant Content

Important Note: The Battery Container(i.e. the Data Logger) should not be opened or incinerated since the following ingredients contained within could be harmful under some circumstances if exposed.

Materials

Li	Lithium is included in this section due to its vigorous reaction with water forming a strong hydroxide.	(CAS # 7439-93-2)
$SOCl_2$	Thionyl Chloride.	(CAS # 7719-09-7)
Br_2	Bromine.	(CAS # 7726-95-6)
Cl_2	Chlorine.	(CAS # 7762-50-5)

In case of accidental ingestion of a cell or its contents, obtain prompt medical advice.

II. Storage and Disposal

Storage: Data logger operating and storage temperature is -40°C to +70°C. Do not subject data logger or internal battery pack to temperatures in excess of 100°C(212°F). Such abuse can result in loss of seal. leakage and/or cell explosion & possible subsequent data logger explosion.

In case of fire in an adjacent area, use water, CO_2, or dry chemical fire extinguishers if battery pack remains in the data logger. In cases where the data logger has been damaged and subsequent damage to the battery pack has occured, or if the data logger is directly involved in flame, use Lith-X(Graphite Base). In this case, use no water, CO_2 or halogen extinguishers. Avoid fume inhalation($LiOH$, $SOCl_2$, SO_2, HCl).

Disposal: In order to maintain data logger integrity and warranty, do not attempt to remove the battery pack. Should removal become necessary, follow the precautions as above and dispose of in accordance with appropriate Federal, State and local regulations.

III. Handling and Use Precautions

Use: Do not use this product for other than its original intended use. This product contains no user-serviceable parts. Do not remove front panel screws for other than emergency access to battery pack. Maintenance and service should only be performed by In-Situ, Inc. or an authorized representative.

Charging: The cells comprising the internal battery pack-are primary cells and are not designed to be charged or recharged. The instrument has no capability to do so. To attempt to do so may cause the cells to leak or explode.

Baroid Environmental, Safety and Transportation Data Sheet

BENSEAL®

I PRODUCT IDENTIFICATION

SUPPLIER Baroid Drilling Fluids, Inc.	**REGULAR TELEPHONE NO.** (713) 987-5900 **EMERGENCY TELEPHONE NO.** (713) 987-4000

ADDRESS
P.O. Box 1675 Houston, Texas 77251

TRADE NAME
BENSEAL®

GENERIC DESCRIPTION
WESTERN BENTONITE, SODIUM MONTMORILLONITE

II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT	%	HAZARD DATA
SILICA 7631-86-9	2-6	Low concentrations of crystalline silica (SiO_2) in the form of Quartz, Cristobalite, and Tridymite may be present. (See Section V)

III PHYSICAL DATA

BOILING POINT (°F) NA	**MELTING POINT** ND	**FREEZING POINT** ND
SPECIFIC GRAVITY (H_2O =1) 2.5	**VAPOR PRESSURE (mm Hg)** NA	
VAPOR DENSITY (AIR = 1) NA	**SOLUBILITY IN H_2O , % BY WT.** NA	
% VOLATILES BY VOL. NA	**EVAPORATION RATE (BUTYL ACETATE = 1)** NA	
APPEARANCE AND ODOR Tan powder, odorless	**Density @ 20° C (Uncompacted):** ND	
pH NA		

NA = Not Applicable ND = Not Determined

BENSEAL®

2	HEALTH HAZARD
0	FLAMMABILITY
0	REACTIVITY

Ratings based on NIOSH "Identification System for Occupationally Hazardous Materials" (1974)

Baroid Drilling Fluids, Inc.
P.O. Box 1675, Houston, Texas 77251

BEST Sheet

IRE AND EXPLOSION DATA

BENSEAL will not support combustion.

No fire or explosion hazard.

EXTINGUISHING MEDIA: Water, Foam, Carbon Dioxide

V HEALTH HAZARD INFORMATION

CARCINOGENICITY – SEE ROUTES OF EXPOSURE AND EFFECTS (BELOW)

ACUTE ORAL LD_{50} ND	ACUTE DERMAL LD_{50} ND	AQUATIC TOXICITY (LC_{50}) 10,000 mg/l

ROUTES OF EXPOSURE AND EFFECTS

This product contains free crystalline silica which according to the IARC has exhibited limited evidence of carcinogenicity in humans. Prolonged inhalation of the powder may result in Silicosis, a noncancerous lung disease.

TLV for Respirable Dust $$\frac{10\ \text{mg/m}^3}{\%\ \text{Respirable Quartz} + 2}$$

TLV for "Total Dust" $$\frac{30\ \text{mg/m}^3}{\%\ \text{Quartz} + 3}$$

If cristobalite or tridymite is detected, use one-half the value calculated from formula for quartz.

SKIN: Potential irritant; prolonged contact may cause irritation.

EYES: Irritant

INHALATION: Irritation to lungs, nose, and throat; prolonged inhalation may cause lung injury or disease.

EMERGENCY AND FIRST AID PROCEDURES

No procedures required beyond normal personal hygiene – wash all contacted areas with soap and water.

BEST Sheet

I REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY

None

INCOMPATIBILITY

None

HAZARDOUS DECOMPOSITION PRODUCTS

None

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION

Will not occur.

VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

Normal housekeeping; causes slippery surfaces when wet.

NEUTRALIZING CHEMICALS

NA

WASTE DISPOSAL METHOD

Dispose of in accordance with all local, state, and federal regulations.

