WORK PLAN

FOR THE

INVESTIGATION AND DESIGN OF THE INTERIM REMEDIAL MEASURE FOR THE VADOSE ZONE

AT THE

FORMER IMC MAGNETICS CORP.
MANUFACTURING FACILITY
WESTBURY, NEW YORK

MARCH 1996

Prepared For:

IMC MAGNETICS CORP.

Prepared By:

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FOR THE INVESTIGATION AND DESIGN OF THE INTERIM REMEDIAL MEASURE FOR THE VADOSE ZONE
FORMER IMC MAGNETICS CORP. MANUFACTURING FACILITY
WESTBURY, NEW YORK
(HAI DOCUMENT #NMB004D.009)

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1.0 INTRODUCTION

1.1 General

Hull & Associates, Inc. (HAI) has been retained by IMC Magnetics Corp. (IMC) to conduct an Interim Remedial Measure (IRM) at the former IMC facility, located at 570 Main Street, Westbury, New York (Site). The Site lies in the New Cassel Industrial Area (NCIA), a Class 2 inactive hazardous waste site as designated by the New York State Department of Environmental Conservation (NYSDEC).

This Work Plan has been prepared for IMC, the NYSDEC, HAI and its subcontractors. This Work Plan, designated as HAI Document #NMB004D.009, is supported by the documents described in section 1.9.

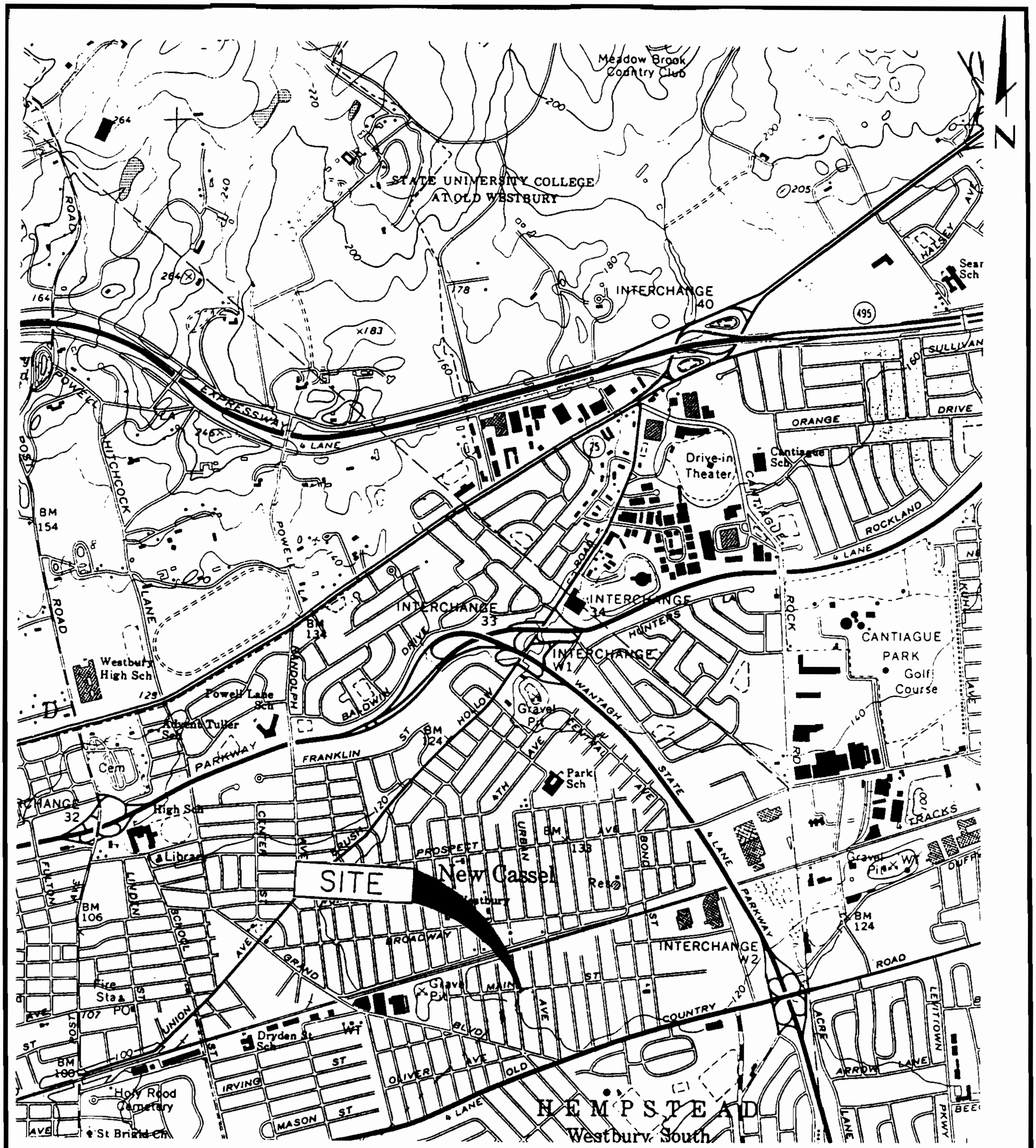
This Work Plan is arranged in five sections. Section 1.0 describes the Site, project objectives, project management, and organization of this Work Plan and supporting documents. Section 2.0 discusses the proposed work. Section 3.0 discusses reporting requirements and section 4.0 provides a schedule of implementation. Finally, section 5.0 lists the references used to prepare this Work Plan.

1.2 Site Description

The Site is located at 570 Main Street in Westbury, New York, and is within the 170-acre NCIA. A Site Location Map is presented on Figure 1-1. The Site was occupied by IMC from the early 1950s until 1992. The property is slightly over two acres with one manufacturing building and a paved parking lot covering most of the area. The Site is currently vacant except for a portion of the building occupied by Castle Collision.

1.3 Site History and Operations

Products made during IMC's occupation of the Site included, among others, induction motors, fans and blowers, stepper motors and other rotating machines. Manufacture of these products required



SOURCE: USGS 7.5 MIN. QUADRANGLE
HICKSVILLE, NEW YORK - 1967
(PHOTOREVISED - 1979)

FIGURE I-1

Hull & Associates, Inc.
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INTERIM REMEDIAL MEASURE WORK PLAN

SITE LOCATION MAP

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the use of a variety of substances, several of which are currently subject to regulation. Upon cessation of IMC's operation in 1992, Anson Environmental, Ltd. (Anson) developed a Closure Plan pursuant to NYCRR Part 373. Sampling and analyses conducted by Anson during closure activities identified several areas where unsaturated soils are contaminated by chlorinated hydrocarbons, petroleum hydrocarbons and metals. Anson's findings are more fully discussed in sections 1.4 and 1.6.

An investigation lead by the NYSDEC preliminarily concluded that the Site is one of two potential source areas contributing to the ground-water contamination described as the "570 Main Street Plume".[1] This conclusion is based on limited data and has not been confirmed by investigations performed by LMS or Anson. The investigation report also recommended that an Interim Remedial Measure (IRM) be implemented to remove source areas that may be impacting ground water. An IRM, as defined in NYRCRR 375-1.3(n), is an activity(s) to mitigate both emergency and non-emergency conditions to prevent or remedy environmental damage. An IRM can typically be "undertaken without extensive investigation and evaluation," while still achieving the applicable criteria specified in NYCRR Part 375. IMC has proposed activities in this Work Plan consistent with this definition.

1.4 Previous Investigations

1.4.1 Anson Environmental, Ltd.

Anson has performed preliminary investigative activities associated with the closure of the IMC manufacturing operation at the Site.[2] Anson reportedly developed a closure plan for the IMC facility in 1992; however, this closure plan was not available for HAI's review. Implementation of this closure plan began in March 1993, and consisted of exposing abandoned leaching pools and septic

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[1] *Site Investigation Report, New Cassel Industrial Area Site, North Heampstead, Nassau County*, Lawler, Matusky & Skelly Engineers, February 1995, p. 6-4 and 6-5.

[2] 1993 *Closure Plan Implementation, Volume I, IMC Magnetics, Corp.*, Anson Environmental, Ltd., undated; an untitled report from Anson Environmental, Ltd. to representatives of IMC Magnetics Corp., July 21, 1993; *Closure Plan, History, IMC Magnetics Corp.*, Anson Environmental, Ltd., December 3, 1993; and *Closure Plan, IMC Magnetics Corp.*, Anson Environmental, Ltd., December 3, 1993.

tanks from three areas of the Site, designated as Area 1, Area 2, and Area 3, respectively. Sediment and soil samples were collected from these locations for laboratory analyses. Sediment samples were also collected from four floor drains in the building for laboratory analyses. Finally, a composite sample of water collected during power washing of floors in the building and samples of concrete floors were submitted for laboratory analyses.

The findings of these field activities are discussed in Anson's 1993 *Closure Plan Implementation* report, the untitled July 21, 1993 report, and the undated *Closure Plan, Final Report*. This information has been used as the preliminary basis of the vadose zone investigations proposed herein. A summary of Anson's findings and a discussion of potential source areas is provided in section 1.6.

1.4.2 Lawler, Matusky & Skelly Engineers, February 1995

Lawler, Matusky & Skelly Engineers (LMS) was contracted by NYSDEC to conduct a site investigation for the NCIA.[3] The investigation consisted of a file review, ground-water sampling and analysis from 56 existing monitoring wells, and ground-water sampling and analysis from newly installed *Geoprobe* stations. The Site was identified as a potential source of ground-water contamination in the plume designated as the "570 Main Street plume"; however, this was never confirmed by investigations conducted by LMS or Anson.

1.5 Hydrogeology

Soils beneath the Site consist of granular glacial outwash deposits. It is not known whether the building was constructed on fill or native material, but for the purposes of this Work Plan, it is assumed that the fill would be similar in texture to the glacial outwash deposits.

There are apparently no significant permeability changes in the glacial deposits down to the water table, which is approximately forty-eight to fifty feet below grade. It is assumed that permeability values for the glacial deposits are relatively high (i.e., 5.0×10^{-3} cm/sec to 1.5×10^{-1} cm/sec) and percent organic carbon content is relatively low.

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[3] *Site Investigation Report, New Cassel Industrial Area Site, North Heampstead, Nassau County, Lawler*, Matusky & Skelly Engineers, February 1995.

Ground-water flow is toward the southwest at an approximate gradient of 0.002. Typical seasonal fluctuations in the local water table are reported to be on the order of one to two feet.

1.6 Potential Source Areas and Contaminant Distribution

This discussion of potential source areas and contaminant distribution is based on data from previous investigations at the Site. The proposed vadose zone investigation described in section 2.0 is also based on these existing data. Modifications to this discussion and the proposed vadose zone investigation may be required based on the results of the file review, forensic studies, and surveying currently being performed.

Based on Anson's work at the Site, HAI has identified several potential source areas. These potential source areas are shown on Figure 1-2. The most thoroughly studied locations are:

1. Area 1, located outside the building in the property's northeast corner;
2. Area 2, located outside the building in the property's northwest corner; and
3. Area 3, located outside the building near the property's southwest corner.

Area 1 contains a concrete septic tank (designated ST-1), with a base at three feet below grade, and two leaching pools (designated LP1-A and LP1-B). Area 2 contains two leaching pools (designated LP2-A and LP2-B) that are apparently not connected to a septic tank. LP2-A is constructed of concrete (eight-foot diameter), and is connected by four-inch diameter transite pipe to LP2-B, which is constructed of cinder blocks and has a basal depth of approximately twelve feet. Area 3 contains a septic tank (designated ST-3), constructed with concrete sides and a soil base, which is connected to two leaching pools (designated LP3-A and LP3-B).

NOTES:

DIMENSIONS OF PROPERTY AND BUILDING ARE BASED ON FIELD MEASUREMENTS USING A MEASURING TAPE.

LOCATIONS AND DIMENSIONS OF FLOOR DRAINS, SEPTIC TANKS, LEACHING POOLS AND AREAS 1, 2 AND 3 ARE ESTIMATED BASED ON ANSON ENVIRONMENTAL, LTD.S' INVESTIGATIONS.

FIGURE 1-2

Hull & Associates, Inc.
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FORMER IMC MAGNETICS CORP. MANUFACTURING FACILITY
INTERIM REMEDIAL MEASURE WORK PLAN

SITE PLAN WITH
POTENTIAL SOURCE AREAS
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Anson also identified five probable floor drains or penetrations which are considered potential source areas for the purposes of this Work Plan. Several other potential source areas may be considered during the investigation. First, regulated substances were stored or used in several areas, including: the paint shop and alodine lab in the northwest portion of the building; and the paint storage room, drum storage area and maintenance area in the east-central portion of the building. Pipes leading from floor drains to septic tanks, leaching pools or sewers, are also potential source areas. Finally, slop sinks, sumps, areas of cracked/damaged floors where chemicals were handled, and degreaser locations will be evaluated more closely during the forensic studies.

To date, VOCs, primarily chlorinated hydrocarbons, and metals have been detected in accumulated sediments and/or unsaturated soils beneath the septic tanks, leaching pools and floor drains/penetrations. The highest concentrations of VOCs were detected at twelve feet below grade beneath LP2-B, where total VOC concentrations were approximately 1.5 x 10^8 μg/kg. The primary constituent beneath LP2-B is tetrachloroethene(PERC), although toluene and xylenes were found in excess of 1 x 10^6 μg/kg and 1,1,1-trichloroethane (1,1,1-TCA) was 668,000 μg/kg. PERC concentrations exceed 1.0 x 10^7 μg/kg at several other locations and extend to a depth of twenty feet near LP2-B.[4]

Anson's studies identified four heavy metals in the vadose zone, including mercury, cadmium, chromium and lead. Barium was also detected in floor drain/penetration sediments at FD-2 and FD-5. Chromium was the most prevalent heavy metal detected at the Site. The highest concentration was 7,500,000 μg/kg in a sample collected at a depth of twelve feet at LP2-B. At a depth of eighteen to twenty feet, the chromium concentration was 40,000 μg/kg. Chromium was also detected at LP1-B (26,000 μg/kg at eighteen to twenty feet), ST-1 (27,000 μg/kg at three feet), LP2-A (18,000 μg/kg at eighteen to twenty feet), LP3-B (14,000 μg/kg at eighteen to twenty feet) and ST-3 (50,000 μg/kg at ten to twelve feet).

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[4] Specifically, PERC exceeded 1 x 10^7 μg/kg at depths of seven, twelve and eighteen to twenty feet at LP2-B and in sediments collected from FD-2.

The highest concentrations of mercury, cadmium and lead in vadose zone soils were detected at twelve feet below the surface at LP2-B, at respective concentrations of 2,300 μg/kg, 21,000 μg/kg and 190,000 μg/kg. Cadmium was also detected in LP2-B at seven feet below the surface at a concentration of 6,300 μg/kg.

1.7 Project Description and Objectives

Subsurface investigations will be conducted to gather sufficient data for evaluation and design of a soil vapor extraction (SVE) system, and to define the nature and vertical and horizontal extent of contaminants in the vadose zone at the Site. Specifically, a SVE pilot testing program is proposed, and, in conjunction with the subsurface investigations, is intended to provide sufficient data to implement design of a full-scale SVE system. As described in section 2.2, this Work Plan presumes that SVE will be an appropriate technology for VOC contaminant removal in the vadose zone and that a full-scale SVE system will be implemented as an IRM. The project will also gather sufficient data to evaluate the potential for metals to adversely impact ground water.

1.8 Project Organization

HAI will manage the project out of its Dublin, Ohio office, with support from its offices in Bedford, New Hampshire, and Austin, Texas. During implementation, HAI is charged with assuring that the type and quality of work conforms with this Work Plan and supporting documents. More specifically, HAI is responsible for overall project management, including:

1. preparing work plans, specifications and associated documents describing rationale and methods to obtain data;
2. implementing and assuring compliance with work plans;
3. coordinating subcontractors and vendors;
4. controlling project schedule and costs;
5. assuring conformance with applicable federal, state and local regulations; and
6. communicating with IMC.

As discussed below, Land Tech Remedial, Inc. (LTR) of Farmingdale, New York, has teamed with HAI as HAI's subcontractor during inplementation of this Work Plan. Together, they will be jointly responsible for:

1. enforcing health and safety protocols; and
2. meeting project quality assurance goals.

1.8.1 Project Team

The work will be performed, on behalf of IMC, by HAI and several subcontractors. The primary subcontractor will be Land Tech Remedial, Inc. (LTR) of Farmingdale, New York. LTR will assist HAI with preparing work plans and reports and will perform a majority of the field investigations. Other subcontractors include:

1. Laboratory Resources, Inc. in Teterboro, New Jersey (fixed laboratory analyses);
2. R & L Drilling in Islip, New York (drilling services);
3. Ivan Czipott, PLS in Hicksville, New York (registered surveyor); and
4. W.M. Engineering in Columbus, Ohio (electrical and instrumentation design services).

The above list identifies the subcontractors which are intended to be used. Other subcontractors may be used as necessary.

1.8.2 Communication

In general, IMC will communicate with NYSDEC. HAI will communicate with IMC primarily through its Project Manager. In some instances, discussions between IMC and the Project Hydrogeologist, Quality Assurance Officer, or Health and Safety Officer will be required. Subcontractors will communicate with IMC via HAI's Project Manager, Project Engineer, or Quality Assurance Officer. LTR's Project Hydrogeologist will also, on occasion, communicate directly with IMC. A graphical representation of communication links is provided in Figure 1-3.

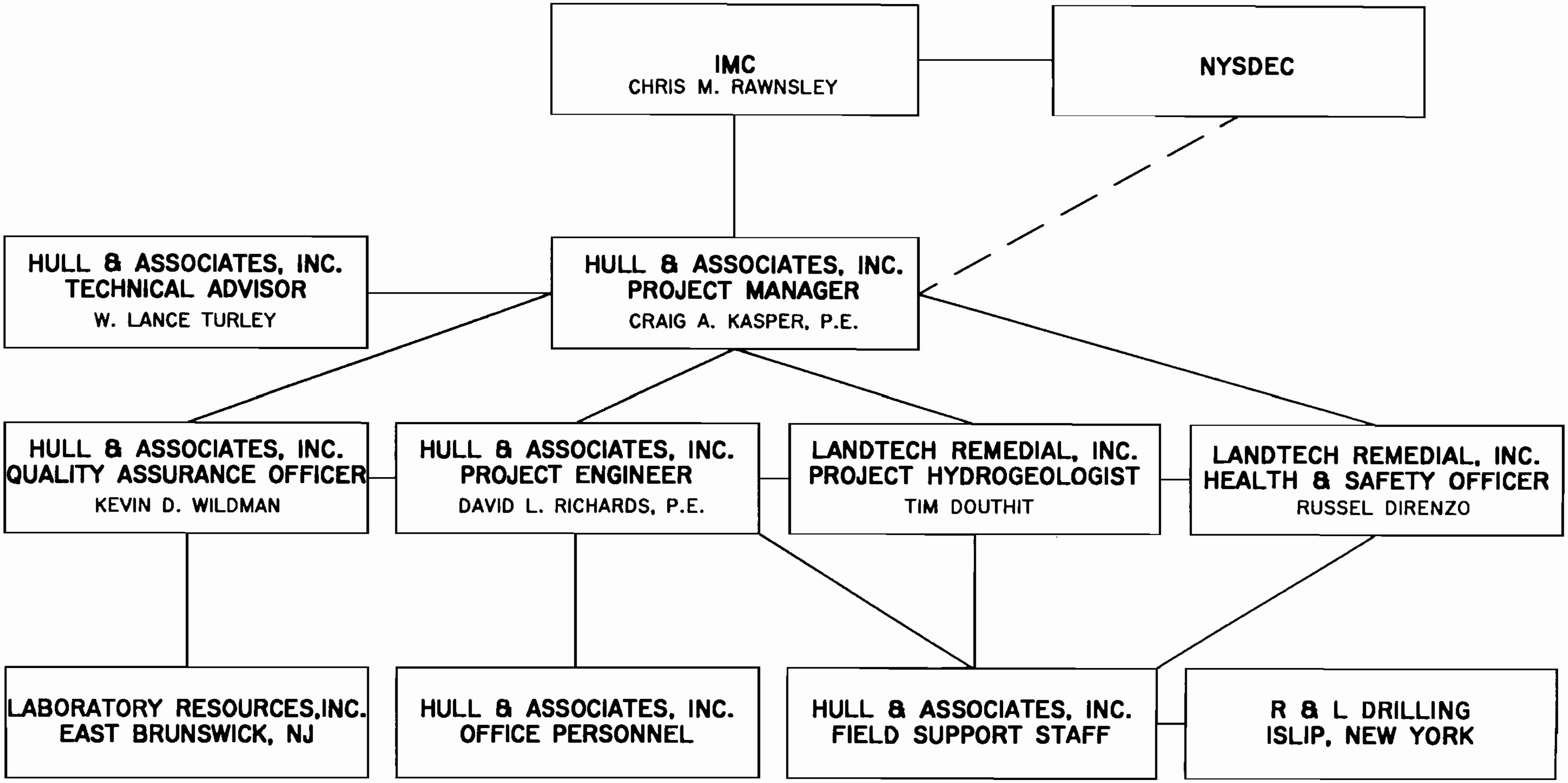

FIGURE I-3

Hull & Associates, Inc.
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FORMER IMC MAGNETICS CORP. MANUFACTURING FACILITY
INTERIM REMEDIAL MEASURE WORK PLAN

PROJECT COMMUNICATIONS
PROTOCOL

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1.8.3 Project Staff

A brief description of the project staff and their responsibilities is given below. Figure 1-4 is a graphical representation of the project management structure.

Project Manager

The Project Manager for HAI is Mr. Craig Kasper, P.E. Mr. Kasper will be responsible for the overall development and management of the project, including:

1. administering work, quality assurance and health and safety plans;
2. interpreting data and fulfilling reporting requirements;
3. helping to identify circumstances which necessitate interim actions and communicating to IMC when such circumstances are suspected or encountered;
4. providing communication between HAI project personnel, subcontractors, and IMC; and
5. meeting the time requirements specified herein.

Technical Project Supervisors

The technical project supervisors include the Project Engineer and the Project Hydrogeologist. These persons are Mr. Dave Richards, P.E. (HAI) and Mr. Tim Douthit (LTR), respectively. Technical Project Supervisors communicate directly with the Project Manager, and, in many instances, support the Project Manager in discussions with IMC.

The Project Engineer will assist in data interpretation and designing the IRM. The Project Hydrogeologist will be instrumental in identifying data requirements and interpreting data, and will be responsible for the day-to-day field activities and data collection.

Site Health and Safety Officer

The Site Health and Safety Officer is Mr. Russel DiRenzo of LTR. Duties of the Health and Safety Officer are included in the Health and Safety Plan (HASP), Appendix C.

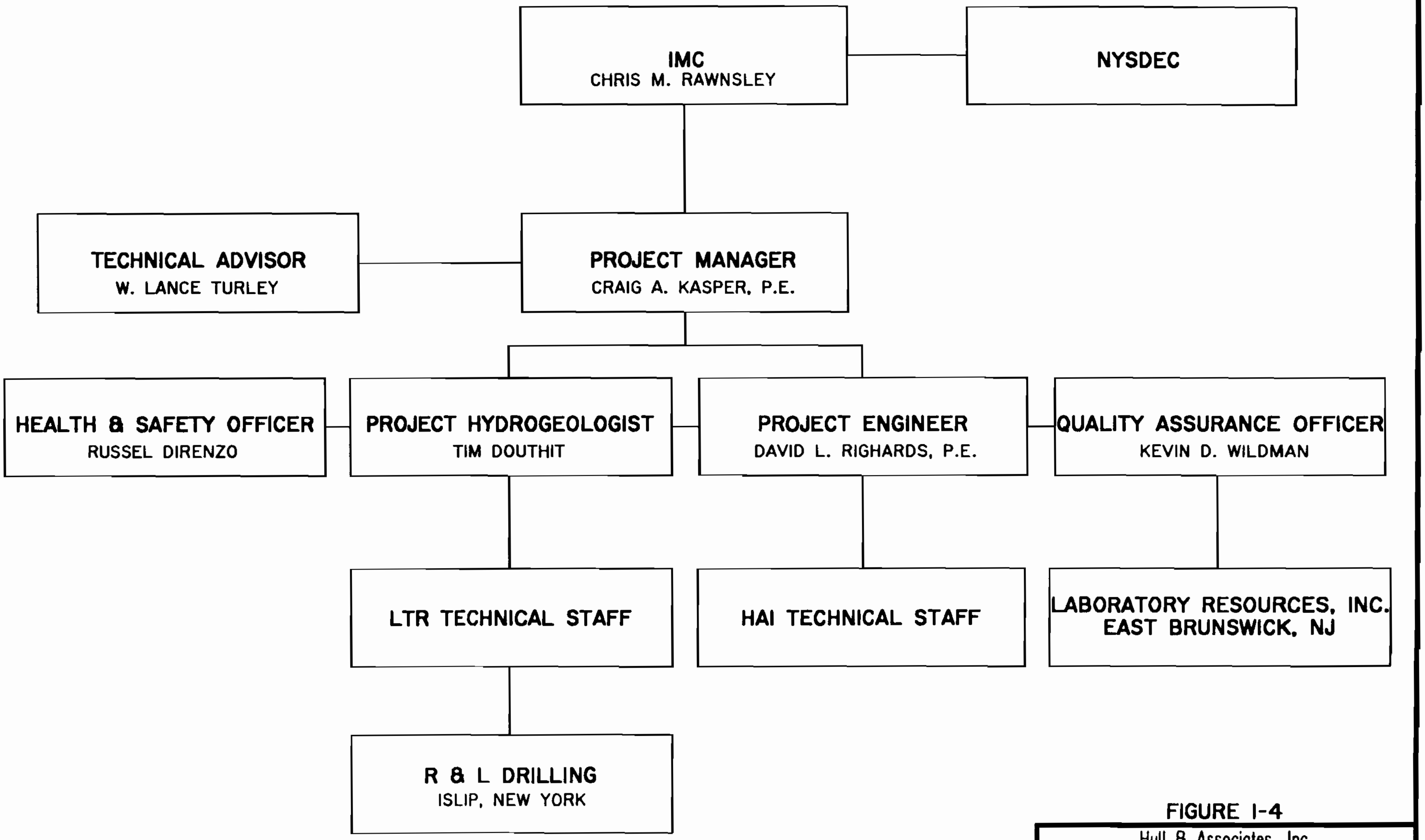

FIGURE I-4

Hull & Associates, Inc.
DUBLIN, OHIO

FORMER IMC MAGNETICS CORP. MANUFACTURING FACILITY
INTERIM REMEDIAL MEASURE WORK PLAN
PROJECT MANAGEMENT
CHART
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Quality Assurance Officer

The Quality Assurance Officer is Mr. Kevin Wildman. Duties and responsibilities of the Quality Assurance Officer are discussed in the Quality Assurance Project Plan (QAPP), Appendix B.

Laboratory Project Manager

The Laboratory Project Manager is Mr. Paul Ioannides, an employee of Laboratory Resources, Inc. The Laboratory Project Manager communicates with the Quality Assurance Officer, and reports to the Laboratory Director. In addition, responsibilities of the Laboratory Project Manager include:

1. communicating between the laboratory and the field Quality Assurance Officer and Project Manager;
2. relating special needs of the field operations personnel to the laboratory;
3. performing final review of all data packages before reporting results;
4. coordinating the sample load with the laboratory's available resources; and
5. providing appropriate glassware and equipment to meet sampling objectives.

Technical Advisor

Mr. W. Lance Turley of HAI will serve as the technical advisor for the project. Mr. Turley will assist primarily in evaluating contaminant distribution, fate and transport relative to the effectiveness of SVE.

1.9 Organization of Work Plan and Supporting Documents

1.9.1 General

This Work Plan is supported by a Field Sampling and Analysis Plan (FSAP), a QAPP, and a HASP. These supporting documents are included as bound appendices to this Work Plan. Specifically, the FSAP is included as Appendix A, the QAPP is included as Appendix B, and the HASP is included as Appendix C. A brief description of the Work Plan and supporting documents is provided below.

1.9.2 Work Plan

This Work Plan provides the overall approach for the proposed investigative tasks. Rationale for gathering data, sampling locations and frequencies, and activities necessary to obtain the data are described. The Work Plan also provides a discussion on the interpretation and reporting of the data to achieve the objectives of the work. The detailed procedures for sampling of media are provided in the FSAP, Appendix A.

1.9.3 Field Sampling and Analysis Plan

The FSAP in Appendix A is intended to provide field sampling and analysis guidelines for soils. Specifically, the FSAP includes discussions on:

1. sample locations and frequency;
2. sample designation;
3. soil sampling equipment and procedures;
4. field analytical procedures;
5. sample handling procedures;
6. decontamination of equipment;
7. documentation procedures;
8. field quality control procedures; and
9. management of potentially contaminated materials.

1.9.4 Quality Assurance Project Plan

The QAPP in Appendix B is comprised of two documents, including Laboratory Resources, Inc.'s *Corporate Quality Assurance Manual* and LTR's *Analysis of Volatile Organic and Chlorinated Compounds by Gas Chromatography: Methods and QA/QC Procedures*. These documents apply to the fixed laboratory analysis and mobile laboratory analysis, respectively. Both documents describe the policies, organization, and specific quality assurance and control activities required to meet the data quality objectives for the project.

1.9.5 Health and Safety Plan

The HASP in Appendix C has been prepared to address the procedures required to perform the field activities in a safe manner, and includes such items as:

1. project organization structure;
2. hazard assessment;
3. hazard communication and training;
4. contaminant monitoring;
5. safety considerations;
6. communications;
7. decontamination and cleanup procedures;
8. emergency response;
9. medical surveillance; and
10. site management.

2.0 INTERIM REMEDIAL MEASURE INVESTIGATION AND DESIGN

2.1 General

Subsurface investigations will be conducted to more completely assess the nature and vertical and horizontal extent of VOCs and metals in the vadose zone at the Site and to gather sufficient data for design of a SVE system. Following the subsurface investigation, a SVE pilot test will be conducted, followed by design of a full-scale system. The IRM will include the following elements:

1. Task 1 - File Review
2. Task 2 - Source and Release Identification and Surveying
3. Task 3 - Vadose Zone Investigation
4. Task 4 - Interim Report
5. Task 5 - Soil Vapor Extraction Pilot Test
6. Task 6 - Final Investigation Report
7. Task 7 - IRM Design
8. Task 8 - IRM Implementation

A description of the tasks is presented in sections 2.3 through 2.10.

2.2 Presumptive Remedy

SVE is an in-situ soil remediation technique which consists of drawing air through contaminated soils in the vadose zone using a vacuum blower connected to a series of extraction points. Removal of VOCs from the vadose zone is accomplished by partitioning VOCs into the vapor phase as the air passes through contaminated areas and the subsequent removal of the VOC-laden air at the extraction points.

SVE appears to be the most suitable technology for remediation of VOC contamination in the vadose zone at the Site based on available information considering that:

1. the relatively high-permeability soils, relative to the surface covering (building and pavement), will allow rapid induced air flow and large radii of vacuum influence per each vapor extraction well;

2. the apparent homogeneity of the soils will promote predictable air flow patterns and relatively consistent rates of contaminant removal;

3. the probable low total organic carbon content of the soils will allow rapid contaminant mass removal, allowing the soils to retain very little sorbed VOCs; and

4. the properties of the organic compounds (e.g., relatively high vapor pressures and volatility) render them amenable to SVE.

Consequently, the Work Plan is based on a presumption that SVE is applicable at the Site. HAI believes this to be consistent with U.S. EPA guidance, the National Contingency Plan, and New York State regulation and guidance.

Also, data will be gathered to allow evaluation of the potential for metals to adversely impact ground water.

2.3 Task 1 - File Review

This task includes review of the available private or public files associated with past and current operations at the Site and surrounding properties. If appropriate, interviews with individuals having knowledge of past operations and/or facility construction at the Site will be conducted. This task has been initiated and information obtained will be used to modify this Work Plan where appropriate.

2.4 Task 2 - Source and Release Identification and Surveying

In order to focus the vadose zone investigation described under Task 3 below, a study will be conducted to identify the potential release mechanisms of contaminants into the subsurface. The study will be based on the forensic evaluation of the physical plant and available historical information. Techniques that may be used include sewer dye tracing, smoke testing, acoustic and radio frequency tracing, and procurement and review of construction plans.

A topographical and property survey of the Site will be completed by a surveyor registered in the State of New York. The survey may be tied into the appropriate state coordinate system so the data are relative to work being conducted in off-site portions of the NCIA.

This task has been initiated and information obtained will be used to modify this Work Plan as required. The modified sections will be submitted to NYSDEC.[5]

2.5 Task 3 - Vadose Zone Investigation

2.5.1 Proposed *Geoprobe* Sampling Locations and Depth Intervals

The subsurface investigation of the Site will utilize an initial, flexible grid sampling layout that will be modified in the field according to the results of the real-time data collected during the subsurface investigation. The workable initial grid system will involve the installation of soil borings with a closer spacing (e.g., 20 feet) near potential source areas and further (e.g., 50 to 100 feet) in areas expected to reflect minimal environmental impact. Based on Anson's work at the Site, potential source areas include:

1. "Area 1," which includes septic tank ST-1 and leaching pools LP1-A and LP1-B, located at the northeastern corner of the property;
2. "Area 2," which includes leaching pools LP-2A and LP-2B, located at the northwestern corner of the property;
3. "Area 3," which includes septic tank ST-3 and leaching pools LP-3A and LP-3B, located in the southwestern portion of the property; and
4. five probable floor drain/penetration locations inside the building.

The configuration of the initial soil sampling grid is presented in Figure 2-1. The base map for this figure will be modified based on the survey information currently being obtained and the initial sampling grid may be modified based on the findings of the file review and forensic studies. Based on the findings of the real-time analytical data collected during the subsurface investigation (section 2.5.4.1), the grid may be further tightened in areas of higher subsurface environmental impact or relaxed in areas documented to be free of subsurface impact.

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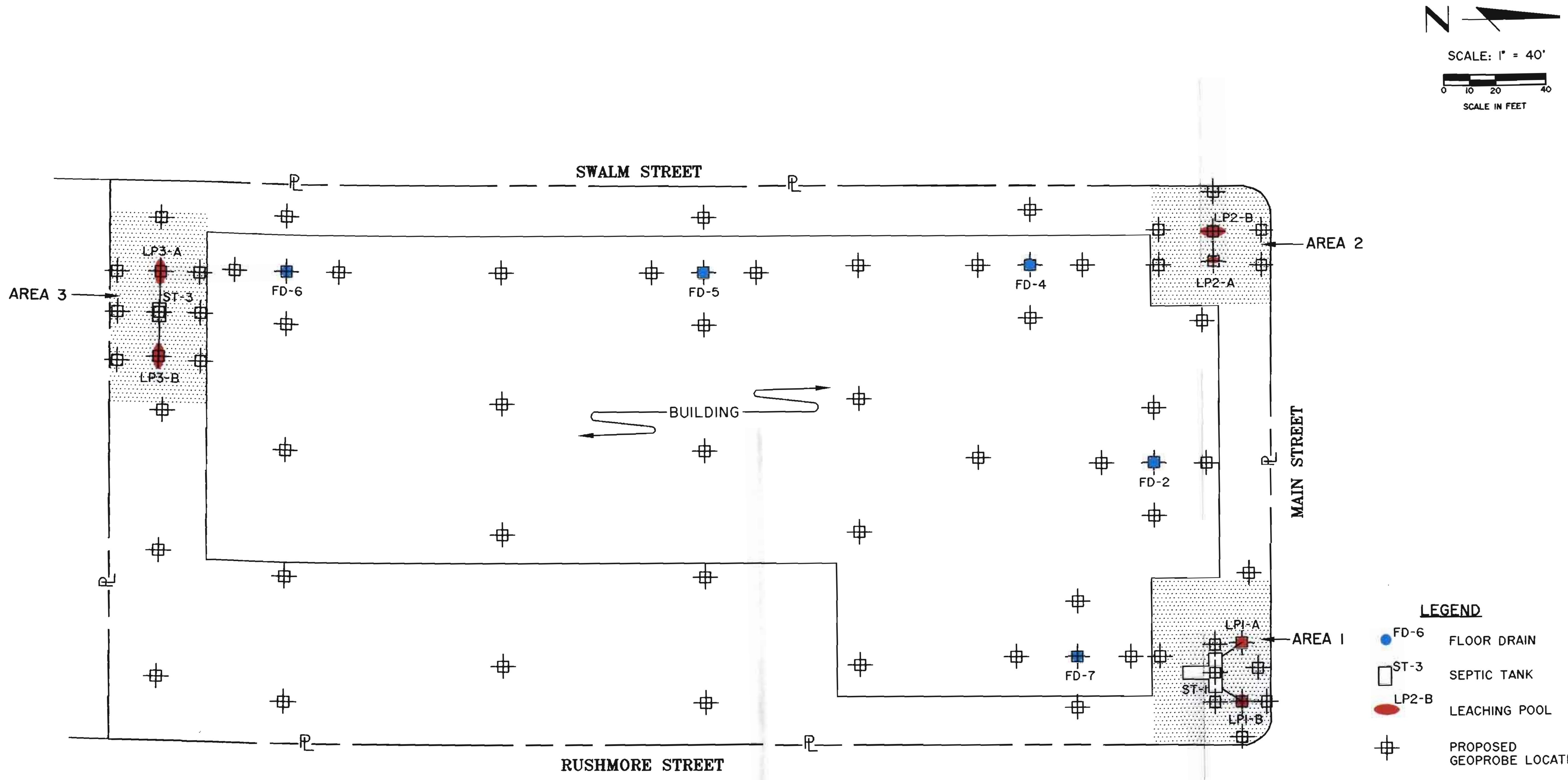
[5] This approach was discussed with representatives of NYSDEC and IMC during a June 20, 1995 meeting at the Site. It was also discussed in a July 12, 1995 letter from Mr. Craig Kasper of HAI to Dr. Chittibabu Vasudevan, P.E. of NYSDEC.



NOTES:

DIMENSIONS OF PROPERTY AND BUILDING ARE BASED ON FIELD MEASUREMENTS USING A MEASURING TAPE.

LOCATIONS AND DIMENSIONS OF FLOOR DRAINS, SEPTIC TANKS, LEACHING POOLS AND AREAS 1, 2 AND 3 ARE ESTIMATED BASED ON ANSON ENVIRONMENTAL, LTD.S' INVESTIGATIONS.

FIGURE 2-1

Hull & Associates, Inc.
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PROPOSED GEOPROBE SAM
LOCATIONS
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The total depth of exploration at the Site will be soil-boring specific, and will be based on the contaminant profile delineated through the field screening activities and the results of the real-time analytical data. However, all of the soil borings will be limited in scope to the unsaturated zone (i.e., from grade to approximately 50 feet below grade).

One soil boring, located in Area 2, will be sampled on a continuous basis from grade to 50 feet below grade to completely characterize the unsaturated zone for subsequent remediation design purposes. The remaining soil borings will be sampled on 5-foot intervals, beginning at the interval of 4 to 6 feet below grade. The individual soil borings will be advanced until two successive soil samples show no evidence of VOCs based on field screening and/or field analytical results. In order to assess the potential impact of elevated concentrations of heavy metals in the unsaturated zone of the Site, two soil borings will be installed to generate depth profiles of any metals detected at the Site above cleanup levels designated in the November 16, 1992, Technical and Administrative Guidance Document (TAGM).[6] The two subject soil borings will be located in areas which have been determined to have the highest potential for elevated metals concentrations in unsaturated soils based on previous investigations and the forensic study currently being conducted. Each soil boring will be installed to a total depth of 46 feet below grade, and will be sampled on 10 foot intervals, beginning at the interval 4 to 6 feet below grade. Soil samples will be submitted to a fixed laboratory for analysis of lead, chromium, barium, cadmium and mercury by the EPA SW-846 Method 7000 series and toxicity characteristic leaching procedure (TCLP) metals extraction. The TCLP extraction will be archived and analyzed only if the total metals analyses detect concentrations which exceed NYSDEC cleanup levels according to the November 16, 1992, TAGM.

2.5.2 Drilling and Soil Sampling Procedures

Soil borings will be installed using a *Geoprobe*, which is a narrow-diameter, truck-mounted drill rig. The *Geoprobe* advances narrow diameter (1 to 1 3/8 inches) sampling probes into the subsurface

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[6] Based on soil cleanup levels detailed in the NYSDEC technical and administrative guidance memorandum (TAGM) titled "Division Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels." November 16, 1992. The soil cleanup levels from NYSDEC's November 16, 1992 TAGM are only being used as a basis for comparison and are not to be construed as the cleanup goals for the IRM.

using a hydraulic hammer. The sampling probes consist of stainless steel tools which are percussively advanced into the subsurface via 3-foot long carbon-steel, hollow drill rods. The effective drilling depth of the *Geoprobe* in the unconsolidated overburden present at the Site is approximately 80 to 100 feet below grade, exceeding the expected maximum depth of 50 feet.

Soil samples will be collected using a decontaminated, two-foot long, 1 3/8-inch outer diameter piston sampler fitted with new, factory-cleaned acetate sampling liners. The soil sampler is advanced to the target sampling depth, at which point a retaining pin is removed from the top of the soil sampler using 1/4-inch diameter retrieval rods inserted through the hollow centers of the drill rods. Removing the retaining pin allows the piston to be displaced by the soil at the target depth as the sampler is driven an additional two feet into the subsurface. The sampler is then retrieved to the surface and the soil sample is removed, intact, in the acetate liner. Soil samples will be described using the Unified Soil Classification System (USCS) terminology. All soil samples will be field-screened for potential volatile organic compounds (VOCs) using a photoionization detector (PID) or flame ionization detector (FID), and measurements will be noted on the boring log. Following the field screening, soil samples will be given directly to the on-site chemist for analysis as described in section 2.5.4.

2.5.2.1 Unified Soil Classification System

Selected samples (one per discrete unconsolidated unit) will be chosen for classification in accordance with the USCS. The soils laboratory analyses will conform to American Society of Testing and Materials (ASTM) procedures and will include determination of the natural moisture (ASTM D 2216-80), Atterberg Limits (ASTM D 4318-84) and grain size distribution utilizing a long-hydrometer (ASTM D 422-63).

2.5.2.2 Decontamination Procedures

Prior to the drilling of the first borehole and after the completion of each boring, down hole equipment and associated tools will be decontaminated with a high-pressure, high-temperature wash. Decontamination will be observed by the supervising hydrogeologist and will be initiated after completion of each boring to minimize the potential of cross-contamination.

Soil sampling tools will be decontaminated between each use in accordance with HAI Standard Operating Procedure (SOP) F1000 included in the FSAP, Appendix A.

2.5.3 Air Monitoring

Air quality monitoring will be conducted for worker health and safety during on-site activities. Air pathway analysis at the Site will consist of:

1. real-time particulate monitoring during all activities in the work area when disturbance of soils occurs (i.e., drilling during the soil vapor extraction well installation), and
2. real-time VOC monitoring during all drilling activities.

Particulate monitoring will be performed both upwind and downwind of the work area using a Miniature Real-Time Aerosol Monitoring (MINIRAM) device. Particulate concentration readings will be taken at each soil boring location prior to drilling and at half-hour intervals thereafter until drilling is completed. Readings will also be taken at any time a visible increase in particulates is noted by the supervising hydrogeologist. If particulate concentrations exceed action levels as specified by the HASP, appropriate personal protective equipment will be utilized.

VOC monitoring will be conducted using PID or FID. Breathing zone VOC monitoring will be conducted prior to drilling and at half-hour intervals thereafter until drilling is completed. If concentrations of VOCs exceed action levels as specified in the HASP, appropriate personal protective equipment will be utilized.

2.5.4 Soil Analytical Procedures

2.5.4.1 Field Laboratory Analytical Procedures

Soil samples collected during the subsurface investigation will be given directly to a chemist for on-site analysis in a mobile laboratory. After the sample is transferred to the mobile laboratory, it will become the sole custody of the analyst operating the laboratory. Since soil samples are analyzed within approximately one hour following collection, conventional chain of custody protocols will not be used. All samples will be chilled to 4° C immediately after collection and maintained at that temperature until analyzed.

The mobile laboratory consists of an enclosed, weatherproof and temperature-controlled environment outfitted with a generator and equipped with an SRI model 8610 semi-portable gas chromatograph (GC) with photoionization and flame ionization detector options. For the analysis of benzene, toluene, ethylbenzene and xylene (BTEX) and PERC, TCE, 1,1,1-TCA, 1,1-DCE and trans 1,2-DCE, an SRI dry electrolytic conductivity detector (DELCD) will be employed in series with a PID. Peak areas of detected chlorinated organic compounds will be integrated using a two-channel *Peaksimple* III data system on the mobile laboratory's computer, and converted to parts per billion (ppb) units based on established calibration curves.

Analysis of soil samples for chlorinated organic compounds including BTEX, PERC, TCE, 1,1,1-TCA, 1,1-DCE and trans 1,2-DCE employs a static headspace extraction technique as outlined in USEPA SW-486 Method 3810. Chlorinated compound analysis will be conducted utilizing this modified headspace method performed directly in a 40 ml screw cap septum vial. Detection limits for BTEX, PERC, TCE, 1,1,1-TCA, 1,1-DCE and trans 1,2-DCE in soil using modified EPA method 3810 are 5 ppb for each compound. Analytical uncertainties are expected to be better than the EPA required ±20% by Method 8020.

2.5.4.2 Fixed Laboratory Analytical Procedures

Confirmatory soil samples will be submitted to a fixed laboratory for the analysis of aromatic and chlorinated VOCs by EPA SW-846 Methods 8010/8020 and lead, chromium, barium, cadmium and mercury by EPA SW-846 Method 7000 series.

Per area of concern, identified in section 2.5.1 and/or delineated during the subsurface investigation itself, one "worst-case" soil sample and one "clean" soil sample will be submitted to a fixed laboratory for organic analysis. "Worst-case" soil samples will be defined as those samples determined to have the highest *combined* PERC, TCE, 1,1,1-TCA, 1,1-DCE and trans 1,2-DCE concentrations through analyses in the mobile laboratory. "Clean" samples will be defined as those samples containing *individual* PERC, TCE, 1,1,1-TCA, 1,1-DCE and trans 1,2-DCE concentrations below their respective NYSDEC soil cleanup levels on the basis of the analyses in the mobile laboratory. The fixed laboratory data will be used as a point of comparison with the data generated by the field laboratory.

2.5.4.3 Physiochemical and Geotechnical Analytical Procedures

Physicochemical and geotechnical analyses that may be performed on a limited number of representative soil samples include: moisture content, specific gravity, total organic carbon content, bulk density, particle size distribution, consolidation, compaction and exchange capacity. These data may be used in subsequent remediation system design, if necessary.

2.5.5 Soil Vapor Extraction (SVE) Well Installation and Construction

One soil vapor extraction well will be installed in Area 2 using a hollow stem auger (HSA) drill rig fitted with 6.25 inch I.D. augers. Prior to and following the installation of the SVE well, the augers will be decontaminated using steam cleaning. The well will be installed to a total depth of 55 feet below grade, and will consist of several "nested" screens within the same borehole. The actual screened intervals will be designated to coincide with specific contaminant distributions and/or geological features based on the results of the continuously sampled soil boring installed in Area 2. However, based on previous investigations of the area, as well as its generally homogenous geology, it is expected that three 15-foot screens positioned from 3 to 18, 21 to 36 and 39 to 54 feet below grade will be sufficient. Individual SVE points within the extraction well will consist of 2-inch diameter, 40 slot, schedule 40 PVC screen, screw coupled to 2-inch diameter schedule 40 PVC casing. Bentonite seals will be installed between screened intervals and at ground surface to prevent short-circuiting of air between screened sections and/or directly from the surface. Morie #2 gravel pack will be installed adjacent to the screened intervals of the individual SVE points.

Three nested vapor monitoring wells will also be installed at the Site at varying radial distances (between 10 and 30 feet) from the extraction well. The nested vapor monitoring wells will also be installed using a HSA drill rig as described above. Each vapor monitoring well will consist of individual monitoring points, appropriately screened to monitor each individual extraction interval of the soil vapor extraction well. Monitoring points will consist of 5 feet of 1-inch diameter, 20 slot, Schedule 40 PVC screen, screw coupled to 1-inch diameter, schedule 40 PVC casing. Up to four points will be installed in each borehole, depending on the final configuration of the soil vapor extraction well. Morie # 2 gravel pack will be installed adjacent to the screened intervals of the monitoring points, and bentonite seals will be placed between screened intervals to avoid short circuiting effects.

Soil boring logs will be generated for each soil boring installed during the subsurface investigation. Soil boring logs will include:

1. soil boring designation number;
2. total depth of soil boring;
3. drilling apparatus specification;
4. lithologic description of each soil sample collected according to USCS terminology;
5. results of the field VOC screening; and
6. graphic representation of the soil boring, indicating the depths of each soil sample collected.

Well construction diagrams will be generated for the soil vapor extraction well and the attendant soil vapor monitoring wells. Well construction diagrams will include:

1. well designation number;
2. total depth of well;
3. drilling apparatus specification;
4. well construction and materials descriptions; and
5. graphic representation of well construction details, indicating depth of screened intervals, location of bentonite seals, etc.

2.5.6 Data Interpretation

The analytical data will be used to determine the horizontal and vertical extent of contamination at the Site. The boring logs and physiochemical/geotechnical data will be used to evaluate the Site stratigraphy and potential contaminant migration pathways. Finally, the data from the subsurface investigation will be used in conjunction with the SVE pilot testing data (section 2.7) to design the full-scale SVE system.

2.5.7 Materials Management

Soil cuttings from the drilling operations will be collected and stockpiled separately on-site. If VOCs emanating from the stockpiled soils do not exceed action limits within the breathing zone, as specified in the HASP, soils will be placed on and secured under polyethylene sheeting. If VOCs emanating from the stockpiled soils exceed the HASP breathing zone action limits, the soils will be stored on-site in NYS DOT-approved 55-gallon steel drums or roll-off containers. After the completion of drilling activities, the stockpiled soils will be analyzed for waste characterization. According to the results of the waste characterization analysis, the soils will either be transported off-site and disposed of, remediated on-site as necessary, or used as on-site backfill.

2.6 Task 4 - Interim Report

An interim report will be prepared and submitted to NYSDEC summarizing the findings of the vadose zone investigations and the refined approach to SVE pilot testing based on these findings. The report will focus on providing rationale for the pilot testing locations and methodologies, or modifications thereto, previously presented in the Work Plan.

2.7 Task 5 - Soil Vapor Extraction Pilot Test

SVE pilot testing will be conducted to establish design parameters for the full-scale SVE system. Specifically, the area of vacuum influence created in the vadose zone at various vapor flowrates and wellhead vacuums will be measured. This information will be used to determine extraction well spacing and to size the vacuum blower(s). VOC concentrations in the vapor discharge stream will also be monitored to evaluate VOC removal rates and vapor discharge treatment requirements. The collected field data will be evaluated using the computer-based analytical model *Hyper-Ventilate* to determine the SVE radius of influence as a function of air flow, screened interval, nature of contaminants to be removed, and time.

2.7.1 Procedures and Monitoring

The SVE pilot testing program will be developed to confirm SVE as an appropriate remedial technology and to establish design parameters for a full-scale remediation system deemed necessary on the basis of the subsurface investigation. Specifically, the area of vacuum influence created in the vadose zone at various vapor flowrates and wellhead vacuums will be measured. This information will be used to determine potential SVE well spacing and to size vacuum extraction blower(s).

SVE testing will be conducted by attaching a vacuum blower to the extraction well and monitoring the induced vacuum in surrounding vapor monitoring wells. In order to minimize potential VOC emissions during the SVE pilot test, the effluent air flow from the extraction blower may be piped through one 175-lb. vapor phase carbon unit.

Three extraction rates will be tested. At each extraction rate, the following parameters will be measured every 30 minutes:

1. vacuum at the extraction wellhead;
2. air flow from the extraction well;
3. VOCs from the extraction well; and
4. induced vacuum in the surrounding wells.

Vacuum at the extraction wellhead will be measured utilizing either a manometer or vacuum gauges (*Magnahelic*® or equivalent). Air flow from the extraction well will be measured using a hot-wire anemometer. VOCs from the extraction well will be measured via either a PID or a FID. Induced vacuum in the surrounding wells will be measured using *Magnahelic*® or equivalent vacuum gauges. Once an apparent equilibrium has been reached (expected to be between one and one-half hours), the next extraction will be tested.

During the course of the SVE pilot test, a minimum of one *Tedlar* bag air sample will be collected from the effluent port of the extraction blower on the influent side of the vapor phase carbon unit. The air sample will be submitted to a fixed laboratory for the analysis of volatile aromatic and halogenated hydrocarbons. The results of the analysis will be used to estimate potential off-gas treatment options for any subsequent SVE remediation option deemed necessary on the basis of the subsurface investigation.

2.7.2 Data Interpretation

The SVE pilot test program will be conducted utilizing a field data acquisition vehicle (DAVE). DAVE measures all relevant parameters associated with SVE testing, including air flow, vacuum influence, and chemical-specific parameters. The collected data will be reduced and modeled in real-time to allow on-site evaluation and optimization of many potential SVE operating scenarios.

The collected data will be modeled and analyzed using the EPA-approved computer-based analytical model *Hyper-Ventilate* in order to determine the SVE radius of influence as a function of air flow, screened interval, nature of contaminants to be removed, and time.

2.8 Task 6 - Final Investigation Report

Following completion of the SVE pilot study, a final report will be prepared and submitted to NYSDEC, and may include:

1. a brief discussion of local geology/hydrogeology in the vicinity of the Site;
2. a narrative summary of activities and results from Task 1 (File Review) and Task 2 (Source and Release Identification and Surveying);
3. a discussion of field activities conducted for Tasks 3 and 5;
4. a scale base map showing Site structures and *Geoprobe* soil boring locations, confirmed source areas, and wells/probes for the SVE pilot system;
5. tabulated analytical data and interpretations and, as appropriate, two or three-dimensional isoconcentration maps and geologic profiles showing distributions of VOCs and heavy metals; emphasis will be made on delineating "clean" portions of the Site and portions that will undergo SVE;
6. proposed cleanup goals;
7. documentation comparing mobile laboratory data with TCL/TAL data from a fixed laboratory; and
8. a conceptual design for installation and operation of a SVE remedial system.

2.9 Task 7 - IRM Design

The design of a full-scale SVE system will be based primarily on the vertical and lateral VOC contaminant distribution in the vadose zone and the design parameters established during the pilot testing. Due to the thickness of the vadose zone (i.e., approximately 50 feet), each extraction point may consist of up to three extraction wells with screens positioned at shallow, middle, and lower zones, respectively. This will allow a more uniform vapor flow distribution and provide operational flexibility.

Detailed design documents will be prepared for construction of the proposed SVE system. This effort will consist of design calculations including vacuum blower(s) sizing and air emission control system selection and sizing. Detailed design drawings will include vapor extraction well placement, monitoring probe/passive vent/air injection point locations, underground trench routes, treatment physical plant design and layout, and electrical and instrumentation details. Technical specifications will include well installation procedures, equipment and material specifications, contractor submittal requirements, and overall performance requirements. An operation and maintenance (O/M) plan and monitoring plan will be prepared for implementation of the IRM.

2.10 Task 8 - IRM Implementation

Following NYSDEC approval of the SVE system design, bids will be solicited to qualified contractors for SVE system construction. A preliminary construction schedule will be prepared prior to receipt of bids and modified based on input from the selected contractor. Following construction, HAI and LTR personnel will operate and maintain the SVE system.

3.0 REPORTING REQUIREMENTS

3.1 General

HAI proposes to submit monthly progress reports, an interim report, and a final report as part of the IRM. A brief description of each report and the timing of report submittals are described below.

3.2 Monthly Progress Reports

Monthly progress reports will be submitted to NYSDEC by the tenth day of each month and will include:

1. a description of the progress on the IRM and work conducted during the previous month;
2. identification of all work plans, reports and other deliverables described in this Work Plan that were completed during the previous month;
3. a description regarding the percentage completion, unresolved delays encountered or anticipated that may affect the schedule of the IRM discussed in this Work Plan, and efforts made to mitigate the delays;
4. a description of any modifications to this Work Plan and any future work plans;
5. changes in key personnel; and
6. a description of the actions, including, but not limited to, data collection and implementation of work plans that are scheduled for the next month.

3.3 Interim Report

An interim report will be prepared and submitted to NYSDEC summarizing the results of the vadose zone investigations and a refined approach to SVE pilot testing based on these findings. The report will focus on providing rationale for the pilot testing locations and methodologies, or modifications thereto, previously presented in the Work Plan.

3.4 Final Report

Following completion of the SVE pilot study, a final report will be prepared and submitted to NYSDEC. The potential content of this report is described in section 2.8.

4.0 SCHEDULE OF IMPLEMENTATION

An estimated project schedule is presented in Figure 4-1. The durations estimated for the field work are based on work being conducted during normal business hours Monday thru Friday. The schedule may require modification due to unexpected field conditions or NYSDEC review time.

FIGURE 4-1
REVISED ESTIMATED PROJECT SCHEDULE FOR THE IRM AT THE FORMER IMC MAGNETICS CORPORATION SITE IN WESTBURY, NEW YORK

Task Description	**Duration of Task (weeks)**	**Accumulated Project Time (weeks)**
Task 1 - File Review	2	2
Task 2 - Source and Release Identification and Surveying	2	4
NYSDEC Review of Work Plan[1]	4	8
Task 3 - Vadose Zone Investigation	3	11
Task 4 - Interim Report	2	13
NYSDEC Review of Interim Report[1]	2	15
Task 5 - Vacuum Extraction Pilot Test	1	16
Task 6 - Final Investigation Report	4	20
NYSDEC Review of Final Report[1]	4	24
Task 7 - IRM Design	4	28
NYSDEC Review of IRM Design[1]	4	32
Task 8 - IRM Implementation	Not Specified	Not Specified

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[1] It is assumed that this duration includes time for NYSDEC's review as well as time for IMC to address any comments and re-submit the document, if necessary. This duration may require modification based on the extent and time of NYSDEC's review.

5.0 REFERENCES

A variety of technical documents and publications were referred to during the course of this project. Some of the references consulted are presented below. Referenced documents and publications may or may not have been reviewed in their entirety. The guidelines and procedures presented in the referenced documents and publications have not been strictly adhered to unless otherwise stated.

NMB (USA) Inc.'s solicitation for qualifications and proposals for the IMC Magnetics Corporation facility, Westbury, New York, March 7, 1995;

Revised Draft Preliminary Assessment Report, New Cassel Industrial Area, Lawler Matusky & Skelly Engineers, October, 1994;

an untitled report from Anson Environmental Ltd. to representatives of IMC Magnetics Corp., dated July 21, 1993;

Closure Plan, IMC Magnetics Corp., Anson Environmental Ltd., December 3, 1993;

Closure Plan, History, Anson Environmental Ltd., December 3, 1993;

1993 Closure Plan Implementation, Volume 1, IMC Magnetics Corp., Anson Environmental Ltd, undated;

Closure Plan, Final Report, IMC Magnetics Corp., Anson Environmental Ltd., undated;

New Cassel Industrial Area Site North Hempstead Nassau County, Lawler, Matusky & Skelly Engineers, final submittal dated February 1995;

New York State Statutes, Article 27, Title 13 - Inactive Hazardous Waste Disposal Sites;

New York State Regulations, Title 6, Chapter IV, Subchapter B, Part 375 - Inactive Hazardous Waste Disposal Site Remedial Program;

Memorandum from Michael J. O'Toole, Jr., "Division Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels", November 16, 1992;

STARS (Spill, Technology and Remediation Series) Memo #1 Petroleum-Contaminated Soil Guidance Policy, prepared by NYSDEC Division of Construction Management, Bureau of Spill Prevention and Response, August 1992; and

Review draft *Soil Screening Guidance*, EPA/540/R-94/101, U. S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, December 1994.

APPENDIX A

Field Sampling and Analysis Plan (FSAP)

FIELD SAMPLING AND ANALYSIS PLAN

FOR THE

INVESTIGATION AND DESIGN OF THE INTERIM REMEDIAL MEASURE FOR THE VADOSE ZONE

AT THE

FORMER IMC MAGNETICS CORP.
MANUFACTURING FACILITY
WESTBURY, NEW YORK

MARCH 1996

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FIELD SAMPLING AND ANALYSIS PLAN FOR THE INVESTIGATION AND DESIGN OF THE INTERIM REMEDIAL MEASURE FOR THE VADOSE ZONE
FORMER IMC MAGNETICS CORP.
MANUFACTURING FACILITY
WESTBURY, NEW YORK

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1.0 INTRODUCTION

1.1 General

This Field Sampling and Analysis Plan (FSAP) has been prepared for IMC Magnetics Corp. (IMC); Hull and Associates, Inc. (HAI) field personnel and subcontractors; Land Tech Remedial, Inc. (LTR) field personnel and subcontractors, and other representatives for use during the vadose zone investigation at the former IMC Magnetics manufacturing facility in Westbury, New York (Site). The FSAP is intended to provide field sampling and analysis guidelines. HAI Standard Operating Procedures (SOPs) are located in Appendix A. While this document details sampling and analysis procedures, it is not meant to be a stand alone document and should be used in conjunction with the Work Plan, the Quality Assurance Project Plan (Appendix B of the Work Plan), and the Health and Safety Plan (Appendix C of the Work Plan). These documents are bound with this document and collectively form HAI Document #NMB004D.009.

1.2 Project Description

1.2.1 Soil Sampling Program

The investigation activities for soil will consist of the installation of soil borings to visually characterize the subsurface stratigraphy. Soil samples collected from soil borings will be analyzed at the on-site mobile laboratory for benzene, toluene, ethylbenzene, and xylenes (BTEX), tetrachloroethene (PERC), trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethene, (1,1-DCE), and trans 1,2-dichloroethene (trans 1,2-DCE) by modified EPA method 3810. In addition, selected subsurface soil samples will be analyzed for aromatic and chlorinated VOCs by EPA Method SW-846 8010/8020 and for lead, chromium, barium, cadmium, and mercury in accordance with EPA SW-846-7000 series.

1.2.2 Soil Vapor Extraction (SVE) Pilot Testing Program

The pilot testing program for the Site will consist of the installation of a SVE extraction well and approximately three SVE vapor monitoring wells. These wells will be used to conduct an SVE pilot test to determine the efficacy of SVE technology at the Site, as well as to produce design parameters for a potential full-scale SVE remediation system.

2.0 SOIL

2.1 Objectives

A soil boring program will be implemented to:

1. assess the Site geology by describing the unconsolidated overburden material to a maximum depth of fifty feet;
2. assess the unconsolidated hydrogeologic strata and the presence of confining layers; and
3. define the extent of potential contamination within soils.

2.2 Vadose Zone Soil Boring and Subsurface Investigation

Soil borings will be completed at the locations described in the Work Plan. Soil samples will be collected from all soil borings excluding those associated with the installation of the SVE pilot testing wells and vapor monitoring wells. Chemical analyses, visual soil descriptions, and textural analyses of these samples will also be conducted.

2.2.1 Sample Locations and Frequency

One soil boring located in Area 2 will be continuously sampled on 2-foot intervals to a total depth of 50 feet below grade. Two soil borings will be installed in areas determined to have the highest potential for elevated metals concentration in the vadose zone for metals delineation. These borings will be sampled on 10-foot intervals beginning at the interval 4 to 6-feet below grade and extending to 46 feet below grade. The remaining soil borings will be sampled on 5-foot intervals beginning at 4 to 6-feet below grade until two successive samples show no presence of VOCs as determined by the on-site analytical services.

2.2.2 Sample Designation

Soil samples will be identified using a Sample Identification Number (SIN). An example of a valid SIN for a soil sample would be as follows:

```
NMB004- SB1-SS3-D157
  |      |  |    └──── Dublin Employee #157
  |      |  └───────── Soil Sample Number
  |      └──────────── Soil Boring Station
  └─────────────────── Project Number
```

The sample identification of the soil samples will identify the station number (e.g., soil boring number, SB-X) and the soil sample number. Soil sample numbers are sequential and begin at one for each boring.

2.2.3 Sampling Equipment and Procedures

Soil borings will be completed using a *Geoprobe*. The *Geoprobe* will advance narrow diameter (1 to 1 3/8 inches) sampling probes into the subsurface using a hydraulic hammer mechanism.

2.2.3.1 *Geoprobe* Soil Sampling

Soil samples will be obtained by using a decontaminated, 2-foot long, 1 3/8 inch outer diameter piston sampler fitted with new, clean, acetate sampling liners. The soil sampler will be advanced to the target sampling depth, where the piston retaining pin will be removed. The soil sampler will be driven an additional 2 feet into the subsurface, displacing the piston with soil. The soil sampler will then be retrieved to the surface, and the soil sample will be removed from the sampler in the acetate liner.

2.2.4 Sample Handling

Each sample collected from soil borings will be split into two portions. The first portion will be utilized for headspace analysis. This portion will then be analyzed at the on-site laboratory. The second portion will be placed in the appropriate laboratory supplied analytical containers and placed on ice for possible future analysis at the fixed laboratory.

2.2.5 Headspace Analysis of Soil Samples

Soil samples will be analyzed in the field utilizing a photoionization detector (PID) or a flame ionization detector (FID) as described in HAI SOP No. 4008 (Appendix A). This screening will be performed on all soil samples collected during soil boring installation. Soil samples will be screened within 10 minutes of the time samples are collected. Calibration procedures for the PID and FID are included in HAI SOP No. 4008 (Appendix A).

2.2.6 Sample Handling and Chemical Analysis

A portion of each sample, as described above, collected from the continuously sampled and 5-foot interval sampled soil borings will be submitted to the on-site chemist for analysis of BTEX, PCE, TCE, 1,1,1-TCA, 1,1-DCE and trans 1,2-DCE by modified EPA method 3810. As described in the Work Plan, the "worst-case" soil sample per area of concern exhibiting the highest combined concentrations of PCE, TCE, 1,1,1-TCA, 1,1-DCE and trans 1,2-DCE by modified EPA method 3810 will be submitted to a fixed laboratory for analysis of aromatic and chlorinated VOCs by EPA Method SW-846 8010/8020 and for lead, chromium, barium, cadmium, and mercury in accordance with EPA SW-846 7000 series. Additionally, one "clean" sample per area of concern, exhibiting individual concentrations of PCE, TCE, 1,1,1-TCA, 1,1-DCE and trans 1,2-DCE by modified EPA method 3810 below their respective NYSDEC soil cleanup levels will be submitted to a fixed laboratory for analysis.[1] The soil samples collected from the two soil borings installed for metals delineation will be submitted to a fixed laboratory for the analysis of lead, chromium, barium, cadmium, and mercury in accordance with EPA SW-846 7000 series, and TCLP metals extraction. The TCLP extraction will be archived and analyzed only if the total metals analyses detect metals in concentrations above the NYSDEC cleanup levels. Sample selection may deviate from the above as approved by the Project Manager.

For quality assurance purposes, one field blank shall be collected for every twenty samples analyzed or a minimum of one per day. The sample shall be collected by decontaminating the *Geoprobe* soil sampler according to HAI SOP No. F1000 (Appendix A) and passing laboratory supplied water through the sampler. The water shall be collected in the properly preserved containers specified in

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[1] Based on soil cleanup levels detailed in the NYSDEC technical and administrative guidance memorandum, "Division Technical and Administrative Guidance Memorandum: Determination of Soil Cleanup Objectives and Cleanup Levels," November 16, 1992 (TAGM HWR-92-4046). The soil cleanup levels from NYSDEC's November 18, 1992 TAGM are only being used as a basis for comparison and are not to be construed as the cleanup goals for the IRM.

the QAPP and analyzed for the same parameters as the soil samples in the mobile laboratory by modified EPA method 3810.

Samples submitted for fixed laboratory analysis will be accompanied by trip blanks. Trip blanks will be prepared by the laboratory. The trip blank will be subject to the same handling and transportation procedures as the samples. **Trip blanks will be required at the rate of one per shipping container that contains samples for volatile analyses.** Trip blanks must remain in the sample shipping containers during sample collection and transportation (i.e., roundtrip).

2.2.6.1 Special Handling Considerations

Samples collected for chemical or physical analysis shall be stored in a manner to prevent the samples from freezing in cold weather. Samples collected in weather conditions above freezing for chemical analysis shall be stored at 4°C by placing them on ice in an ice chest or by storing them in the refrigerator located in the mobile laboratory immediately after the samples are obtained.

2.2.7 Chain-of-Custody

The chain-of-custody will trace possession and handling of individual samples from the time of field collection through laboratory analysis. The chain-of-custody program will include: sample labels, sample seals, field logbook, chain-of-custody record; sample analysis request sheet; and laboratory logbook. Chain-of-custody documentation will be used solely for samples submitted to a fixed laboratory. Because samples to be submitted to the mobile laboratory are analyzed within approximately one hour, and are sole custody of the analyst operating the mobile laboratory, conventional chain-of-custody documentation is unnecessary for these samples.

Sample Labels

All sample labels will contain the following information:

1. sample I.D. number;
2. name of collector;
3. date and time of collection;
4. place of collection; and
5. parameter requested for analysis.

Sample Seal

A seal will be placed on the sample container or on the shipping container to ensure that samples have not been disturbed during transportation.

Field Log Book

An up-to-date field log book will be kept by each sampling team. The log book shall include, but not be limited to, the following:

1. boring I.D.;
2. boring depth;
3. date and time of sample collection;
4. sampling sequence;
5. types of containers used to store samples;
6. sample I.D. numbers;
7. parameters requested for analysis/preservatives;
8. field analysis data and methods (i.e. temp, pH, etc.);
9. destination (lab) and transporter;
10. field observations; and
11. samplers.

Chain-of-Custody Record

The chain-of-custody record will be maintained to trace sample possession and time of collection for samples submitted to fixed laboratories. The chain-of-custody will accompany each sample and record the:

1. sample number;
2. signature of collectors;
3. date and time of collection;
4. sample type;
5. number of containers;
6. analytical parameters requested;
7. signature of relinquishee and dates of possession by each party; and
8. preservatives.

Laboratory Logbook

The laboratory will maintain a record of the processing steps that are applied to each sample (i.e. sample preparation techniques, instrumental methods, experimental conditions, QC results). The time, date and name of the person performing each processing will also be recorded.

2.2.8 Soil Classification and Field Descriptions

Samples will be classified in the field according to HAI SOP No. F1006 (Appendix A). Samples may be chosen for textural analyses at the discretion of the field hydrogeologist at a minimum of one sample per distinct stratigraphic interval.

2.2.9 Decontamination of Equipment

All soil sampling equipment such as the drill rig and related equipment shall be decontaminated in accordance with HAI SOP No. F1000 (Appendix A). All decontamination rinse water shall be collected and containerized for disposal.

2.2.10 Decommissioning of Soil Borings

Each soil boring that is not utilized for monitoring well installation shall be decommissioned by adding granular bentonite or bentonite slurry.

2.2.11 Disposal of Unused Soil Samples

All extraneous soils that are excavated during soil boring installation shall be properly stored and secured according to HAI SOP No. F1000 (Appendix A).

2.2.12 Air Quality Monitoring

Air quality monitoring will be performed for worker health and safety during the soil boring program as described in the Work Plan. Monitoring procedures and action levels are described in the HASP (Appendix C).

3.0 SOIL VAPOR EXTRACTION PILOT TESTING

3.1 Objectives

A soil vapor extraction pilot test program will be implemented to:

1. evaluate SVE as a remedial technology;
2. determine soil air permeability values;
3. establish design parameters for potential full-scale remediation system installation; and
4. evaluate the need for potential off-gas treatment technologies.

3.2 SVE Well Construction and Installation Procedures

3.2.1 SVE Well Locations

One SVE well has been proposed for this investigation. The SVE well will be "nested" and will consist of up to three separate screened intervals located in the same borehole. The number of screened intervals in the extraction well may vary based on the thickness of the unconsolidated/glacial material, the stratigraphy encountered, and/or the contaminant distribution encountered at the proposed location.

A minimum of three SVE vapor monitoring wells will be installed at varying radial distances away from the SVE extraction well. The vapor monitoring wells will also be nested so that screened sections will correspond in depth to the screened sections of the SVE extraction well. The vapor monitoring wells will be installed from 10 to 30 feet away from the SVE extraction well.

3.2.2 New Well Designation (Numbering)

New SVE extraction and vapor monitoring wells installed will be numbered to uniquely identify each well. Each SVE well nest will be numbered sequentially beginning at the next available well number for the Site. Monitoring and extraction points will be designated with an S, M, or D to signify whether the point is screened in the shallow, medial, or deep interval of the unsaturated zone of the Site.

3.2.3 SVE Well Installation Equipment and Procedures

3.2.3.1 Hollow Stem Auger Drilling

SVE wells will be installed utilizing hollow stem augers in accordance with HAI SOP No. F2000 (Appendix A).

3.2.3.2 SVE Well Construction Specifications

Each SVE well will be installed in accordance with HAI SOP No. F2003 (Appendix A).

3.2.4 Decontamination of Equipment

All sampling equipment including the drill rig and associated well construction equipment will be decontaminated in accordance with HAI SOP No. F1000 (see Appendix A).

3.2.5 Disposal of Auger Cuttings

All auger cuttings and extraneous soils that are excavated during SVE well installation shall be properly stored and secured according to HAI SOP No. F2013 (Appendix A).

3.2.6 Air Quality Monitoring

Air quality monitoring will be performed for worker health and safety during the SVE well installation program as described in the Work Plan. Monitoring procedures and action levels are described in the HASP (Appendix C).

3.3 SVE Pilot Testing

3.3.1 Locations and Frequency

SVE testing will be conducted on the SVE extraction well to determine design parameters in the screened intervals of the unsaturated zone. It is estimated that three stages of SVE flow rates will be tested per SVE extraction well screened interval; however, the testing format may vary based on observed field data.

3.3.2 Documentation

All SVE pilot test data will be recorded in field notebooks. At a minimum, the following information should be recorded for the pilot testing program:

1. personnel performing the tests;
2. well designation;
3. weather conditions;
4. test data; and
5. any other observations made during the tests.

3.3.3 SVE Pilot Testing

SVE pilot testing will be conducted by attaching a vacuum blower to the extraction well and monitoring the induced vacuum in surrounding monitoring points. It is estimated that three stages of air flow will be tested per screened section of the extraction well. During each stage, the following parameters will be measured every 30 minutes:

1. Vacuum at the extraction well head;
2. Air flow from the extraction well;
3. Volatile organic compounds (VOCs) from the extraction well using a PID or FID;
4. Induced vacuum in the surrounding SVE vapor monitoring wells.

Once an apparent equilibrium has been reached (after approximately 1 to 1.5 hours), the next air flow stage will be tested.

3.3.4 *Tedlar* Bag Effluent Air Sampling

During the SVE pilot testing, a minimum of one *Tedlar* bag air sample will be collected per SVE extraction well screened interval. The air sample will be collected from the SVE pilot testing stage, per screened interval, which produces the highest VOC emissions based on PID or FID effluent monitoring. The air sample will be submitted to a fixed laboratory for analysis of volatile aromatic and halogenated organic compounds by EPA method T014 or equivalent.

3.3.5 Quality Monitoring

Air quality monitoring will be performed for worker health and safety during the SVE pilot testing program as described in the Work Plan. Monitoring procedures and action levels are described in the HASP (Appendix C).

4.0 REFERENCES

A variety of technical documents, administrative documents, and publications were referred to during the preparation of this document. Some of the references consulted are presented below. Referenced documents and publications may or may not have been reviewed in their entirety. The guidelines and procedures presented in the documents and publications referenced may not have been strictly adhered to unless otherwise stated.

"RCRA Ground-Water Monitoring and Technical Enforcement Guidance Document," EPA, 1986.

"Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans," EPA, 1983.

"A Compendium of Superfund Field Operations Methods," EPA, 1987.

"Laboratory Soil Testing Army Corps of Engineers, Engineers Manual," 1110-2-1906, November 30, 1970.

"1990 Annual Book of ASTM Standards, "Soil and Rocks; Dimension Stone; Geosynthetics," Volume 04.08, 1988.

Calabrese, E.J. and Kostecki, P.T., 1989, Petroleum Contaminated Soils, Lewis Publishers, Volume II, Pages 134-135.

"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," USEPA, SW-846, 3rd Edition, September 1986.

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

"Methods for the Determination of Organic Compounds in Drinking Water," EPA/600/4-88/039, December 1988; modified for U.S. EPA Region I.

APPENDIX A

Hull & Associates, Inc.
Standard Operating Procedures

List of Standard Operating Procedures

F1000 - Decontamination of Field Equipment

F1006 - Field Soil Classification/Description

F2000 - Overburden/Glacial Drilling - Utilizing Hollow Stem Augers

F2002 - Decommissioning of Overburden/Glacial Geotechnical Soil Borings

F2003 - Vacuum Extraction Well Installation

F2012 - Procedure for Proper Containment/Storage of Used Drilling Fluids, Decon Fluids, and Purged Ground Water

F2013 - Procedure for Proper Containment/Storage of Soil Produced from Drilling Operations (Auger Cuttings) and Soil Excavations

F3000 - Subsurface Soil Sampling Utilizing a Split Spoon Sampler

F4008 - Soil/Water Sample Headspace Screening with a Photoionization Detector

SOP No. F1000
DECONTAMINATION OF FIELD EQUIPMENT

1.0 Purpose

This section documents the procedures that will be followed when decontaminating field equipment. The equipment may include split spoon soil samplers, bailers, trowels, shovels, hand augers, drilling rigs, soil vapor sampling equipment, or any other type of reusable equipment used during field investigations.

In appropriate, decontamination will be performed as a quality assurance measure and safety precaution. Proper decontamination will be performed to minimize cross contamination between sampling locations or sampling intervals and transporting potentially contaminated materials off-site.

Decontamination of the drilling rigs, if appropriate, will be conducted in a designated decontamination area. Most smaller equipment (e.g., submersible pumps, etc.) can be decontaminated at the sampling location or between collection points. All decontamination materials that cannot be recycled will be properly packaged and disposed of based upon the nature of contamination.

2.0 Equipment and Materials

- High-pressure steam cleaner
- Cleaning fluids: non-phosphatic soap and/or detergents, potable water, distilled/deionized water, hydrochloric/nitric acid, isopropanol, acetone, methanol, and/or hexane
- Shovels and brushes
- Paper towels
- Disposable gloves
- Waste storage containers: plastic bags, drums, boxes
- Cleaning containers: plastic buckets, etc.
- Plastic sheeting
- Personal protective equipment

3.0 General

A. All decontamination will be performed under the assumption that the equipment is contaminated.

B. An adequate supply of all decontamination equipment and materials will be available on site.

4.0 Procedures

The following sections present the decontamination procedures that will be followed during the performance of all field tasks. If different or more extensive procedures are required, they will be pre-approved by the Project Manager and Quality Assurance Officer.

4.1 Drilling Rig and Associated Equipment

A. All equipment associated with the selected drilling method coming in contact with potential contamination, both as part of subsurface equipment advancement and due to aboveground contact with drilling fluids, extracted soils, drill rig lubricants and fuels, etc., will be decontaminated prior to use of this equipment for soil boring advancement. At the discretion of the Project Manager, the entire drilling rig may be decontaminated due to foreign substances adhering two the rig as a result of operations, transplant from off-site, or travel between soil boring locations.

B. A high-pressure steam cleaner should be used to remove foreign material from inside and outside of drilling equipment that will not come into contact with test samples. Decontamination of sampling equipment (e.g., split-spoon samplers) is described in section 4.2.

C. All liquid and solid material produced from this operation will be collected and properly contained.

D. The date, time, and decontamination procedure used will be recorded on the boring log or daily field report or in a field notebook.

4.2 Split Spoon Barrel Sampler

To ensure that the potential for cross contamination is minimized during subsurface investigations, the split spoon sampler will be decontaminated between sampling intervals.

A. After collecting the split spoon sample, the sampler will be disassembled and decontaminated by first physically removing any adhering soil material from the sampler.

B. The sampler will be placed in a bucket containing a non-phosphatic soap solution (e.g., *Liquinox*) and scrubbed until visibly clean.

C. The sampler will then be thoroughly rinsed with potable water until all soap solution is removed.

D. The sampler will be reassembled.

4.3 Submersible Pump

This procedure will be employed to decontaminate the submersible pumps that are used in well purging and/or development operations.

A. After removing the pump from the well, all exterior surfaces (the housing and hose) will be wiped with clean paper towels and placed on clean plastic. If any extraneous material is present on the outside of the pump or hose, it will be removed using a stiff brush.

B. The pump will then be placed in a suitably sized container of non-phosphatic soap solution (e.g., *Liquinox*) and potable water. If possible, the pump will be turned on to circulate the solution through the pump.

C. If sampling for metals, local sampling protocol may require that the pump will be placed in a bucket containing ten percent hydrochloric or nitric acid and, if possible, turned on to circulate the acid through the pump. If sampling for organics, local sampling protocol may also require placing the pump in solvent pesticide grade isopropanol, acetone, methanol, and/or hexane alone, or if required, in some combination, and turned on to circulate the solution through the pump. **The compatibility of any corrosive materials with the internal or external parts of the pump must be verified prior to their use. In addition, the use of flammable materials for decontamination is prohibited unless the pump is certified to be intrinsically safe.**

D. Following each cleaning sequence described in B and C above, the pump will then be placed in a suitably sized container of clean potable or distilled water and then thoroughly rinsed. The pump will be turned on until the internal portion of the pump and tubing is free of cleaning solution; otherwise, the pump will be hand-circulated around the container and clean water will be cascaded into the pump. The outside of the pump housing will also be thoroughly rinsed with potable or distilled water. The last rinse applied to the pump system will always be distilled water.

E. The pump and hosing will be properly stored to ensure that the system remains clean during transportation to other well heads. The pump and hosing will not be allowed to come in contact with the ground at any time during handling and transportation. If this occurs, the pump and tubing will be recleaned.

F. All liquids and waste materials produced during this operation will be properly stored and disposed as determined by the Project Manager.

4.4 Bailers

This section documents the procedures that will be followed during the decontamination of re-useable bailers employed during purging or sampling operations.

A. After removing a dedicated bailer from the well, or a non-dedicated bailer from its transport packaging, it will be wiped with clean paper towels and placed on clean plastic.

B. The bailer will be scrubbed with non-phosphatic soap solution inside and out. The inside of the bailer will be scrubbed with a cylinder brush to ensure that interior walls are thoroughly cleaned.

C. If sampling for metals, local sampling protocol may require that the bailer is rinsed with ten percent hydrochloric or nitric acid. If sampling for organic, local sampling protocol may also require that the bailer be rinsed with solvent-grade isopropanol, acetone, methanol, and/or hexane alone, or if required, in some combination.

D. Following completion of each cleaning sequence described above in B and C, the bailer will be rinsed with potable (as approved by the Project Manager) or distilled water until it is free of the soap solution.

E. The bailer will then be wiped dry using paper towels.

F. The bailer will be properly stored and the bailer cord properly disposed of to prevent contamination from occurring between sampling locations. To properly store the bailer, the entire bailer will be placed in its dedicated PVC storage tube or wrapped in inert material (e.g., *Saran* wrap, aluminum foil, etc.).

G. All paper towels and plastic sheeting used during decontamination procedures will be placed in a trash bag and properly disposed. Liquids used for decontamination of the bailers will be collected, properly stored, and disposed of as directed by the Project Manager.

4.5 Soil Gas Sampling Equipment

This section documents the procedures that will be adhered to during the decontamination of soil gas survey equipment between sampling locations.

A. Any extraneous soil material on the sampling rods will be removed prior to washing the rods.

B. The collection rods, nipples, and shield point adapter will be placed in a suitably sized container and thoroughly scrubbed with a brush and non-phosphatic soap (e.g., *Liquinox*) solution.

C. The parts will be completely rinsed with distilled water until all residue of the soap solution is removed.

D. The collection rods will be wiped dry with paper towels and properly stored to prevent contamination between sampling locations.

4.6 Sampling Spoons, Trowels, or Scoops

A. All buckets, brushes, spoons, spades or trowels will be cleaned with a non-phosphate detergent (e.g., *Liquinox*) solution and rinsed well with distilled water prior to sample collection.

B. Two decontamination buckets will be prepared with an adequate amount of cleaning solution and one decontamination brush will be dedicated to each bucket.

C. Vinyl, latex, or nitrile gloves will be worn.

D. A two-stage decontamination process will be used. The grossly soiled sampling device will first be cleaned in the first bucket, rinsed with distilled water, then cleaned again in the second bucket and finally rinsed thoroughly with distilled water. The first bucket will be dedicated for removing the gross soil, sludge, or sediment.

E. When the cleaning solution in the first bucket becomes dirty, the solution shall be properly discarded and the second bucket will replace the first. A new cleaning solution will be prepared in the original first bucket and it will now become the second bucket.

4.7 Monitoring Well/Piezometer/Ground-Water Extraction Well/Soil Vapor Probe/Vacuum Extraction Well Casing and Screen Pre-Installation Decontamination Procedures

This section documents the procedures that will be adhered to during the pre-installation decontamination of a monitoring well, piezometer, ground-water extraction well, soil vapor probe, and vacuum extraction well casings and screens and bottom caps. The following procedures apply to both PVC and Type 304 stainless steel casing and screen materials.

A. All personnel handling the well materials will be wearing clean vinyl, nitrile or latex protective gloves.

B. When the well casing and screen is removed from the packaging, the well materials will be placed on clean saw horses or an equivalent support device. The well materials shall be washed with a clean stiff brush and a non-phosphatic soap solution (e.g., *Liquinox*).

C. After the well materials are washed, they will be rinsed with potable water.

D. A high pressure steam cleaner may then be used to thoroughly remove any remaining soap or soiled areas.

E. The final step will be to rinse the well materials with distilled water. The well materials shall remain on the saw horses until well construction commences.

4.8 Interface Probe and Water Level Indicator

The entire length of the probe and tape that was inserted into the well will be decontaminated by washing with a non-phosphate detergent (e.g., *Liquinox*) and then rinsing with distilled water.

5.0 Documentation

The procedure(s) employed, date(s), and time(s) will be recorded on the appropriate documentation (e.g., daily field reports, field notebooks, boring logs, etc.). Any deviation from these procedures must be noted. Deviations must be approved by the Project Manager and Quality Assurance Officer.

6.0 Special Notes

None

7.0 Applicable Standards and References

None

SOP No. F1006
FIELD SOIL CLASSIFICATION/DESCRIPTION

1.0 Purpose

This section documents the procedures to visually classify soils in the field. All descriptions shall follow ASTM D653 and D2488. As a field guide, the attached table summarizes the parameters to properly classify a soil sample.

2.0 Equipment and Materials

- Pocket penetrometer
- Visual soil classification reference (e.g., attached table)
- Dropper bottle with diluted HCl

3.0 Procedures

In general, soil descriptions shall be written in the following format:

- density or consistency classification/color/second major constituent (adjective)/major constituent (principle noun)/minor constituents/moisture content/other characteristics

For example: hard brown silty clay with a trace of sand and gravel, moist, fractured.

Moisture contents may be written as: saturated, wet, very moist, moist, slightly moist, and dry.

Damp may be substituted for moist.

Other characteristics that should be mentioned are: fractures, fracture fillings, laminations, varves, organic content, oxidation, mineral fillings, sorting, and any evidence of potential contamination.

See attached Table.

4.0 Documentation

A sample identification will be documented on the soil boring logs.

5.0 Special Notes

None

6.0 Applicable Standards and References

None

HULL & ASSOCIATES, INC.
PROCEDURES FOR VISUAL SOIL CLASSIFICATION

TERMINOLOGY

Unless otherwise noted, all terms utilized herein refer to the Standard Definitions presented in ASTM D 653 and D 2488.