VIII INDUSTRIAL HYGIENE CONTROL MEASURES

VENTILATION REQUIREMENTS

Mechanical, general room ventilation.
Use local ventilation to maintain TLV (see Section V)

SPECIFIC PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY

Use a NIOSH approved mechanical filter respirator for nontoxic dusts, if dust concentration exceeds 10mg/m^3

EYE

Goggles

GLOVES

Work gloves

OTHER CLOTHING AND EQUIPMENT

Apron, eyewash station

BEST Sheet

SPECIAL PRECAUTIONS

PRECAUTIONARY STATEMENTS

Avoid prolonged inhalation.

Recommended Labeling:

Front Panel: CAUTION
See back panel for caution before use.

Back Panel: CAUTION
This product contains free crystalline silica which according to the IARC has exhibited limited evidence of carcinogenicity in humans. Prolonged inhalation of the powder may result in Silicosis, a noncancerous lung disease. Avoid creating dusty conditions and use a NIOSH approved dust respirator.

HER HANDLING AND STORAGE REQUIREMENTS

Store in sheltered area or cover for moisture protection.

DEPARTMENT OF TRANSPORTATION INFORMATION

PROPER SHIPPING NAME: Not Regulated	**PLACARDS:** None
HAZARD CLASS: Not Hazardous	**REPORTABLE QUANTITY:** None
HAZARDOUS SUBSTANCE: None	**ID NUMBER:** None
LABEL: None Required	

Prepared by: Environmental Services DATE September, 1989

Baroid Environmental, Safety and Transportation Data Sheet

AQUA-GROUT CATALYST

I PRODUCT IDENTIFICATION	
SUPPLIER Baroid Drilling Fluids, Inc.	**REGULAR TELEPHONE NO.** (713) 987-5900 **EMERGENCY TELEPHONE NO.** (713) 987-4000
ADDRESS P.O. Box 1675 Houston, Texas 77251	
TRADE NAME AQUA-GROUT™ CATALYST	
GENERIC DESCRIPTION Inorganic admixture	

II HAZARDOUS INGREDIENTS

MATERIAL OR COMPONENT		**%**	**HAZARD DATA**
Silica	7631-86-9	0.5-2	Low concentrations of
			crystalline silica (SiO_2)
			in the form of quartz,
			cristobalite, and tridymite
			may be present.
			(SEE SECTION V)

III PHYSICAL DATA

BOILING POINT (°F) NA	**MELTING POINT** NA	**FREEZING POINT** NA
SPECIFIC GRAVITY (H_2O =1) 0.58	**VAPOR PRESSURE (mm Hg)** NA	
VAPOR DENSITY (AIR = 1) NA	**SOLUBILITY IN H_2O, % BY WT.** 70%	
% VOLATILES BY VOL. NA	**EVAPORATION RATE (BUTYL ACETATE = 1)** NA	
APPEARANCE AND ODOR Tan powder, no odor	**Density @ 20° C:** ND	
pH NA		

NA = Not Applicable ND = Not Determined

AQUA-GROUT™ CATALYST

2	HEALTH HAZARD
0	FLAMMABILITY
0	REACTIVITY

Ratings based on NIOSH "Identification System for Occupationally Hazardous Materials" (1974)

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EST Sheet

IV RE AND EXPLOSION DATA

Flash point: None

Flammability limits: Not applicable

Fire extinguishing media: Use media applicable to the surrounding material

Special firefighting procedures: Wear full protective equipment including self-contained breathing apparatus.

Unusual fire and explosion hazard: Toxic gases may be released when burned.

V HEALTH HAZARD INFORMATION

CARCINOGENICITY-SEE ROUTES OF EXPOSURE AND EFFECTS (BELOW)

ACUTE ORAL LD$_{50}$ ND	ACUTE DERMAL LD$_{50}$ ND	AQUATIC TOXICITY (LC$_{50}$) ND

ROUTES OF EXPOSURE AND EFFECTS

This product contains free crystalline silica which according to the IARC has exhibited limited evidence of carcinogencity in humans.

TLV for respirable dust:

$$\frac{10\ \text{mg/m}^3}{\%\ \text{respirable quartz} + 2}$$

TLV for "total dust":

$$\frac{30\ \text{mg/m}^3}{\%\ \text{quartz} + 3}$$

If Cristobalite or Tridymite is detected, use one-half the value calculated from formula for quartz.

Skin: Potential irritant

Eye: Irritant

Inhalation: Irritation to lungs, nose, and throat; prolonged inhalation may result in silicosis, a noncancerous lung disease.

EMERGENCY AND FIRST AID PROCEDURES

Flush all areas contacted with running water. If irritation persists, contact physician.

Ingestion: Drink water. Do not induce vomiting.

Inhalation: Remove to fresh air. If breathing is difficult, give oxygen. If breathing has stopped, give artificial respiration. Get medical attention.

BEST Sheet

VI REACTIVITY DATA

CONDITIONS CONTRIBUTING TO INSTABILITY

None

INCOMPATIBILITY

Strong Oxidizers

HAZARDOUS DECOMPOSITION PRODUCTS

Burning may release oxides of chlorine

CONDITIONS CONTRIBUTING TO HAZARDOUS POLYMERIZATION

Not applicable

VII SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED

Sweep up and hold for disposal. Flush spill area with water.

NEUTRALIZING CHEMICALS

NA

WASTE DISPOSAL METHOD

Dispose of in accordance with all local, state and federal regulations.

VIII INDUSTRIAL HYGIENE CONTROL MEASURES

VENTILATION REQUIREMENTS

Mechanical, general room ventilation.
Use local ventilation to maintain TLV (SEE SECTION V)

SPECIFIC PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY

If dust concentrations exceed TLV (SEE SECTION V) use a NIOSH approved mechanical approved mechanical filter respirator for nontoxic dusts.

EYE

Goggles, if extremely dusty conditions

GLOVES

General duty work gloves

OTHER CLOTHING AND EQUIPMENT

Apron, eyewash station