PARTICLE SIZES

Boulders		-	Greater than 12 inches (305mm)
Cobbles		-	3 inches (76.2mm) to 12 inches (305mm)
Gravel:	Coarse	-	3/4 inches (19.05mm) to 3 inches (76.2mm)
	Fine	-	No. 4 - 3/16 inches (4.75mm) to 3/4 inches (19.05mm)
Sand:	Coarse	-	No. 10 (2.00mm) to No. 4 (4.75mm)
	Medium	-	No. 40 (0.425mm) to No. 10 (2.00mm)
	Fine	-	No. 200 (0.074mm) to No. 40 (0.425mm)
Silt		-	0.005mm to 0.074mm
Clay		-	Less than 0.005mm

COHESIONLESS SOILS

Classification

The major soil constituent is the principle noun, i.e. sand, silt, gravel. The second major soil constituent and other minor constituents are reported as follows:

Second Major Constituent (percent by weight)			Minor Constituents (percent by weight)	
Trace	-	1 to 12%	Trace	- 1 to 12%
Adjective (clayey, silty, etc.)	-	12 to 35%	Little	- 12 to 23%
And	-	Over 35%	Some	- 23 to 33%

Density Classification	Relative Density %	Approximate Range of (N)
Very Loose	0-15	0-4
Loose	16-35	5-10
Medium Dense	36-65	11-30
Dense	66-85	31-50
Very Dense	86-100	Over 50

Relative Density of Cohesionless Soils is based upon an evaluation of the Standard Penetration Resistance (N), modified as required for depth effects, sampling effects, etc.

COHESIVE SOILS

If clay content is sufficient so that clay dominates soil properties, clay becomes the principal noun with the other major soil constituent as modifier; i.e., silty clay. Other minor soil constituents may be included in accordance with the classification breakdown for cohesionless soils; i.e., silty clay, trace of sand, little gravel.

Consistency	Unconfined Compressive Strength (psf)			Approximate Range of (N)
Very Soft	Below		500	0 - 2
Soft	500	-	1000	3 - 4
Medium Stiff	1000	-	2000	5 - 8
Stiff	2000	-	4000	9 - 15
Very Stiff	4000	-	8000	16 - 30
Hard	8000	-	16000	31 - 50
Very Hard	Over		16000	Over 50

Consistency of cohesive soils is based upon an evaluation of the observed resistance to deformation under load and not upon the Standard Penetration Resistance (N).

SAMPLE DESIGNATIONS

AS - Auger Sample - Directly from auger flight.
BS - Miscellaneous Samples - Bottle or Bag.
S - Split Spoon Sample - ASTM D 1586-67.
LS - Liner Sample S with liner insert 3 inches in length.
ST - Shelby Tube Sample - 3 inch diameter unless otherwise noted.
PS - Piston Sample - 3 inch diameter unless otherwise noted.
RC - Rock Core - NX core unless otherwise noted.

STANDARD PENETRATION TEST (ASTM D1586): A 2.0" outside-diameter, 1-3/8" inside-diameter split barrel sampler is driven into undisturbed soil by means of a 140-pound weight falling freely through a vertical distance of 30 inches. The sampler is normally driven three successive 6-inch increments. The second and third blows are added to determine the Standard Penetration Resistance (N).

SOP No. F2000
OVERBURDEN/GLACIAL DRILLING - UTILIZING HOLLOW STEM AUGERS

1.0 Purpose

This section documents the procedures to advance hollow stem augers in the overburden/glacial material to collect geotechnical and hydrogeologic data and install ground-water monitoring wells.

2.0 Equipment and Materials

The driller shall be capable of providing power-driven sectional hollow stem auger flights with a minimum inside diameter of four inches. In addition, the following equipment will be on-site and provided by the drilling contractor:

- Drill rods, minimum size equivalent to the "A" rod, with an O.D. of 1 5/8 inch and an I.D. of 1 1/8 inch
- Hollow stem augers with a minimum of four-inch I.D.
- Hollow stem auger plug
- Drive hammer (1) 300 pound and (1) 140 pound ± 5 pounds
- Eighteen and twenty-four inch split-spoon barrel samplers
- Tri-cone roller and diamond core bit
- Water tank and pump
- Steam cleaner

3.0 Procedures

The boring will be advanced by rotating the hollow stem augers to the desired depth to collect a sample or install a well. For sample collection, the augers will be advanced to a particular depth and samples collected from the material ahead of the augers. The hole will then be advanced to the maximum penetration point of the sampler with the hollow stem plug in place. During the drilling operations for installating the monitoring wells, the borehole will be drilled using a hollow stem plug or auger plug. This will prevent drilling material from entering the augers.

To advance further into the borehole, additional flights of augers will be added one at a time to meet the required depth. If an obstruction is encountered, the driller must attempt to penetrate the obstruction using the tri-cone roller bit, coring device, or other acceptable equipment. If attempts to penetrate the obstruction are unsuccessful, the boring will be abandoned in accordance with HAI SOP No. F2002, and relocated upgradient of the decommissioned boring. It should be noted that the spoil material and unused soil samples produced from the drilling operation will be properly stored in DOT approved open-top steel drums or covered with visqueen in accordance with HAI SOP No. F2013.

Hollow stem augering will be employed **without** the use of drilling fluids unless approval is given by the Project Manager. When water is used in the drilling operations, it will not be recirculated back into boring unless approval is given by the Project Manager. Water produced from this operation will be properly contained in accordance with SOP No. F2012.

Upon completion and if a monitoring well is not installed, each boring will be abandoned in accordance with HAI SOP No. F2002.

4.0 Documentation

The details of the boring operations will be recorded on the HAI boring logs which will contain all pertinent data. Any deviations from this SOP and the reason for the deviation shall be documented.

5.0 Special Notes

Hollow stem augering is often the simplest technique for performing soil investigations and sampling. However, certain physical site characteristics often preclude the use of this technique. These characteristics may include: depth to ground water, soil characteristics (e.g., heaving sands) and the equipment used.

6.0 Applicable Standards and References

None

SOP No. F2002
DECOMMISSIONING OF OVERBURDEN/GLACIAL GEOTECHNICAL SOIL BORINGS

1.0 Purpose

This section documents procedures to decommission geotechnical borings drilled entirely in glacial/overburden material.

2.0 Equipment and Materials

- Drilling rig with hollow-stem augers or drive/spin casing
- Sodium-bentonite or cement-bentonite slurry
- Concrete

3.0 Procedures

A. The geotechnical boring to be decommissioned will be sealed by using a thick slurry mixture of sodium-bentonite or cement-bentonite slurry, which is injected at the bottom of the borehole using a tremie pipe. The casing or auger stem will be periodically filled as a section of the casing or augers is withdrawn to maintain a continuous seal. When completed, the slurry will be allowed to settle for approximately 18 to 24 hours. The borehole will then be reinspected and additional grout will be added if necessary.

B. After the slurry has reached a static level, the remaining annular space will be sealed with approximately three feet of concrete (in traffic areas). In areas which can support vegetative growth, the slurry will be leveled at approximately two feet below ground surface. The remaining two feet will then be filled with topsoil.

4.0 Documentation

All pertinent data such as the total depth of drilling, the amount of slurry used, the mixture of slurry used, the thickness of the slurry column, and the thickness of the concrete plug will be recorded on the soil boring log. The decommissioning of any geotechnical soil boring shall be performed under prior approval of the Project Manager.

5.0 Special Notes

If a new boring and/or monitoring well is installed, it will be placed approximately ten feet away and hydraulically upgradient from the previous location to prevent any potential effect of the sodium-bentonite slurry on the ground-water quality.

6.0 Applicable Standards and References

None

SOP No. F2003
VACUUM EXTRACTION WELL INSTALLATION

1.0 Purpose

This section documents the procedures that will be followed when constructing vacuum extraction (VE) wells.

2.0 Equipment and Materials

- Drilling rig with the capability of installing a four-inch diameter VE well using hollow stem augers
- Twenty-four inch split spoon barrel sampler
- Four-inch PVC casing and four-inch PVC slotted screen
- Clean filter sand (grain size ranging from 0.58 mm to 2.0 mm equivalent to U.S. standard sieve No. 30 and No. 10, respectively)
- Sodium-bentonite pellets, chips or granules
- 3000 psi concrete
- Flush mount protective manhole or other applicable protective casing
- Four-inch PVC tee (if underground header pipe will be connected to the well)

3.0 Procedures

A. The VE wells will be installed in a minimum of a 6.25 inch (ID) hollow stem auger borehole. The borehole will be advanced with hollow stem augers and sampled with a twenty-four inch split spoon sampler in accordance with HAI SOP No. F2000 and HAI SOP No. F3000, respectively. The borehole will be advanced until the piezometric surface or water table is encountered, or the predetermined depth has been achieved, at which time the drilling and sampling shall cease.

B. Once saturation is encountered, a one foot layer of clean filter sand (see Section 2.0 for proper grain size) to serve as a cushion will be placed at the bottom of the borehole. The PVC screen and casing shall be carefully lowered in the borehole. Figure F2003-1 illustrates a generalized schematic of the VE well construction. Screen length and slot size will be determined by the Project Manager.

C. Clean sand pack will be placed in the annular space around the screened portion of the well. This sand pack must extend a maximum of one foot above the top of the screen. The sand pack will serve as a filtering medium to mitigate the introduction of formational fines.

D. Sodium-bentonite pellets, chips or granules will be placed on top of the sand pack (one foot minimum thickness) to protect the extraction well from surface water infiltration. After placement, an appropriate quantity of potable or distilled water shall be poured into the borehole to hydrate the sodium-bentonite. A bentonite slurry will be placed in the remaining annulus to three feet below the surface.

E. Once the necessary piping is connected to the vacuum extraction well, a minimum three foot depth of concrete shall be placed around the wellhead to serve as an anchor. This concrete anchor must extend to the ground surface and serve as an apron with the surface sloping away from the well to divert surface water away from the wellhead. In addition to the concrete anchor, a flush-mount manhole or protective casing will be installed to protect the vacuum extraction well. If a flush-mount manhole is used, the VE well should be situated at an elevation in the manhole to allow a slip-on cap to be installed.

4.0 Documentation

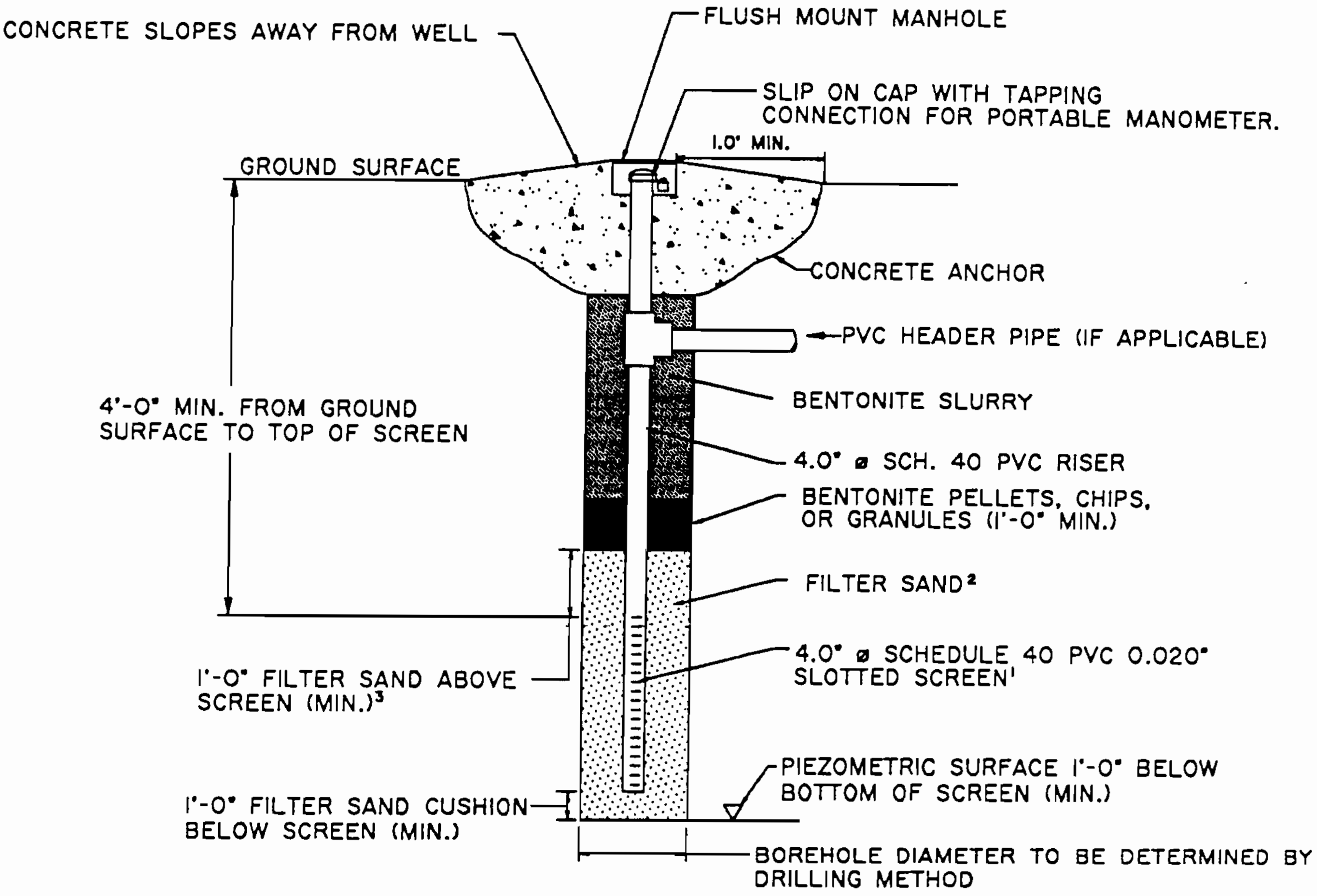
All pertinent construction data such as the total depth of borehole, the length of PVC screen, the thickness of the sand pack, the slot opening size, and the thickness of the sodium-bentonite seal will be recorded on the well construction log.

5.0 Special Notes

None

6.0 Applicable Standards and References

None



[1] SCREEN SLOT SIZE WILL VARY DEPENDING UPON FORMATION CHARACTERISTICS.

[2] FILTER PACK GRAIN SIZE WILL VARY DEPENDING UPON SCREEN SLOT SIZE.

[3] SAND FILTER CUSHION HEIGHT MAY BE ALTERED TO LESS THAN 1'-0" IF THE TOP OF THE SCREEN IS WITHIN 4'-0" OF THE GROUND SURFACE.

FIGURE F2003-1

Hull & Associates, Inc.

VACUUM EXTRACTION WELL CONSTRUCTION DIAGRAM

DATE:
AUGUST 1995

STD

IM\1000004I
07/27/96 SCHOONOV
UNIT 1 DISK 1

SOP No. F2012
PROCEDURE FOR PROPER CONTAINMENT/STORAGE OF USED DRILLING FLUIDS, DECON FLUIDS, AND PURGED GROUND WATER

1.0 Purpose

This section documents the procedures to properly contain or store drilling fluids that will be recirculated from a borehole, fluids extracted from a monitoring well, and decontamination fluids.

2.0 Equipment and Materials

- Five-gallon buckets
- Thirty-gallon trash can
- Portable water tank (of appropriate size)
- Dot approved, closed-top, 55-gallon steel drum, Type 17E
- Paint pen or permanent marker (indelible)

3.0 Procedures

A. Monitoring Wells/Extraction Wells Purge Water -All ground water that is extracted from a monitoring well/extraction well and not utilized for laboratory analysis must be temporarily stored in a DOT-approved fifty-five gallon steel drum with a closed top. The drum will be marked with the date of generation, the identification of the well the water was purged from, and the words "Purge Water". Purge water shall never be disposed of on the ground, into a sewer, or into a nearby stream unless permits are obtained. Water may only be discharged to a sewer or stream if permission has been granted from the appropriate agency.

B. Drilling Fluids - All water that is introduced to a boring by the drill rig to aid in the drilling procedure will not be recirculated back through the boring unless approval is given by the Project Manager. If water must be collected for disposal, the fluids shall be directed from the augers into a portable storage tank or tub via an overflow adaptor. The contents of the portable tank will then be disposed of as directed by the Project Manager.

C. Aquifer Test Purge Water - Water that is removed from the aquifer during a long duration or step-drawdown aquifer test will be disposed of as directed by the Project Manager.

Water that is extracted from a monitoring well to determine in-situ aquifer characteristics will be stored in a portable container near the test well and then disposed of as directed by the Project Manager. The portable container will be marked with the date of generation and the identification of the test well that water was extracted from.

D. Decontamination Fluids - Any fluids generated from decontamination procedures will be stored in DOT-approved fifty-five gallon steel drums with a closed top. The date of generation and the words "Decon Fluids" will be clearly marked on the drum.

4.0 Documentation

The volume of water extracted from a well from developing or purging activities will be recorded on the Ground-Water Data Sheet and in the field notebook.

The volume of ground water that is extracted from a monitoring well/extraction well will be recorded on the Aquifer Test Data Sheet and in the field notebook.

The volume of water collected from a boring during drilling procedures will be recorded on the Soil Boring Log.

The volume of decon fluids shall be recorded in a field notebook, soil boring log, or Ground-Water Data Sheet.

5.0 Special Notes

None

6.0 Applicable Standards and References

None

SOP No. F2013
PROCEDURE FOR PROPER CONTAINMENT/STORAGE OF SOIL PRODUCED FROM DRILLING OPERATIONS (AUGER CUTTINGS) AND SOIL EXCAVATIONS

1.0 Purpose

This section documents the procedures to be followed to properly contain auger cuttings or soils excavated in areas of known or suspected contamination.

2.0 Equipment and Materials

- Shovel
- DOT-approved 55-gallon steel drums with locking open-top lids, Type 17H
- Visqueen
- Straw bales
- Stakes or concrete blocks
- Paint pen or permanent marker (indelible)

3.0 General

A. Auger cuttings - All soil produced from drilling operations (auger cuttings) that is not saved for physical or chemical analysis will be containerized on-site in DOT approved 55-gallon drums or stockpiled on and covered with visqueen in accordance with the procedures described in Section 4.0.

B. Excavated Soils - All soil excavated from areas of known or suspected contamination will be stockpiled on and covered with visqueen in accordance with the procedures described in Section 4.0.

4.0 Procedures

A. Drum Storage - Drums used to containerize auger cuttings will be clean DOT-approved 55-gallon steel drums with locking open-top lids.

Auger cuttings will be placed in drums as soon as possible to avoid contaminating the ground surface near the boring. Each drum shall be clearly labeled to identify the date of generation and the boring it was generated from. If multiple drums are needed for a particular boring, they will be consecutively numbered as they are generated. An example of proper drum labeling is as follows:

8/6/94
SB5-001
(Soil Boring 5 - Drum No. 001)

Drums may also be labeled with a self-adhesive label which may include the following information:

Generator's Name and Address
Site Number
Date
Soil Boring Number(s)

Soil from different soil boring locations will not be mixed unless otherwise directed by the Project Manager. After the drums of soil are properly labeled and secured with a tight fitting lid, drums will be moved to a drum staging area. The location of the drum staging area will be coordinated with the site owner/operator. The location selected should be away from traffic patterns, but accessible for future pick-up.

B. Stockpiling - Excavated soils will be stockpiled in accordance with Figure F2013-1. Mixing auger cuttings from different locations will be verified with the Project Manager and the location of the stockpile will be coordinated with the site owner/operator. Prior to selecting a location, the volume of soil to be stockpiled will be estimated to determine the space requirements for stockpiling. The location selected should be away from traffic patterns, but accessible for future pick-up. It may be appropriate to form separate stockpiles for soils generated from different sources.

C. Soil Disposal - Prior to beginning the project, if possible, the Project Manager will determine the soil disposal alternatives. If required, the sampling procedure and list of parameters for analysis will be in accordance with the selected disposal facility's requirements.

5.0 Documentation

A. If auger cuttings are placed in drums, the following information will be included on the soil boring log, field notebook, or in the daily field report:

- the number of drums generated
- labeling procedures
- the type of drums used

B. If auger cuttings or excavated soils are stockpiled, this will be noted on the soil boring log, field notebook, or the daily field report. The estimated volume of soil produced from each source should also be noted.

C. Photographs will be taken of the drum staging area or the soil stockpile to document that proper handling procedures were followed.

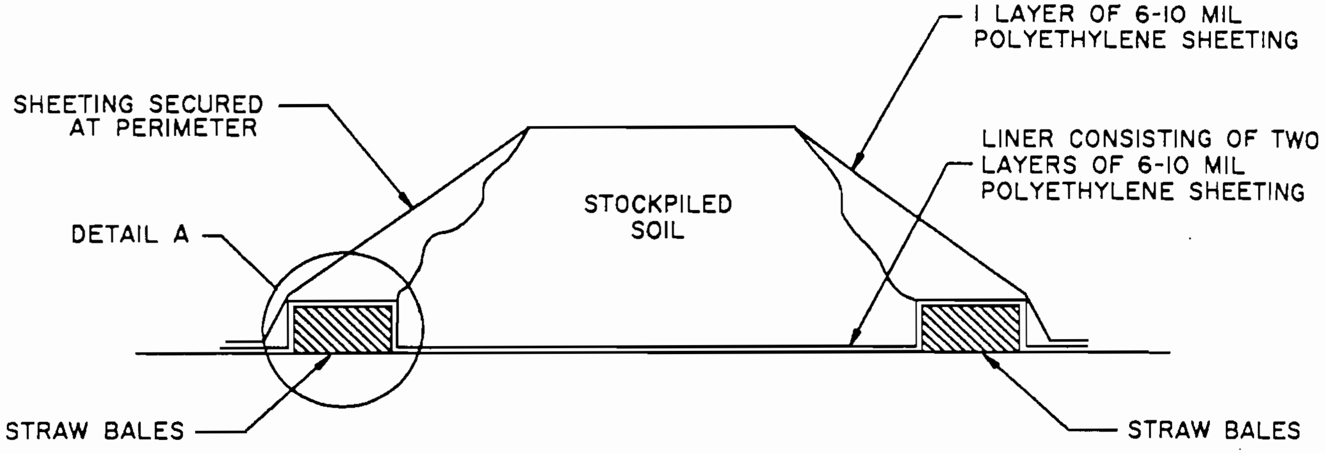
D. Chain-of-custody records will be completed for composite soil samples sent to the laboratory for analysis.

6.0 Special Notes

None

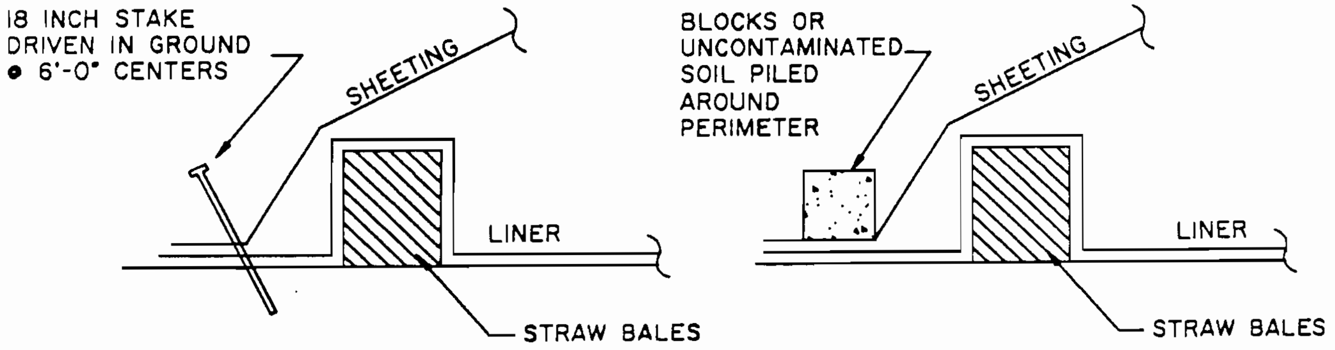
7.0 Applicable Standards and References

None



SECTION

SCALE: NONE



DETAIL A
SHEETING AND LINER ANCHORING
DETAILS

SCALE: NONE

FIGURE F2013-1

Hull & Associates, Inc.

STOCKPILED SOIL DETAILS

DATE:
AUGUST 1993

STD

HH\10000016
06/08/93
SCHOONOV

SOP No. F3000
SUBSURFACE SOIL SAMPLING UTILIZING A SPLIT SPOON SAMPLER

1.0 Purpose

Subsurface soil samples will be collected at discrete intervals to determine the physical and textural characteristics of the overburden/glacial material. Additionally, selected soil samples may be used to evaluate levels of contamination at various depths and aerial extent depending on the objectives of the project.

2.0 Equipment and Materials

- Analytical method-specified sample jars, if required
- One pint mason jars and/or ZipLoc bag
- 18 or 24-inch split-spoon sampling barrel with an appropriate drill rod assembly
- Drill rig with 140-pound drive weight system that allows for a 30-inch free fall
- Stainless steel laboratory spoon or spatula
- Clean disposable wipes
- Drill rig capable of utilizing a hollow stem auger system or drive and wash system

3.0 Procedures

A. After the borehole has been advanced to the desired sampling depth with the auger system or casing system, the split-spoon sampler will be assembled and lowered carefully into the bottom of the hole.

B. With the 18-inch or 24-inch split spoon set securely at the bottom of the augers or casing, the drill rod will be marked at consecutive six-inch intervals for the purpose of recording the number of blows to drive the sampler six inches. The length of sampler will depend on subsurface conditions (e.g., compactness, etc.) and will be subject to the approval of the Project Manager. If the sampler does not reach the base of the augers or casing, the sampler will be withdrawn and the borehole will be cleaned out to ensure that the sampler collects a representative sample of the overburden/glacial material for the particular sampling interval.

C. The split spoon sampling barrel, independent of the length of the sampler, will be driven by a free-falling drop hammer weighing 140 pounds and falling thirty inches (ASTM D 1586-84). The sampler will be driven using Standard A drilling rods or equivalent connected between the sampler and the driving weight. The number of blows to drive the sampler for each six-inch interval will be recorded. The sampler will be driven at least the length of sampler (e.g., 24 inches), unless sampler refusal occurs or the blow count exceeds 100 per six-inch drive. If greater than 100 blows per six-inch drive occurs, then the driving will stop and the sampler retrieved. Prior to removal, the sampler may have to be rotated clockwise to free the sampler from dense soils. Upon removal, the amount of bumping or banging on the drill rods will be minimized to reduce disturbance to the sample and the possibility of losing a sandy sample.

D. If conditions necessitate, the drilling fluids (e.g., potable water, etc.) will be added to mitigate the problem of "heaving" sand. If this problem occurs, the augers or casing will be kept full during sampling and sampling recovery. This procedure will only be followed under the approval of the Project Manager. In cases where samples are collected for chemical analyses, no drilling fluid will be added to the borehole. This procedure must be followed to protect the chemical integrity of the soil sample.

E. The sampler will be retrieved and immediately opened to measure the length of recovery. Recovery will then be recorded on the soil boring log. Any loose material at the top of the sampler will not be included in the measurement of recovery and will be discarded (this is usually material that has fallen into the borehole). The samples will immediately be visually described utilizing the parameters described in HAI SOP No. F1006. All pertinent data will be recorded on the soil boring log corresponding to the particular soil boring.

F. If the sample recovery is insufficient, the sampler will be reassembled and placed back into the borehole. The sampling procedure will then be repeated.

G. If headspace analysis is required, the sample will be placed into a clean one-half or one-pint sample jar after it has been visually described in accordance with HAI SOP No. 1006. Headspace analysis will be performed on soil samples in accordance with HAI SOP No. F4008.

H. The collected soil samples will be placed in a properly labeled sample jar. The labeling will include, but is not limited to, the date of collection, project number, boring designation, sample number, and sampling interval.

I. After each sampling interval, the split spoon barrel sampler will be decontaminated in accordance with HAI SOP No. F1000.

4.0 Documentation

All sampling information will be recorded on a properly labeled soil boring log. Any additional comments or problems incurred during the sampling event will also be recorded.

5.0 Special Notes

None

6.0 Applicable Standards and References

None

SOP No. F4008
SOIL/WATER SAMPLE HEADSPACE SCREENING WITH A PHOTOIONIZATION DETECTOR

1.0 Purpose

This section documents the procedures that will be followed to perform headspace screening on soil and water samples utilizing a photoionization detector (PID).

2.0 Equipment and Materials

- A photoionization detector equipped with the appropriate eV bulb
- Calibration gas (isobutylene)
- Mason jars (pints or quarts) with mason jar lid rings
- 1 qt. *Zip-loc* baggies
- Aluminum foil

3.0 Procedures

A. The PID will be calibrated in accordance with the manufacturers' requirements. Calibration should be performed at a minimum interval of once per day, specifically at the beginning of each day. The time, date, and other pertinent calibration information (e.g., span setting) will be recorded in the field notebook or on the appropriate field data sheet. If a log book is kept with the instrument, the information will also be recorded in it.

B. When the sample (e.g., soil or water) is collected, it will be placed into the glass sample jar until the jar is approximately half full. The mouth of the jar will be sealed with clean aluminum foil and the lid ring (without the lid) placed on the jar and the foil sealed against the jar. The sample jar will be agitated for at least fifteen seconds taking care to avoid piercing the foil seal. The sample will be allowed to develop for five to ten minutes in a warm area. The probe will be inserted through the foil seal and the maximum meter response (which should occur after two to five seconds) will be recorded.

As an alternative, *Zip-loc* baggies may be used to screen soil samples. The sample will be prepared in the same manner as with a glass jar. After the sample has developed, the probe will be inserted through the upper portion of the baggie to obtain the headspace reading.

C. Special care will be taken to avoid inserting the probe directly into the sample (e.g., soil or water), thus preventing permanent damage to the instrument.

4.0 Documentation

PID readings and calibration data will be recorded in the field notebook or on an appropriate data sheet.

5.0 Special Notes

Use of the PID shall be avoided in atmospheres with high humidity. The meter response is affected by high humidity. In addition, the meter should be acclimated to the atmosphere that will be measured (i.e., the PID will not be used immediately after taking it from a heated car or building to a cool outdoors. Approximately fifteen to thirty minutes should pass before it is used).

6.0 Applicable Standards and References

Calabrese, E.J and P.T. Kostecki. Petroleum Contaminated Soils, Volume 2. Lewis Publishers, Inc. pp 133-135. 1989.

APPENDIX B

Quality Assurance Project Plan (QAPP)

Land Tech Remedial Inc., Analytical Services

ANALYSIS OF VOLATILE AROMATIC AND CHLORINATED COMPOUNDS BY GAS CHROMATOGRAPHY: METHODS AND QA/QC PROCEDURES

INTRODUCTION

This *Method* and *Quality Assurance/Quality Control (QA/QC) Program* outlines the operational guidelines of Land Tech Remedials (LTR) Analytical Services. Methods and QA/QC procedures employed by LTR are specifically designed to meet the standards of analytical methods required by regulatory agencies, and to serve the individual needs of our clients. The purpose of this document is to provide information on laboratory operations and procedures of LTR's Analytical Services starting at the time of sample collection to the delivered data in a site investigation report.

OBJECTIVES

- ➲ To deliver analytical data that are scientifically valid, defensible and represent our sound professional judgment.
- ➲ To ensure that the selected analytical method, its sensitivity, accuracy and precision meets the requirements of regulatory agencies and is adequate for the intended use of the sample data.
- ➲ To offer a competitive, highly advanced analytical program that can be specifically tailored for every investigation in the field of environmental assessment and remediation.

METHODOLOGY

I. Equipment and Materials

Equipment: Analysis of volatile aromatic and chlorinated components by LTR's Analytical Services are performed using SRI 8610 Gas Chromatographs with JNW DB 5 capillary columns. For analysis of volatile aromatic components LTR's Analytical Services utilize a Photo-Ionization Detector (PID) in series with a Flame-Ionization Detector (FID), and for analysis of chlorinated components a Photo-Ionization Detector (PID) in series with an Electrolytic Conductivity Detector (ELCD). Peak areas of target components are integrated using a two channel Peaksimple III data system installed on a Toshiba model T3200 portable computer. Weights and dilutions are determined using a Mettler top-loading balance to 0.01 g, and a Fisher constant temperature water bath is used for thermal and phase equilibration required for analytical methods. Samples that are not immediately analyzed are stored in a under-counter refrigerator/freezer at 4° C.

Materials: Sampling vials, 40 ml I-Chem screw cap septum vials, and sample preparation equipment (B-D disposable plastic syringes and needles) are used only once then disposed of in a safe and appropriate manner. Spatula for soil sample preparation are cleaned with soapy water and dried with a clean paper towel. For headspace injections separate, clearly labeled gas-tight glass syringes are used for standards, blanks, low-, and high-concentration samples. After each use the syringes are disassembled, the needle is cleaned with the appropriate wires, the plunger wiped clean, and the syringe barrel is baked at 50° C and purged with clean air or nitrogen gas.

Maintenance: In the daily start-up procedure for the operation of the gas chromatograph LTR's Analytical Services follows start-up recommendations of the manufacturer along with our internal standard operating procedure. This procedure includes scrupulous cleaning of the photo-ionization detector lamp window, visual inspection of column, leak testing of connections, checking and setting of gas flow rates, setting of column temperature and integration parameters and replacement of the injector port septum.

In-house inspection and maintenance of water bath and refrigerator are routinely performed. The analytical balance is checked annually by a service representative with NBS traceable weights.

Reagents and Standards: Standards are prepared using certified high purity analytical standards (Chem Service) in methanol that are stored at 4° C and properly disposed of at their expiration date. Preparation of standards proceeds by gravimetric dilution of these certified standard solutions with deionized water to the desired concentration. After dilution standards are immediately and carefully transferred into 40 ml screw cap septum vials and permanently labeled with their content of components and their precise concentrations. Standards should be prepared daily but under no circumstances are they to be stored for more than 48 hours at 4° C.

II. Personnel Requirements and Training

All personnel of LTR's Analytical Services must have adequate education, training, and experience to carry out their responsibilities as gas chromatography analyst. To ensure that each analyst has acquired both sufficient and applicable knowledge the main objectives and analytical tasks are periodically reviewed, and recommendations for additional training needs are evaluated.

III. Sample Handling and Documentation

Proper sample collection, preservation and storage, preparation, and documentation of sample are the first steps in ensuring highest quality analytical data. Once a sample of ground water or soil is collected by field personnel, it is immediately sealed in the appropriate container and labeled with the location of probe, depth of sampling interval, and collection time. The field technician is responsible for plotting probe locations on the site map and recording the date, time, site coordinates and depth of collected samples, soil type (e.g. geological description, presence of discoloration, odor, and soil moisture content).

Immediately after securing the collected sample, it becomes sole custody of the analyst of LTR's Analytical Services. The receipt of each sample is documented by the analyst based the sample ID, depth of sampling interval, time of receipt, and a brief sample description (e.g., color, odor, presence of sheen). All samples are chilled to 4° C immediately after collection and maintained at that temperature until analyzed. Because of the specialized nature of our testing, additional preservation (other than refrigeration) of aqueous samples will only be required if samples are not analyzed within eight hours of being sampled. It is the analyst's responsibility to verify probe location and commence with sample preparation requirements prior to analysis. Because sample analyses are performed on-site within hours, conventional chain of custody protocols are not necessary.

IV. Methods for Analysis of Volatile Aromatic and Chlorinated Components

Sample preparation and analytical methodology for determination of purgeable aromatics in water has been adapted from "Methods for the Determination of Organic Compounds in Drinking Water", Report No. EPA/600/4-88/039 (revised July 1991), EPA Methods 502.2 and 503.1. Analytical Services will develop special methods as requested and when considered suitable.

Analysis by EPA Method 3810 (Headspace): Analysis of water and soil samples for volatile aromatic (EPA 8020) and chlorinated components (EPA 8010) in LTR's mobile laboratories (see Table 1) employs a static headspace extraction technique as outlined in USEPA SW-486 Method 3810. LTR's Analytical Services analyze volatile aromatic and chlorinated components by a modified headspace method to be performed directly in a 40 ml screw cap septum vial in which an aqueous sample is collected in the field. For analysis of 8020 components LTR's Analytical Services utilize a Photo-Ionization Detector (PID) in series with a Flame-Ionization Detector (FID), and for analysis of 8010 components a Photo-Ionization Detector (PID) in series with an Dry-Electrolytic Conductivity Detector (DELCD).

Table 1.

8020	Detection Limit in Soil	Detection Limit in Water
Benzene	5 ppb	1 ppb
Toluene	5 ppb	1 ppb
Ethylbenzene	5 ppb	1 ppb
p, m-Xylene	5 ppb	1 ppb
Chlorobenzene	5 ppb	1 ppb
1,2-Dichlorobenzene	5 ppb	1 ppb
1,3-Dichlorobenzene	5 ppb	1 ppb
1,4-Dichlorobenzene	5 ppb	1 ppb
Methyl Tertiary Butyl Ether	10 ppb	5 ppb

8010	Detection Limit in Soil	Detection Limit in Water
1,1-Dichloroethene	5 ppb	1 ppb
trans-1,2-Dichloroethene	5 ppb	1 ppb
cis-1,2-Dichloroethene	5 ppb	1 ppb
1,1-Dichloroethane	5 ppb	1 ppb
1,1,1-Trichloroethane	5 ppb	1 ppb
Tetrachloroethene	5 ppb	1 ppb
Trichloroethene	5 ppb	1 ppb
Chloroform	5 ppb	1 ppb
Methylene Chloride	5 ppb	1 ppb

Static headspace involves a partitioning of volatile compounds between the aqueous and vapor phases enclosed in a gas-tight vial. To achieve representative and reproducible results, the static headspace method requires that chemical and thermal equilibrium be achieved within the sample vial. Therefore, all standards, blanks and samples are placed in a constant temperature water bath (25° C) for at least 30 minutes. Then a 10 cc disposable B&D luer lock syringe is inserted through the septum to withdraw 10 cc of sample solution. The vial is kept in an inverted position and shaken thoroughly for 2 minutes. The vial, with 10 ml of headspace, is then again placed in the water bath for at least 5 minutes to reach thermal and phase equilibrium. At the time of analysis, 100 µL of the sample gas phase are withdrawn using a gas-tight glass syringe, and directly injected into the column of the gas chromatograph. When the volume of headspace to volume of aqueous phase is a constant ratio in all samples and standards, a standard calibration curve can be used for each target compound to determine its concentration in a unknown water or soil sample. Detection limits for volatile aromatic and chlorinated components are summarized in Table 1, and analytical uncertainties are better than the EPA required ±20%.

Methanol Extraction Technique: At high expected concentrations of chlorinated compounds (> 1000 ppb) a methanol extraction method will be used for analysis. This method is based on extracting the contaminants from sediment or soil with methanol. For sediment/soil that are insoluble in methanol approximately 4 g (wet weight) of sample are weighed into a tared 20 ml vial. About 9 ml of methanol are added to the sample and the mixture shaken for two minutes. Using a disposable pipette, approximately 1 ml of the extract is diluted with deionized water in a 40 ml screw cap septum vial and subsequently treated and analyzed following the headspace method. Matrix matching standards for this method are prepared using certified high purity analytical standards in the desired working range.

V. Pre-Sample Run Procedures

Start-up Procedure: This daily performed instrument performance check includes scrupulous cleaning of the photo-ionization detector lamp window, visual inspection of column, leak testing of connections, checking and setting of gas flow rates, setting of column temperature and integration parameters and replacement of the injector port septum.

GC Instrument Calibration: Separate matrix matching standards are prepared for method EPA 8010 and the methanol extraction technique. For each target compound a seven-point calibration curve in the desired working range has been established using certified high purity analytical standards. The GC instrument calibration is verified daily by an internal Quality Control four-point calibration. QC standards are prepared using certified high purity analytical standards in the routine working range and analyzed before samples are run. Data are recorded in quality control logs and checked for systematic trends (e.g. drift of the gas chromatograph) and biases. Retention times of individual compounds are determined at the beginning of each day's operation using the QC standards, and with every additional standard run (at least after every tenth sample analysis).

Method and Water Blanks: Method and deionized water blanks are run at least once with each batch of samples to assess contamination in sample treatment, reagents and glass ware. The method blank determines if any compounds were retained on the column from a previous batch of samples, whereas the water blank is an aliquot of deionized water prepared and analyzed following the identical procedure which is used for samples. Method and water blanks are run at the frequency required by the method and must be within required QC limits before sample analysis can begin.

Duplicate Sample Analysis: The reproducibility of standards and samples is determined by the analysis of two aliquots of the same standard or sample. Duplicate analysis serves as an internal check on sampling techniques, analytical accuracy, and precision.

VI. Post-Sample Run Procedures

Each blank, standard and sample chromatogram is carefully interpreted by the analyst and integration constraints for every peak thoroughly evaluated. Then a hard copy and a computer data file is generated for each standard, blank and sample chromatogram with the following information:

- Sample/standard identification.
- Date, time of analysis and operator.
- Site location and client ID.
- Carrier gas flow rate.
- Column temperature parameters and detector channel(s).
- Column type, length and diameter.
- Temperature in the mobile lab and outside weather conditions.

External Quality Control Samples: To ensure the analytical capability is maintained and to detect any possible deviation from highest quality data, external quality control samples are to be periodically analyzed at six month intervals. Samples are obtained as part of the Proficiency Analytical Testing Program. These QC samples serve as an independent check on the total analytical procedures.

CORPORATE QUALITY ASSURANCE MANUAL

Laboratory Resources INC.

A UNITED WATER RESOURCES CO. (NYSE)

Laboratory
Resources INC.
100 Hollister Road, Teterboro, NJ 07608, 201-288-3700

April 26, 1994

CORPORATE
QUALITY ASSURANCE
MANUAL

Prepared by: Lee F. Cramer
Lee F. Cramer
Quality Assurance Director

Approved by:
August F. Percocco
President

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SCOPE OF THE CORPORATE QUALITY ASSURANCE MANUAL

This Corporate Quality Assurance Manual contains general quality assurance information necessary to implement the Laboratory Resources, Inc. (LRI) Quality Assurance Program. All LRI management and analytical personnel are required to be familiar with the contents of this manual and are responsible for implementation of the Quality Assurance Program within their respective domains.

This manual does not, however, include all the information necessary for complete implementation of the Quality Assurance Program. Additional information and procedures are found in the following LRI manuals.

1. *Statement of Qualifications:* Information about LRI facilities, instrumentation, organization, and resumes for key personnel
2. *Sample Management Manual:* Procedures for sample management, including sample login, storage, and chain of custody
3. *Corporate Data Management Manual:* Procedures for data management, including data review, validation, deliverables generation, and compliance screening
4. *Standard Operating Procedures for Analyses:* Method-specific quality control requirements

QUALITY ASSURANCE POLICY

Prepared by: ______________________
President

Reviewed and implemented by: ______________________
Quality Assurance Director

The quality assurance policy of Laboratory Resources, Inc., is expressed in the following extract from the corporate Mission Statement.

> **Laboratory Resources will be known for its ability to consistently meet customer demands and for the high quality of analysis which becomes part of every analytical report it generates. Customers will be assured their expectations will be met on time, every time.**

QUALITY ASSURANCE OBJECTIVES

Prepared by: ______________________
Quality Assurance Director

Reviewed and approved by: ______________________
President

Results generated by environmental laboratory analyses are used to make decisions involving the expenditure of large amounts of time and money, and could even lead to the incarceration of responsible parties. It is imperative, therefore, that the data supplied by the laboratory are of known and measurable quality. The following quality assurance objectives ensure that data produced by Laboratory Resources, Inc., (LRI) will meet these requirements.

- Ensure compliance with certification requirements
- Ensure compliance with regulatory agencies
- Ensure compliance with contract requirements
- Ensure compliance with published methodologies
- Establish minimum standards consistent with industry practices

The procedures in this manual were developed to achieve these objectives and are binding on all LRI employees.

INSTRUMENT SPECIFICATIONS

Prepared by: ______________________
Quality Assurance Director

Reviewed and implemented by: ______________________
General Manager

Prepurchase Requirements for All Instruments

1. The Technical Director shall review all proposed instrument purchases to ensure the following requirements are met:

   a. The instrument must meet all requirements of the analytical procedure(s) for which it will be used.
   b. The instrument must meet all requirements of this section of the Quality Assurance Manual.
   c. The proposed purchase shall be reviewed for compatibility with existing and proposed hardware and software, operator training requirements, and fit into the overall LRI business plan.

2. If the purchase includes software or involves interfacing with software, the proposal must be reviewed by the information systems analyst for compatibility and stability.

Analytical Balances

Analytical balances must have a minimum sensitivity of 0.1 mg (0.0001 g).

General Purpose Balances

General purpose balances must have a minimum sensitivity less than 1% of the target weight or 0.1 g, whichever is less.

Visual/Ultraviolet Spectrophotometers

Spectrophotometers must have a bandwidth of no more than 20 nm and a wavelength accuracy of ±2.5 nm.

pH Meters

pH meters must have an accuracy and readability of at least ±0.05 pH units within the pH range of 2.0 to 10.0.

Specific Ion Meters

Specific ion meters must have an accuracy and readability of at least ±5 mV.

Conductivity Meters

Electrodes for conductivity meters should have platinum electrodes; nonplatinum electrodes must be calibrated against a platinum electrode every six months.

Thermometers

1. All thermometers must be of the appropriate immersion type for the intended use.

2. Thermometers used for measurement of water sample temperature must be graduated in 0.1 °C increments.

3. Thermometers used for temperature monitoring of incubators must be graduated in 0.2 °C increments.

3. Thermometers used for temperature monitoring of refrigerators, and ovens must be graduated in 0.5 °C increments.

Temperature Control Equipment

1. Freezers used for storing organic standards or extracts must maintain a temperature not exceeding -10 °C.

2. Refrigerators used for storing standards or sample must maintain a temperature between 1 °C and 4.5 °C.

3. BOD incubators must maintain a temperature of 20.0 °C ±1.0 °C.

4. Total coliform incubators must maintain a temperature of 35.0 °C ±0.5 °C.

5. Fecal coliform incubators must maintain a temperature of 44.5 °C ±0.2 °C and a relative humidity of at least 90%.

INSTRUMENT MAINTENANCE

Prepared by:

Quality Assurance Director

Reviewed and implemented by:

General Manager

The chart on the following page lists minimum maintenance requirements for gas chromatography (GC), gas chromatography/mass spectrometry (GC/MS), inductively coupled argon plasma (ICP), graphite furnace atomic absorption (GFAA), and direct aspiration flame atomic absorption (FLAA) instruments. The maintenance requirements listed are general and minimal; any additional maintenance requirements listed in the manufacturers' manuals are also required and shall be included with these minimum requirements in the LRI instrument operation manual.

All scheduled and unscheduled maintenance activities shall be recorded in the instrument maintenance logbook. A separate instrument logbook is required for each instrument. The maintenance logbook must conform to the requirements of the Laboratory Notebook Procedures section of this manual and must be maintained in the same room as the instrument. The following information shall be recorded for each maintenance event:

Date and time maintenance was initiated
Triggering event
Description of maintenance performed
Date and time maintenance was completed
Initials of person who performed maintenance
Initials of supervisor if maintenance was not performed by supervisor

Minimum Maintenance Requirements

Instrument	Procedure	Frequency
GC/MS	Change pump oil	Annually or when oil becomes dark
	Change alumina beads	Annually or when beads become dark
	Change VOA packed columns	When ketone peaks broaden
	Change BNA capillary columns	When the column becomes too short to resolve N-nitrosodimethylamine or when response for acids can't be restored
	Change BNA glass wool liner	Daily or after analysis of "dirty" extract
	Change VOA trap	When gases and ketones lose sensitivity
	Clean VOA source	When BFB m/z 75 is too high
	Clean BNA source	When DFTPP m/z's 219 and 502 are too low or ion focus is greater than 30 V
GC	Change septa	Daily or every sequence, whichever occurs first
	Change injection liners	At the beginning of each sequence
	Clip column	Every two months; sooner if indicated by chromatography
	Change pesticide column	Every six months; sooner if indicated by chromatography
	Change volatiles column	Annually; sooner if indicated by chromatography
	Change oxygen and moisture filters	Annually; sooner if indicated
	Change volatiles trap	Annually; sooner if indicated
	Clean ECD detector	Annually
	Change PID lamp	Every six months
ICP	Clean torch	Weekly
	Clean nebulizer end cap	Weekly
	Replace pump tubing	Weekly
	Clean filters	Weekly
	Clean autosampler	Weekly
	Adjust dark current and light current	Annually
Furnace	Clean contact rings	Daily
	Change contact rings	Monthly
	Clean quartz windows	Daily
	Check cooling water	Weekly
	Align optics	As required
Flame AA	Clean instrument	Weekly
	Align optics	As required

GLASSWARE SPECIFICATIONS

Prepared by: Quality Assurance Director

Reviewed and implemented by: General Manager

1. All glassware used for chemical analysis must be manufactured from borosilicate glass unless specified otherwise by the analytical procedure.

2. All volumetric glassware must be Class A. Volumetric glassware shall not be exposed to temperatures greater than 105 °C.

3. Dangerously broken, chipped, or cracked glassware shall not be used for analysis. This does not apply to broken tips on separatory funnels.

4. Before use, glassware must be cleaned according to the Glassware Cleaning procedure in this manual.

5. Mohr and similar measuring pipettes shall not be used for chemical analysis.

GLASSWARE CLEANING

Prepared by: ______________________
Quality Assurance Director

Reviewed and
implemented by: ______________________
General Manager

This procedure is to be used for cleaning all glassware used for sample analysis.

ALL GLASSWARE MUST BE THOROUGHLY RINSED WITH TAP WATER BEFORE SUBMITTING TO BE CLEANED.

Glassware cleaning personnel must wear their lab coats, aprons, gloves, and safety glasses as required by laboratory safety policies.

Initial Cleaning of All Glassware

1. Thoroughly wash the glassware in tap water and phosphate-free detergent until the glassware is free of visible material. If this does not adequately clean the glassware, soak the glass in Chromerge™ solution for one hour.
2. Rinse the glassware at least four times with tap water to remove all detergent.
3. INORGANIC ANALYSIS GLASSWARE ONLY.
    a. Rinse the glassware with 20% nitric acid, taking care that all internal surfaces are rinsed.
    b. Rinse the glassware with tap water to remove all traces of the nitric acid.
4. Thoroughly rinse the glassware with reagent water (DI water).
5. Dry the glassware at 105 °C in the drying oven.
6. Return the glassware to the appropriate room.

Pre-analysis Rinsing for Organic Analysis Glassware

This procedure is to be performed by the analyst just prior to using the glassware for extraction or analysis.

1. Rinse the glassware with acetone.

2. Rinse the glassware with the solvent to be used in the extraction or analysis procedure.

REAGENT SPECIFICATIONS

Prepared by: ______________________
Quality Assurance Director

Reviewed and
implemented by: ______________________
General Manager

Reagent Water

Reagent water used for chemical or microbiological analyses must meet the following specifications. If any parameters are outside control limits the reagent water cannot be used until the reagent water supply is serviced. Bottled reagent water may be used if the laboratory reagent water supply is out of specifications provided the bottled water is tested and found to meet the requirements below.

Reagent Water for Chemical Analyses

1. Conductivity must be measured and recorded daily. The control limit for conductivity is 0.5 μmho/cm maximum (2 Megohm/cm minimum) at 25 °C.
2. pH must be measured and recorded daily. The pH must be between 5.5 and 7.5 units.
3. Specific chemical contamination is monitored by the analysis of method blanks. The reagent water supply must meet all method-specific requirements for method blank analysis.

Additional Monitoring for Microbiology Analyses

1. Residual chlorine must be analyzed and recorded monthly, and must be less than 0.1 mg/L.
2. Heterotrophic plate count must be analyzed and recorded monthly, and must be less than 1000 colonies/mL.
3. Cadmium, chromium, copper, lead, nickel, and zinc must be analyzed and recorded annually, and the concentration of each metal must be less than 50 μg/L.
4. All TAL metals must be analyzed and recorded annually, and the total concentration of all metals must be less than 1000 μg/L.

5. Bacterial quality must be analyzed and recorded annually, and must be between 0.8 and 3.0.

Reagents

1. All inorganic reagents shall be ACS Reagent Grade or equivalent unless the analytical procedure specifies a different grade.

2. All organic reagents used to prepare standards shall be of the highest quality obtainable. Organic reagents used to prepare general reagent solutions shall be free of detectable interferences as demonstrated by the analysis of acceptable method blanks.

3. All organic solvents shall be free of detectable residue as demonstrated by the analysis of acceptable method blanks. For organic analyses contamination shall not be restricted to target analytes.

Other Supplies

1. Supplies such as filter paper, glass wool, and boiling beads must be free of contamination as demonstrated by the analysis of acceptable method blanks. For organic analyses, contamination shall not be restricted to target analytes.

2. Supplies such as those listed above used for preparation of organic extracts shall be prerinsed with the solvent(s) used in the extraction and concentration procedures.

3. All dessicants must contain moisture indicators.

REAGENT LABELLING, DOCUMENTATION, AND STORAGE

Prepared by: ______________________
Quality Assurance Director

Reviewed and implemented by: ______________________
General Manager

Purchased Chemicals and Solutions

1. The labels of all purchased chemicals and solutions must be marked with the date of receipt. If chemicals or solutions are purchased in case quantities, the date of receipt can be marked on the outer case at the time of receipt. As each container is removed from the case the date of receipt must be copied to the label on the container.

2. As new stock is received, rotate the old stock so that the oldest stock is most accessible (in front or on top) and the newest stock is least accessible (in back or on bottom).

3. If an expiration date is not provided by the manufacturer, the following default dates shall be recorded on the label:

   a. Volatile organic solutions: one (1) month from the date opened
   b. Other solutions with organic solvents: three (3) months from the date opened
   c. Aqueous solutions: six (6) months from the date opened
   b. Neat chemicals: two (2) years from the date opened

4. If the storage requirements are not provided by the manufacturer, the following storage requirements apply:

   a. Aqueous solutions and neat chemicals: store at room temperature
   b. Solutions in organic solvents:
      1) Sealed ampules may be stored at room temperature until opened
      2) All other containers must be stored in a freezer (-15 °C)
      3) Volatile organic solutions shall not be stored with any other solutions

Solutions Prepared in the Laboratory

1. The following information shall be recorded on the storage container label for each standard:

   Name of solute
   Concentration
   Solvent (if other than water)
   Storage conditions
   Expiration date
   Lot number

2. The following information shall be recorded in the laboratory notebook or logbook:

   Date prepared
   Name of solute
   Weight of solute
   Solvent (if other than water)
   Final volume of solution
   Concentration of solute
   Lot number assigned to solution
   Name of preparer

3. The following expiration times apply to all solutions where the expiration time is not provided by the method:

   a. Volatile organic solutions: one (1) month
   b. Other solutions with organic solvents: three (3) months
   c. Aqueous solutions: six (6) months

4. If the storage requirements are not provided by the method, the following storage requirements apply:

   a. Solutions with organic solvents shall be stored in a freezer (-15 °C)
   b. Volatile organic solutions shall not be stored with any other solutions
   c. Aqueous solutions shall be stored at room temperature

STANDARDS LABELLING, DOCUMENTATION, AND STORAGE

Prepared by: ______________________
Quality Assurance Director

Reviewed and
implemented by: ______________________
General Manager

Labelling

The following information shall be recorded on the storage container label for each standard:

Name of solute
Concentration
Solvent (if other than water)
Storage conditions
Expiration date
Lot number

Documentation

The following information shall be recorded in the standards preparation logbook:

Date prepared
Name of solute
Manufacturer of solute
Lot number of solute
Weight of solute
Purity of solute
Corrected weight of solute if purity is less than 95%
Solvent (if other than water)
Manufacturer of solvent
Lot number of solvent
Final volume of solution
Concentration of solute
Lot number assigned to standard
Name of preparer

Purchased Standards

1. All certificates and documentation pertaining to concentrations, purity, traceability, *etc.*, must be retained for a minimum of five (5) years.

2. The concentrations of uncertified standards must be verified using primary standards or secondary standards that can be traced to primary standards. Record verification data in the standards preparation logbook.

Storage

Expiration

The following expiration times apply where the expiration time is not provided by the manufacturer or method:

a. Volatile organic standards: one (1) month
b. Other standards with organic solvents: three (3) months
c. Aqueous standards: six (6) months

Storage Conditions

The following storage conditions apply where the storage conditions are not specified by the manufacturer or method:

a. Standards with organic solvents shall be stored in a freezer (-15 °C)
b. Volatile organic standards shall not be stored with any other standards
c. Aqueous metals standards and stable inorganic standards shall be stored at room temperature
d. Unstable aqueous standards shall be stored in a refrigerator (1 - 4 °C)

PERSONNEL REQUIREMENTS BY FUNCTION

Prepared by: Quality Assurance Director

Reviewed and implemented by: General Manager

The personnel requirements of this section merge the USEPA minimum requirements for certification and contract compliance. The requirements are listed by function; the actual titles will differ in certification and contract documents. If an individual performs more than one function, that individual must satisfy the requirements for all the functions he or she performs. In addition, many contracts require redundancy for most functions.

This is a guidance document and the requirements herein are not mandatory for LRI laboratories. However, all personnel employed by LRI must meet the minimum requirements for the states in which the laboratory holds or seeks certification, as well as the requirements of any contracts in which the laboratory is engaged.

Industrial Hygiene Laboratory Director

Education

- Bachelor's degree in science

Experience

- Full certification by the American Board of Industrial Hygiene ***or***
- Five years combined education beyond the bachelor's degree level and experience in an industrial hygiene laboratory

Industrial Hygiene Laboratory Manager

Education

- Bachelor's degree in science

Experience

- Full certification in chemical aspects by the American Board of Industrial Hygiene ***or***
- Five years combined education beyond the bachelor's degree level and experience, at least half of which must be in industrial hygiene chemistry and the remainder in other analytical chemistry procedures

Environmental Laboratory Manager

Education

- Bachelor's degree in science
- If the degree is not in chemistry, chemistry courses equivalent to a minor in chemistry are required

Experience
- Two years of experience in an environmental laboratory

Quality Assurance Officer

Education
- Bachelor's degree in any scientific or engineering discipline

Experience
- Three years of laboratory experience
- One year of applied experience with quality assurance principles and practices in an environmental laboratory

Deliverables/Compliance Screening Supervisor

Experience
- Three years of experience in compliance screening and preparing data deliverables
- One year of supervisory experience in the preparation of data deliverables

Sample Custodian

Experience
- Three years of experience in sample receiving, login, chain-of-custody documentation, and internal transfer
- One year of related supervisory experience

GC/MS Supervisor

Education
- Bachelor's degree in any scientific or engineering discipline
- If the degree is not in chemistry, chemistry courses equivalent to a minor in chemistry are required
- A formal training course in GC/MS operation

Experience
- Three years of experience in interpretation of GC/MS data, and operation and maintenance of GC/MS systems
- One year of supervisory experience

Mass Spectral Interpretation Specialist

Education
- Bachelor's degree in any scientific or engineering discipline
- A formal training course in mass spectral interpretation

Experience
- Two years of experience in mass spectral interpretation

GC/MS Operator

Education
- Bachelor's degree in any scientific or engineering discipline ***or*** increase the experience requirement to three years
- A formal training course in GC/MS operation

Experience

- One year of experience in operation and maintenance of GC/MS systems

GC Supervisor

Education

- Bachelor's degree in any scientific or engineering discipline
- If the degree is not in chemistry, chemistry courses equivalent to a minor in chemistry are required

Experience

- Three years of experience in interpretation of GC data, and operation and maintenance of GC systems
- One year of supervisory experience

Pesticide Residue Specialist

Education

- Bachelor's degree in any scientific or engineering discipline

Experience

- Two years of experience in interpretation of GC data, and operation and maintenance of GC systems

GC Operator

Education

- Bachelor's degree in any scientific or engineering discipline *or* increase the experience requirement to three years
- If the degree is not in chemistry, chemistry courses equivalent to a minor in chemistry are required

Experience

- One year of experience in operation and maintenance of GC systems

Organic Extraction Supervisor

Education

- Bachelor's degree in any scientific or engineering discipline

Experience

- Three years of experience in organic sample preparation
- One year of supervisory experience

Extraction/Concentration Specialist

Education

- High school diploma
- A college level course in general chemistry

Experience

- One year of experience in extraction and concentration

Inorganic Chemistry Supervisor

Education

- Bachelor's degree in any scientific or engineering discipline

Experience
- Three years of laboratory experience
- One year of supervisory experience

ICP Spectroscopist

Education
- Bachelor's degree in any scientific or engineering discipline
- Specialized training in ICP spectroscopy

Experience
- Two years of experience with ICP analysis of environmental samples

ICP Operator

Education
- Bachelor's degree in any scientific or engineering discipline *or* increase the experience requirement to four years
- A short course in ICP

Experience
- One year of experience in operation and maintenance of ICP systems

AA Operator

Education
- Bachelor's degree in any scientific or engineering discipline *or* increase the experience requirement to four years

Experience
- One year of experience in operation and maintenance of ICP systems

Inorganic Sample Preparation Specialist

Education
- High school diploma
- A college level course in general chemistry

Experience
- Six months of experience in an analytical laboratory
- If microwave digestion is used, six months of experience in sample dissolution using microwave digestion techniques is required

Classical Chemistry Specialist

Education
- Bachelor's degree in any scientific or engineering discipline *or* increase the experience requirement to three years

Experience
- One year of experience in classical procedures

Microbiology Supervisor

Education

- Bachelor's degree in science
- A minimum of three credits in microbiology
- A minimum of two weeks formal training in microbiological analysis of drinking water

Experience

- One year of experience in microbiology

Microbiology Specialist

Education

- High school diploma or equivalent

Experience

- One year of experience in sanitary, water, milk, or food microbiology

Industrial Hygiene Analyst

Same as the requirements for the corresponding specialist above

Systems Manager

Education

- Bachelor's degree with four or more intermediate courses in programming, information management, database systems management, or systems requirements analysis

Experience

- Three years of experience in data systems management or programming
- One year of experience with the software being used for data management and generation of laboratory reports

Programmer Analyst

Education

- Bachelor's degree with four or more intermediate courses in programming, information management, database systems management, or systems requirements analysis

Experience

- Two years of experience in systems or applications programming
- One year of experience with the software being used for data management and generation of laboratory reports

EMPLOYEE TRAINING

Prepared by: ______________________
Quality Assurance Director

Reviewed and implemented by: ______________________
General Manager

1. The manager of administration shall orient all new employees and provide each new employee with an Employee Packet. The new employee shall verify that he or she has reviewed the materials provided in the Employee Packet by signing the form provided at the end of the Employee Handbook.

2. Safety training is the responsibility of the laboratory safety officer.

    a. Each employee whose duties involve work in the laboratory or sample management areas shall receive a copy of the laboratory contingency plan, chemical hygiene plan, and chemical waste plan. This must be read and a statement signed by the employee indicating the plans were understood.

    b. The employee shall be given a tour of the laboratory, and all safety equipment and exit locations shall be pointed out.

    c. The employee shall receive the laboratory safety training course and then must complete the safety training examination and obtain a passing grade for each section of the test.

    d. In addition to the above, employees whose duties require access to the hazardous waste storage room shall receive respirator training and a respirator fit test.

3. Each new analyst shall receive orientation from his or her immediate supervisor. This orientation shall include location of the Quality Assurance Manual, SOPs, notebooks, and physical layout of the department. The new analyst shall be briefed on quality assurance practices, use of SOPs, and laboratory etiquette.

4. Each analyst must be qualified in each analysis he or she is to perform.

    a. The analyst will be provided with a copy of the LRI SOP for the procedure in which he or she is to be qualified. The analyst will be provided an opportunity to discuss the procedure with the department manager or a lead technician designated by the department manager. When it is determined that the analyst understands the procedure and its quality control requirements, the analyst and department manager shall enter the analysis name and LRI SOP number in the Laboratory Training Log, and both the analyst and department manager shall sign and date the entry LRI SOP READ AND UNDERSTOOD.

b. The analyst will perform the analysis on blanks and laboratory control samples under the direct supervision of the department manager or lead technician. The analyst must demonstrate proficiency in the analysis of QC samples by obtaining results within the method specified laboratory control sample recovery limits. When acceptable proficiency has been demonstrated, the analyst and department manager shall sign and date the Laboratory Training Log entry PROFICIENCY DEMONSTRATED.

NOTE: Some analyses, such as ignitability, cannot be spiked. In these cases a standard reference material or previously analyzed sample must be analyzed.

APPROVED ANALYTICAL METHODS

Prepared by: Quality Assurance Director

Reviewed and implemented by: General Manager

Most environmental regulations stipulate the methods which must be used to perform analyses. This stipulation may take the form of a specific procedure, or a list of procedures or references from which an appropriate method may be chosen. In general, these procedures must be performed without modification. There are two exceptions:

1. If a regulatory agency modifies a published procedure, the modified procedure must be used for analyses performed within the agency's jurisdiction.

2. The stipulated procedure may not be appropriate for analysis of some samples. (This most often happens when a water method is specified for a nonaqueous sample.) When this occurs, the laboratory must, with the client's permission, work with the regulatory agency to determine a course of action. Possible actions are, in order of preference, to (1) use a different procedure, (2) use an agency modification, (3) use a laboratory modification, or (4) delete the analysis for the affected samples. When contacting the regulatory agency, the laboratory should be prepared to suggest appropriate alternate or modified procedures. The section in this manual on Alternate Methods should be consulted.

   NOTE: Any agreement reached between the laboratory, client, and regulatory agency must be confirmed in writing, and the written document must include the scope of the agreement. (The scope of the agreement may be specific samples only, a specific project, any project for this agency, *etc.*) The written confirmation must be included in all applicable hardcopy data packages.

Divisions of Laboratory Resources, Inc., (LRI) are restricted to methods from the following list. When selecting methods from this list, the laboratory must ensure that the method is appropriate for the regulation and the sample to be analyzed. Methods with an asterisk (*) appended are LRI modifications that must be approved before use.

Leachate Procedures

EP Toxicity Extraction by Federal Register/SW-846 method 1310
TCLP Bulk Extraction by Federal Register/SW-846 method 1311
TCLP Zero Headspace Extraction by Federal Register/SW-846 method 1311

Organic Extractions

Extraction Procedures

Herbicides by SM14 method 509B
Herbicides by EPA method 515.1
Herbicides by SW-846 method 8150
Pesticides and PCBs by ASP 12/91
Pesticides and PCBs by OLM02 (CLP)
Pesticides and PCBs by EPA method 505
Pesticides and PCBs by EPA method 508
Pesticides and PCBs by EPA method 608
Pesticides and PCBs by SW-846 method 3510
Pesticides and PCBs by SW-846 method 3520
Pesticides and PCBs by SW-846 method 3550
~~Pesticides and PCBs by SW-846 method 3580~~
Petroleum Hydrocarbons Fingerprint by SW-846 method 8015*
Phthalates by EPA method 606
Phthalates by SW-846 method 3510
Phthalates by SW-846 method 3520
Phthalates by SW-846 method 3550
Phthalates by SW-846 method 3580
Semivolatiles (BNA) by ASP 12/91
Semivolatiles (BNA) by OLM02 (CLP)
Semivolatiles (BNA) by EPA method 625
Semivolatiles (BNA) by SW-846 method 3510
Semivolatiles (BNA) by SW-846 method 3520
Semivolatiles (BNA) by SW-846 method 3550
Semivolatiles (BNA) by SW-846 method 3580

Cleanup Procedures

Acid/Base Partition Cleanup by 3650
Alumina Cleanup by 3611
Fluorisil Cleanup by EPA method 608/SW-846 method 3660
Gel Permeation Cleanup by SW-846 method 3640
Sulfur Cleanup by EPA method 608/SW-846 method 3660

Organic Analyses

Gas Chromatography Methods

Alcohols by SW-846 method 8015*
Herbicides by SM14 method 509B
Herbicides by EPA method 515.1
Herbicides by SW-846 method 8150
Pesticides and PCBs by ASP 12/91
Pesticides and PCBs by OLM02 (CLP)
Pesticides and PCBs by EPA method 505
Pesticides and PCBs by EPA method 508
Pesticides and PCBs by EPA method 608
Pesticides and PCBs by SW-846 method 8080
Petroleum Hydrocarbons Fingerprint by SW-846 method 8015*
Petroleum Hydrocarbons by ASTM method D3328
Phthalates by EPA method 606
Phthalates by SW-846 method 8060
Volatiles by EPA method 501.1
Volatiles by EPA method 502.2
Volatiles by EPA method 503.1
Volatiles by EPA method 504
Volatiles by EPA method 601
Volatiles by EPA methods 601 + 602
Volatiles by EPA method 602
Volatiles by EPA method 603
Volatiles by SW-846 method 8010
Volatiles by SW-846 methods 8010 + 8020
Volatiles by SW-846 method 8020
Volatiles by SW-846 method 8021

Gas Chromatography/Mass Spectrometry Methods

Semivolatiles (BNA) by ASP 12/91
Semivolatiles (BNA) by OLM02 (CLP)
Semivolatiles (BNA) by EPA method 625
Semivolatiles (BNA) by SW-846 method 8270
Volatiles by ASP 12/91
Volatiles by OLM02 (CLP)
Volatiles by EPA method 524.2
Volatiles by EPA method 624
Volatiles by SW-846 method 8240
Volatiles by SW-846 method 8260

Metals Preparation and Analyses

ICP Methods

General Metals by ICP, ASP 12/91
General Metals by ILM03 (CLP)
General Metals by EPA method 200.7
General Metals by SW-846 method 6010
General Metals in Sludge by NJDEPE method DEP 100

Furnace Methods

Aluminum by EPA method 202.2
Antimony by EPA method 204.2
Arsenic by EPA method 206.2
Arsenic by SW-846 method 7060
Arsenic by ASP 12/91
Arsenic by ILM03 (CLP)
Arsenic in Sludge by NJDEPE method DEP 100
Antimony by SW-846 method 7041
Barium by EPA method 208.2
Beryllium by EPA method 210.2
Beryllium by SW-846 method 7091
Cadmium by ASP 12/91
Cadmium by ILM03 (CLP)
Cadmium by EPA method 213.2
Cadmium by SW-846 method 7131
Chromium by EPA method 218.2
Chromium by SW-846 method 7191
Copper by EPA method 220.2
Iron by EPA method 236.2
Lead by ASP 12/91
Lead by ILM03 (CLP)
Lead by EPA method 239.2
Lead by SW-846 method 7421
Manganese by EPA method 243.2
Molybdenum by EPA method 246.2
Molybdenum by SW-846 method 7481
Nickel by EPA method 249.2
Selenium by ASP 12/91
Selenium by ILM03 (CLP)
Selenium by EPA method 270.2
Selenium by SW-846 method 7740
Silver by EPA method 272.2
Thallium by ASP 12/91
Thallium by ILM03 (CLP)

Thallium by EPA method 279.2
Thallium by SW-846 method 7841
Tin by EPA method 282.2
Titanium by EPA method 283.2
Vanadium by EPA method 286.2
Vanadium by SW-846 method 7911
Zinc by EPA method 289.2

Flame Methods

Aluminum by SW-846 method 7020
Barium by EPA method 208.1
Barium by SW-846 method 7080
Beryllium by EPA method 210.1
Beryllium by SW-846 method 7090
Cadmium by EPA method 213.1
Cadmium by SW-846 method 7130
Calcium by EPA method 215.1
Calcium by SW-846 method 7140
Chromium by EPA method 218.1
Chromium by SW-846 method 7190
Copper by EPA method 220.1
Copper by SW-846 method 7210
Iron by EPA method 236.1
Iron by SW-846 method 7380
Lead by EPA method 239.1
Lead by SW-846 method 7420
Iron by EPA method 236.1
Iron by SW-846 method 7380
Lead by EPA method 239.1
Lead by SW-846 method 7420
Magnesium by EPA method 242.1
Magnesium by SW-846 method 7450
Manganese by EPA method 243.1
Manganese by SW-846 method 7460
Nickel by EPA method 249.1
Nickel by SW-846 method 7520
Potassium by EPA method 258.1
Potassium by SW-846 method 7610
Silver by EPA method 272.1
Silver by SW-846 method 7760
Sodium by EPA method 273.1
Sodium by SW-846 method 7770
Thallium by EPA method 279.1
Thallium by SW-846 method 7840

Zinc by EPA method 289.1
Zinc by SW-846 method 7950

Cold Vapor Methods

Mercury by ASP 12/91
Mercury by ILM03 (CLP)
Mercury by EPA method 245.1
Mercury by SW-846 method 7470
Mercury by SW-846 method 7471

General Chemistry

Methods for Water and Aqueous Preparations

Acidity by EPA method 305.1
Alkalinity by EPA method 310.1
Alkalinity, Bicarbonate, by SM16 method 403
Alkalinity, Phenolphthalein Endpoint, by EPA method 310.1
Ammonia Nitrogen by EPA method 350.1
Ammonia Nitrogen by EPA method 350.3
Ammonia Nitrogen with Distillation by EPA method 350.2
Biochemical Oxygen Demand (BOD), 5-Day, by SM16 method 507
Biochemical Oxygen Demand (BOD), 20-Day, by SM16 method 507
Biochemical Oxygen Demand, Carbonaceous (CBOD), 5-Day, by SM16 method 507
Biochemical Oxygen Demand, Carbonaceous (CBOD), 20-Day, by SM16 method 507
Biochemical Oxygen Demand, Nitrogenous (NBOD), 5-Day, by SM16 method 507
Biochemical Oxygen Demand, Nitrogenous (NBOD), 20-Day, by SM16 method 507
Bromide by EPA method 300.0
Carbon, Total Organic (TOC) by SW-846 method 9060
Chemical Oxygen Demand (COD) by HACH method 8000
Chloride by EPA method 325.3
Chlorine Demand by SM16 method 409A
Chlorine, Residual, by EPA method 330.5
Chromium, Hexavalent, by SM16 method 312B
Chromium, Hexavalent, by SW-846 method 7196
Color by EPA method 110.2
Conductance, Specific, by EPA method 120.1/SW-846 method 9050
Cyanide by ASP 12/91
Cyanide by ILM03 (CLP)
Cyanide, Amenable, by EPA method 335.1/SW-846 method 9010
Cyanide, Free, by EPA method 335.2
Cyanide, Total by EPA method 335.2/SW-846 method 9010
Fluoride by EPA method 340.2
Formaldehyde by AOAC method 20.062
Halides, Total Organic (TOX) by SW-846 method 9020

Hardness by SM16 method 314A
Hardness by SM16 method 314B
Kjeldahl Nitrogen, Total (TKN) by EPA method 351.3
Langelier Index by SM16 method 203
Nitrate Nitrogen by EPA method 352.1
Nitrate Nitrogen by Calculation (nitrate-nitrite *minus* nitrite)
Nitrate-Nitrite Nitrogen by EPA method 353.1
Nitrite Nitrogen by EPA method 354.1
Odor (TON) by EPA method 140.1
Oil & Grease by EPA method 413.1/SW-846 method 9070
Oil & Grease by EPA method 413.2
Organic Nitrogen by Calculation (TKN *minus* Ammonia-N)
Orthophosphate Phosphorus by EPA method 365.2
Oxygen, Dissolved (DO) by SM16 method 421B
Oxygen, Dissolved (DO) by EPA method 360.2
Petroleum Hydrocarbons by EPA method 418.1
pH by EPA method 150.1/SW-846 method 9040
Phenolics by EPA method 420.1
Phosphorus by EPA method 365.2
Salinity by SM16 method 210
Solids, Settleable by EPA method 160.5
Solids, Total (TS) by EPA method 160.3
Solids, Total Dissolved (TDS) by EPA method 160.1
Solids, Total Fixed or Mineral (TFS or TMS) or by EPA method 160.4
Solids, Total Fixed or Mineral Suspended (TFSS or TMSS) by EPA methods 160.2 and 160.4
Solids, Total Suspended (TSS) by EPA method 160.2
Solids, Total Volatile (TVS) by EPA method 160.4
Solids, Total Volatile Suspended (TVSS) by EPA methods 160.2 and 160.4
Sulfate by EPA method 375.4/SW-846 method 9038
Sulfide by EPA method 376.1
Sulfide by EPA method 376.2
Sulfide by SW-846 method 9030
Sulfite by EPA method 377.1
Surfactants (mbas) by SM16 method 512B
Tannin by SM16 method 513
Turbidity by EPA method 180.1

Methods for Sludge

NOTE: The methods in this category are specific to sludge analysis. Most of the methods listed for soils and sediments can also be used to analyze sludges.

Ash Content by NJDEPE method DEP 013

Oil & Grease by NJDEPE method DEP 036
pH by NJDEPE method DEP 010
Phenols by NJDEPE method DEP 032
Residue, Total by NJDEPE method DEP 012
Residue, Total Volatile by NJDEPE method DEP 013
Solids, Total (TS) by 209F
Solids, Total Fixed (TFS) by 209F
Solids, Total Volatile (TVS) by 209F
Specific Gravity by SM16 method 213E

Methods for Soil, Sediment, and Other Fine Particulates

CAUTION: Care must be exercised when analyzing powdered chemicals or suspected powdered chemicals using these methods. Consult your supervisor before proceding.

Acidity by EPA method 305.1*
Alkalinity by EPA method 310.1*
Ammonia Nitrogen with Distillation by EPA method 350.2*
Biochemical Oxygen Demand (BOD) 5-Day by SM16 method 507*
Chemical Oxygen Demand (COD) by HACH method 8000*
Chloride by SW-846 method 9252*
Chromium, Hexavalent, Digestion by SW-846 method 3060 (2^{ND} edition)
Chromium, Hexavalent, Digestion by SW-846 method 3060, NJDEPE modification
Cyanide by ASP 12/91
Cyanide by ILM03 (CLP)
Cyanide by SW-846 method 9010*
Formaldehyde by AOAC method 20.062*
Moisture for Dry Weight Adjustment
Nitrate (as N) by SW-846 method 9200*
Nitrate-Nitrite Nitrogen by EPA method 353.1*
Nitrite Nitrogen by EPA method 354.1*
Oil & Grease by SW-846 method 9071
Orthophosphate by EPA method 365.2*
Petroleum Hydrocarbons by EPA method 418.1, NJDEPE modification
pH in Soil by SW-846 method 9045
Phosphorus by EPA method 365.2*
Sulfite by EPA method 377.1*
Surfactants (MBAS) by SM16 method 512B*
Water by Dean Stark (ASTM D95)

Methods for General Nonaqueous Matrices

Ash by ASTM D482
Chlorine by ASTM method D808
Heat of Combustion by ASTM D240

Ignitability by SW-846 method 1010/ASTM method D93
Paint Filter Liquids Test by SW-846 method 9095
Sulfur by ASTM D129

Methods for Waste Characterization

CAUTION: Care must be exercised when analyzing samples for waste characterization. Wear appropriate safety gear and perform all analyses in an approved fume hood.

NOTE: The methods in this category are specific to waste characterization analyses. Methods in other categories may also be required for complete characterization.

Bulk Density
Cyanide Spot Test
Flammability
Hexane Solubility
Odor
Oxidizer Spot Test
Peroxide Spot Test
pH
Physical State
Redox Potential Spot Test
Sulfide Spot Test
Viscosity
Water Solubility/Reactivity

Microbiology

Bacteriological Suitability by SM18 method 9020B
Coliforms, Fecal (MF) by EPA p. 124
Coliforms, Fecal (MPN) by EPA p.132
Coliforms, Presence or Absence
Coliforms, Total (MF) by SM18 method 9132
Coliforms, Total (MF) by EPA p. 108
Coliforms, Total (MF) Chlorine Present EPA p. 111
Coliforms, Total (MPN) by EPA p.114
Fecal Streptococci by EPA p.136
Heterotrophic Plate Count by SM16 method 907
Microscopic Identification (Algae Scan)

Industrial Hygiene

General

Acetic Acid by NIOSH method 1603
Alkaline Dusts by NIOSH method 7401
Ammonia by NIOSH method S205
Ammonia by NIOSH method 5347
Carbon Black by NIOSH method 5000
Chromic Acid by NIOSH method 7600
Nuisance Dust by NIOSH method 0500
Fluoride by NIOSH method 7902
Formaldehyde by NIOSH method 3500
Hydrogen Sulfide by NIOSH method S4
MDI by NIOSH method 142
NO/NO_2 Profile by NIOSH method S321
Ozone by NIOSH method S8
Phenol by NIOSH method 3502
Respirator Dust by NIOSH method 0600
Sulfur Dioxide by NIOSH method S308
Sulfuric Acid by NIOSH method S174
TDI by NIOSH method 141

Asbestos

Asbestos, Bulk by EPA method 40 CFR 763, Appendix A
Asbestos, Fiber in Air by NIOSH method 7400A

Metals

Aluminum by NIOSH method 7013
Arsenic by NIOSH method 7900
Barium by NIOSH method 7055
Beryllium by NIOSH method 7102
Cadmium by NIOSH method 7048
Chromium by NIOSH method 7024
Chromium, Hexavalent by NIOSH method 7600
Cobalt by NIOSH method 7027
Copper by NIOSH method 7029
Lead by NIOSH method 7082
Lead in Paint Chips by ASTM ZAP method
Mercury by NIOSH method 6009
Metals by NIOSH method 173
Metals by NIOSH method 7300
Metals by OSHA method ID-121
Selenium by NIOSH method 190
Tin, Organic by Elf Atochem AA-64

Vanadium by NIOSH method S388
Zinc by NIOSH method 7030

Organics

Acetate Solvents by NIOSH method 1450
Acrolein by NIOSH P&CAM method 118
Alcohols by NIOSH method 1400
Aliphatic Solvents by NIOSH method 1500
Aromatic Solvents by NIOSH method 1501
Cellosolve Solvents by NIOSH method 1403;
Chlorinated Solvents by NIOSH method 1003;
Ethyl Acetate by NIOSH method S49
Ethylene Glycol by NIOSH method 5500
Heptachlor by NIOSH method S287
Isobutanol by NIOSH method 1401
Isopropyl Acetate by NIOSH method S50
Ketones by NIOSH method 1300
Ketones by NIOSH method 2500
Methanol by NIOSH method 2000
Methylene Chloride by NIOSH method 1005
PCBs by NIOSH method 5503
Pesticides by NIOSH method 5510
Petroleum-based Products by NIOSH method 1550
Pesticides by NIOSH method 5510
Pesticides by OSHA method 57
Polyaromatic Hydrocarbons (PAH) by NIOSH method 5515
Solvent Profile by OSHA method 7
Tetrachloroethene by NIOSH method 5335
Trichloroethene by NIOSH method 1022
Turpentine by NIOSH method 1551

Air Toxics

Volatile Organic Compounds by EPA TO-1
Volatile Organic Compounds by EPA TO-2
Chlorinated Pesticides and PCBs by EPA TO-4
Polynuclear Aromatic Hydrocarbons by EPA TO-13

Field Services

Explosivity by Field meter
Temperature, Water by SM16 method 212

QUANTITATION LIMITS

Prepared by: ______________________
Quality Assurance Director

Reviewed and implemented by: ______________________
General Manager

The quantitation limit for a procedure is the smallest concentration of analyte that can be measured with known confidence. The following procedure for calculating method detection limits and quantitation limits is derived from 40 CFR 136 Appendix B.

Method Detection Limit (MDL)

The MDL procedure that follows is taken from 40 CFR 136 Appendix B. This procedure is defined as "the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero." The results obtained are specific to the sample matrix and analytical system.

1. If the approximate MDL is known, or an accurate estimate can be made, proceed to step 2. Otherwise, obtain an initial estimate of the method detection limit as follows.

   Prepare a synthetic sample (see step 2) with target analyte concentration equivalent to the lowest standard used for calibration. For procedures that do not use a calibration curve, such as gravimetric or titrimetric procedures, prepare the synthetic samples at a concentration equivalent to 5 times the lowest theoretical result obtainable. Analyze 3 aliquots of the synthetic sample and calculate the standard deviation. The initial estimate of the method detection limit is 3 times the standard deviation.

2. Prepare a synthetic sample with the target analyte concentration at 3 times the estimated method detection limit. The sample must be large enough to provide at least the number of aliquots required in step 3. Alternatively, individual samples may be prepared, but this will introduce an extra variable into the procedure.

   Prepare the synthetic sample by adding an appropriate amount of target analyte to reagent water and mixing thoroughly. Retain a portion of the reagent water used to be analyzed as method blanks.

3. Analyze 7 aliquots of the synthetic sample. The 7 aliquots should be processed on separate occasions and each analyst certified in the analysis should analyze a proportionate share of the

aliquots. If more than one instrument is used for analysis, all 7 samples must be analyzed on each instrument. Each sample aliquot must be carried through the entire analytical procedure exactly as required by the LRI SOP or other procedural reference.

4. Calculate the analyte concentration for each sample using the formula(s) in the calculations section of the procedure. If the procedure requires that the reagent blank be subtracted, a separate reagent blank must be analyzed with each sample aliquot, and the average blank measurement subtracted from each sample measurement.

5. Calculate the standard deviation and method detection limit as described below. If the concentration of the synthetic sample used is more than 5 times the calculated method detection limit, repeat this procedure using a reduced concentration.

6. Use the equations from Appendix A of this manual to calculate the standard deviation, then calculate the MDL as follows:

$$MDL = 3.143s$$

where MDL = method detection limit in the same units as sample concentrations
s = standard deviation of 7 analyte concentration measurements

Report results to the same number of significant digits as used to report sample concentrations.

7. Calculate the upper control limit at 95% confidence from two or more studies as follows:

$$UCL_{pooled} = k\sqrt{\frac{\Sigma s_i^2}{n}}$$

where UCL_{pooled} = upper control limit calculated from pooled MDL study data
k = factor from Table 7B-1 corresponding to the number of studies
s_i = standard deviation of 7 analyte concentration measurements from study i
n = number of studies

Report results to the same number of significant digits as used to report sample concentrations.

8. The UCL_{pooled} shall be the lowest value reported as a quantitation limit by LRI laboratories.

Table 7B-1

Values of *k* for pooled MDL data

Number of Studies	Total Number of Sample Analyses	*k*
1	7	6.920
2	14	4.426
3	21	3.775
4	28	3.467
5	35	3.285
6	42	3.162
7	49	3.074
8	56	3.007
9	63	2.953
10	70	2.910
11	77	2.874
12	84	2.843
13	91	2.817
14	98	2.794
15	105	2.773
16	112	2.755
17	119	2.739
18	126	2.724
19	133	2.711
20	140	2.699

The values of *k* for this table were calculated as the Student's t value at 99% confidence times the chi square over degrees of freedom at 95% confidence in QuattroPro as follows:

```
@TINV(0.02,f)* @SQRT(f/@CHIINV(0.975,f))
```

where f = degrees of freedom.

PREPARATION, REVIEW, REVISION, AND DISTRIBUTION OF SOPs

Prepared by: ______________________
Quality Assurance Director

Reviewed and implemented by: ______________________
General Manager

The procedures in this section provide the means by which standard operating procedures (SOPs) are prepared, reviewed, revised, approved, distributed, maintained, and archived. In the text that follows, "SOP" refers to a document describing a single procedure, such as this procedure, and "SOP manual" or "manual" refers to a collection of related procedures within a single binding, such as the Quality Assurance Manual.

Preparation

1. The following three items must be included as the first pages to appear in each SOP manual.

    a. The title page shall contain the title of the SOP manual and the signature of the person(s) responsible for overview of the activities addressed in the manual.

    b. The Distribution Control Page shall contain a brief description of the document control policy and a statement declaring whether the copy is controlled. For controlled copies, the following additional information shall be entered in blue ink:

        1) Controlled copy number
        2) Name and affiliation of person to whom the manual is issued
        3) Signature of the corporate document control officer
        4) Expiration date

    c. The table of contents shall contain the SOP number, title, and latest revision date for each SOP included in the manual. The table of contents serves as the revision control document and therefore must be revised for every revision of the manual.

2. Each page of the SOP must have a document control header in the upper right corner of each page with the following four lines.

Title of SOP manual	Revision Date
SOP number	Page *n* of *total pages*

3. The following items must appear immediately following the document control header on the first page of each SOP

   a. Title of the SOP
   b. Signature of the person with primary responsibility for writing the SOP ("Prepared by").
   c. Signature of the person with primary responsibility for overview of the activities addressed by the SOP, if different from the writer (Reviewed and approved by).
   d. Signature of the person directly responsible for implementing the procedure, if different from the those above (Reviewed and implemented by).

4. The remainder of each SOP will vary depending on its function. The following subsections present minimum standards for each type of SOP.

   Analytical Procedures

   a. References: Include the full name, volume, edition, publication date, and method number for each reference.
   b. Applicability: List the target analytes, matrices, and regulations for which the method is applicable.
   c. Important Notes: Information, warnings, and cautions that should be known to anyone performing the procedure.
   d. Procedure: Step-by-step instructions for performing the procedure.
   e. Quality Control: List all quality control requirements for method validation, instrument performance check, initial and continuing calibration, method blanks, duplicate analyses, matrix spike analyses, laboratory control sample analyses, and all method-specific quality control, including control limits and corrective action.
   f. Calculations: Formulae for all calculations required to obtain reported values, including quality control results, in the correct units. Include the number of significant digits for each result.
   g. Reagents: List all neat chemicals with specifications; list solutions with detailed and specific preparation instructions. Include storage conditions and expiration times for all solutions.

   Sample Management Procedures

   a. Include the title of the person(s) responsible for performing each procedure.

Review, Revision, and Approval

1. Each SOP should also be submitted in draft for comment to those who are familiar with its content and/or those who will use it. The request for comment must be accompanied by a memo

indicating a cutoff date, which should not be less than 14 days nor more than 30 days. After review of the comments and modification of the procedure where necessary, the SOP must be reviewed and approved by the person responsible for overview of the activities addressed by the SOP.

2. Revisions of an SOP must go through all the review and approval procedures required for the initial version.

Distribution and Maintenance

1. SOP manuals are distributed as controlled or uncontrolled documents. The distribution of controlled documents must be recorded to ensure that they are updated when new or revised SOPs are released. All SOP manuals for use within Laboratory Resources, Inc., must be controlled documents. In addition, SOP manuals submitted to regulatory agencies in support of certification or submitted to clients for contract compliance must be controlled for the duration of the certification or contract.

2. The corporate document control officer (CDCO) shall be responsible for maintaining updated masters for all controlled documents.

   a. The CDCO shall maintain a distribution log for all controlled documents in which the following information shall be recorded for each controlled copy:

      Document name
      Controlled copy number
      Name of recipient
      Date of issue
      Date control expires (for copies with contract duration)

   b. New and/or revised SOPs must be submitted with a revised table of contents to the CDCO for distribution. The CDCO shall add the revised table of contents and the new and/or revised SOPs to the master document, removing the obsolete table of contents and SOPs to archival storage.

   c. The CDCO shall provide an update instruction sheet along with the revised table of contents and SOPs to every current controlled copy recipient listed in the distribution log. The instruction sheet will indicate which pages are to be added, which pages are to be deleted, and which pages are to be replaced.

   d. Obsolete SOPs must be archived for at least ten years from the date they are removed from circulation.

LABORATORY NOTEBOOK PROCEDURES

Prepared by: Quality Assurance Director

Reviewed and implemented by: General Manager

Laboratory Notebooks

1. Laboratory notebooks shall be permanently bound with each page sequentially prenumbered.

2. All notebook entries must be in black ink.

3. Correct errors by drawing a single line through the incorrect data. Initial and date the error, and continue with the correct data. **No other means of correcting errors is permitted.**

4. Record the analytical method number at the top of each page. Do not include more than one method per page.

5. Record all information needed to reconstruct the analyses and recalculate results.

6. Do not record confidential information such as client names, project names, *etc.*, in the laboratory notebook.

7. Each page must be signed and dated by the analyst and his or her supervisor when analyses are completed. Any unused portion of the page must be lined out.

Laboratory Notebook Control

1. The quality assurance manager shall maintain a log of issued and returned laboratory notebooks. This log shall be maintained in a bound, prenumbered notebook meeting all the requirements of a laboratory notebook.

2. The following information shall be recorded in the logbook when each notebook is issued:

   notebook number
   number of previous notebook
   signature of person receiving the notebook
   notebook use (instrument log, solids analysis, *etc.*)

date of issue

3. The following information shall be recorded in the laboratory notebook when it is issued:

notebook number
signature of person receiving the notebook
date of issue

4 When the notebook is completed it shall be returned to the document control officer. The document control officer shall record the date returned in the notebook log and place the notebook in archival storage. Laboratory notebooks must be archived for at least ten years following the date of the last entry

METHOD VALIDATION

Prepared by: ______________________
Quality Assurance Director

Reviewed and implemented by: ______________________
General Manager

A method validation study must be performed before any new procedure can be used for sample analysis. This section delineates the minimum requirements for a method validation study. Most analytical procedures have specific requirements with respect to method validation. If the method-specific requirements are more restrictive than these requirements, they supersede these requirements; otherwise, they are in addition to these requirements.

1. Perform a method detection limit (MDL) study following the procedures in the Quantitation Limits section of this manual. The following acceptance criteria must be met:

    a. The MDL determined must be less than the concentration used for the study but not less than 20% of the concentration used for the study.

    b. The MDL study must demonstrate the ability to achieve the detection limits published in the reference within the experimental variance of the method. If the experimental variance is not given in the reference, the MDL determined by the study can not be more than 50% greater than the published detection limit. If the detection limit is not given in the reference, contact the LRI Technical Director or Quality Assurance Director for appropriate action.

2. Follow the procedures in the Employee Training section of this manual to qualify each analyst who is to perform the new procedure.

INSTRUMENT PERFORMANCE CHECK

Prepared by: ______________________
Quality Assurance Director

Reviewed and implemented by: ______________________
General Manager

General

Instrument performance checks ensure the proper functioning of an analytical instrument prior to analysis. Specific performance check procedures are included in the instrument operation manuals and are frequently incorporated into analytical procedures. When an instrument has passed the required performance checks, no adjustment of operating parameters is permitted that will alter instrument performance. In addition to the frequency requirements of the instrument operation manuals and analytical methods, an instrument performance check must be performed whenever the operating parameters have been changed.

An instrument has failed the performance check requirements and corrective action must be initiated if it does not meet the requirements of the operation manuals <u>and</u> the analytical method. If the manual and method have conflicting requirements, the requirements of the method shall have precedence over the operation manual requirements.

Corrective action will vary from instrument to instrument. The following general procedure should be followed to find and correct the problem.

1. Review the instrument adjustment procedure and ascertain that the instrument is properly adjusted.

2. If adjustment fails to solve the problem, review the trouble-shooting procedures to determine the cause of the problem.

3. If the problem cannot be solved by adjustment and trouble-shooting, the instrument must be adjusted or repaired by a qualified professional service representative.

After adjustment and/or repair is completed, the instrument performance check must be repeated. The instrument may not be used for analysis until the performance check has passed.

Analytical Balances

Perform the following checks each day the analytical balance is used, and just prior to preparing calibration standards.

1. Ascertain that the balance is level and adjust if necessary.

2. Check the balance with at least two Class S weights bracketing the range normally used or, if the check is performed just prior to calibration standard preparation, use one Class S weight as near the target weight as possible. The maximum permissible error is 0.2 mg (0.0002 g). Record the results of all balance weight checks in the balance logbook.

General Purpose Balances

Perform the following checks each day the balance is used.

1. Ascertain that the balance is level and adjust if necessary.

2. Check the balance with at least two Class S weights bracketing the range normally used or, if the check is performed just prior to using the balance, use one Class S weight as near the target weight as possible. The maximum permissible error is 1% or 0.1 g, whichever is less. Record the results of all balance weight checks in the balance logbook.

Ultraviolet/Visual Wavelength Spectrophotometers

Perform the following check annually.

1. Prepare a potassium chromate test solution: Dissolve 2.80 g of potassium hydroxide (KOH) in 900 mL of reagent water in a 1000-mL volumetric flask. Add 0.400 g of potassium chromate (K_2CrO_4) and dissolve completely; then adjust the volume to 1000 mL with reagent water. Adjust temperature of solution to 25 ±1 °C.

2. Using a 1.00-cm cell, measure the absorbance or transmittance at each of the following wavelengths. The measured absorbance or transmittance must fall within the range specified. Record the results in the spectrophotometer maintenance logbook.

Wavelength (nm)	Transmittance*	Absorbance*
220	0.347 - 0.367	0.433 - 0.456
275	0.170 - 0.180	0.744 - 0.770
325	0.780 - 0.828	0.082 - 0.108
375	0.099 - 0.105	0.979 - 1.005
420	0.728 - 0.774	0.112 - 0.138

*Acceptance limits are based on ±3% of theoretical transmittance.

Conductivity Meters

Perform the daily electrode performance test and annual linearity test as directed in the Conductivity procedure. Record the results in the conductivity meter logbook.

Thermometers

Calibrate thermometers annually as follows.

1. Immerse an NBS-certified thermometer and the thermometer to be calibrated in a circulated ice-water bath. Take care to immerse both thermometers correctly according to immersion type. Record the temperature readings of both thermometers after the readings have stabilized for at least one minute.

2. Immerse an NBS-certified thermometer and the thermometer to be calibrated in a circulated warm or hot water bath. If possible, adjust the temperature of the water bath to be near the temperature to be monitored by the thermometer being calibrated; otherwise, adjust the temperature of the water bath as near boiling as possible. Take care to immerse both thermometers correctly according to immersion type. Record the temperature readings of both thermometers after the readings have stabilized for at least one minute.

3. Tag the thermometer with an identifying label and the temperature error.

Temperature Control Equipment

The temperature of all freezers, refrigerators, incubators, and ovens shall be monitored by means of a calibrated thermometer properly immersed in water, mineral oil, or sand, and the temperature shall be recorded daily. Temperature control equipment that is out of specification must be adjusted immediately or removed from service.

INITIAL CALIBRATION

Prepared by:
Quality Assurance Director

Reviewed and implemented by:
General Manager

An initial calibration must be performed before any other analyses may be performed. The initial calibration establishes the relationship between instrument response and sample concentration, and the working concentration range of the analytical system. This section delineates the minimum requirements for initial calibration analysis. Most analytical procedures have specific requirements with respect to calibration. If the method-specific requirements are more restrictive than these requirements, they supersede these requirements; otherwise, they are in addition to these requirements.

1. Levels: A minimum of five (5) nonzero concentrations must be used unless the method specifies less. The lowest concentration must be greater than the quantitation limit but should be no greater than four times (4×) the quantitation limit. The highest concentration should be near but below the upper linear range of the instrument. The remaining three concentrations must be evenly spaced between the lowest and highest concentrations.

2. Calibration: The instrument is calibrated by calculating the linear regression for each analyte of interest (see Appendix A). The resulting equation is used to calculate sample concentrations.

3. Frequency: The initial calibration must be performed whenever (1) a continuing calibration fails to meet quality control limits or (2) every 90 days, whichever occurs first.

4. Quality Control Limit: The correlation coefficient for each target analyte must be greater than 0.995. An initial calibration has failed quality control requirements and corrective action must be initiated if the correlation coefficient for any target analyte is less than 0.995.

5. Verification: The initial calibration must be verified by analyzing an independently prepared standard with target analyte concentrations within the calibration range. This standard must pass all the continuing calibration check requirements.

6. Corrective Action: If an initial calibration fails quality control requirements, the analytical system must be investigated to determine the cause of the problem and an acceptable initial calibration must be obtained.

CONTINUING CALIBRATION CHECK

Prepared by: ______________________
Quality Assurance Director

Reviewed and
nplemented by: ______________________
General Manager

continuing calibration check must be performed before any quality control or sample analyses may be erformed. The continuing calibration check determines whether the initial calibration is still valid. This ection delineates the minimum requirements for continuing calibration check analysis. Most analytical rocedures have specific requirements with respect to calibration. If the method-specific requirements re more restrictive than these requirements, they supersede these requirements; otherwise, they are in ddition to these requirements.

Level: The concentration of the continuing calibration check standard should be the same as the midlevel initial calibration standard.

Procedure: Calculate the concentration of each analyte of interest in the continuing calibration check standard from the linear regression equations derived from the initial calibration.

Frequency: The continuing calibration check must be performed before sample analyses (except immediately following an initial calibration), again at the end of the analytical sequence, and every 24 hours during the sequence. Additional continuing calibration checks throughout the sequence are recommended to bracket groups of sample analyses (usually after every 10 sample analyses).

NOTE: An analytical sequence begins with the initial calibration or continuing calibration check and continues <u>without interruption</u> until the final continuing calibration check. No changes in analytical conditions are permitted during an analytical sequence.

Quality Control Limits: The calculated analyte concentrations must fall within 15% of their theoretical (or true) values. A continuing calibration check has failed quality control requirements and corrective action must be initiated if the concentration of any target analyte is greater than 115% of its theoretical value or less than 85% of its theoretical value.

Corrective Action:

a. If the continuing calibration check that starts an analytical sequence fails quality control requirements, the continuing calibration check may be repeated once. All target analytes must pass quality control requirements in the second continuing calibration check in order for samples to be analyzed; otherwise, a new initial calibration must be performed.

b. If any continuing calibration check during or at the end of an analytical sequence fails quality control requirements, analyses must be terminated, the problem resolved, and all analyses performed since the last acceptable continuing calibration check or initial calibration must be repeated.

METHOD BLANK ANALYSIS

Prepared by: ______________________
Quality Assurance Director

Reviewed and implemented by: ______________________
General Manager

Analytical systems must be demonstrated to be free of contamination by the successful analysis of method blanks. This section delineates the minimum requirements for method blank analysis. Many analytical procedures have specific requirements with respect to method blank analysis. If the method-specific requirements are more restrictive than these requirements, they supersede these requirements; otherwise, they are in addition to these requirements.

NOTE: Method blanks are not to be used to correct analytical results.

1. Preparation: Method blanks must be prepared and analyzed in the same manner as the samples with which they are prepared and analyzed, except that sample is omitted or, for analysis of water samples, replaced with deionized water. The final concentration of all reagents used is the same in the method blank and the samples.

2. Frequency: A method blank shall be prepared and analyzed with each batch of samples analyzed or one method blank per 20 samples, whichever is more frequent. The maximum time span for a valid sample batch is thirty days. These frequencies are for a single matrix and method; quality control samples cannot be shared by matrices or methods.

3. Quality Control Limits:

   a. Method blanks must be free of contamination by nonexempted target analytes at or above the reported quantitation limit. The maximum allowable concentration for exempted target analytes three times (3×) the reported quantitation limit. A method blank has failed quality control requirements and corrective action must be initiated if (1) any nonexempted target analyte is detected at or above the reported quantitation limit or (2) the concentration of any exempted target analyte is greater than 2.5 times the reported quantitation limit.

   b. The exempted target analytes are:

      methylene chloride
      acetone

2-butanone
toluene
bis(2-ethylhexyl) phthalate

4. Corrective Action: If a contaminated method blank is encountered, sample analysis must be terminated and the analytical system must be investigated to determine the cause of the problem. The method blank and all associated samples (including quality control samples) must be reprepared and reanalyzed.

SAMPLE DUPLICATE ANALYSIS

Prepared by: Quality Assurance Director

Reviewed and implemented by: General Manager

Sample duplicates are analyzed to demonstrate the precision of an analytical system. This section delineates the minimum requirements for sample duplicate analysis. Many analytical procedures have specific requirements with respect to sample duplicate analysis. If the method-specific requirements are more restrictive than these requirements, they supersede these requirements; otherwise, they are in addition to these requirements.

1. Preparation: For inorganic analyses, two equivalent aliquots of the sample selected for duplicate analysis are prepared and carried through the preparation and analysis procedures together. For organic analyses that do not specify a duplicate analysis, a second matrix spike is prepared and carried through the preparation and analysis. All references to sample duplicates in this document apply equally to matrix spike duplicates.

2. Frequency: A sample duplicate shall be prepared and analyzed with each batch of 20 samples. The maximum time span for a valid sample batch is thirty days. This frequency is for a single matrix and method; quality control samples can not be shared by matrices or methods.

3. Relative Percent Difference (RPD): The relative percent difference is used to evaluate precision for analyses that measure concentration of an analyte directly.

$$RPD = \frac{200|C_1 - C_2|}{C_1 + C_2}$$

where RPD = relative percent difference
C_1 = original sample concentration
C_2 = sample duplicate concentration

NOTE: The relative percent difference cannot be calculated if either or both analyses are below the quantitation limit.

4. Difference: The absolute value of the difference of two measurements is used to evaluate precision for analyses that do not measure analyte concentrations directly (*e.g.*, temperature, pH, ignitability).

$$D = |M_1 - M_2|$$

where D = absolute value of the difference between two measurements
M_1 = original sample measurement
M_2 = duplicate sample measurement

5. Control Limits: The equations for calculating the mean and standard deviation are included in Appendix A of this manual. Use the data from at least 20 sample and sample duplicate analyses to calculate warning and control limits. Eliminate outliers using the method in Appendix A.

   a. RPD: The warning limit is the mean RPD plus two times (2×) the standard deviation, and the control limit is the mean plus three times (3×) the standard deviation. A sample duplicate analysis has failed quality control requirements and corrective action must be initiated if (1) the RPD is greater than the control limit or (2) the concentration for one analysis is less than the quantitation limit and the concentration for the other analysis is greater than two times (2×) the quantitation limit.

   b. Difference: The warning limit is the mean difference plus two times (2×) the standard deviation, and the control limit is the mean plus three times (3×) the standard deviation. A sample duplicate analysis has failed quality control requirements and corrective action must be initiated if the difference is greater than the upper control limit.

6. The relative percent difference or absolute difference, as appropriate, must be plotted on control charts showing the mean, warning limits, and control limits.

7. Corrective Action: If a sample duplicate analysis fails quality control requirements, the failure must be included in the nonconformance summary. No further action is required.

MATRIX SPIKE ANALYSIS

Prepared by: ______________________
Quality Assurance Director

Reviewed and implemented by: ______________________
General Manager

Matrix spikes are analyzed to demonstrate the accuracy of an analytical system. This section delineates the minimum requirements for matrix spike analysis. Many analytical procedures have specific requirements with respect to matrix spike analysis. If the method-specific requirements are more restrictive than these requirements, they supersede these requirements; otherwise, they are in addition to these requirements.

1. Preparation: Matrix spikes are prepared with the same sample size that is used for the samples with which they are analyzed. The spiking solution is added immediately after the sample aliquot is measured, and is mixed as thoroughly as practical with the sample. Subsequent treatment and analysis of the spiked sample is the same as that for the unspiked samples.

2. Level: The amount of spike added to the sample must give a concentration that will fall between the lowest and highest calibration standards when carried through the analysis procedure without dilution. The preferred concentration is 25% of the highest calibration standard; this concentration yields usable recovery data without dilution at low to moderate sample concentrations.

3. Frequency: A matrix spike shall be prepared and analyzed with each batch of 20 samples. The maximum time span for a valid sample batch is thirty days. For organic analyses that do not specify a duplicate analysis, a matrix spike duplicate shall be prepared and analyzed with each matrix spike and shall serve the same function as a duplicate analysis. This frequency is for a single matrix and method; quality control samples cannot be shared by matrices or methods.

4. Recovery (Accuracy):

$$C_t = \frac{A_s}{S_s}$$

$$R = \frac{100(C_s - C_u)}{C_t}$$

where C_t = theoretical concentration of spiked sample

A_s = amount of analyte added to spiked sample
S_s = size of sample aliquot spiked
R = recovery, %
C_s = measured concentration of spiked sample
C_u = measured concentration of unspiked sample

5. Relative Percent Difference (Precision): See the section on Sample Duplicate Analyses.

6. Control Limits: The equations for calculating the mean and standard deviation are included in Appendix A of this manual.

    a. Recovery: Use the data from at least 20 matrix spike analyses to calculate warning and control limits for recovery. Do not include data from matrix spike duplicate analyses. Eliminate outliers using the method in Appendix A.

    The upper warning limit is the mean recovery plus two times (2×) the standard deviation, and the upper control limit is the mean plus three times (3×) the standard deviation. The lower warning limit is the mean recovery minus two times (2×) the standard deviation, and the lower control limit is the mean minus three times (3×) the standard deviation. A matrix spike analysis has failed quality control requirements and corrective action must be initiated if the recovery is greater than the upper control limit or less than the lower control limit.

    b. RPD: See the section on Sample Duplicate Analyses.

7. The percent recovery must be plotted on control charts showing the mean, warning limits, and control limits.

8. Corrective Action: If the procedure utilizes surrogate spikes in every sample analyzed, all samples for which the surrogate spikes meet quality control requirements shall be considered acceptable regardless of the associated matrix spike recoveries. Samples for which surrogate spikes do not meet quality control requirements must be reprepared and reanalyzed.

    If the procedure does not utilize surrogate spikes, the following corrective action protocol applies.

    a. If a matrix spike recovery is outside control limits and the RPD is within control limits, the problem is attributed to matrix interference and no further action is required.

    b. If the matrix spike is outside control limits and the laboratory control sample is acceptable, the problem is attributed to matrix interference and no further action is required.

    c. If the matrix spike recovery is outside control limits and the concentration of the same analyte in the unspiked sample is more than four times (4×) the concentration of spike analyte added, the problem is attributed to sample analyte concentration and must be noted in the nonconformance summary. No further action is required.

d. If the matrix spike recovery is positive and outside control limits and the RPD is outside control limits, the problem must be noted in the nonconformance summary. No further action is required.

e. If the matrix spike has zero or negative recovery, report the problem to the quality assurance officer for a specific corrective action procedure.

LABORATORY CONTROL SAMPLE ANALYSIS

Prepared by: ____________________
Quality Assurance Director

Reviewed and implemented by: ____________________
General Manager

Laboratory control samples are analyzed to demonstrate the accuracy of an analytical system. They are supplemental to matrix spikes and, because environmental matrices are not involved, provide useful information when matrix interference is encountered. Laboratory control sample (LCS) analyses are optional unless specifically required by the analytical procedure.

This section delineates the general requirements for LCS analysis. If the analytical procedure requires LCS analysis, the method-specific requirements supersede these requirements.

1. Preparation: Laboratory control samples are prepared in the same manner as matrix spikes except that spiking solution is added to laboratory reagent water (DI water) instead of sample. Subsequent treatment and analysis of the LCS is the same as that for environmental samples.

2. Level: The amount of spike added must be the same as that used for matrix spikes unless specified otherwise by the analytical method.

3. Frequency: A LCS shall be prepared and analyzed with each batch of 20 samples. The maximum time span for a valid sample batch is thirty days. This frequency is for a single matrix and method; quality control samples cannot be shared by matrices or methods.

4. Recovery (Accuracy):

$$C_t = \frac{A_s}{S_s}$$

$$R = \frac{100(C_s - C_u)}{C_t}$$

where C_t = theoretical concentration of spiked sample
A_s = amount of analyte added to spiked sample
S_s = size of sample aliquot spiked
R = recovery, %
C_s = measured concentration of spiked sample

C_u = measured concentration of unspiked sample

5. Control Limits: The equations for calculating the mean and standard deviation are included in Appendix A of this manual.

   Use the data from at least 20 LCS analyses to calculate warning and control limits for recovery. Eliminate outliers using the method in Appendix A.

   The upper warning limit is the mean recovery plus two times (2×) the standard deviation, and the upper control limit is the mean plus three times (3×) the standard deviation. The lower warning limit is the mean recovery minus two times (2×) the standard deviation, and the lower control limit is the mean minus three times (3×) the standard deviation. An LCS analysis has failed quality control requirements and corrective action must be initiated if the recovery is greater than the upper control limit or less than the lower control limit.

6. The percent recovery must be plotted on control charts showing the mean, warning limits, and control limits.

7. Corrective Action: If the procedure utilizes surrogate spikes in every sample analyzed, all samples for which the surrogate spikes meet quality control requirements shall be considered acceptable regardless of the associated LCS recoveries. Otherwise, if the LCS recovery is outside control limits, sample analysis must be terminated and the analytical system must be investigated to determine the cause of the problem. The LCS and all associated samples (including quality control samples) must be reprepared and reanalyzed.

QUALITY ASSURANCE ASSESSMENT

Prepared by: ______________________
Quality Assurance Director

Reviewed and implemented by: ______________________
General Manager

The previous sections in this manual addressed specific quality assurance requirements and their implementation. This section addresses audits, which are the primary procedures for assessing compliance with these requirements and the requirements of other LRI procedural manuals. Appropriate forms for use with each of the audits described are included in Appendix B of this manual.

Each audit is based on a single LRI procedural manual. The auditor shall conduct the audit as directed in the *Instructions to the auditor* near the top of the audit form. Immediately following the audit, the auditor shall meet with the General Manager or his/her designee and determine appropriate measures to correct any deficiencies found. If a condition is found that affects the accuracy or defensibility of reported data, the deficient practice must be suspended until the condition is corrected. Otherwise, a maximum of 30 days may be allowed to correct deficiencies. The corrective actions to be taken shall be recorded in the audit logbook. The audit logbook must be signed by the auditor and the General Manager. A follow-up audit shall be performed within 45 days to determine whether the corrective actions were properly completed.

The Quality Assurance Program Compliance Audit is based on the Corporate Quality Assurance Manual and determines the degree to which a laboratory is in compliance with general quality assurance program requirements. This audit is performed annually.

The Qualifications Audit is based on the Statement of Qualifications and determines whether quality assurance information is accurate and updated. This audit is performed quarterly.

The Sample Management Audit is based on the Sample Management Manual and determines the degree of compliance with sample management procedures. This audit is performed annually.

The Analytical Method Audit is based on the standard operating procedures for analyses and determines whether analytical procedures are being performed properly. This audit is performed annually for each analyst.

MATH AND STATISTICS

The following topics are included in this appendix.

Significant Digits
Rounding
Arithmetic Mean (Average)
Standard Deviation
Linear Regression
Test for Outliers

Significant Digits

The n most significant digits of a value are the leftmost nonzero digit and the $n-1$ digits to its immediate right.

Examples: In the following numbers, the two most significant digits are underlined: 12678, 507, 8.033, 0.0003927.

Rounding

1. Carry at least one digit beyond the last significant digit throughout all calculations.

2. Round the final result by changing all digits beyond the last significant digit to zeroes; drop these zeroes if they are to the right of the decimal point.

    a. If the value dropped is greater than half the last significant digit, increase the last significant digit by one.

    Example: 12873 rounds to 13000

    b. If the value dropped is less than half the last significant digit, the last significant digit remains unchanged.

    Example: 12173 rounds to 12000

    c. If the value dropped is *exactly* half the last significant digit, the last significant digit remains unchanged if it is even (or zero) and is increased by one if it is odd.

    Examples: 12500 rounds to 12000 and 13500 rounds to 14000

Arithmetic Mean (Average)

$$\overline{X} = \frac{\sum X_i}{n}$$

where $\overline{X}$ = the arithmetic mean
X_i = the value of observation i
n = total number of observations

Standard Deviation

$$s = \sqrt{\frac{\sum (X_i - \overline{X})}{(n-1)}}$$

where s = the standard deviation
X_i = the value of observation i
$\overline{X}$ = the arithmetic mean
n = total number of observations

Linear Regression

$$m = \frac{n\sum x y_i - \sum x_i \sum y_i}{n\sum x_i^2 - (\sum x_i)^2}$$

$$b = \frac{\sum y_i - m\sum x_i}{n}$$

$$r = \frac{n\sum x y_i - \sum x_i \sum y_i}{\sqrt{(n\sum x_i^2 - (\sum x_i)^2)(n\sum y_i^2 - (\sum y_i)^2)}}$$

where x_i = independent measurement
y_i = dependent measurement corresponding to x_i
n = total number of observations
m = the slope
b = the y-intercept
r = the correlation coefficient

Test for Outliers

The highest or lowest value in a group for which the mean and standard deviation have been calculated shall be considered an outlier if the statistic T is greater than the critical value from the table below.

$$T = \frac{\bar{X} - X_i}{s}$$

where $\bar{X}$ = the arithmetic mean for the group with X_i included
X_i = the value to be tested
s = the standard deviation for the group with X_i included

Critical Values for 1% Tests of Discordancy for a Single Outlier in a Normal Distribution

Number of Measurements	Critical Value	Number of Measurements	Critical Value
3	1.15	15	2.71
4	1.49	16	2.75
5	1.75	18	2.82
6	1.94	20	2.88
7	2.10	30	3.10
8	2.22	40	3.24
9	2.32	50	3.34
10	2.41	60	3.41
12	2.55	100	3.60
14	2.66	120	3.66

AUDIT FORMS

The following audit forms are included in this appendix.

Quality Assurance Program Compliance Audit
Qualifications Audit
Sample Management Audit
Analytical Method Audit

Laboratory Resources, Inc., Quality Assurance Program Compliance Audit

Facility Audited ________________________ Date ____________

Auditor's Signature ________________________ Number of Attached Pages ______

This audit is based on the LRI Corporate Quality Assurance Manual (CQAM).

Instructions to the auditor: Check the box labelled "YES" if the audit item is in compliance. Check the box labelled "NO" if the audit item is not in compliance. Enter a description of each noncompliant item in the facility's Audit Logbook with a corrective action plan and completion date. Attach copies of the Audit Logbook pages to this audit form and distribute copies to the General Manager of the facility audited, the Technical Director, and the President of LRI.

YES	NO	
☐	☐	A copy of the most recent release of the CQAM is available in each room where samples are logged in, stored, prepared, or analyzed and in each room where data is processed.
☐	☐	The facilities, instrumentation, organization, and key personnel are in agreement with the Statement of Qualifications.
☐	☐	Analytical balances have a minimum sensitivity of 0.1 mg and are clean, level, and checked with Class S weights daily or before use.
☐	☐	General purpose balances have sufficient sensitivity for their intended use and are clean, level, and checked with Class S weights daily or before use.
☐	☐	Spectrophotometers are checked annually with potassium chromate solution and spectrophotometer cells are properly maintained.
☐	☐	Conductivity meters have platinum electrodes, or nonplatinum electrodes that have been calibrated against platinum electrodes within the past year. Daily and annual checks are performed.
☐	☐	pH meters have a readability of at least ±0.05 pH units, are calibrated at pH 7.00 and 4.00, and are checked at pH 10.00.
☐	☐	Specific ion meters have a readability of at least ±5 mV.
☐	☐	Thermometers have appropriate graduations, are properly immersed, and are calibrated annually against an NBS-certified thermometer.
☐	☐	The temperature of freezers, refrigerators, incubators, and ovens is monitored and recorded daily.
☐	☐	Instrument maintenance logbooks are available for all instruments and required instrument maintenance procedures are performed and recorded.
☐	☐	Volumetric glassware is Class A and is not exposed to temperatures exceeding 105 °C. Mohr and similar measuring pipettes are not used.
☐	☐	Glassware is rinsed by analysts before it is submitted for cleaning, and the correct cleaning protocols are followed.

YES	NO	
☐	☐	The conductivity and pH of reagent water is checked and recorded daily.
☐	☐	Residual chlorine and heterotrophic plate count are performed and recorded monthly on the reagent water source used for microbiology analyses.
☐	☐	Heavy metals and bacterial quality are analyzed and recorded annually on the reagent water source used for microbiology analyses.
☐	☐	Reagents, standards, and solvents are of the correct grades and are properly labelled, documented, and stored. Expired reagents and solutions are not used.
☐	☐	Employees are trained according to LRI protocol and training is properly documented.
☐	☐	The laboratory uses only methods listed as approved in the CQAM.
☐	☐	SOPs and manuals are in compliance with the CQAM policy for preparation, review, revision, and distribution.
☐	☐	Laboratory notebooks are in compliance with CQAM laboratory notebook procedures, corrections are made properly, and the pages are signed by the analyst and supervisor.
☐	☐	Method validation studies are available for all procedures.
☐	☐	Instrument performance checks, initial calibrations, and continuing calibration checks are performed at the required frequencies.
☐	☐	Method blanks are free of contamination from other than exempted compounds, and the latter do not exceed 2.5 times the quantitation limit.
☐	☐	Sample duplicates, matrix spikes, matrix spike duplicates, and laboratory control samples are performed at the required frequencies and the data is plotted on control charts.

Auditor's Signature ______________________________ Date ________________

This audit is based on the LRI Statement of Qualifications (SOQ).

Instructions to the auditor: Check the box labelled "YES" if the audit item is in compliance. Check the box labelled "NO" if the audit item is not in compliance. Enter a description of each noncompliant item in the space provided and distribute copies to the Manager of Communications, the Director of Sales and Marketing, and the President of LRI.

YES	NO	
☐	☐	Information describing LRI facilities is complete and up to date.
		____
		____
		____
		____
☐	☐	Information describing LRI instrumentation is complete and up to date.
		____
		____
		____
		____
☐	☐	Information describing the organization of LRI is complete and up to date.
		____
		____
		____
		____
☐	☐	Resumes for key LRI personnel are up to date and all key personnel are included.
		____
		____
		____

Laboratory Resources, Inc., Sample Management Audit

Facility Audited ______________________ Date __________

Auditor's Signature ______________________ Number of Attached Pages ______

This audit is based on the LRI Sample Management Manual.

Instructions to the auditor: Check the box labelled "YES" if the audit item is in compliance. Check the box labelled "NO" if the audit item is not in compliance. Enter a description of each noncompliant item in the facility's Audit Logbook with a corrective action plan and completion date. Attach copies of the Audit Logbook pages to this audit form and distribute copies to the General Manager of the facility audited, the Technical Director, and the President of LRI.

YES NO

☐ ☐ A copy of the Corporate Quality Assurance Manual is available in the sample management area.

☐ ☐ A copy of the Sample Management Manual is available in the sample management area.

☐ ☐ Chain of custody forms are properly signed and dated with no breaks in the chain of custody.

☐ ☐ The sample management personnel verify the pH of acid- and base-preserved samples and records the information in a notebook.

☐ ☐ The pH of samples submitted for volatile organics analysis is determined by the analyst at the time of analysis and recorded in the appropriate logbook.

☐ ☐ The sample management personnel check sample volume against the volume required for the requested analyses.

☐ ☐ A temperature control bottle is shipped with all coolers, and the temperature of the water in this bottle is measured and recorded when the cooler is received at the laboratory.

☐ ☐ Internal chain of custody forms are properly completed when required.

☐ ☐ Analyses are put on hold until instructions are received from the client when any of the following situations is encountered: samples are received physically damaged or improperly preserved, the cooler temperature is above 4.5 °C, insufficient sample quantity is received for the analyses requested, or the chain of custody form is not properly completed.

☐ ☐ The sample containers provided by the laboratory are of the correct size and type and contain appropriate preservatiyes.

☐ ☐ Sample containers are securely packed in coolers with shock-absorbent material separating the bottles.

☐ ☐ Custody seals are placed on the hinged and opposite sides of the cooler before shipping.

☐ ☐ The laboratory does not recycle sample containers.

YES	NO	
☐	☐	Case lots of sample containers are marked with the month and year of receipt, and stock is rotated so that the oldest cases are most accessible and are used first.
☐	☐	Original copies of bottle cleaning certificates are maintained on file.
☐	☐	Access to samples is restricted to authorized personnel only.
☐	☐	Sample storage refrigerators are maintained at 4 °C ±2 °C and the temperature of refrigerators is checked and recorded daily.
☐	☐	The laboratory segregates samples received under contract from regulatory agencies from commercial samples.
☐	☐	The laboratory follows advertised procedures for receipt of samples outside regular business hours.
☐	☐	The laboratory has established and adheres to procedures for handling rush analyses and analyses with short (<48 hours) holding times.
☐	☐	When "TOTAL" and "DISSOLVED" analytes are requested for the same sample, the filtered and unfiltered fractions are assigned different sample numbers.
☐	☐	LRI sample labels are applied to sample containers in such a way as not to obstruct the client's label.

Facility Audited ______________________________ Date __________

Procedure Audited ______________________________ Analyst ______________________________

Auditor's Signature ______________________________ Number of Attached Pages _____

This audit is based on the LRI standard operating procedures for analyses.

Instructions to the auditor: Check the box labelled "YES" if the audit item is in compliance. Check the box labelled "NO" if the audit item is not in compliance. Enter a description of each noncompliant item in the facility's Audit Logbook with a corrective action plan and completion date. Attach copies of the Audit Logbook pages to this audit form and distribute copies to the General Manager of the facility audited, the Technical Director, and the President of LRI.

YES	NO	
☐	☐	The method is approved in the LRI Corporate Quality Assurance Manual (CQAM).
☐	☐	The reagents and standards used meet the requirements of the method and the CQAM.
☐	☐	Preparation of reagents and standards is recorded as required by the CQAM.
☐	☐	Reagents and standards are labelled as required by the CQAM.
☐	☐	Applicable instrument performance checks are performed as required by the method and the CQAM
☐	☐	Initial calibration is performed as required by the method and the CQAM.
☐	☐	Continuing calibration checks are performed as required by the method and the CQAM.
☐	☐	Method blanks are analyzed and meet the requirements of the method and the CQAM.
☐	☐	Matrix spikes are analyzed at the required frequency and the recoveries are recorded on control charts.
☐	☐	Sample duplicates or matrix spike duplicates are analyzed at the required frequency and the RPDs are recorded on control charts.
☐	☐	Laboratory control samples are analyzed at the required frequency.
☐	☐	Appropriate corrective action is taken and recorded for failed quality control analyses.
☐	☐	No deviations from method protocol were observed.
☐	☐	The analyst demonstrated acceptable analytical skills.

APPENDIX C

Health and Safety Plan (HASP)

HEALTH AND SAFETY PLAN

FOR THE

INVESTIGATION AND DESIGN OF THE INTERIM REMEDIAL MEASURE FOR THE VADOSE ZONE

AT THE

FORMER IMC MAGNETICS CORP.
MANUFACTURING FACILITY
WESTBURY, NEW YORK

MARCH 1996

Prepared For:

IMC MAGNETICS CORP.

Prepared By:

LAND TECH REMEDIAL, INC.
31 DUBON COURT
FARMINGDALE, NY 11735
(516) 694-4040

HEALTH AND SAFETY PLAN

FOR THE

INVESTIGATION AND DESIGN OF THE INTERIM REMEDIAL MEASURE FOR THE VADOSE ZONE

AT THE

FORMER IMC MAGNETICS CORP.
MANUFACTURING FACILITY
WESTBURY, NEW YORK

LAND TECH REMEDIAL, INCORPORATED DOES NOT GUARANTEE THE HEALTH OR SAFETY OF ANY PERSON ENTERING THIS SITE. DUE TO THE POTENTIAL HAZARDS OF THIS SITE AND THE ACTIVITIES OCCURRING THEREON, IT IS NOT POSSIBLE TO DISCOVER, EVALUATE, AND PROVIDE PROTECTION FOR ALL POSSIBLE HAZARDS WHICH MAY BE ENCOUNTERED. STRICT ADHERENCE TO THE HEALTH AND SAFETY GUIDELINES SET FORTH HEREIN WILL REDUCE, BUT NOT ELIMINATE, THE POTENTIAL FOR INJURY AT THIS SITE. THE HEALTH AND SAFETY GUIDELINES IN THIS PLAN WERE PREPARED SPECIFICALLY FOR THIS SITE AND SHOULD NOT BE USED ON ANY OTHER SITE WITHOUT PRIOR RESEARCH AND EVALUATION BY TRAINED HEALTH AND SAFETY SPECIALISTS.

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SECTION 1.0
PROJECT IDENTIFICATION

Client:	IMC Magnetics Corp.
Site:	Former IMC Magnetics Corp. Manufacturing Facility
Location:	570 Main Street, Westbury, New York
Project:	Investigation and Design of the Interim Remedial Measure

SECTION 2.0
INTRODUCTION

This Health and Safety Plan (HASP) establishes guidelines and requirements for safety of personnel during the performance of field activities associated with the referenced project. The procedures and protocols in this plan have been established to ensure that a mechanism is in place to protect project personnel in the event that hazardous materials are found during the project. All employees of Land Tech Remedial, Inc. (LTR), its subcontractors, and other contractors who have adopted this HASP involved in field activities on this project are required to abide by the provisions of this HASP.

Compliance with this HASP is required of all persons who enter the working areas of this project. The content of this HASP may change or undergo revision based upon additional information made available to health and safety (H&S) personnel, monitoring results or changes in the technical scope of work. Any changes proposed must be reviewed by designated Land Tech Remedial, Inc. (LTR) staff.

2.1 SITE DESCRIPTION

The site is located at 570 Main Street in Westbury, New York. The property is slightly over two acres with one manufacturing building and a paved parking lot covering most of the area. The site is currently vacant except for a portion of the building occupied by Castle Collision.

Substances of potential concern which have been detected at the site include volatile aromatic and halogenated organic compounds and metals. Compounds of concern potentially present at the site are listed in Section 4.1.2

2.2 KEY PERSONNEL

	PROJECT MANAGER	**HEALTH AND SAFETY OFFICER**
NAME:	Timothy L. Douthit	Russel Direnzo
PHONE:	(516) 694-4040	(203) 261-2673

2.2.1 Health and Safety Personnel Designations

The following briefly describes the health and safety personnel designations and general responsibilities which will be employed for this project

LTR PROJECT MANAGER (PM):

The LTR Project Manager will be present on-site during the conduct of all activities and will be responsible for all health and safety activities. The project manager has stop-work authorization which he will execute upon his determination of an imminent safety hazard, emergency situation, or other potentially dangerous situation, such as extreme weather conditions. Authorization to proceed with work will be issued by the HSO after such action. The project manager will initiate and execute all contact with support facilities and personnel when this action is appropriate. Additionally, the project manager has the authority to temporarily suspend an individual from field activities for infractions of the HASP, pending further consideration by the HSO.

LTR HEALTH AND SAFETY OFFICER (HSO)

The HSO has overall responsibility for development and implementation of this HASP. The HSO also shall approve any changes to this plan due to modification of procedures or newly proposed site activities, and will interface with the LTR Project

Manager in matters of health and safety. It is also the responsibility of the HSO to ensure that proper health and safety equipment is available for the project.

The HSO will be responsible for the development of safety protocols and procedures necessary for field operations for the resolution of any outstanding safety issues which arise during the conduct of site work. Health and safety related duties and responsibilities will be assigned only to qualified individuals by the HSO. Before personnel may work on-site, currentness of acceptable medical examination and acceptability of health and safety training (i.e. OSHA-approved 40-hour HAZWOPER training or current 8-hour refresher training) must be approved by the HSO pursuant to all applicable standards.

The LTR HSO has the authority to take the following actions:

- To suspend work or otherwise limit exposures to personnel if a HASP appears to be unsuitable or inadequate.
- To direct personnel to change work practices if they are deemed to be hazardous to health and safety.
- To remove field personnel from the project if their actions or condition endangers their health and safety or the health and safety of coworkers.
- To suspend work in a potential hazardous situation as well as to restart activities as conditions allow.

LTR SITE SAFETY OFFICER

The LTR Site Safety Officer (LTR SSO) and any LTR Alternate Site Safety Officer(s) (Alternate LTR SSO) have the following responsibilities:

- To direct health and safety activities on-site.
- To report safety-related incidents or accidents to the LTR Project Manager and LTR HSO.
- To assist the LTR Project Manager in all aspects of implementing the HASP.
- To maintain health and safety equipment on-site, as specified in the HASP.
- To inspect health and safety activities on-site, as specified in the HASP, and report results to the LTR Project Manager and the LTR HSO.

The LTR SSO has the authority to take the following actions:

- To temporarily suspend field activities, if health and safety of field personnel are endangered, pending further consideration by the LTR HSO.
- To temporarily suspend an individual from field activities for infractions of the HASP, pending further consideration by the LTR HSO.

SECTION 3.0
WORK PLAN

The work activities which may be performed under this HASP are limited to the following:

- Site inspections.
- Installation of narrow-diameter soil borings using a Geoprobe®.
- Collection, classification and field screening of soil samples.
- Field analysis of soil samples via a mobile laboratory.
- Installation of wells and monitoring points using a hollow stem auger drill rig.
- Light trenching using hand-held construction and demolition equipment, as well as earth-moving equipment (backhoe).
- Light construction (equipment enclosures, fencing, etc.)
- Remediation system pilot testing.
- Remediation system construction.

This HASP does not cover any site activities other than those specifically listed above. Other possible work activities not described above may only be conducted after approval of an appropriate Addendum to this HASP by the LTR HSO.

This HASP is terminated following the completion of Work Plan activities. Use of this HASP after this date to perform the work activities described herein, or other activities in addition to those described herein, is not permitted and constitutes a violation of LTR's Health and Safety Program. If work is to be performed after this date, the HASP must be reviewed and modified, if necessary, by the LTR HSO.

SECTION 4.0
HAZARD ASSESSMENT

An assessment of the hazards has been made for each of the activities specified in Section 3.0. Suspected physical, biological, chemical and flammable hazards were evaluated. The following paragraphs summarize the risks that have been identified.

For the activities listed in Section 3.0, the following hazards have been identified:

- chemical hazards;
- physical hazards;
- heat stress (depending on season work is to be performed);
- cold stress (depending on season work is to be performed);
- biological hazards such as mosquitoes, ticks, snakes, and rabid animals;
- skin and eye contact with contaminants;
- ingestion of contaminants;
- inhalation of organic vapors or contaminated dusts; and,
- flammable hazards.

4.1 CHEMICAL HAZARDS

4.1.1 Description of Chemical Hazards

The chemical hazard evaluation is based on the history of the Site and the initial investigations at the Site and is conducted to identify materials that potentially may be present and to ensure that site activities, personnel protection, and emergency response are consistent with the specific contaminants expected to be encountered. The hazard analysis forms the foundation for this HASP.

4.1.2 Enumeration of Potential Hazardous Chemicals

Based on existing site data, the following is a list of chemicals potentially present at the Site. The list is potentially incomplete, and consists only of chemicals which may be present in various Site media. Materials Safety Data Sheets (MSDS) for each of the listed compounds are included in Appendix II.

- Tetrachloroethylene (PERC)
- Methylene Chloride
- Trichloroethylene (TCE)
- 1,1,1 Trichloroethane (1,1,1 TCA)
- Chloromethane
- Toluene
- Xylenes
- Cadmium
- Chromium
- Lead
- Mercury

4.1.3 Control of Exposure to Chemical Hazards

Ingestion of constituents of concern will be controlled on this site by prohibiting eating and smoking at the Site (see Section 8.0) and by requiring all field personnel to decontaminate themselves upon leaving the Exclusion Zone. Drinking of liquids will take place only after personal decontamination has taken place (except in a heat stress emergency situation). If necessary, drink breaks will be scheduled at least every two hours to avoid heat stress problems.

Skin and eye contact with some of the constituents at the site may cause skin or mucous membrane irritation or severe burns. Many of those constituents can be absorbed into the bloodstream through the skin or eyes.

Any body area which comes in contact with contaminated materials will be washed with soap and rinsed immediately. All field personnel will report any skin or eye contact symptoms to the LTR SSO. The person will be treated by a physician and steps will be taken to eliminate similar exposures.

Potential hazards will be reduced by protecting against exposures to hazardous materials via utilization of appropriate personal protective equipment (PPE). PPE to protect the body against contact with known or anticipated chemical hazards can be divided into five levels of protection categories (Level A, B, C, Modified D, and D) according to the degree of protection afforded. The initial levels of personal protective equipment to be used while performing the activities at the Site described in Section 3.0 are discussed in Section 7.2, Initial PPE Levels for Specific Work Tasks. Personal Protective Equipment and Levels of Protection are discussed in Section 7.0 of this HASP.

4.2 PHYSICAL HAZARDS, HEAT STRESS AND COLD EXPOSURE

There is a risk of physical injury when working near heavy equipment. Field personnel should be aware of these hazards and take steps to avoid contact with them. Physical hazards associated with excavation activities are identified and safety procedures presented in Attachment III, Safety Guidelines for Excavations.

Use of steel-toed steel shank work boots, safety glasses or goggles, and hard hats will be required when in the Exclusion Zone and Contamination Reduction Zone. Personnel should be cognizant that when PPE such as respirators, gloves, and protective clothing are worn, visibility, hearing, and manual dexterity are impaired.

In addition, the PPE required for some activities (coveralls and respirators) places a physical strain on the wearer. A Heat Stress prevention plan will be implemented to deal with this health hazard during warm weather. The plan outlines heat stress identification, treatment, prevention and monitoring. Fluids will be provided at regular intervals during the work periods in order to maintain adequate body fluid levels for the field personnel.

4.3 BIOLOGICAL HAZARDS

Numerous types of pest organisms may be present, including mosquitoes, snakes and ticks. Field personnel are encouraged to use insect repellents before donning PPE. To avoid snake bites, personnel should check for snakes before walking through grassy or debris strewn areas. Also, field personnel may be required to wear knee high boots while at the Site to protect feet and lower leg areas. A first aid kit, insect and tick repellent and treatment will be available for use in the field. In many parts of the northeast United States, tick-borne diseases pose a significant health risk during warm months.

4.4 FLAMMABLE HAZARDS

Flammable hazards are not expected to be significant during the course of this work due to the low levels of flammable materials encountered during previous investigations at the Site. However, as a precaution, air monitoring, as specified in Section 6.0, will be conducted during all intrusive activities.

SECTION 5.0
GENERAL HEALTH AND SAFETY REQUIREMENTS

5.1 MEDICAL EXAMINATION

Before commencing any of the activities defined in Section 3.0, all personnel following this HASP must have a current medical examination as part of a medical surveillance program. This medical surveillance program must meet the requirements of OSHA Regulations 29 CFR 1910.120(f).

5.2 TRAINING

All personnel working on-site and potentially exposed to hazardous substances, health hazards or safety hazards shall be thoroughly trained as specified in OSHA Regulations 29 CFR 1910.120(e). This training program will include: (1) attendance at an initial 40-hour basic health and safety training course off the Site; (2) a minimum of three days of actual field experience under the direct supervision of a trained, experienced supervisor; (3) on-site, site-specific training; and (4) an 8-hour annual update in the basic health and safety training course.

On-site management and supervisors directly responsible for, or who supervise employees engaged in, hazardous waste operations must have received: (1) 40 hours initial training (in accordance with OSHA Regulations 29 CFR 1910.120(e)); (2) three days of supervised field experience; (3) 8 hours of site supervisor training; (4) additional training at the time of job assignment on such topics as, but not limited to: their company's safety and health program and the associated employee training program; personal protective equipment program; spill containment program; air quality monitoring, emergency response; monitoring equipment usage and calibration; and, health hazardous monitoring procedure and techniques; and (5) an 8-hour annual update in the basic health and safety training course.

Special training will be provided at the time of job assignment to on-site personnel who may be exposed to unique or special hazards not covered by the initial 40-hour basic health and safety course. Since it is not anticipated that any unique or special hazards will be encountered during this project, special training will not be required for the work activities covered by this HASP. If unique or special hazards are unexpectedly encountered, specialized training will be provided.

5.3 INCIDENT REPORTING

Any incident or accident involving personnel working at this Site will require that a LTR Incident/Accident Report be filed. Situations covered by this policy include, but are not limited to, fires, explosions, illnesses, injuries, and automobile accidents. These reports must be sent to the LTR HSO within 24 hours of the incident/accident. Worker's Compensation Insurance reports for LTR employees will be filed within 48 hours of each accident or illness which results from work related activities and requires medical attention. The LTR SSO will complete this form in case of an incident. Any injuries/illnesses requiring medical attention or resulting in lost work time shall be immediately reported to the LTR HSO.

5.4 ILLUMINATION, SANITATION AND CONFINED SPACE ENTRY

5.4.1 Illumination

All major work tasks are expected to occur during daylight hours. The illumination requirements set forth by OSHA Regulations 29 CFR 1910.120 (m) will be met.

5.4.2 Sanitation

The sanitation requirements regarding potable and non-potable waters, toilet facilities and washing facilities will be followed as set forth in OSHA Regulations 29 CFR 1910.120(n). Food handling and temporary sleeping quarters requirements are not applicable to this site.

5.4.3 Confined Space Entry

Confined space entry will not be required in connection with the field work activities to be performed under this HASP.

5.5 WORK PROCEDURES

Whenever possible, field personnel should work from a position upwind of work activities.

5.6 RESPIRATOR MAINTENANCE, FIT-TESTING AND DECONTAMINATION

Respirators, if used, will be cleaned daily according to procedures described herein. Cartridges will be replaced either daily or if breakthrough is detected at any time while in use. The following checks will be performed on a daily basis in addition to the above:

- Exhalation valve - pull off plastic cover and check valve for debris or for tears in the neoprene valve which could cause leakage.
- Inhalation valves - screw off both cartridges and visually inspect neoprene valves for tears. Make sure that the inhalation valves and cartridge receptacle gaskets are in place.
- Make sure a protective lens cover is attached to the lens.

- Make sure you have the right cartridges (see Section 7.1).
- Make sure that the face piece harness is not damaged. The serrated portion of the harness can fragment which will prevent proper face seal adjustment.
- Make sure the speaking diaphragm retainer ring is hand tight.

To don respirator, fit facepiece on nose bridge making sure that you are able to breathe through nose. Then swing bottom of facepiece into contact with the chin. When using elastic or rubber headbands, position headbands with longest straps above the ears and over the crown of the head and headbands with shortest straps below the ears around nape of the neck. When using cradle headband, position cradle headband around the crown of the head; position bottom headbands below the ears and around the nape of the neck. Then, adjust the straps for a comfortable fit by moving adjustment slides to lengthen or shorten straps. Adjust the straps just snug enough so that no air leaks around the facepiece. It is not necessary to pull the straps so tight that the respirator digs into the face.

THE RESPIRATOR MUST BE SUBJECTED TO THE FOLLOWING TIGHTNESS TEST BEFORE EACH USE.

Test respirator for leakage using a positive pressure method. Lightly place palm over exhalation valve cover. Exhale gently. A slight positive pressure should build up inside the respirator. If any leakage is detected around the facial seal, readjust head harness straps and repeat test until there is no leakage. If other than facial seal leakage is detected, the condition must be investigated and corrected before another test is made. A negative pressure test should also be performed. Lightly place palms over cartridges or filter holders. Inhale gently and the facepiece should collapse against the face. The respirator must pass the tightness tests before the respirator is used. The respirator will not furnish protection unless all inhaled air is drawn through suitable cartridges or filters.

To decontaminate respirators, the following steps should be undertaken:

- Wash with Alconox soap and water solution and brush gently. (This step will remove any soil/solid particulate matter that may have been collected on the respirator during field activities.)
- Rinse with distilled/deionized water, making sure that the inhalation valves and exhalation valves are clean and free of obstruction.
- Spray with acetone. NOTE: this step should only be done if the respirator materials will not be degraded by he acetone. (This step will remove any traces of organic material

collected on the respirator during field activities.)

- Rinse with distilled/deionized water.
- Wipe with sanitizing solution. (This step will assure the sterility of the respirator.)
- Allow respirator to dry.
- Place the respirator inside a sealed bag or a clean area away from extreme heat or extreme cold.

5.7 LTR PROJECT MANAGER NOTIFICATION

All field personnel must inform the LTR SSO or the Alternate LTR SSO before entering the Site.

IF ANY PREVIOUSLY UNIDENTIFIED POTENTIAL HAZARDS ARE DISCOVERED DURING ANY FIELD WORK, LEAVE THIS AREA OF THE SITE IMMEDIATELY AND CONTACT THE LTR SSO FOR FURTHER INSTRUCTIONS.

5.8 LTR PROJECT SAFETY LOG

A Project Safety Log will be used to record entry and exit dates and times of all field personnel and visitors to the Site; accidents, injuries, and illnesses; incidences of safety infractions by field personnel; air quality and personal exposure monitoring data; and other information related to safety matters. All accidents, illnesses, or other incidents are to be reported promptly to the LTR SSO. A copy of the LTR Project Safety Log for this Site is provided in Attachment .

5.9 OSHA INFORMATION POSTER

In accordance with the Occupational Safety and Health Act of 1970, a copy of the OSHA information poster must be present at the Site. It will be posted at full size (11" x 17") in a permanent structure or temporary field office, or be distributed to on-site personnel in this HASP.

5.10 PROHIBITIONS

Smoking, eating, drinking, chewing tobacco or toothpicks, application of cosmetics, storing food or food containers, and having open fires will be permitted only in designated areas to be established by the LTR SSO. Under no circumstance shall smoking, eating, drinking, chewing tobacco or toothpicks, or application of cosmetics be permitted in the Exclusion Zone or the Contamination Reduction Zone. Good personal hygiene should be practiced by field personnel to avoid ingestion of contaminants.

5.11 INITIAL SITE SAFETY MEETING AND SIGNING OF HEALTH AND SAFETY PLAN COMPLIANCE AGREEMENT

The LTR SSO will hold an initial site safety meeting with LTR, subcontractor and contractor field personnel before work activities start at the Site. During this meeting, it will be verified that all personnel have been provided with or have reviewed a HASP for the work activities to be performed at this Site. For LTR personnel, its subcontractors personnel, and contractor personnel whose employer(s) have adopted this HASP, the HASP shall be reviewed, discussed and questions will be answered. Signed Health and Safety Plan Compliance Agreement Forms of personnel who will be following this HASP will be collected by the LTR SSO and filed. Individuals refusing to sign the Form will not be allowed to work on the Site.

5.12 DAILY SITE SAFETY BRIEFINGS

During field operations, site safety briefings will be held at the start of each day by the LTR SSO to review and plan specific health and safety aspects of scheduled work. All field personnel who are following this HASP are required to attend these briefings. Potential subjects that may be discussed are presented below:

1. Preliminary

- Medical clearances.
  - Training requirements.
  - Written HASP availability.
  - Designation of responsibilities for on-site personnel.
- Identification of on-site personnel trained and certified to administer First Aid.

2. Training topics

- Review of HASP including:
  - types of hazards;
  - pathways of exposure;
  - levels of protection;
  - contamination avoidance;
  - prohibitions;
  - work procedures;
  - confined space entry;
  - work zones;
  - emergency response procedures; and,
  - specific on-site area/work tasks of concern, including excavation safety procedures.
- Decontamination.
- Personnel Protective Equipment.
- Air Quality Monitoring Program.

3. Questions and Answers

5.13 UNDERGROUND STRUCTURES

Caution will be exercised whenever the possibility of encountering subsurface obstructions exists. Before beginning intrusive activities, all available sources of information (such as site utility drawings, "one-call" services, public utility drawings, construction drawings, and discussions with former employees) will be reviewed. The area will be excavated using manual equipment if drilling or digging in the vicinity of suspected underground structures and until the nature of the obstruction is discerned.

SECTION 6.0
AIR QUALITY MONITORING AND MITIGATIVE MEASURES FOR CONTROL OF EMISSIONS

6.1 AIR QUALITY MONITORING INSTRUMENTATION

While performing field activities at the Site, an air quality survey will be performed and the results will be recorded. Several instruments that may be used to monitor air quality are discussed below:

- Photoionization Detector

The HNu Systems Model PI-101 Photoionization Detector (HNu PID) or equivalent will be used to detect trace concentrations of certain organic gases and a few inorganic gases in the air. Methane and the major components of air are not detected by the 11.7 eV HNu PID. The HNu PID probe selected for this project is the 11.7 eV due to its ability to quantify the group of contaminants of concern at the Site. The HNu PID detects mixtures of compounds simultaneously. HNu PID readings do not measure concentrations of any individual compound when a mixture of compounds are present.

The HNu PID will be calibrated twice each day (before start of work and at the conclusion of work) using an isobutylene standard for calibration. Calibrations will be documented. HNu PID readings will be measured in the breathing zone of the most highly exposed worker (i.e., closest to the source) at least hourly.

- Combustible Gas Indicator/Oxygen Meter

The GasTech Triple Range Combustible Gas Indicator/Oxygen Meter (CGI) or equivalent may be used at the discretion of the LTR SSO to measure the concentration of flammable vapors and gases, oxygen, and hydrogen sulfide (in addition to sulfur dioxide) in the air during field activities. Flammable gas concentrations are measured as percentages of the Lower Explosion Limit (LEL). Oxygen content is measured as a percentage of total air. Hydrogen sulfide concentration (which includes sulfur dioxide) is measured in parts per million.

- Multigas Detector Tubes

Draeger Multigas Detector Tubes will be used at the discretion of the LTR SSO to detect and quantify the concentration of selected contaminants in the air. The detector tubes to be employed must be sensitive in the concentration ranges in the OSHA Permissible Exposure Limit (PEL) range for those contaminants. It should be realized that most "compound specific" detector tubes will also detect interference from other aromatic or aliphatic hydrocarbons; readings do not differentiate between which compounds are present. A Draeger pump and detector tubes for benzene, which has a relatively low OSHA PEL, hydrogen sulfide and sulfur dioxide will be present at the Site at all times.

The tube readings will be compared to OSHA PELs to determine what level of protection is required. If HNu PID readings are elevated when compared to background (e.g. 4 ppm or more above background) or if phase product or odorous material is detected, then detector tubes for benzene will be employed. Detector tubes for hydrogen sulfide and sulfur dioxide will be employed when the hydrogen sulfide reading on the CGI exceeds 4 ppm.

- Personal Monitor for Aerosol and Dust

The MIE, Inc. Model PDM-3 MiniRam Personal Monitor for Aerosol and Dust (MiniRam Monitor) will be used at the discretion of the LTR SSO to detect and quantify the concentration of fugitive dust that may be created during ground disrupting operations. The instrument is capable of measuring fugitive dust at concentrations as low as 0.1 mg/m^3.

The MiniRam Monitor will be calibrated twice daily, before start of work and at the conclusion of work.

6.2 AIR QUALITY RESPONSE LEVELS

A number of response levels will be used during field work if contamination is encountered during air monitoring. The LTR HSO will be notified as soon as practical of upgrading from the initial levels of protection. The following response levels will apply to the work activities covered by this HASP.

Air Quality Measurement[1]	Response
HNu PID reading less than 5 ppm above background (1 min average)	Level D Protection or Modified Level D Protection (at the discretion of LTR SSO)
CGI reading less than 25% LEL	
Oxygen reading greater than 19.5% and less than 23.5%*	
Hydrogen sulfide reading less than 5 ppm (CGI and Draeger Detector Tubes)	
Benzene reading less than 0.5 ppm (Draeger Detector Tubes)	
MiniRam Monitor reading less than 2.5 mg/m^3	
No dust visible in breathing zone	

[1] All Air Quality Measurements, with the exception of CGI measurements for flammable vapors and gases, should be made in the breathing zone of personnel who, in the opinion of the LTR SSO, are most exposed to airborne contaminants. Measurements of flammable vapor and gas levels should be made in the vicinity of the nearest ignition source.

* Note that combustible gas readings are not valid in atmospheres with <19.5 percent oxygen, and that if such a condition exists, work should be ceased in that area and the LTR HSO contacted.

Air Quality Measurement(1)	**Response**
HNu PID reading greater than 5 ppm and less than 10 ppm above background (1 min average)	Level C Protection
Benzene reading greater than 0.5 ppm and less than 5 ppm (Draeger Detector Tube)	
MiniRam Monitor reading greater than 2.5 mg/m^3 and less than 10 mg/m^3	
Dust visible in breathing zone	

Air Quality Measurement(1)	**Response**
HNu PID reading greater than 10 ppm above background (1 min average)	Level B Protection
Oxygen reading less than 19.5% or greater than 23.5%*	
Hydrogen sulfide reading greater than 5 ppm (CGI and/or Draeger Detector Tube)	
MiniRam Monitor reading greater than 10 mg/m^3	
Excessive dust in breathing zone	

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(1) All Air Quality Measurements, with the exception of CGI measurements for flammable vapors and gases, should be made in the breathing zone of personnel who, in the opinion of the LTR SSO, are most exposed to airborne contaminants. Measurements of flammable vapor and gas levels should be made in the vicinity of the nearest ignition source.

* Note that combustible gas readings are not valid in atmospheres with <19.5 percent oxygen, and that if such a condition exists, work should be ceased in that area and the LTR HSO contacted.

Air Quality Measurement[1]	Response
CGI reading greater than 25% LEL	Suspend work in immediate area and notify LTR HSO and LTR Project Manager. Conduct air monitoring periodically to determine when work may be continued. Take mitigative measures as discussed in Section 6.3 to suppress emissions as appropriate. All ignition sources will be shut off. The work zones will be evacuated immediately. Work will not resume until the CGI readings are continuously below 25% LEL for 15 minutes or more.

(1) All Air Quality Measurements, with the exception of CGI measurements for flammable vapors and gases, should be made in the breathing zone of personnel who, in the opinion of the LTR SSO, are most exposed to airborne contaminants. Measurements of flammable vapor and gas levels should be made in the vicinity of the nearest ignition source.

Background HNu PID readings will be taken at least twice per day (before start of work and at the conclusion of work). Background levels will be taken at a location which is not affected by on-site work. Once work at the Site begins, relocation of the original background location may be required.

Should work at the Site be conducted using respiratory protection, the need for a personal exposure monitoring program will be evaluated by the LTR HSO. Details of this program and any monitoring equipment required for its implementation will be specified in an Addendum to this HASP prepared by the LTR HSO.

6.3 MITIGATIVE MEASURES FOR CONTROL OF EMISSIONS

Vapor or dust emissions resulting from field operations, if they were to occur, are not anticipated to exceed the action levels. If the action levels are exceeded at any monitoring location, implementation of mitigative measures to suppress emissions should be investigated. Appropriate mitigative measures would include ceasing operations until the exact cause of the emissions could be identified and corrected. Vapor control actions may include vapor suppression foams, covering exposed soil piles with plastic sheeting and/or spraying exposed soil piles and drilling sites with water. Fugitive dust emission control actions may consist of spraying of water in areas of the Site where dust is generated. The use of water will be supplemented by the use of calcium chloride, if necessary.

SECTION 7.0
PERSONAL PROTECTIVE EQUIPMENT

7.1 DESCRIPTION OF LEVELS OF PROTECTION

The personal protection equipment specified in this HASP will be available to all field personnel. The following requirements will be followed in accordance with OSHA Regulations:

- facial hair will not interfere with the proper fit of respirators;
- contact lenses will not be worn; and,
- eyeglasses that interfere with the proper fit of full-face respirators will not be worn.

Level D Personal Protective Equipment

- Hard hat
- Safety glasses or goggles
- Steel-toed and steel shank work boots (if rubber boots not worn)
- Nitrile-butadiene rubber outer gloves(1)
- Regular Tyvek coveralls(1)
- Latex surgical gloves (to be worn underneath outer gloves)(1)
- Rubber overboots, steel-toed and steel shank rubber boots, or disposable "booties"(1)
- Hearing protection around drilling equipment

(1) Optional, at discretion of LTR SSO.

Modified Level D Personal Protective Equipment

- Hard hat
- Safety glasses or goggles
- Steel-toed and steel shank work boots (if rubber boots not worn)
- Rubber overboots, steel-toed and steel shank rubber boots, or disposable "booties"
- Nitrile-butadiene rubber outer gloves
- Latex surgical gloves (to be work underneath outer gloves)
- Polyethylene coated or Saranex impregnated Tyvek coveralls(1) (taped at cuffs)
- Hearing protection around drilling/heavy equipment

(1) Choice at discretion of LTR SSO

Level C Personal Protective Equipment

- Hard hat
- Full-face MSA respirator with GMC-H combination cartridges
- Steel-toed and steel shank work boots (if rubber boots not worn)
- Rubber overboots, steel-toed and steel shank rubber boots, or disposable "booties"
- Nitrile-butadiene rubber outer gloves
- Latex surgical gloves (to be worn underneath outer gloves)
- Polyethylene coated or Saranex impregnated Tyvek coveralls (taped at cuffs)

Air monitoring equipment described previously will be provided. A first aid kit, multi-purpose dry chemical UL Class 10A-10B-C fire extinguisher, eye wash station, appropriate barricades and alarm horns will be present and maintained at the Site.

A list of personal protective equipment for the levels of protection which might be required at this Site is included as Attachment .

Selection of the PPE specified for this project is based on a review of the identified or suspected hazards, routes of potential exposure to on-site workers (inhalation, skin absorption, ingestion, and skin or eye contact) and the performance of the personal protective equipment in providing a barrier to these hazards. In addition, the choice of PPE has been reviewed to match the work requirements and task-specific conditions to provide adequate protection without causing unnecessary physical impairment to the worker.

7.2 INITIAL PPE LEVELS FOR SPECIFIC WORK TASKS

The following initial PPE levels have been established for the work activities described in Section 3.0, Work Plan:

Work Activity	PPE Level of Protection
All site activities	Modified D

SECTION 8.0
DESIGNATION OF WORK ZONES

To minimize the movement of contaminants from the Site to uncontaminated areas, three work zones will be set up. The three work zones will consist of the following:

Zone 1:	Exclusion Zone
Zone 2:	Contamination Reduction Zone
Zone 3:	Support Zone

The Exclusion Zone is the area where contamination occurs or could occur. Initially, the Exclusion Zone should extend a distance of 25 ft from the edge of intrusive activity unless conditions at the Site warrant either a larger or smaller distance as determined by the LTR SSO. All persons entering the Exclusion Zone must wear the applicable level of protection as set forth in Section 7.1, Personal Protective Equipment and Section 7.2, Initial PPE Levels for Specific Work Tasks. It is anticipated that work zones will be established at each individual area of intrusive work rather than encompass the entire Site.

The Support Zone is the area of the Site where significant exposure to contamination is not expected to occur during non-intrusive activities. The Support Zone is considered to be the "clean area" of the Site.

Between the Exclusion Zone and Support Zone is the Contamination Reduction Zone which provides a transition zone between the contaminated and clean areas of the Site. The Contamination Reduction Zone will be located directly outside of the Exclusion Zone. All personnel must decontaminate when leaving the Exclusion Zone. A Contamination Reduction Zone (decontamination area) will be established adjacent to each individual area of intrusive work.

SECTION 9.0
DECONTAMINATION PROCEDURES

The following steps will be taken for decontamination of personnel:

- Deposit equipment that needs to be decontaminated on plastic drop cloths.
- Wash boots and outer gloves with long handled brushes in wash tub containing Alconox and water.
- Rinse boots and outer gloves with long handled brushes in a wash tub containing clear water or use a sprayer to rinse off boots and gloves.
- Remove tape and place in disposal drum.
- Remove outer gloves and place in disposal drum.
- Remove suit and place in disposal drum.
- Remove respirator and place on table to be decontaminated.
- Remove inner gloves and place in disposal drum.
- Wash hands and face.

All tools or equipment which have been in contact with contaminated materials should be decontaminated after leaving the Exclusion Zone. This decontamination is to be performed using a high pressure/hot water "steam type" cleaner or a spray/rinse decontamination sequence as described in Section 5.6, Respirator Maintenance, Fitting and Decontamination, as appropriate.

Contaminated liquids from the decontamination area and contaminated clothing should be disposed of in accordance with site protocols.

SECTION 10.0
EMERGENCY RESPONSE PLAN

The purpose of this section of the HASP is to address how personnel at the Site will respond to emergencies. The types of potential emergencies that are addressed by this Plan include:

- Fires;
- Chemical exposures; and,
- Physical injuries.

Decontamination procedures as specified in Section 9.0 will be followed to prevent the spread of contamination off-site.

10.1 EMERGENCY RECOGNITION AND PREVENTION

10.1.1 Fires

Fires are possible whenever flammable gases or vapors are present in proper concentrations and an ignition source is present. The construction equipment itself provides an ignition source. To prevent fires, a CGI as specified in Section 6.0 will be used to detect flammable concentrations of gases or vapors. Ignition sources will be turned off and the area evacuated if vapors or gases reach 25% of the Lower Explosion Limit (LEL) as measured by the CGI. Work will not resume until the LTR SSO observes CGI readings below 25% of the LEL for a minimum of 15 consecutive minutes.

10.1.2 Chemical Exposures

Work should always be performed in a manner that minimizes exposure to contaminants through skin or eye contact, inhalation or ingestion. Work practices that shall be followed to reduce the risk of chemical exposure include:

- PPE, as specified in Section 7.0, for the appropriate work activities and areas as defined by the LTR SSO, will be used by all field personnel following this HASP. A formal revision to the HASP must be made by the LTR HSO to modify the PPE specifications.
- Keep hands away from face during work activities.
- Minimize all skin and eye contact with contaminants.

- Stand upwind of possible sources.

Early recognition of the symptoms of chemical exposure is essential for the prevention of serious chemical exposure incidents. Symptoms of exposure to the types of compounds potentially present at the Site include the following: fatigue, weakness; eye, nose, and/or throat irritation; headache; dizziness; nausea; vomiting; malaise; tremors; aggressive confusion; cyanosis (blue color to skin); anemia; and muscle spasms. If a person experiences any of these symptoms, or others, or recognizes any of the symptoms in a fellow worker, the person experiencing the symptoms shall immediately stop work and report his or her symptoms to the LTR SSO. If the symptoms persist or appear to be damaging in any way, the LTR SSO will make arrangements to take the individual to a hospital for medical treatment. If the symptoms are serious, work activities in the area where the person was exposed will be discontinued until more is known about the incident. Incident reporting procedures as specified in Section 5.3 will be initiated.

10.1.3 Physical Injuries

Site personnel should constantly look for potential safety hazards such as holes or ditches; improperly positioned objects, such as drums or equipment that may fall; sharp objects, such as nails, metal shards, and broken glass; protruding objects at eye or head level; slippery surfaces; steep grades; uneven terrain or unstable surfaces, such as walls that may cave in or flooring that may give way. Site personnel should inform the LTR SSO of any potential hazards observed so that corrective action can be taken. Site personnel shall be constantly aware of heavy equipment in area, and shall stay out of pathway of moving equipment or parts.

10.2 EMERGENCY ALERTING PROCEDURES

The LTR SSO will alert the appropriate work groups when an emergency occurs through the use of radios or by directly contacting the work group. The LTR SSO and any isolated work group will carry radios if direct contact cannot be maintained. A single blast from an air horn will be used to signal workers to stop work and assemble in the Contamination Reduction Zone. If evacuation of the Site is necessary, three blasts from an air horn will be used to signal workers.

10.3 EVACUATION PROCEDURES AND ROUTES

Normally, personnel should evacuate through the Contamination Reduction Zone, and from there, to the Support Zone. If a fire blocks entry into the Contamination Reduction Zone, personnel will proceed directly to the Support Zone. Evacuation from the Contamination

Reduction Zone will proceed in an upwind direction from the emergency. If evacuation to the Support Zone does not provide sufficient protection from the emergency, personnel will be advised to evacuate the Site proper.

10.4 TELEPHONE NUMBERS OF EMERGENCY SERVICES

A portable phone shall be located in an on-site vehicle along with the emergency numbers given below (see also Attachment I):

Emergency Service	Telephone Number
Ambulance	911
Fire Department	911
Police Department	911
Hospital	(516) 542-2655
Poison Control Center	(800) 962-1253
USEPA National Response Center	(800) 438-2427

These telephone numbers must be verified by the LTR SSO prior to the start of fieldwork.

10.5 EMERGENCY RESPONSE PERSONNEL

The LTR SSO will have the primary role in responding to all emergencies at the Site. The LTR SSO, or the Alternate LTR SSO, will be present at the Site during all work activities. If any emergency such as a fire, chemical exposure, or physical injury occurs, the LTR SSO shall be notified immediately. *The LTR SSO will have certification in First Aid.* All site personnel will take direction from the LTR SSO in cases of emergency response.

After an emergency has occurred at the Site, the causes and responses to that emergency should be thoroughly investigated and documented by the LTR Project Manager and LTR SSO; this documentation will be submitted to the LTR Corporate Health and Safety Administrator and LTR HSO within 48 hours of the emergency.

10.6 DECONTAMINATION PROCEDURES DURING AN EMERGENCY

Decontamination of an injured or exposed worker or during a site emergency shall be performed only if decontamination does not interfere with essential treatment or evacuation.

If a worker has been injured or exposed and decontamination can be done: wash, rinse, and/or cut off protective clothing and equipment.

If a worker has been injured or exposed and decontamination cannot be done:

- Wrap the victim in blankets, plastic or rubber to reduce contamination of other personnel;
- Alert emergency and off-site medical personnel to potential contamination; and,
- Have the LTR SSO or other personnel familiar with the incident and contaminants at the Site accompany the victim to the hospital.

10.7 EMERGENCY MEDICAL TREATMENT AND FIRST AID PROCEDURES

Emergency medical treatment or First Aid may be administered at the Site by the LTR SSO or other personnel who have been certified in First Aid.

General emergency medical and First Aid procedures are as follows:

- Remove the injured or exposed person(s) from immediate danger.
- Render First Aid, if necessary, decontaminate affected personnel, if necessary.
- Call an ambulance for transport to local hospital immediately. <u>This procedure should be followed even if there is no apparent serious injury.</u>
- Evacuate other personnel at the Site to safe places until the LTR SSO determines that it is safe for work to resume.
- Report the accident to the LTR HSO immediately.

10.8 DIRECTIONS TO THE NASSAU COUNTY MEDICAL CENTER FROM SITE

Directions to the Nassau County Medical Center from the Site are repeated in Attachment I.

The directions to the Nassau County Medical Center from the Site must be verified by the LTR SSO prior to the start of field work. A copy of the directions will be maintained in the LTR SSO's vehicle on site for easy access. A map depicting the route will also be included with the directions.

SECTION 11.0
GEOTECHNICAL LABORATORY CONSIDERATIONS

In accordance with the requirements of OSHA Regulations 29 CFR 1910.1450, Occupational Exposure to Hazardous Chemicals in Laboratories, and the LTR Hazardous Waste Health and Safety Manual, a Chemical Hygiene Plan must be prepared and approved by the LTR HSO prior to transporting any potentially contaminated sample to a LTR Geotechnical Laboratory.

SECTION 12.0
PERSONNEL ASSIGNMENTS

12.1 PROJECT PERSONNEL

LTR personnel authorized to enter the Site and work on this project subject to compliance with provisions of the HASP, are:

LTR Project Manager	Tim Douthit
LTR Site Manager	Chris Poole
LTR Site Safety Officer	Chris Poole
LTR Corporate Health and Safety Officer	Russel Direnzo

Other personnel who meet HASP requirements, including training and participation in a medical surveillance program, may enter and work on the Site subject to compliance with provisions of the HASP.

12.2 PROJECT SAFETY RESPONSIBILITIES

Personnel responsible for implementing this Health and Safety Plan are the LTR Project Manager and the LTR Site Safety Officer. Their specific responsibilities and authority are described in the LTR Hazardous Waste Health and Safety Manual.

SECTION 13.0
HEALTH AND SAFETY PLAN APPROVALS

LTR Health and Safety Officer | Date

LTR Project Manager | Date

LTR Health and Safety Officer | Date

SECTION 14.0
HEALTH AND SAFETY PLAN COMPLIANCE AGREEMENT

I,________________________________ (print name), have received a copy of the Health and Safety Plan for ______________________________________, dated ________________. I have read the HASP, understand it, and agree to comply with all of its provisions. I understand that I could be prohibited from working on the project for violating any of the safety requirements specified in the Health and Safety Plan.

Signed:

______________________________________	______________
Signature	Date

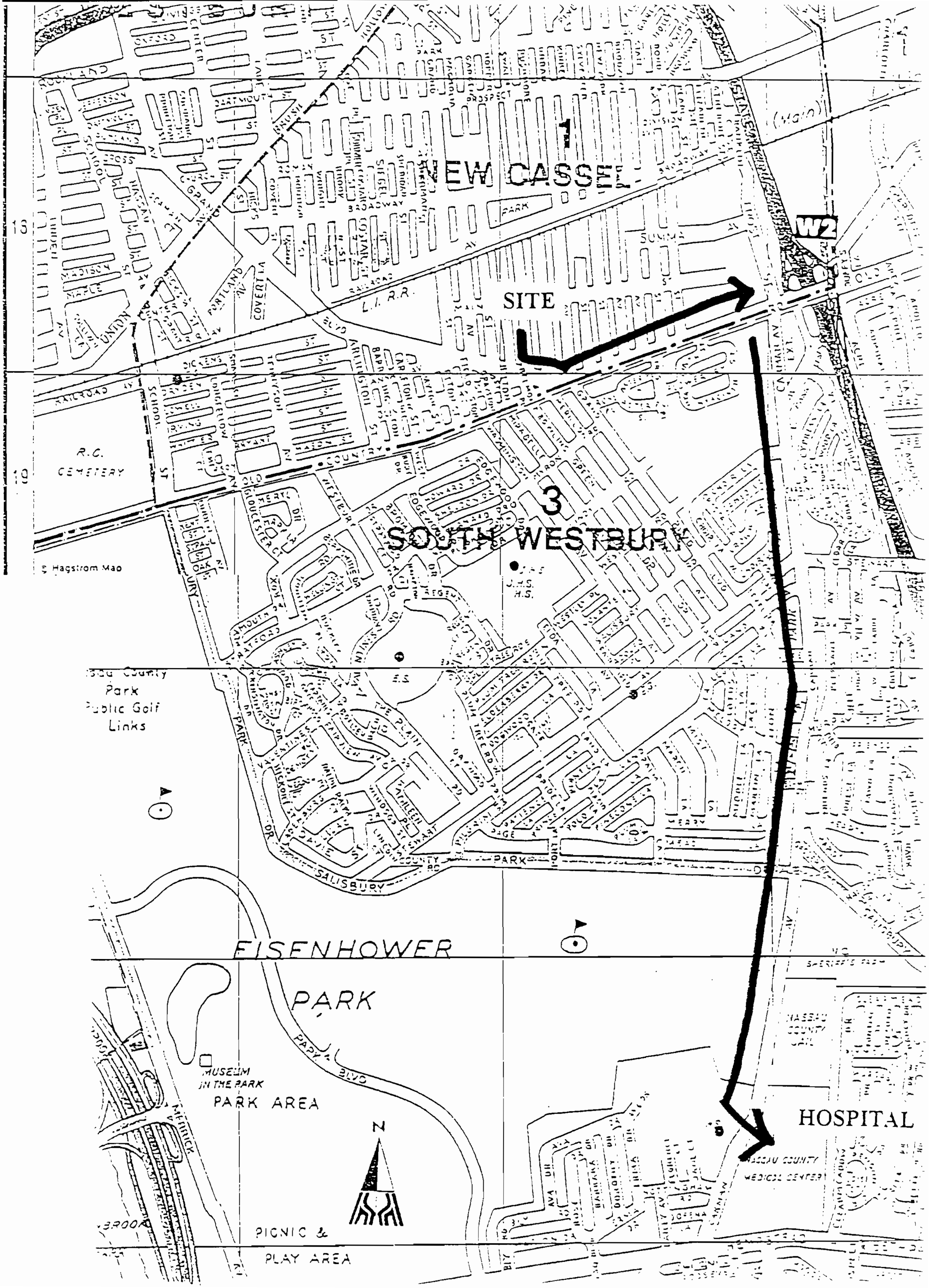
____
Company

ATTACHMENT I

DIRECTIONS TO NASSAU COUNTY MEDICAL CENTER

DIRECTIONS TO NASSAU COUNTY MEDICAL CENTER

- Proceed south from site along Swalm or Rushmore to Old Country Road.
- Proceed east on Old Country Road to Carman Avenue
- Proceed south on Carman Avenue to the Nassau County Medical Center, which is located on the east side of Carman Avenue, north of Hempstead Turnpike (Route 24).


SITE
HOSPITAL
1
NEW CASSEL
3
SOUTH WESTBURY
W2
L.I.R.R.
R.C. CEMETERY
J.H.S. H.S.
E.S.
THE PLAIN
OLD COUNTRY RD
SALISBURY
PARK
EISENHOWER
PARK
MUSEUM IN THE PARK
PARK AREA
PICNIC &
PLAY AREA
NASSAU COUNTY JAIL
NASSAU COUNTY MEDICAL CENTER
SHERIFF'S FARM
Park
Public Golf
Links
BROADWAY
PROSPECT
RAILROAD AV
MERRICK
N
© Hagstrom Map

ATTACHMENT II

MATERIAL SAFETY DATA SHEETS (MSDS)

Genium Publishing Corporation
One Genium Plaza
Schenectady, NY 12304-4690 USA
(518) 377-8854

Material Safety Data Sheets Collection:
Sheet No. 23
Cadmium Metal/Powder
Issued: 9/77 Revision: D, 5/93

Section 1. Material Identification

41

Cadmium Metal/Powder (Cd) Description: Occurs naturally in the mineral greenockite (cadmium sulfide). This form is rare and most cadmium is obtained by extraction from other ores containing it as a mineral (lead, copper, and zinc). Zinc sulfide ores are the main source; by direct distillation or recovery from the electrolytic process. Used in electroplating other metals, fire protection systems, nickel-cadmium storage batteries, power transmission wire, TV phosphors, pigments for ceramic glazes, machinery enamels, baking enamels, photography and lithography, selenium rectifiers, electrodes for cadmium-vapor lamps, and photoelectric cells; as a fungicide and a Weston standard cell control of atomic fission in nuclear reactors.

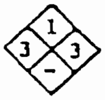
Other Designations: CAS No. 7440-43-9, colloidal cadmium.

Manufacturer: Contact your supplier/distributor. Consult latest *Chemical Week Buyers' Guide*(73) for suppliers list.

Cautions: Cadmium is a highly toxic metal. Symptoms may be delayed several hours and include pulmonary edema (fluid in lungs) which can be fatal. Chronic effects include kidney damage. Cd is considered a carcinogen by several government agencies. The powder is pyrophoric and presents a significant fire/explosion hazard.

Powder

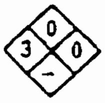
HMIS		R	3
H	3*	I	4
F	1	S	2
R	3	K	3



Genium

Solid

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



*Chronic effects PPE-Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Cadmium, ca 100%

1992 OSHA PEL
8-hr TWA: 5 $\mu g/m^3$

1992 OSHA SECAL*
TWA: 15 or 50 $\mu g/m^3$

1990 IDLH Level
50 mg/m^3

1993-94 ACGIH TLVs
TWA: 0.01 mg/m^3 (total dust), Class A2 carcinogen
TWA: 0.002 mg/m^3 (respirable fraction)

1991 DFG (Germany) MAK
None established

1992 NIOSH REL
Carcinogen, keep as low as possible

1992 Toxicity Data†
Human, inhalation, LC_{Lo}: 39 mg/m^3/20 min caused cardiac changes, thrombosis, and respiratory depression.
Rat, oral, LD_{50}: 225 mg/kg; details not reported.
Woman, inhalation, LC_{Lo}: 129 $\mu g/m^3$ for 20 continuous years produced lung tumors.
Man, TC_{Lo}: 88 $\mu g/m^3$/8.6 years caused kidney and ureter toxicity with protein in the urine.

* Separate engineering control limit: to be achieved in processes and work places where it is not possible to achieve the PEL through engineering and work practices alone. The SECAL for Cd is 15 or 50 $\mu g/m^3$ depending on the processes involved. See Federal Register 57 (178): 42222, Table VIII-B1, 9/14/92.

†See NIOSH, *RTECS* (EU9800000), for additional mutation, reproductive, tumorigenic, and toxicity data.

Section 3. Physical Data

Boiling Point: 1409 °F (765 °C)
Melting Point: 610 °F (321 °C)
Vapor Pressure: 0.095 mm Hg at 609.6 °F (320.9 °C)
Refraction Index: 1.13
Mohs Hardness: 2.0
Molecular Weight: 112.4

Density: 8.642
Water Solubility: Insoluble
Other Solubilities: Soluble in nitric (rapidly), hydrochloric (slowly), and other acids. The solid is soluble in ammonium nitrate solution, but the powdered form undergoes an explosive reaction.

Appearance and Odor: Silver-white, blue-tinged, lustrous, odorless, soft metal that is easily cut with a knife. The powder is grayish-white.

Section 4. Fire and Explosion Data

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

Extinguishing Media: The solid metal is not flammable, but the finely divided powder is pyrophoric. As a rule, the more finely divided the powder is, the greater the potential for explosion. Use carbon dioxide, dry chemical, or sand. **Unusual Fire or Explosion Hazards:** Processes that create cadmium dust such as cutting, grinding, or welding present a serious explosion hazard in presence of ignition sources. Avoid creation of cadmium dust clouds. **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. Do not release runoff from fire control methods to sewers or waterways; dike for proper disposal.

Section 5. Reactivity Data

tability/Polymerization: Cadmium easily tarnishes in moist air as it is oxidized to cadmium oxide. The solid is stable in dry air. The powder is pyrophoric. Cd becomes brittle at 176 °F (80 °C). Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Include ammonium nitrate (powdered Cd), hydrazoic acid, tellurium, zinc, ammonia, sulfur, selenium, nitryl fluoride, an oxidizing agents. **Conditions to Avoid:** Creation of d dust clouds, exposure to heat and ignition sources, and contact with incompatibles. **Hazardous Products of Decomposition:** Thermal oxidative composition of Cd can produce toxic cadmium oxide (CdO) fumes.

Section 6. Health Hazard Data

arcinogenicity: The following agencies list Cd as a carcinogen: IARC Class 2A (probably carcinogenic in humans),(183) NTP Class 2 (reasonably ticipated to be a carcinogen),(169) and NIOSH Class X (carcinogen defined without further categorization),(183) ACGIH TLV-A2 (suspected human arcinogen),(185) EPA-B1 (Probable human carcinogen) and DFG MAK-A2 (unmistakably carcinogenic in animal experimentation only).(183)

Summary of Risks: Dust or fume inhalation generally results in acute symptoms delayed up to 24 hr. Effects include a flu-like syndrome similar to tal fume fever with chills, fever, and muscle pain in the back and limbs. Pulmonary edema (fluid in lungs) can develop after severe exposure and y result in death. If victim recovers, residual changes may include lung fibrosis (thickening) and vascular changes. Long-term exposure to Cd damages the liver and kidneys (accumulates, half-life = 7 to 30 yr). Proteinuria (protein in urine) of low molecular weight is the first sign of tubular dysfunction. Excess urinary glucose is also seen. Bone demineralization similar to osteoporosis (decreased bone density)...

Continue on next page

ction 6. Health Hazard Data, *continued*

:urs *not* as a direct effect of Cd exposure, but indirectly by altering kidney regulation of calcium and phosphorus which are needed for strong, ılthy bones. Some studies show a correlation between anemia (low hemoglobin in blood) and high Cd levels. Selenium (Se) and zinc (Zn) appear suppress Cd toxicity; Se binds up Cd preventing it from entering body tissue and Zn may compete for the same metabolic site. **Medical Condi-ns Aggravated by Long-Term Exposure:** Kidney, blood, or respiratory disorders. **Target Organs:** Blood, kidney, liver, respiratory system. **imary Entry Routes:** Inhalation, ingestion. **Acute Effects:** Inhalation may cause irritation of the eyes, nose, and throat, nausea and vomiting, lominal colic, diarrhea, chest tightness, cough, headache, and weakness. Pulmonary edema could develop up to 24 hr post exposure. Kidney nage may occur after acute exposures but is more likely with chronic exposure. **Chronic Effects:** Symptoms may be delayed several yr after last posure and include perforation of the nasal septum (tissue between the nostrils), loss of smell, chronic bronchitis, severe progressive emphysema, norexia, insomnia, fatigue, pallor, anemia, kidney damage, bone demineralization, lung fibrosis and possible cancer of the respiratory tract.

RST AID

es: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of ter until transported to an emergency medical facility. Consult a physician immediately.

kin: *Quickly* remove contaminated clothing. Wash exposed area with soap and water.

ıalation: Remove exposed person to fresh air and support breathing as needed.

gestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless otherwise advised, have *conscious and alert* person drink 1 to 2 glasses of water to dilute. *Do not* induce vomiting because of cadmium's irritating nature.

ote to Physicians: ß-2 microglobulin excretion of > 200 µg/g creatinine indicates kidney dysfunction as does a renal cortex [Cd] of 180 to 220 'g of wet kidney cortex. Blood Cd levels are *not* indicative of exposure.

ction 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel, isolate and ventilate area, deny entry, and stay upwind. Shut off ignition sources. Cleanup personnel should tect against inhalation. Carefully scoop up small spills and place in sealed impermeable containers. *Do not* disperse dust by sweeping. nember that Cd powder can be pyrophoric and must be handled carefully. Prevent entry into sewers, drains, and waterways. Follow applicable HA regulations (29 CFR 1910.120).

posal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

A Designations

ed as a RCRA Hazardous Waste (40 CFR 261.24): D006, Characteristic of Toxicity; regulatory level = 1.0 mg/L

ed as a CERCLA Hazardous Substance* (40 CFR 302.4): Final Reportable Quantity (RQ), 10 lb (4.54 kg)† [* per CWA, Sec. 307(a)]

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

ted as a SARA Toxic Chemical (40 CFR 372.65)

HA Designations

ed as an Air Contaminant (29 CFR 1910.1027)

o reporting of releases of this substance is required if the diameter of the pieces of the solid metal is equal to or exceeds 100 µm (0.004 in.)

ction 8. Special Protection Data

gles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because tact 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 any detectable concen-on, use a SCBA or supplied air respirator (with auxiliary SCBA) with a full facepiece operated in pressure-demand or other positive-pressure le. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respira- do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that ludes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient tary storage areas. **Other:** Wear gloves, boots, aprons, and gauntlets to prevent Cd dust from contacting skin. **Ventilation:** Provide general and l exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL or SECAL (Sec. 2). Lunchroom facilities should not concentrations above 2.5 µg/m^3 at any time. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work by controlling it at its source.[103] **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, washing facilities. **Contaminated Equipment:** Separate contaminated work clothes from street clothes; launder before reuse. Remove Cd from s and clean PPE. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using Cd, especially before eating, cing, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

age/Handling Requirements: Store in a cool, dry, well-ventilated area away from heat, ignition sources, and incompatibles. Do not allow nium dust to build up in storage area.

neering 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.

inistrative Controls: Prohibit workers from removing Cd from protective clothing and equipment by blowing, shaking, or any other means lisperses Cd into the air. Employees must not enter eating facilities while wearing PPE unless it is vacuumed with a HEPA. Consider preplace- and periodic medical exams of exposed workers emphasizing the blood, kidneys, liver, and respiratory system. Educate workers on Cadmium's carcinogenicity.

Transportation Data (49 CFR 172.101)

Shipping Name: Poisonous solids, n.o.s.*,
phoric metals, n.o.s.†
Hazard Class: 6.1*, 4.2†
ID No.: UN2811*, UN1383†
Packing Group: III*, I†
Label: Keep away from food*, Spontaneously Combustible†
al Provisions (172.102): —*, B11†

Packaging Authorizations
a) **Exceptions:** 173.153*, None†
b) **Non-bulk Packaging:** 173.213*, .187†
c) **Bulk Packaging:** 173.240*, .242†

Quantity Limitations
a) **Passenger Aircraft or Railcar:** 100 kg*, Forbidden†
b) **Cargo Aircraft Only:** 200 kg*, Forbidder

Vessel Stowage Requirements
a) **Vessel Stowage:** A*, D†
b) **Other:**

* Solid metal, † Powder

S Collection **References:** 26, 73, 100, 101, 103, 124, 126, 127, 132, 133, 136, 139, 148, 159, 167, 169, 183, 185, 186

red by: M Gannon, BA; **Industrial Hygiene Review:** PA Roy, MPH, CIH; **Medical Review:** TW Thoburn, MPH, MD

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

Material Safety Data Sheets Collection:

Sheet No. 83
Chromium Metal/Powder

Issued: 3/81 Revision: A, 11/89

Section 1. Material Identification 30

Chromium Metal/Powder Description: Obtained from chrome ore, chromite ($FeCr_2O_4$), by electrolysis of chromium solutions, by direct reduction (ferrochrome), and by reducing the oxide with finely divided carbon or aluminum. Used for chromeplating other metals; for greatly increasing metal resistance and durability; in manufacturing chrome-steel or chrome-nickel-steel alloys (stainless steel); as a constituent of inorganic pigments; as protective coating for automotive and equipment accessories; and in nuclear and high-temperature research.
Other Designations: Chrome; Cr; CAS No. 7440-47-3.
Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S 1
K 1

Genium

HMIS
H 2
F 1
R 1
PPG*
* Sec. 8

Section 2. Ingredients and Occupational Exposure Limits

Chromium metal/powder, ca 100%

OSHA PEL	ACGIH TLV, 1988-89*	NIOSH REL, 1987†	Toxicity Data‡
8-hr TWA: 1 mg/m³	TLV-TWA: 0.5 mg/m³	8-hr TWA (for chromium metal and insoluble salts): 1 mg Cr/m³	Rat, implant, TD_{Lo}: 1200 µg/kg body weight administered intermittently over six weeks

* This TLV is applicable to Cr^{+2} and Cr^{+3} compounds. For water soluble and water-insoluble Cr^{+6}, the 8-hr TWA is 0.05 mg Cr^{+6}/m^3. Certain water-insoluble Cr^{+6} compounds (zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate, and sintered chromium trioxide) are designated as A1a (human carcinogen).

† The NIOSH REL (10-hr TWA) for carcinogen Cr^{+6} compounds is 1 µg/m³; for noncarcinogenic Cr^{+6} compounds (including chromic acid), the RELs (10-hr TWAs) are 25 µg/m³ and 50 µg/m³ (15-min ceiling). The noncarcinogenic compounds include mono- and dichromates of hydrogen, cesium, sodium, lithium, potassium, rubidium, ammonia, and Cr^{+6} (chromic acid anhydride). Any and all Cr^{+6} materials excluded from the noncarcinogenic group above are carcinogenic Cr^{+6} compounds.

‡ See NIOSH, *RTECS* (GB4200000), for additional data with references to tumorigenic effects.

Section 3. Physical Data

Boiling Point: 4783 °F (2642 °C)
Melting Point: 3452 °F (1900 °C)
Vapor Pressure: 1 mm Hg at 2941 °F (1616 °C)
Vapor Density (Air = 1): 1.79
Atomic Weight: 51.996 g/mol
Specific Gravity (H_2O = 1 at 39 °F (4 °C)): 7.2 at 68 °F (20 °C)
Water Solubility: Insoluble

Appearance and Odor: Steel-gray, lustrous metal; no odor.

Section 4. Fire and Explosion Data

Flash Point: None reported	Autoignition Temperature: Cloud, 1076 °F (580 °C); dust layer, 752 °F (400 °C)	LEL: Dust cloud explosion, 0.230 oz/ft³*	UEL: None reported

Extinguishing Media: Use dry chemical or sand.
Unusual Fire or Explosion Hazards: Particle size and dispersion in air determine reactivity. Chromium powder explodes spontaneously in air, while chromium dust suspended in CO_2 is ignitable and explosive when heated.
Special Fire-fighting Procedures: Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

*One hundred percent of dust goes through a 74-µm sieve. A 140-mJ spark can ignite a dust cloud.

Section 5. Reactivity Data

Stability/Polymerization: Chromium is stable when properly handled and stored. Hazardous polymerization cannot occur.
Chemical Incompatibilities: Chromium reacts readily with dilute, not nitric, acids to form chromous salts. It is soluble in acids (not nitric) and strong alkalis. Its powder is incompatible with strong oxidizing agents, including high O_2 concentration. Evaporation of mercury (Hg) from Cr amalgam leaves pyrophoric chromium. Finely divided Cr attains incandescence with nitrogen oxide, potassium chlorate, and sulfur dioxide. Molten lithium at 18 °C severely attacks Cr. Fused ammonium nitrate below 200 °C reacts explosively and may ignite or react violently with bromine pentafluoride.
Hazardous Products of Decomposition: Thermal oxidative decomposition of Cr can produce toxic chromium oxide fumes.

Section 6. Health Hazard Data

Carcinogenicity: The NTP and OSHA list chromium as a human carcinogen.

Summary of Risks: When ingested chromium is a human poison, with gastrointestinal (GI) effects. Chromium 3 (Cr^{+3}) compounds show little or no toxicity. Less soluble chromium 6 (Cr^{+6}) compounds are suspected carcinogens and severe irritants of the larynx, nasopharynx, lungs, and skin (Sec. 2). Chromic acid or chromate salts cause irritation of the skin and respiratory passage. Ingestion leads to severe irritation of the gastrointestinal tract, renal damage, and circulatory shock. Chromium metal (when heated to high temperatures) and insoluble salts are said to be involved in histological fibrosis of the lungs, which may progress to clinically evident pneumoconiosis. Exposure to chromate dust and powder can cause skin (dermatitis) and eye irritation (conjunctivitis).

Medical Conditions Aggravated by Long-Term Exposure: An incresed incidence of bronchogenic carcinoma occurs in workers exposed to chromate dust.

Target Organs: Respiratory system.

Primary Entry: Inhalation, percutaneous absorption, and ingestion.

Acute Effects: Acute exposures to dust may cause headache, coughing, shortness of breath, pneumoconiosis, fever, weight loss, nasal irritation, inflammation of the conjunctiva, and dermatitis.

Chronic Effects: Asthmatic bronchitis.

FIRST AID

Eyes: Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

Skin: Brush off chromium dust. 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: Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person slowly drink 1 to 2 glasses of water to dilute. Do not induce vomoting. A physician should evaluate all ingestion cases.

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

Physician's Note: Acute toxicity causes a two-phase insult: 1) multisystem shock due to gastrointestinal corrosivity and 2) hepatic, renal, hematopoetic insult. Treatment should use ascorbic acid as a neutralizer with gastric lavage. If the ingestion is substantial, exchange transfusions and/or consider hemodialysis. Treat allergic dermatitis with local cortisone or 10% ascorbic acid to reduce Cr^{+6} to Cr^{+3}. Ten percent EDTA in a lanolin base applied every 24 hr helps heal skin ulcers.

Section 7. Spill, Leak, and Disposal Procedures

Spill/Leak: Notify safety personnel of large spills. Cleanup personnel should wear protective clothing and approved respirators. Remove heat and ignition sources. Provide adequate ventilation. Keep airborne dust at a minimum. Remove spills quickly and place in appropriate containers for disposal or reuse.

Disposal: Reclaim salvageable metal. 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): 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)

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. Wear an SCBA with a full facepiece when the particle concentration's upper limit is 0 mg/m^3.

Warning: Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

ther: Wear impervious rubber gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

entilation: Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA standard ec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

afety Stations: Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

ontaminated Equipment: Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder ntaminated 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, oking, using the toilet, or applying cosmetics.

ction 9. Special Precautions and Comments

Storage Requirements: Store material in cool, dry, well-ventilated area separate from acids and oxidizing agents. Seal and protect containers from physical damage. Keep away from heat or ignition sources.

gineering Controls: Avoid dust inhalation. Practice good housekeeping (vacuuming and wet sweeping) to minimize airborne particulates a to prevent dust accumulation. Use nonsparking tools and ground electrical equipment and machinery.

Transportation Data (49 CFR 172.101, .102): Not listed

DS Collection References: 1, 2, 26, 38, 80, 87, 88, 89, 100, 109, 124, 126

Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Hardies, MD

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(518) 377-8854

Material Safety Data Sheets Collection:

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

Section 1. Material Identification

32

Lead (Inorganic) (Pb) Description: Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a constuction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.

Other Designations: CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.

Manufacturer: Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R 0
I 4
S -
K 0

Genium
1
3 0
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HMIS
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R 0
PPG*
* Sec. 8

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

Section 2. Ingredients and Occupational Exposure Limits

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

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

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

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

1988 NIOSH REL
10-hr TWA: <100 μg/m³

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

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

Section 3. Physical Data

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

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

* Lead dissolves more easily at a low pH.

Section 4. Fire and Explosion Data

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

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

Section 5. Reactivity Data

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

Section 6. Health Hazard Data

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

Continue on next page

[illegible]ction 6. Health Hazard Data, *continued*

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

ST AID

s: Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical lity. Consult a physician immediately.
kin: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health nplaints develop.
alation: Remove exposed person to fresh air and support breathing as needed. Consult a physician.
estion: Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with ac syrup. Consult a physician immediately.

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

ysician's Note: For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic mia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gival 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

ill/Leak: Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of s or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formaof dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled erial 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.

A Designations

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

HA Designations

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

Section 8. Special Protection Data

ggles: Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
pirator: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if neces- wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an S[illegible]A. *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 -ups, pleats, or pockets retain less dust from lead.
tilation: Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
S[illegible]ty 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 terial from your shoes and equipment. Launder contaminated clothing before wearing.
ments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before g, drinking, smoking, using the toilet, or applying cosmetics.

Section 9. Special Precautions and Comments

age Requirements: Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct ght, and heat and ignition sources.
[illegible]neering 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 piratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
U[illegible]r 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 dical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of oyment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead ption level. Maintain worker PbBs at or below 40 μg/100 g of whole blood. To minimize adverse reproductive health effects to parents and de[illegible]loping 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)

Shipping Name: Lead compounds, soluble, n.o.s.
Hazard Class: 6.1
ID [illegible]o.: UN2291
IMO Label: St. Andrews Cross (X, Stow away from foodstuffs)
DG Packaging Group: III

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

OCCUPATIONAL SAFETY AND HEALTH GUIDELINE FOR INORGANIC LEAD

INTRODUCTION

"Inorganic lead" is defined as lead oxides, metallic lead, and lead salts (including organic salts such as lead soaps but excluding lead arsenate). This guideline summarizes pertinent information about inorganic lead for workers, employers, and occupational safety and health professionals who may need such information to conduct effective occupational safety and health programs. Recommendations may be superseded by new developments in these fields; therefore, readers are advised to regard these recommendations as general guidelines.

SUBSTANCE IDENTIFICATION

- **Formula:** Pb
- **Synonyms:** C.I. pigment metal 4, C.I. 77575, KS-4, lead flake, lead S2
- **Identifiers:** CAS 7439-92-1; RTECS OF7525000; DOT 1794
- **Appearance and odor:** Bluish-white, silvery, or gray odorless solid

CHEMICAL AND PHYSICAL PROPERTIES

- **Physical data**

1. Molecular weight: 207.19
2. Boiling point (at 760 mmHg): 1,740°C (3,164°F)
3. Specific gravity (water = 1): 11.34
4. Melting point: 327.5°C (621.5°F)
5. Insoluble in water

- **Reactivity**

1. Incompatibilities: Lead reacts vigorously with oxidizing materials. Contact with hydrogen peroxide or active metals such as sodium or potassium may cause fires or explosions.
2. Hazardous decomposition products: Toxic fumes (e.g., lead oxide) may be released in a fire involving inorganic lead.

- **Flammability**

1. Extinguishant: Dry sand, dry dolomite, or dry graphite
2. Caution: Lead is combustible in powder form when exposed to heat or flame

- **Warning properties**

Evaluation of warning properties for respirator selection: Based on lack of information on odor threshold and eye irritation levels, inorganic lead should be treated as a chemical with poor warning properties.

EXPOSURE LIMITS

The current Occupational Safety and Health Administration (OSHA) permissible exposure limit (PEL) for inorganic lead is 50 micrograms of lead per cubic meter of air ($\mu g/m^3$) as a time-weighted average (TWA) concentration over an 8-hour workshift. If a worker is exposed to lead for more than 8 hours in any workday, the PEL, as a TWA for that day, shall be reduced according to the following formula: maximum permissible limit (in $\mu g/m^3$) = 400 divided by hours worked in the day. The National Institute for Occupational Safety and Health (NIOSH) recommended exposure limit (REL) is 100 $\mu g/m^3$ as a TWA for up to a 10-hour workshift, 40-hr. workweek. The American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value (TLV®) is 0.15 mg/m^3 (150 $\mu g/m^3$) as a TWA for a normal 8-hour workday and a 40-hour workweek (Table 1).

Table 1.—Occupational exposure limits for inorganic lead

	Exposure units $\mu g/m^3$
OSHA PEL TWA	50
NIOSH REL TWA	100*
ACGIH TLV® TWA	150

* Air level to be maintained such that worker blood lead remains ≤60 $\mu g/100g$.

HEALTH HAZARD INFORMATION

- **Routes of exposure**

Inorganic lead may cause adverse health effects following exposure via inhalation or ingestion.

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service   Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Standards Development and Technology Transfer

- **Summary of toxicology**

1. *Effects on animals:* In rats or mice, chronic oral administration or subcutaneous or intraperitoneal injection of lead subacetate, lead acetate, or lead phosphate produced cancer of the kidneys. Intravenous or intraperitoneal injection of lead nitrate, lead acetate, or lead chloride to pregnant mice, rats, or hamsters caused increased fetal mortality and malformations of the posterior extremities and urogenital and intestinal tracts in the offspring.
2. *Effects on humans:* Inhalation or ingestion of inorganic lead has caused peripheral neuropathy with paralysis of the muscles of the wrists and ankles, encephalopathy, anemia (due to decreased red blood cell life and impaired heme synthesis), proximal kidney tubule damage, decreased kidney function, and chronic kidney disease. Lead can accumulate in the soft tissues and bones, with the highest accumulation in the liver and kidneys, and elimination is slow. Lead can penetrate the placental barrier, resulting in neurologic disorders in infants.

- **Signs and symptoms of exposure**

1. *Short-term (acute):* Exposure to inorganic lead can cause decreased appetite, insomnia, headache, muscle and joint pain, colic, and constipation.
2. *Long-term (chronic):* Exposure to inorganic lead can cause weakness, weight loss, nausea, vomiting, constipation, blue or blue-black dot-like pigmentation on the gums ("lead line"), severe headache and abdominal cramps, delirium, convulsions, and coma.

RECOMMENDED MEDICAL PRACTICES

- **Medical surveillance program**

Workers with potential exposures to chemical hazards should be monitored in a systematic program of medical surveillance intended to prevent or control occupational injury and disease. The program should include education of employers and workers about work-related hazards, placement of workers in jobs that do not jeopardize their safety and health, earliest possible detection of adverse health effects, and referral of workers for diagnostic confirmation and treatment. The occurrence of disease (a "sentinel health event," SHE) or other work-related adverse health effects should prompt immediate evaluation of primary preventive measures (e.g., industrial hygiene monitoring, engineering controls, and personal protective equipment). A medical surveillance program is intended to supplement, not replace, such measures.

A medical surveillance program should include systematic collection and epidemiologic analysis of relevant environmental and biologic monitoring, medical screening, morbidity, and mortality data. This analysis may provide information about the relatedness of adverse health effects and occupational exposure that cannot be discerned from results in individual workers. Sensitivity, specificity, and predictive values of biologic monitoring and medical screening tests should be evaluated on an industry-wide basis prior to application in any given worker group. Intrinsic to a surveillance program is the dissemination of summary data to those who need to know, including employers, occupational health professionals, potentially exposed workers, and regulatory and public health agencies.

- **Preplacement medical evaluation**

Prior to placing a worker in a job with a potential for exposure to inorganic lead, the physician should evaluate and document the worker's baseline health status with thorough medical, environmental, and occupational histories, a physical examination, and physiologic and laboratory tests appropriate for the anticipated occupational risks. These should concentrate on the function and integrity of the kidneys and the hematopoietic (blood cell forming), nervous, gastrointestinal, and reproductive systems.

A preplacement medical evaluation is recommended in order to detect and assess preexisting or concurrent conditions which may be aggravated or result in increased risk when a worker is exposed to inorganic lead at or below the NIOSH REL.

The examining physician should consider the probable frequency, intensity, and duration of exposure, as well as the nature and degree of the condition, in placing such a worker. Such conditions, which should not be regarded as absolute contraindications to job placement, include preexisting neuromuscular disease. In addition to the medical interview and physical examination, the physician should consider obtaining additional baseline electrophysiologic and electromyographic studies and an assessment of fertility, using standardized methods and evaluation criteria. The physician should also obtain baseline values for the complete blood count including the reticulocyte count and for those tests which characterize prior internal exposure (e.g., blood lead level) and the effects of prior exposures (e.g., erythrocyte zinc protoporphyrin and delta-aminolevulinic acid dehydrogenase).

- **Periodic medical screening and/or biologic monitoring**

Occupational health interviews and physical examinations should be performed at regular intervals. Additional examinations may be necessary should a worker develop symptoms that may be attributed to exposure to inorganic lead. The interviews, examinations, and appropriate medical screening and/or biologic monitoring tests should be directed at identifying an excessive decrease or adverse trend in the physiologic function of the kidneys and the hematopoietic (blood cell forming), nervous, gastrointestinal, and reproductive systems as compared to the baseline status of the individual worker or to expected values for a suitable reference population. The following tests should be used and interpreted according to standardized epidemiologic procedures and evaluation criteria: a complete blood count with reticulocyte count and those tests which characterize prior internal exposure (e.g., blood lead level) and the effects of exposures (e.g., erythrocyte zinc protoporphyrin and delta-aminolevulinic acid dehydrogenase).

- **Medical practices recommended at the time of job transfer or termination**

The medical, environmental, and occupational history interviews, the physical examination, and selected physiologic and laboratory tests which were conducted at the time of placement should be repeated at the time of job transfer or termination. Any changes in the worker's health status should be compared to those expected for a suitable reference population. Because occupational exposure to inorganic lead may cause adverse reproductive effects and diseases of prolonged inductionlatency, the need for medical surveillance may extend well beyond termination of employment.

- **Sentinel health events**

1. Acute SHE's include: Acute renal failure.
2. Delayed-onset or reproductive SHE's include: Inflammatory and toxic neuropathy and chronic renal failure.

MONITORING AND MEASUREMENT PROCEDURES

- **TWA exposure evaluation**

Measurements to determine worker exposure to inorganic lead should be taken so that the TWA exposure is based on a single entire workshift sample or an appropriate number of consecutive samples collected during the entire workshift. Under certain conditions, it may be appropriate to collect several short-term interval samples (up to 30 minutes each) to determine the average exposure level. Air samples should be taken in the worker's breathing zone (air that most nearly represents that inhaled by the worker).

- **Method**

Sampling and analysis may be performed by collecting inorganic lead with cellulose membrane filters followed by acid digestion and analysis by atomic absorption. A detailed sampling and analytical method for inorganic lead may be found in the *NIOSH Manual of Analytical Methods* (method number 7082).

PERSONAL PROTECTIVE EQUIPMENT

Chemical protective clothing (CPC) should be selected after utilizing available performance data, consulting with the manufacturer, and then evaluating the clothing under actual use conditions.

Workers should be provided with and required to use CPC, gloves, face shields (8-inch minimum) and other appropriate protective clothing necessary to prevent skin contact with inorganic lead.

Workers should be provided with and required to use dust-proof safety goggles where inorganic lead may come in contact with the eyes.

SANITATION

Clothing which is contaminated with inorganic lead should be removed immediately and placed in closed containers for storage until it can be discarded or until provision is made for the removal of inorganic lead from the clothing. If the clothing is to be laundered or cleaned, the person performing the operation should be informed of inorganic lead's hazardous properties.

Change and shower rooms should be provided with separate locker facilities for street and work clothes.

Skin that becomes contaminated with inorganic lead should be promptly washed with soap and water.

The storage, preparation, dispensing, or consumption of food or beverages, the storage or application of cosmetics, the storage or smoking of tobacco or other smoking materials, or the storage or use of products for chewing should be prohibited in work areas.

Workers who handle inorganic lead should wash their faces, hands, and forearms thoroughly with soap and water before eating, smoking, or using toilet facilities.

COMMON OPERATIONS AND CONTROLS

Common operations in which exposure to inorganic lead may occur and control methods which may be effective in each case are listed in Table 2.

Table 2.—Operations and methods of control for inorganic lead

Operations	Controls
During primary (ore) and secondary (scrap) smelting of lead; during the manufacture of storage batteries; during typecasting and remelting of type metal in printing	Process enclosure, local exhaust ventilation, dust control, personal protective equipment
During soldering in the fabrication of metal articles	Process enclosure, local exhaust ventilation, personal protective equipment
During melting and pouring of lead and alloys containing lead; during welding, burning, and cutting of metal structures containing lead or painted with lead containing surface coatings	Local exhaust ventilation, personal protective equipment
During the use of lead in the manufacture of surface coatings, including paints and varnishes; during the manufacture of ceramics and glass	Local exhaust ventilation, personal protective equipment

EMERGENCY FIRST AID PROCEDURES

In the event of an emergency, remove the victim from further exposure, send for medical assistance, and initiate emergency procedures.

- **Eye exposure**

Where there is any possibility of a worker's eyes being exposed to inorganic lead, an eye-wash fountain should be provided within the immediate work area for emergency use.

If inorganic lead gets into the eyes, flush them immediately with large amounts of water for 15 minutes, lifting the lower and upper lids occasionally. Get medical attention as soon as possible. Contact lenses should not be worn when working with this compound.

- **Skin exposure**

Where there is any possibility of a worker's body being exposed to inorganic lead, facilities for quick drenching of the body should be provided within the immediate work area for emergency use.

If inorganic lead gets on the skin, wash it immediately with soap and water. If inorganic lead penetrates the clothing, remove the clothing immediately and wash the skin with soap and water. Get medical attention promptly.

- **Rescue**

If a worker has been incapacitated, move the affected worker from the hazardous exposure. Put into effect the established emergency rescue procedures. Do not become a casualty. Understand the facility's emergency rescue procedures and know the locations of rescue equipment before the need arises.

SPILLS AND LEAKS

Workers not wearing protective equipment and clothing should be restricted from areas of spills or leaks until cleanup has been completed.

If inorganic lead is spilled or leaked, the following steps should be taken:

1. Remove all ignition sources.
2. Ventilate area of spill or leak.
3. For small quantities of liquids containing inorganic lead, absorb on paper towels and place in an appropriate container.
4. Large quantities of liquids containing inorganic lead may be absorbed in vermiculite, dry sand, earth, or a similar material and placed in an appropriate container.
5. If in solid form, inorganic lead may be collected and placed in an appropriate container.
6. Inorganic lead may be collected by vacuuming with an appropriate system.

WASTE REMOVAL AND DISPOSAL

U.S. Environmental Protection Agency, Department of Transportation, and/or state and local regulations shall be followed to assure that removal, transport, and disposal are in accordance with existing regulations.

RESPIRATORY PROTECTION

It must be stressed that the use of respirators is the least preferred method of controlling worker exposure and should not normally be used as the only means of preventing or minimizing exposure during routine operations. However, there are some exceptions for which respirators may be used to control exposure: when engineering and work practice controls are not technically feasible, when engineering controls are in the process of being installed, or during emergencies and certain maintenance operations including those requiring confined-space entry (Table 3).

In addition to respirator selection, a complete respiratory protection program should be instituted which as a minimum complies with the requirements found in the OSHA Safety and Health Standards 29 CFR 1910.134. A respiratory protection program should include as a minimum an evaluation of the worker's ability to perform the work while wearing a respirator, the regular training of personnel, fit testing, periodic environmental monitoring, maintenance, inspection, and cleaning. The implementation of an adequate respiratory protection program, including selection of the correct respirators, requires that a knowledgeable person be in charge of the program and that the program be evaluated regularly.

Only respirators that have been approved by the Mine Safety and Health Administration (MSHA, formerly Mining Enforcement and Safety Administration) and by NIOSH should be used. **Remember! Air-purifying respirators will not protect from oxygen-deficient atmospheres.**

For each level of respirator protection, only those respirators that have the minimum required protection factor and meet other use restrictions are listed. All respirators that have higher protection factors may also be used.

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Table 3.—Respiratory protection for inorganic lead

Condition	Minimum respiratory protection*†
Concentration:	
Less than or equal to 0.5 mg/m³	Any supplied air respirator Any air-purifying respirator with a high-efficiency particulate filter Any self-contained breathing apparatus
Less than or equal to 1.25 mg/m³	Any powered air-purifying respirator with a high-efficiency particulate filter Any supplied-air respirator operated in a continuous flow mode
Less than or equal to 2.5 mg/m³	Any air-purifying full facepiece respirator with a high-efficiency particulate filter Any powered air-purifying respirator with a tight-fitting facepiece and a high-efficiency particulate filter Any self-contained breathing apparatus with a full facepiece Any supplied-air respirator with a full facepiece Any supplied-air respirator with a tight-fitting facepiece and operated in a continuous flow mode
Less than or equal to 50 mg/m³	Any supplied-air respirator with a half-mask and operated in a pressure-demand or other positive pressure mode
Less than or equal to 100 mg/m³	Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode
Planned or emergency entry into environments containing unknown concentrations or levels above 100 mg/m³	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode Any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary self-contained breathing apparatus operated in a pressure-demand or other positive pressure mode
Firefighting	Any self-contained breathing apparatus with a full facepiece and operated in a pressure-demand or other positive pressure mode
Escape only	Any air-purifying full facepiece respirator with a high-efficiency particulate filter Any appropriate escape-type self-contained breathing apparatus

* Only NIOSH/MSHA-approved equipment should be used.

† The respiratory protection listed for any given condition is the minimum required to meet the NIOSH REL of 100 μg/m³ (TWA).

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Material Safety Data Sheet Collection

Mercury MSDS No. 26

Date of Preparation: 1/77 Revision: D, 6/94

Section 1 - Chemical Product and Company Identification 44

Product/Chemical Name: Mercury
Chemical Formula: Hg
CAS No.: 7439-97-6
Synonyms: colloidal mercury, hydrargyrum, liquid silver, Quicksilver
Derivation: Obtained by roasting cinnabar (mercury sulfide) and purified by distillation, or as a by-product of gold mining.
General Use: Used in agricultural poisons, anti-fouling paint, dental amalgams, mining amalgamation (to remove gold and other metals from ore), thermometers, barometers, dry cell batteries, chlorine and caustic soda production, electrical apparatus, and as a neutron absorber in nuclear power plants.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Mercury, ca 100 %wt

OSHA PEL
Ceiling: 0.1 mg/m^3 (vapor and inorganic Hg)
8-hr TWA: 0.05 mg/m^3 (vapor), skin; (Vacated 1989 Final Rule Limit)

ACGIH TLVs
TWA: 0.025 mg/m^3 (inorganic compounds), skin

NIOSH REL
10-hr TWA: 0.05 mg/m^3 (vapor), skin

DFG (Germany) MAK
TWA: 0.01 ppm (0.1 mg/m^3)
Category III: Substances with systemic effects
Onset of Effect: > 2 hr
Half-life: > shift length (strongly cumulative)

Peak Exposure Limit:
0.1 ppm (1 mg/m^3), 30 min. average value, 1/shift

IDLH Level
28 mg/m^3

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Mercury exists as a heavy, odorless, silver-white liquid metal. It is highly toxic by both acute and chronic exposure. Exposure can cause corrosion of the eyes, skin, and respiratory tract and may result in irreversible nervous system damage. It readily forms amalgamations with most metals except iron.

Wilson Risk Scale	
R	1
I	4
S	2*
K	1

*Skin absorption

HMIS	
H	4*
F	0
R	0

*Chronic effects
PPE†
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, eye and skin contact/absorption.
Target Organs: Central nervous system, eyes, skin, respiratory system, liver, kidneys.
Acute Effects
Inhalation: Exposure to high vapor concentrations can cause severe respiratory damage. Other symptoms include wakefulness, muscle weakness, anorexia, headache, ringing in the ear, headache, diarrhea, liver changes, fever, gingivitis, chest pain, difficulty breathing, cough, inflammation of the mouth (stomatitis), salivation, bronchitis, and pneumonitis. Acrodynia (pink or Swifts disease), characterized by redness and peeling of the skin on the toes and fingers, was commonly seen in children in the 1950s and is still *infrequently* seen in workers.
Eye: Irritation and corrosion.
Skin: Skin can become severely irritated if allowed to remain in contact with mercury. Skin absorption will occur at 2.2% of the rate of absorption through the lungs.
Ingestion: Mercury generally passes through the digestive tract uneventfully. However, large amounts may get caught up in the intestine and require surgical removal. If an abscess or other perforation is present along the digestive tract, absorption into the blood stream with subsequent mercury poisoning is possible.
Carcinogenicity: IARC, NTP, and OSHA do not list mercury as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Central nervous system disorders.
Chronic Effects: Chronic exposure appears more common than acute and is primarily associated with central nervous system damage which can be permanent (ex. paresthesia of the hands, lips, feet). Early signs of toxicity include weakness, fatigue, anorexia, weight loss, and gastrointestinal disturbances. If exposure levels are high, characteristic tremors of the fingers, eyelids, and lips occur with progression to generalized tremors of the entire body. Psychic disorders are noticeable and characterized by behavior and personality changes, increased excitability, memory loss, insomnia, and depression. In severe cases, delirium and

cinations may occur. Kidney damage is observed with oliguria (decreased urine output) progressing to anuria (urine sation) and may require dialysis. The cornea and lens of the eyes may take on a brownish discoloration and the extraocular scles may be damaged. This syndrome has been termed *Asthenic-Vegetative Syndrome* or *Micromercurialism.* Chronic ptoms occur increasingly with exposures to 0.1 mg/m^3 or higher. *Mutation:* Aneuploidy and other chromosomal aberrations ve been observed in the lymphocytes from whole blood cultures in workers exposed to mercury. *Reproductive:* Mercury has n detected in stillborn babies of women treated with mercury for syphilis. In a study of six men acutely exposed cupationally) to mercury levels as high as 44 mg/m^3, all suffered impaired sexual function. Repeated skin contact may cause rgic dermatitis in some individuals.

TE: Spilled mercury will release sufficient vapor over time to produce chronic poisoning.

Section 4 - First Aid Measures

lation: Remove exposed person to fresh air and support breathing as needed.

e Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously h flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water and then wash exposed area with p. For reddened or blistered skin, consult a physician.

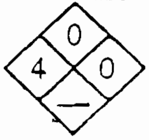
estion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. In general, rcury will pass through the digestive tract uneventfully.

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

to Physicians: BEI: *blood* (15 µg/L), *urine:* (35 µg/g creatinine). Extremely high urine levels of 0.5 to 0.85 mg Hg/L are icative of polyneuropathy. 0.4 to 22 µg/L is reported to be the human lethal blood level. Obtain urinalysis including at a imum: albumin, glucose, and a microscopic examination of centrifuged sediment. Use BAL or 2, 3-dimercaptosuccinic acid helators. *Do not* use calcium sodium EDTA because of nephrotoxicity. An electromyograph may determine extent of nerve dysfunction. It has been noted that exposure to mercury may predispose persons to development of carpal tunnel syndrome.

Section 5 - Fire-Fighting Measures

Genium



h Point: Nonflammable
utoignition Temperature: Nonflammable
: None reported.
: None reported.
nguishing Media: Use agents suitable for surrounding fire.
Unusual Fire or Explosion Hazards: None reported.
ardous Combustion Products: Toxic mercury vapor and mercuric oxide.
-Fighting Instructions: Do not release runoff from fire control methods to sewers or waterways.
Fire-Fighting Equipment: 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.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Keep a mercury spill kit readily available in areas where mercury is used. Notify safety personnel, late and ventilate area, deny entry, and stay upwind.

ll and Large Spills: Follow instructions on mercury spill kit. Most kits come with an aspiration-driven vacuum trap with a rcury "sweeper" (copper or copper-plated brush). Wash spill area with a dilute calcium sulfide or nitric acid solution. If spill cannot be taken up readily, dust the top of the spill with flowers of sulfur or preferably, calcium polysulfide. This will produce a face coating of mercury sulfide which will reduce mercury vapor dispersion into the air.

gulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

dling Precautions: Use appropriate PPE when working with mercury. *Do not* use on porous work surfaces (wood, unsealed crete, etc.) to prevent spills from lodging in cracks.

Storage Requirements: Store in a cool, dry, well-ventilated area away from heat and incompatibles (Sec. 10). Store on non-porous floors and wash them regularly with a dilute calcium sulfide solution. Because mercury will form amalgamations with st metals except iron, metal shelves should be painted with a sufficiently thick coating to prevent this from happening.

Section 8 - Exposure Controls / Personal Protection

ineering Controls: Wherever possible, enclose processes to prevent mercury vapor dispersion into work area.

ilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.(103)

inistrative Controls: Consider pre-placement and periodic medical exams of exposed workers with emphasis on the skin, s, central nervous system, liver, and kidneys.

Respiratory Protection: 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 ≤ 0.5 mg/m^3, use any chemical cartridge respirator with cartridges providing protection against mercury and equipped with an ESLI (end of service life indicator), any SCBA, or any SAR (supplied-air respirator). For ≤ 1.25 mg/m^3, use any SAR operated in continuous-flow mode, any PAPR (powered, air-purifying respirator) with an ESLI. For ≤ 2.5 mg/m^3, use any SCBA or SAR with a full facepiece, any SAR with a tight-fitting facepiece and operated in continuous-flow mode, or any chemical cartridge respirator with a full facepiece, chemical cartridges providing protection against mercury, and equipped with an ESLI. For ≤28 mg/m^3, use any SAR operated in pressure-demand or other positive-pressure mode. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA with full facepiece and operated in pressure-demand or other positive pressure mode. *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.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets made of butyl rubber, nitrile rubber, fluorocarbon rubber, neoprene rubber, polyvinyl chloride, chlorinated polyethylene, or polycarbonate to prevent prolonged or repeated skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. 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 - Physical and Chemical Properties

Physical State: Liquid metal

Appearance and Odor: Silvery-white, odorless

Vapor Pressure: 0.0018 mm Hg at 77 °F (25 °C)

Formula Weight: 200.59

Density ($H_2O=1$): 13.534 g/cm^3 at 77 °F (25 °C)

Boiling Point: 674.09 °F (356.72 °C)

Freezing Point: -37.97 °F (-38.87 °C)

Viscosity: 15.5 mP at 77 °F (25 °C)

Electrical Resistivity: 95.76 μohm at 68 °F (20 °C)

Water Solubility: 0.28 μmol/L at 77 °F (25 °C)

Other Solubilities: Soluble in boiling sulfuric acid, nitric acid (reacts); slightly in lipids, and 2.7 mg/L in pentane. Insoluble in alcohol, ether, cold sulfuric acid, hydrogen bromide, and hydrogen iodide.

Surface Tension: 484 dyne/cm at 77 °F (25 °C)

Critical Temperature: 2664 °F (1462 °C)

Critical Pressure: 1587 atm

Section 10 - Stability and Reactivity

Stability: Mercury does not tarnish at ordinary temperatures but when heated to near its boiling point, it slowly oxidizes to mercuric oxide.

Polymerization: Hazardous polymerization does not occur.

Chemical Incompatibilities: Mercury forms alloys (amalgamates) with most metals except iron. It is incompatible with oxidizers such as bromine, 3-bromopropyne, methylsilane + oxygen, chlorine, chlorine dioxide, nitric acid, or peroxyformic acid; tetracarbonyl nickel + oxygen, alkynes + silver perchlorate, ethylene oxide, acetylenic compounds (explosive), ammonia (explosive), boron phosphodiiodide, methyl azide, nitromethane, and ground sodium carbide.

Conditions to Avoid: Exposure to high temperatures, metal surfaces or incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of mercury can produce mercuric oxide.

Section 11- Toxicological Information

Toxicity Data:*

Reproductive:
Rat, inhalation: 890 ng/m^3/24 hr for 16 weeks prior to mating had an effect on spermatogenesis.

Acute Dermal Toxicity:
Man, skin, TD_{Lo}: 129 mg/kg for 5 continuous hours caused ringing in the ears, headache, and allergic dermatitis.

Acute Oral Toxicity:
Man, oral, TD_{Lo}: 43 mg/kg caused tremor and jaundice or other liver changes.

Acute Inhalation Effects:
Woman, inhalation, TC_{Lo}: 150 μg/m^3/46 days caused anorexia, diarrhea, and wakefulness.
Man, inhalation, TC_{Lo}: 44300 μg/m^3/8 hr caused muscle weakness, liver changes, and increased body temperature.

Chronic Effects:
Rat, inhalation: 1 mg/m^3/ 24 hr for 5 continuous weeks caused proteinuria.

* See NIOSH, *RTECS* (OV4550000), for additional toxicity data.

Section 12 - Ecological Information

cotoxicity: Catfish, LC_{50} = 0.35 mg/L/96 hr; mollusk (*Modiolus carvalhoi*), LC_{50} = 0.19 ppm/96 hr; tadpole (*Rana iexadactyla*), LC_{50} = 0.051 ppm/96 hr. Mercury is transformed to methyl mercury by bacteria in the environment and undergoes bioaccumulation readily. BCF for freshwater fish = 63,000; for saltwater fish = 10,000; and for marine and freshwater invertebrates = 100,000.

nvironmental Degradation: Mercury is expected to volatilize rapidly when deposited on soil surfaces. Once in the air, it can oe transported long distances before being redeposited on soil or in water. In water, mercury appears to bind to particulates where it eventually becomes deposited on the bed sediment. In general, mercury entering the environment can be deposited and revolatilized several times.

Section 13 - Disposal Considerations

isposal: Incineration is *not* an appropriate disposal method. Wastewater may be treated by addition of chlorine to oxidize the mercury to its ionic state. The water can then be passed through an absorbent (an activated charcoal concentrate with a sulfur coating or peanut shell charcoal) to collect the ionic mercury, followed by distillation to recover the mercury. Sodium oorohydride, a reducing agent, can be used to precipitate mercury from waste solutions. Bioremediation, using *Pseudomonas utida*, has also been suggested. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

hipping Name: Mercury
hipping Symbols: A, W
Hazard Class: 8
D No.: UN2809
acking Group: III
Label: Corrosive
Special Provisions (172.102): –

Packaging Authorizations
a) **Exceptions:** 173.164
b) **Non-bulk Packaging:** 173.164
c) **Bulk Packaging:** 173.240

Quantity Limitations
a) **Passenger, Aircraft, or Railcar:** 35 kg
b) **Cargo Aircraft Only:** 35 kg

Vessel Stowage Requirements
a) **Vessel Stowage:** B
b) **Other:** 40, 97

Section 15 - Regulatory Information

PA Regulations:
sted as a RCRA Hazardous Waste (40 CFR 261.33): U151
ted as a CERCLA Hazardous Substance (40 CFR 302.4) per RCRA, Sec. 3001; CWA, Sec. 307(a), CAA, Sec. 112
CERCLA Reportable Quantity (RQ), 1 lb (0.454 kg)
ARA 311/312 Codes: 1, 2
ted as a SARA Toxic Chemical (40 CFR 372.65)
RA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed
OSHA Regulations:
isted as an Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A)

Section 16 - Other Information

eferences: 73, 103, 124, 132, 136, 148, 149, 159, 167, 176, 187, 189

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METHYL CHLORIDE

MTC

Common Synonyms	Gas	Colorless	Odorless or sweet odor
Chloromethane Artic	Floats and boils on water. Flammable, visible vapor cloud is formed.		

Avoid contact with liquid and vapor. Keep people away.
Wear goggles and self-contained breathing apparatus.
Stop discharge if possible.
Shut off ignition sources and call fire department.
Stay upwind and use water spray to "knock down" vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE.
POISONOUS GASES ARE PRODUCED IN FIRE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear goggles and self-contained breathing apparatus.
Stop discharge if possible.
Cool exposed containers and protect men effecting shutoff with water
Let fire burn.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Not irritating to eyes, nose or throat.
If inhaled, will cause nausea, vomiting, headache, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Will cause frostbite.
Flush affected areas with plenty of water
DO NOT RUB AFFECTED AREAS.

Water Pollution

Not harmful to aquatic life.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability, air contaminant
Restrict access
Evacuate area

2. LABEL

2.1 **Category:** Flammable gas
2.2 **Class:** 2

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Halogenated hydrocarbon
3.2 **Formula:** CH_3Cl
3.3 **IMO/UN Designation:** 2.0/1063
3.4 **DOT ID No.:** 1063
3.5 **CAS Registry No.:** 74-87-3

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquefied gas
4.2 **Color:** Colorless
4.3 **Odor:** Faint, sweet, non-irritating; faint ether-like

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Approved canister mask; leather or vinyl gloves; goggles or face shield.
5.2 **Symptoms Following Exposure:** Inhalation causes nausea, vomiting, weakness, headache, emotional disturbances; high concentrations cause mental confusion, eye disturbances, muscular tremors, cyanosis, convulsions. Contact of liquid with skin may cause frostbite.
5.3 **Treatment of Exposure:** Remove to fresh air. Call a doctor and have patient hospitalized for observation of slowly developing symptoms.
5.4 **Threshold Limit Value:** 50 ppm
5.5 **Short Term Inhalation Limits:** 100 ppm for 5 min.
5.6 **Toxicity by Ingestion:** Not pertinent
5.7 **Late Toxicity:** None
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors are nonirritating to the eyes and throat.
5.9 **Liquid or Solid Irritant Characteristics:** No appreciable hazard. Practically harmless to the skin because it evaporates quickly. May cause frostbite.
5.10 **Odor Threshold:** Data not available
5.11 **IDLH Value:** 10,000 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** <32°F C.C.
6.2 **Flammable Limits in Air:** 8.1%-17.2%
6.3 **Fire Extinguishing Agents:** Dry chemical or carbon dioxide. Stop flow of gas.
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Toxic and irritating gases are generated in fires.
6.6 **Behavior in Fire:** Containers may explode
6.7 **Ignition Temperature:** 1170°F
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** 2.2 mm/min.
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** 4.078 (Est.)
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** Reacts with zinc, aluminum, magnesium, and their alloys; reaction is not violent.
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.9 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 36

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** None
8.2 **Waterfowl Toxicity:** None
8.3 **Biological Oxygen Demand (BOD):** None
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Technical grade; "Artic" refrigerant grade
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Safety relief

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-B-C-D-E-F-G

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable gas
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	4
Health	
Vapor Irritant	0
Liquid or Solid Irritant	0
Poisons	2
Water Pollution	
Human Toxicity	0
Aquatic Toxicity	1
Aesthetic Effect	0
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	4
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Gas
12.2 **Molecular Weight:** 50.49
12.3 **Boiling Point at 1 atm:** −11.6°F = −24.2°C = 249°K
12.4 **Freezing Point:** −143.9°F = 97.7°C = 175.5°K
12.5 **Critical Temperature:** 290.5°F = 143.6°C = 416.8°K
12.6 **Critical Pressure:** 969 psia = 65.9 atm = 6.68 MN/m^2
12.7 **Specific Gravity:** 0.997 at −24°C (liquid)
12.8 **Liquid Surface Tension:** 16.2 dynes/cm = 0.0162 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** (est.) 50 dynes/cm = 0.05 N/m at −24°C
12.10 **Vapor (Gas) Specific Gravity:** 1.7
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.259
12.12 **Latent Heat of Vaporization:** 182.3 Btu/lb = 101.3 cal/g = 4.241 X 10^5 J/kg
12.13 **Heat of Combustion:** −5290 Btu/lb = −2939 cal/g = −123.1 X 10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 116.7 psia

NOTES

JUNE 1985

METHYL CHLORIDE

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
−20	62.170
−15	61.860

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
−50	.354
−40	.357
−30	.359
−20	.362

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
	DATA NOT AVAILABLE

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
−30	.332
−20	.320

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
68.02	.600

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
−55	4.590
−50	5.298
−45	6.095
−40	6.987
−35	7.985
−30	9.096
−25	10.330
−20	11.700
−15	13.210
−10	14.880
−5	18.720
0	18.730
5	20.940
10	23.350
15	25.960
20	28.840
25	31.950
30	35.320
35	38.960
40	42.890
45	47.140
50	51.700
55	56.610
60	61.880
65	67.520

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
−55	.05335
−50	.06083
−45	.06913
−40	.07831
−35	.08843
−30	.09957
−25	.11180
−20	.12520
−15	.13980
−10	.15570
−5	.17300
0	.19170
5	.21200
10	.23390
15	.25740
20	.28280
25	.31000
30	.33920
35	.37040
40	.40380
45	.43930
50	.47720
55	.51740
60	.56000
65	.60530

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.177
25	.182
50	.187
75	.192
100	.197
125	.202
150	.207
175	.212
200	.217
225	.221
250	.228
275	.231
300	.236
325	.240
350	.245
375	.249
400	.254
425	.258
450	.263
475	.267
500	.272
525	.276
550	.281
575	.285
600	.289

```
Part Number/Trade Name: METHYLENE CHLORIDE
=============================================================================
                           General Information
=============================================================================
Item Name: METHYLENE CHLORIDE REAGENT
Manufacturer's Name: FISHER SCIENTIFIC, CHEMICAL DIV.
Manufacturer's Street: 1 REAGENT LANE
Manufacturer's P. O. Box:
Manufacturer's City: FAIR LAWN
Manufacturer's State: NJ
Manufacturer's Country: US
Manufacturer's Zip Code: 07410
Manufacturer's Emerg Ph #: 201-796-7100/800-424-9300(CHEMTREC)
Manufacturer's Info Ph #: 201-796-7100
Distributor/Vendor # 1: JOHN J. MCMULLEN ASSOC. (804-873-6500)
Distributor/Vendor # 1 Cage: 3P768
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: 001
Tot Safety Entries This Stk#: 002
Status: SE
Date MSDS Prepared: 27APR92
Safety Data Review Date: 04MAR93
Supply Item Manager: KX
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: BPZMQ
Specification Number:
Spec Type, Grade, Class:
Hazard Characteristic Code: T4
Unit Of Issue: PG
Unit Of Issue Container Qty: 4 LITERS
Type Of Container: UNKNOWN
Net Unit Weight: 11.5 POUNDS
NRC/State License Number: N/R
Net Explosive Weight: N/R
Net Propellant Weight-Ammo: N/R
Coast Guard Ammunition Code: N/R
```

Ingredients/Identity Information

Proprietary: NO
gredient: METHYLENE CHLORIDE (SARA III)
gredient Sequence Number: 01
ercent: 100
gredient Action Code:
gredient Focal Point: D
NIOSH (RTECS) Number: PA8050000
CAS Number: 75-09-2
HA PEL: 500 PPM/C,1000; Z2
GIH TLV: 50 PPM, A2; 9293
Other Recommended Limit: NONE RECOMMENDED

Physical/Chemical Characteristics

Appearance And Odor: CLEAR, COLORLESS LIQUID. MILD, CHLOROFORM-LIKE ODOR.
Boiling Point: 104F,40C
Melting Point: -139F FZ PT
Vapor Pressure (MM Hg/70 F): 400 @ 75F
Vapor Density (Air=1): 2.9
Specific Gravity: 1.32
Decomposition Temperature: UNKNOWN
Evaporation Rate And Ref: 27.5 (BUTYL ACETATE = 1)
Solubility In Water: 1.6%
Percent Volatiles By Volume: 100
Viscosity: 0.44 CPS @68F
pH: N/K
Radioactivity: N/R
Form (Radioactive Matl): N/R
Magnetism (Milligauss): N/R
Corrosion Rate (IPY): UNKNOWN
Autoignition Temperature: 1033F

Fire and Explosion Hazard Data

Flash Point: NONE
Flash Point Method: N/R
Lower Explosive Limit: 13
Upper Explosive Limit: 23
Extinguishing Media: SMALL FIRES: DRY CHEMICAL, CARBON DIOXIDE. LARGE FIRES: WATER SPRAY, FOG, OR REGULAR FOAM.
Special Fire Fighting Proc: WEAR FIRE FIGHTING PROTECTIVE EQUIPMENT AND A FULL FACED SELF CONTAINED BREATHING APPARATUS. COOL FIRE EXPOSED CONTAINERS WITH WATER SPRAY.
Unusual Fire And Expl Hazrds: COMBUSTION OR HEAT OF FIRE MAY PRODUCE HAZARDOUS DECOMPOSITION PRODUCTS AND VAPORS. KEEP UPWIND. FIGHT FIRE FROM A DISTANCE.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): HIGH HEAT, OPEN FLAMES.
Materials To Avoid: ALKALIES, OXIDIZING MATERIALS, WATER, ALUMINUM, ALKALI METALS, SODIUM, POTASSIUM AND MAGNESIUM.
Hazardous Decomp Products: WHEN INVOLVED IN FIRE, METHYLENE CHLORIDE EMITS

GHLY TOXIC AND IRRITATING HYDROGEN CHLORIDE AND PHOSGENE FUMES.
zardous Poly Occur: NO
onditions To Avoid (Poly): NOT APPLICABLE

Health Hazard Data

D50-LC50 Mixture: LD50 ORAL RAT = 1600 MG/KG
ute Of Entry - Inhalation: YES
ute Of Entry - Skin: YES
oute Of Entry - Ingestion: NO
ealth Haz Acute And Chronic: ACUTE: EYE, SKIN AND RESPIRATORY TRACT RITATION, POSSIBLE CORNEAL INJURY, NARCOSIS, CENTRAL NERVOUS SYSTEM FECTS, UNCONSCIOUSNESS, KIDNEY AND LUNG DAMAGE, EVEN DEATH. CHRONIC: ERMATITIS, DELAYED LIVER, KIDNEY AND CENTRAL NERVOUS SYSTEM DAMAGE, GRAVATION OF ARTERY DISEASE.
rcinogenicity - NTP: YES
Carcinogenicity - IARC: YES
C rcinogenicity - OSHA: NO
planation Carcinogenicity: SUSPECTED CARCINOGEN BY NTP AND IARC.
gns/Symptoms Of Overexp: EYE PAIN, SKIN DRYNESS, HEADACHE, DIZZINESS, DROWSINESS, NAUSEA, TINGLING OR NUMBNESS OF THE EXTREMITIES, SENSES OF F LLNESS IN THE HEAD, SENSE OF WARMTH, STUPOR OR DULLNESS, LETHARGY AND UNKENESS. VERY HIGH CONCENTRATIONS MAY LEAD TO UNCONSCIOUSNESS OR EVEN DEATH IN CONFINED OR POORLY VENTILATED AREAS.
M d Cond Aggravated By Exp: PERSONS WITH SKIN, LIVER, KIDNEY, ANGINA, H ART DISEASE, LUNG DISEASE, CORONARY ARTERY DISEASE, ANEMIA OR THOSE WHO ARE HEAVY DRINKERS OR SMOKERS SHOULD NOT BE EXPOSED TO THIS PRODUCT.
Emergency/First Aid Proc: INHALATION: REMOVE TO FRESH AIR. IF NOT B EATHING, GIVE CPR. IF BREATHING IS DIFFICULT, GIVE OXYGEN. CALL A YSICIAN. EYE: FLUSH IMMEDIATELY WITH LARGE AMOUNTS OF WATER FOR 15 MINUTES. GET MEDICAL ATTENTION. SKIN: REMOVE CONTAMINATED CLOTHING. WASH W TH SOAP AND WATER PROMPTLY. INGESTION: DO NOT INDUCE VOMITING. GIVE MILK C WATER TO DRINK ONLY IF CONSCIOUS. GET IMMEDIATE MEDICAL ATTENTION.

Precautions for Safe Handling and Use

S eps If Matl Released/Spill: WEAR RESPIRATOR WITH ORGANIC VAPOR CARTRIDGE OR SCBA AS APPROPIATE. ELIMINATE IGNITION SOURCES. ABSORB IN INERT MATERIAL A D PLACE IN APPROPIATE DISPOSAL CONTAINER AND COVER. FLUSH AREA WITH LARGE A OUNTS OF WATER.
Neutralizing Agent: NONE.
W ste Disposal Method: CONTAMINATED SAWDUST, VERMICULITE OR POROUS SURFACE M ST BE DISPOSED OF IN A PERMITTED HAZARDOUS WASTE MANAGEMENT FACILITY. RECOVERED LIQUIDS MAY BE REPROCESSED OR INCINERATED OR MUST BE TREATED IN A PERMITTED HAZARDOUS WASTE MANAGEMENT FACILITY.
P ecautions-Handling/Storing: STORE IN A COOL, DRY, WELL-VENTILATED L CATION, AWAY FROM ANY AREA WHERE THE FIRE HAZARD MAY BE ACUTE. KEEP CONTAINERS CLOSED WHEN NOT IN USE.
O her Precautions: METHYLENE CHLORIDE VAPORS ARE HEAVIER THAN AIR AND WILL C LLECT IN LOW AREAS. THIS MATERIAL OR ITS VAPORS WHEN IN CONTACT WITH FLAMES, HOT GLOWING SURFACES OR ELECTRIC ARCS CAN DECOMPOSE TO FORM H DROGEN CHLORIDE GAS AND TRACES OF PHOSGENE.

Control Measures

R spiratory Protection: WEAR SCBA OR SUPPLIED AIR RESPIRATOR IF USE C DITIONS GENERATE VAPORS OR MISTS. CANNISTER RESPIRATORS MAY BE

NEFFECTIVE DUE TO POOR WARNING PROPERTIES OF METHYLENE CHLORIDE.
entilation: LOCAL EXHAUST RECOMMENDED TO CONTROL VAPORS BELOW 50% OF TLV.
rotective Gloves: VITON GLOVES RECOMMENDED.
Eye Protection: CHEMICAL SAFETY GOGGLES & FACE SHIELD.
ther Protective Equipment: APRON AND WORK CLOTHING TO MINIMIZE EXPOSURE.
YE WASH STATION & SAFETY SHOWER RECOMMENDED.
Work Hygienic Practices: WASH THOROUGHLY AFTER USE AND BEFORE EATING,
MOKING OR USING TOILET FACILITIES. DO NOT BREATH VAPORS OR MIST.
uppl. Safety & Health Data: TARGET ORGANS ARE SKIN, CNS, CVS, AND EYES.
NOTE TO PHYSICIAN: IF INGESTED, DANGER OF CHEMICAL PNEUMONIA MUST BE
EIHGED AGAINST TOXICITY WHEN CONSIDERING EMTYING STOMACH. IF LAVAGE IS
ERFORMED, ENDOTRACHEAL AND/OR ESOPHAGOSCOPIC CONTROL IS SUGGESTED. DO NOT
IVE EPINEPHRINE OR SIMILAR DRUGS IF AT ALL POSSIBLE.

TRICHLOROETHANE

TCE

Common Synonyms

1,1,1-Trichloroethane
Methylchloroform
Aerothene
Chlorothene

Watery liquid   Colorless   Sweet odor

Sinks in water. Irritating vapor is produced.

Stop discharge if possible. Keep people away.
Avoid contact with liquid and vapor.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies

Fire	Combustible. POISONOUS GASES ARE PRODUCED IN FIRE. Wear goggles and self-contained breathing apparatus Extinguish with dry chemical, carbon dioxide, or foam
Exposure	CALL FOR MEDICAL AID **VAPOR** **Irritating to eyes, nose and throat.** **If inhaled, will cause dizziness or difficult breathing.** Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. **LIQUID** **Irritating to skin and eyes.** **If swallowed, may produce nausea.** Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk and have victim induce vomiting. IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS, do nothing except keep victim warm.
Water Pollution	Effect of low concentrations on aquatic life is unknown. May be dangerous if it enters water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Should be removed
Chemical and physical treatment

2. LABEL

2.1 **Category:** None
2.2 **Class:** Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Halogenated hydrocarbon
3.2 **Formula:** CH_3CCl_3
3.3 **IMO/UN Designation:** Not listed
3.4 **DOT ID No.:** 2831
3.5 **CAS Registry No.:** 71-55-6

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Chloroform-like; sweetish

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or polyvinyl-alcohol-type gloves; chemical safety goggles and face shield; neoprene safety shoes (or leather safety shoes plus neoprene footwear); neoprene or polyvinyl alcohol suit or apron for splash protection.
5.2 **Symptoms Following Exposure:** INHALATION: symptoms range from loss of equilibrium and incoordination to loss of consciousness; high concentration can be fatal due to simple asphyxiation combined with loss of consciousness. INGESTION: produces effects similar to inhalation and may cause some feeling of nausea. EYES: slightly irritating and lachrymatory. SKIN: defatting action may cause dermatitis.
5.3 **Treatment of Exposure:** Get medical attention for all eye exposures and any other serious overexposures. Do NOT administer adrenalin or epinephrine; otherwise, treatment is symptomatic. INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. INGESTION: have victim drink water and induce vomiting. EYES: flush thoroughly with water. SKIN: remove contaminated clothing and wash exposed area thoroughly with soap and warm water.
5.4 **Threshold Limit Value:** 350 ppm
5.5 **Short Term Inhalation Limits:** 1,000 ppm for 60 min. in man
5.6 **Toxicity by Ingestion:** Grade 1; LD_{50} = 5 to 15 g/kg (rat, mouse, rabbit, guinea pig)
5.7 **Late Toxicity:** Data not available
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 100 ppm
5.11 **IDLH Value:** 1,000 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** Data not available
6.2 **Flammable Limits in Air:** 7%-16%
6.3 **Fire Extinguishing Agents:** Dry chemical, foam, or carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Toxic and irritating gases are generated in fires.
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** 932°F
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** (est.) 2.9 mm/min.
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** Reacts slowly, releasing corrosive hydrochloric acid.
7.2 **Reactivity with Common Materials:** Corrodes aluminum, but reaction is not hazardous.
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 36

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
75-150 ppm/*/pinfish/TL_m/salt water
*Time period not specified.
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** Data not available
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Uninhibited; inhibited; industrial inhibited; white room; cold cleaning
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** ORM-A
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	1
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	1
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 133.41
12.3 **Boiling Point at 1 atm:** 165°F = 74°C = 347°K
12.4 **Freezing Point:** <−38°F = <−39°C = <234°K
12.5 **Critical Temperature:** Not pertinent
12.6 **Critical Pressure:** Not pertinent
12.7 **Specific Gravity:** 1.31 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 25.4 dynes/cm = 0.0254 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** (est.) 45 dynes/cm = 0.045 N/m at 20°C
12.10 **Vapor (Gas) Specific Gravity:** 4.6
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.104
12.12 **Latent Heat of Vaporization:** 100 Btu/lb = 58 cal/g = 2.4×10^5 J/kg
12.13 **Heat of Combustion:** (est.) 4700 Btu/lb = 2600 cal/g = 110×10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 4.0 psia

NOTES

TRICHLOROETHANE

12.17
SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
0	85.419
10	84.870
20	84.309
30	83.759
40	83.200
50	82.650
60	82.089
70	81.540
80	80.981
90	80.429
100	79.870
110	79.320
120	78.759
130	78.209
140	77.650
150	77.099
160	76.540

12.18
LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
55	.240
60	.242
65	.244
70	.246
75	.248
80	.250
85	.252
90	.254
95	.256
100	.258
105	.260
110	.262
115	.264
120	.266
125	.268
130	.270
135	.272
140	.274

12.19
LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
	NOT PERTINENT

12.20
LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
15	1.363
20	1.295
25	1.231
30	1.172
35	1.117
40	1.065
45	1.017
50	.972
55	.929
60	.889
65	.852
70	.817
75	.784
80	.753
85	.723

12.21
SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
68.02	.070

12.22
SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
70	2.099
75	2.364
80	2.657
85	2.980
90	3.335
95	3.725
100	4.152
105	4.619
110	5.130
115	5.686
120	6.292
125	6.950
130	7.663
135	8.437
140	9.273
145	10.180
150	11.150
155	12.200
160	13.330
165	14.540
170	15.840
175	17.240
180	18.730
185	20.330
190	22.030

12.23
SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
70	.04925
75	.05495
80	.06119
85	.06799
90	.07540
95	.08346
100	.09220
105	.10170
110	.11190
115	.12300
120	.13490
125	.14770
130	.16150
135	.17630
140	.19220
145	.20920
150	.22730
155	.24670
160	.26730
165	.28930
170	.31270
175	.33760
180	.36390
185	.39180
190	.42140

12.24
IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.146
25	.150
50	.155
75	.159
100	.163
125	.167
150	.171
175	.175
200	.179
225	.183
250	.186
275	.190
300	.193
325	.196
350	.199
375	.202
400	.205
425	.208
450	.210
475	.213
500	.215
525	.217
550	.219
575	.222
600	.223

Part Number/Trade Name: 1,1,1-TRICHLOROETHANE (DIOXANE FREE)

General Information

Item Name: TRICHLOROETHANE, TECHNICAL
Manufacturer's Name: GREAT WESTERN CHEMICAL CO
Manufacturer's Street: 3595 E WAWONA AVE
Manufacturer's P. O. Box:
Manufacturer's City: FRESNO
Manufacturer's State: CA
Manufacturer's Country: US
Manufacturer's Zip Code: 93725
Manufacturer's Emerg Ph #: 209-485-4150
Manufacturer's Info Ph #: 209-485-4150
Distributor/Vendor # 1: GREAT WESTERN CHEMICAL CO (209-466-0721)
Distributor/Vendor # 1 Cage: 5U271
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: A
Safety Focal Point: D
Record No. For Safety Entry: 001
Tot Safety Entries This Stk#: 011
Status: SE
Date MSDS Prepared: 02DEC90
Safety Data Review Date: 30JUN93
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: BQXSX
Specification Number: MIL-T-81533
Spec Type, Grade, Class: N/R
Hazard Characteristic Code: N1
Unit Of Issue: CN
Unit Of Issue Container Qty: 5 GAL
Type Of Container: CAN
Net Unit Weight: 55.0 LBS
NRC/State License Number: N/R
Net Explosive Weight: N/R
Net Propellant Weight-Ammo: N/R
Coast Guard Ammunition Code: N/R

Ingredients/Identity Information

Proprietary: NO
Ingredient: METHYL CHLOROFORM (1,1,1-TRICHLOROEHANE) (SARA III)
Ingredient Sequence Number: 01
Percent: 95 MIN
Ingredient Action Code: A
Ingredient Focal Point: D
NIOSH (RTECS) Number: KJ2975000
CAS Number: 71-55-6
OSHA PEL: 350 PPM/450 STEL
ACGIH TLV: 350 PPM/450STEL;9293
Other Recommended Limit: NONE RECOMMENDED

Proprietary: NO
Ingredient: SEC-BUTYL ALCOHOL (SARA III)
Ingredient Sequence Number: 02
Percent: 1-2
Ingredient Action Code: A
Ingredient Focal Point: D
NIOSH (RTECS) Number: EO1750000
CAS Number: 78-92-2
OSHA PEL: 100 PPM
ACGIH TLV: 100 PPM; 9293
Other Recommended Limit: NONE RECOMMENDED

Proprietary: NO
Ingredient: 1,3-DIOXOLANE
Ingredient Sequence Number: 03
Percent: 2
Ingredient Action Code: A
Ingredient Focal Point: D
NIOSH (RTECS) Number: JH6760000
CAS Number: 646-06-0
OSHA PEL: NOT ESTABLISHED
ACGIH TLV: NOT ESTABLISHED
Other Recommended Limit: NONE RECOMMENDED

Physical/Chemical Characteristics

Appearance And Odor: CLEAR, COLORLESS LIQUID WITH A MILD, SWEETISH, SOLVENT ODOR.
Boiling Point: 165F,74C
Melting Point: <0F,<-18C
Vapor Pressure (MM Hg/70 F): N/K
Vapor Density (Air=1): N/K
Specific Gravity: 1.32
Decomposition Temperature: N/R
Evaporation Rate And Ref: N/K
Solubility In Water: NEGLIGIBLE
Percent Volatiles By Volume: 100
Viscosity: N/K
pH: N/R
Radioactivity: N/R
Form (Radioactive Matl): N/R
Magnetism (Milligauss): N/R

Corrosion Rate (IPY): UNKNOWN
Autoignition Temperature: UNKNON

Fire and Explosion Hazard Data

Flash Point: DOES NOT FLASH
Flash Point Method: N/K
Lower Explosive Limit: 7.5
Upper Explosive Limit: 15.0
Extinguishing Media: FOAM, CARBON DIOXDE, AND DRY CHEMICAL. A WATER "FOG" OR SPRAY SHOULD BE USED TO COOL CONTAINERS ONLY.
Special Fire Fighting Proc: WHEN FIRE FIGHTING, WEAR FULL PROTECTIVE EQUIPMENT, INCLUDING SELF-CONTAINED BREATHING APPARATUS.
Unusual Fire And Expl Hazrds: MAY PRODUCE HAZARDOUS FUMES OR HAZARDOUS DECOMPOSITION PRODUCTS. VAPORS FROM THIS PRODUCT MAY CONCENTRATE IN CONFINED SPACES & FORM AN EXPLOSIVE MIXTURE.

Reactivity Data

Stability: YES
Cond To Avoid (Stability): HOT STORAGE.
Materials To Avoid: OXIDIZERS, REACTIVE METALS AND CAUSTICS.
Hazardous Decomp Products: WHEN HEATED TO DECOMPOSITION, IT EMITS HIGHLY TOXIC CHLORIDE FUMES WITH A SMALL AMOUNT OF PHOSGENE & TOXIC CARBON OXIDES
Hazardous Poly Occur: NO
Conditions To Avoid (Poly): NONE.

Health Hazard Data

LD50-LC50 Mixture: TLV: 350 PPM
Route Of Entry - Inhalation: YES
Route Of Entry - Skin: YES
Route Of Entry - Ingestion: YES
Health Haz Acute And Chronic: HARMFUL IF SWALLOWED OR INHALED.
Carcinogenicity - NTP: NO
Carcinogenicity - IARC: NO
Carcinogenicity - OSHA: NO
Explanation Carcinogenicity: NOT LISTED AS A CARCINOGEN BY NTP, IARC OR OSHA
Signs/Symptoms Of Overexp: CAUSES EYE AND SKIN IRRITATION.
Med Cond Aggravated By Exp: INCREASED SENSITIVITY TO ADRENALINE MAY BE CAUSED BY OVER EXPOSURE.
Emergency/First Aid Proc: INHALATION: REMOVE TO FRESH AIR. IF NOT BREATHING, GIVE CPR. IF BREATHING IS DIFFICULT, GIVE OXYGEN. CALL A PHYSICIAN. EYE: FLUSH IMMEDIATELY WITH LARGE AMOUNTS OF WATER FOR 15 MINUTES. GET MEDICAL ATTENTION. SKIN: REMOVE CONTAMINATED CLOTHING. WASH WITH SOAP AND WATER PROMPTLY. INGESTION: DO NOT INDUCE VOMITING. GIVE MILK OR USP MINERAL OIL. GET IMMEDIATE MEDICAL ATTENTION.

Precautions for Safe Handling and Use

Steps If Matl Released/Spill: CONTAIN SPILLED LIQUID. (FOR SMALL SPILLS, ADD DRY MATERIAL TO CONTAIN) WEARING RECOMMENDED PROTECTIVE EQUIPMENT, REMOVE BULK OF LIQUID. ADD DRY MATERIAL TO ABSORB REMAINING LIQUID; PICK UP AND CONTAINERIZE FOR RECOVERY OR DISPOSAL.
Neutralizing Agent: NONE
Waste Disposal Method: THIS PRODUCT, IF DISPOSED AS SHIPPED, IS NOT A

HAZARDOUS WASTE AS SPECIFIED IN 40 CFR 261. CONSULT STATE OR LOCAL FFICIALS FOR PROPER DISPOSAL METHOD.

recautions-Handling/Storing: STORE IN A COOL, DRY, WELL-VENTILATED AREA. PREVENT WATER OR MOIS AIR FROM ENTERING STORAGE CONTAINERS. KEEP CONTAINERS LOSED WHEN NOT IN USE.

ther Precautions: WHEN EMPTY, THOROUGHLY RINSE CONTAINER WITH WATER BEFORE DISPOSAL, RETURN TO MANUFACTURER, OR ANY OTHER INDUSTRIAL USE. EMPTY ONTAINERS MAY BE HAZARDOUS. THEY MAY CONATIN VAPORS WHICH COULD BE GNITED. DO NOT CUT, PUNCTURE OR WELD CONTAINR

Control Measures

espiratory Protection: IF A NIOSH-PEL IS EXCEEDED, A NIOSH-APPROVED RESPIRATOR WITH AN ORGANIC VAPOR CARTRIDGE OR SUPPLIED AIR IS REQUIRED.

entilation: LOCAL EXHAUST PREFERABLE.

rotective Gloves: RUBBER OR SYNTHETIC RUBBER.

Eye Protection: USE CHEMICAL SAFETY GOGGLES.

ther Protective Equipment: RUBBER APRON , RUBBER BOOTS, EYE WASH, SAFETY HOWER.

ork Hygienic Practices: WASH THOROUGHLY AFTER USE AND BEFORE EATING, SMOKING OR USING TOILET FACILITIES. DO NOT BREATH VAPORS OR MIST.

uppl. Safety & Health Data: FOR INDUSTRIAL USE ONLY. KEEP OUT OF REACH OF HILDREN. PROTECT EYES, SKIN AND CLOTHING FRPN CONTACT WITH PRODUCT. USE WITH ADEQUATE VENTILATION.

TOLUENE

TOL

Common Synonyms

Toluol
Methylbenzene
Methylbenzol

Watery liquid — Colorless — Pleasant odor

Floats on water. Flammable, irritating vapor is produced.

FLAMMABLE.
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.

Exposure

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, vomiting, headache, dizziness, difficult breathing, or loss of consciousness.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting or loss of consciousness.

Water Pollution

Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
May be dangerous if it enters water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Evacuate area

2. LABEL

2.1 **Category:** Flammable liquid
2.2 **Class:** 3

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Aromatic Hydrocarbon
3.2 **Formula:** $C_6H_5CH_3$
3.3 **IMO/UN Designation:** 3.2/1294
3.4 **DOT ID No.:** 1294
3.5 **CAS Registry No.:** 108-88-3

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Pungent; aromatic, benzene-like; distinct, pleasant

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Air-supplied mask; goggles or face shield; plastic gloves.
5.2 **Symptoms Following Exposure:** Vapors irritate eyes and upper respiratory tract; cause dizziness, headache, anesthesia, respiratory arrest. Liquid irritates eyes and causes drying of skin. If aspirated, causes coughing, gagging, distress, and rapidly developing pulmonary edema. If ingested causes vomiting, griping, diarrhea, depressed respiration.
5.3 **Treatment of Exposure:** INHALATION: remove to fresh air, give artificial respiration and oxygen if needed; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 **Threshold Limit Value:** 100 ppm
5.5 **Short Term Inhalation Limits:** 600 ppm for 30 min.
5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} = 0.5 to 5 g/kg
5.7 **Late Toxicity:** Kidney and liver damage may follow ingestion.
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 0.17 ppm
5.11 **IDLH Value:** 2,000 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 40°F C.C.; 55°F O.C.
6.2 **Flammable Limits in Air:** 1.27%-7%
6.3 **Fire Extinguishing Agents:** Carbon dioxide or dry chemical for small fires, ordinary foam for large fires.
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Vapor is heavier than air and may travel a considerable distance to a source of ignition and flash back.
6.7 **Ignition Temperature:** 997°F
6.8 **Electrical Hazard:** Class I, Group D
6.9 **Burning Rate:** 5.7 mm/min.
6.10 **Adiabatic Flame Temperature:** Data not available

(Continued)

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 32

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 1180 mg/l/96 hr/sunfish/TL_m/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** 0%, 5 days; 38% (theor), 8 days
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Research, reagent, nitration-all 99.8 + %; industrial: contains 94 + %, with 5% xylene and small amounts of benzene and nonaromatic hydrocarbons; 90/120: less pure than industrial.
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable liquid
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 92.14
12.3 **Boiling Point at 1 atm:** 231.1°F = 110.6°C = 383.8°K
12.4 **Freezing Point:** —139°F = —95.0°C = 178.2°K
12.5 **Critical Temperature:** 605.4°F = 318.6°C = 591.8°K
12.6 **Critical Pressure:** 596.1 psia = 40.55 atm = 4.108 MN/m^2
12.7 **Specific Gravity:** 0.867 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 29.0 dynes/cm = 0.0290 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** 36.1 dynes/cm = 0.0361 N/m at 25°C
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.089
12.12 **Latent Heat of Vaporization:** 155 Btu/lb = 86.1 cal/g = 3.61 X 10^5 J/kg
12.13 **Heat of Combustion:** —17,430 Btu/lb = —9686 cal/g = —405.5 X 10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** 17.17 cal/g
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 1.1 psia

6. FIRE HAZARDS (Continued)

6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

TOL

TOLUENE

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
—30	57.180
—20	56.870
—10	56.550
0	56.240
10	55.930
20	55.620
30	55.310
40	54.990
50	54.680
60	54.370
70	54.060
80	53.750
90	53.430
100	53.120
110	52.810
120	52.500

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.396
5	.397
10	.399
15	.400
20	.402
25	.403
30	.404
35	.406
40	.407
45	.409
50	.410
55	.411
60	.413
65	.414
70	.415
75	.417
80	.418
85	.420
90	.421
95	.422
100	.424
105	.425
110	.427
115	.428
120	.429
125	.431

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
0	1.026
10	1.015
20	1.005
30	.994
40	.983
50	.972
60	.962
70	.951
80	.940
90	.929
100	.919
110	.908
120	.897
130	.886
140	.876
150	.865
160	.854
170	.843
180	.833
190	.822
200	.811
210	.800

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
0	1.024
5	.978
10	.935
15	.894
20	.857
25	.821
30	.788
35	.757
40	.727
45	.700
50	.673
55	.649
60	.625
65	.603
70	.582
75	.562
80	.544
85	.526
90	.509
95	.493
100	.477

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
68.02	.050

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
0	.038
10	.057
20	.084
30	.121
40	.172
50	.241
60	.331
70	.449
80	.600
90	.792
100	1.033
110	1.332
120	1.700
130	2.148
140	2.690
150	3.338
160	4.109
170	5.018
180	6.083
190	7.323
200	8.758
210	10.410

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
0	.00070
10	.00103
20	.00150
30	.00212
40	.00296
50	.00405
60	.00547
70	.00727
80	.00954
90	.01237
100	.01584
110	.02007
120	.02518
130	.03127
140	.03850
150	.04700
160	.05691
170	.06840
180	.08162
190	.09675
200	.11400
210	.13340

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.228
25	.241
50	.255
75	.268
100	.281
125	.294
150	.306
175	.319
200	.331
225	.343
250	.355
275	.367
300	.378
325	.389
350	.400
375	.411
400	.422
425	.432
450	.443
475	.453
500	.462
525	.472
550	.482
575	.491
600	.500

TRICHLOROETHYLENE

TCL

Common Synonyms
Trichloroethylene
Triclene; Algylen
Chlorylen
Gemalgene
Trethylene
Trichloran; Trilene

Watery liquid Colorless Sweet odor

Sinks in water. Irritating vapor is produced.

Stop discharge if possible. Keep people away.
Avoid contact with liquid and vapor.
Call fire department.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Combustible.
POISONOUS GASES ARE PRODUCED IN FIRE.
Wear goggles and self-contained breathing apparatus.
Extinguish with dry chemical, carbon dioxide, or foam.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause nausea, vomiting, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, difficult breathing, or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water
[illegible] vomiting.
IF SWALLOWED and victim is UNCONSCIOUS OR HAVING CONVULSIONS,
do nothing except keep victim warm.

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Should be removed
Chemical and physical treatment

2. LABEL

2.1 **Category:** None
2.2 **Class:** Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Halogenated hydrocarbon
3.2 **Formula:** $CHCl=CCl_2$
3.3 **IMO/UN Designation:** 9.0/1710
3.4 **DOT ID No.:** 1710
3.5 **CAS Registry No.:** 79-01-6

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Chloroform-like; ethereal

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Organic vapor-acid gas canister; self-contained breathing apparatus for emergencies; neoprene or vinyl gloves; chemical safety goggles; face-shield; neoprene safety shoes; neoprene suit or apron for splash protection.
5.2 **Symptoms Following Exposure:** INHALATION: symptoms range from irritation of the nose and throat to nausea, an attitude of irresponsibility, blurred vision, and finally disturbance of central nervous system resulting in cardiac failure. Chronic exposure may cause organic injury. INGESTION: symptoms similar to inhalation. SKIN: defatting action can cause dermatitis. EYES: slightly irritating sensation and lachrymation.
5.3 **Treatment of Exposure:** Do NOT administer adrenalin or epinephrine; get medical attention for all cases of overexposure. INHALATION: remove victim to fresh air; if necessary, apply artificial respiration and/or administer oxygen. INGESTION: have victim drink water and induce vomiting; repeat three times; then give 1 tablespoon epsom salts in water. EYES: flush thoroughly with water. SKIN: wash thoroughly with soap and warm water.
5.4 **Threshold Limit Value:** 50 ppm
5.5 **Short Term Inhalation Limits:** 200 ppm for 30 min.
5.6 **Toxicity by Ingestion:** Grade 3; LD_{50} = 50 to 500 mg/kg
5.7 **Late Toxicity:** Data not available
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 50 ppm
5.11 **IDLH Value:** 1,000 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 90°F C.C.; practically nonflammable
6.2 **Flammable Limits in Air:** 8.0%-10.5%
6.3 **Fire Extinguishing Agents:** Water fog
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Toxic and irritating gases are produced in fire situations.
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** 770°F
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** Not pertinent
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 36

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 660 mg/l/40 hr/daphnia/kill/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** Data not available
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Technical; dry cleaning; degreasing; extraction
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X-Y

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** ORM-A
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	1
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	2
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	1

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	1
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 131.39
12.3 **Boiling Point at 1 atm:** 189°F = 87°C = 360°K
12.4 **Freezing Point:** −123.5°F = −86.4°C = 186.8°K
12.5 **Critical Temperature:** Not pertinent
12.6 **Critical Pressure:** Not pertinent
12.7 **Specific Gravity:** 1.46 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 29.3 dynes/cm = 0.0293 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** 34.5 dynes/cm = 0.0345 N/m at 24°C
12.10 **Vapor (Gas) Specific Gravity:** 4.5
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.116
12.12 **Latent Heat of Vaporization:** 103 Btu/lb = 57.2 cal/g = 2.4×10^5 J/kg
12.13 **Heat of Combustion:** Not pertinent
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 2.5 psia

NOTES

TCL

TRICHLOROETHYLENE

12.17
SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
0	94.669
5	94.410
10	94.150
15	93.889
20	93.629
25	93.370
30	93.110
35	92.849
40	92.589
45	92.330
50	92.070
55	91.809
60	91.549
65	91.290
70	91.030
75	90.770
80	90.509
85	90.250
90	89.990
95	89.730
100	89.469
105	89.209
110	88.950
115	88.690
120	88.429
125	88.169

12.18
LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.220
10	.221
20	.223
30	.225
40	.226
50	.228
60	.230
70	.231
80	.233
90	.235
100	.236
110	.238
120	.240
130	.241
140	.243
150	.245
160	.246
170	.248

12.19
LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
	NOT PERTINENT

12.20
LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
15	.800
20	.775
25	.750
30	.727
35	.705
40	.684
45	.664
50	.645
55	.627
60	.610
65	.593
70	.577
75	.562
80	.548
85	.534
90	.521
95	.508
100	.496
105	.485
110	.474
115	.463
120	.453

12.21
SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
77.02	.110

12.22
SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
40	.508
50	.678
60	.894
70	1.166
80	1.507
90	1.929
100	2.448
110	3.081
120	3.846
130	4.765
140	5.862
150	7.163
160	8.695
170	10.490
180	12.580
190	15.010
200	17.810
210	21.020

12.23
SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
40	.01245
50	.01628
60	.02105
70	.02695
80	.03418
90	.04296
100	.05354
110	.06619
120	.08120
130	.09891
140	.11960
150	.14380
160	.17180
170	.20390
180	.24080
190	.28280
200	.33040
210	.38420

12.24
IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.136
25	.139
50	.143
75	.146
100	.149
125	.152
150	.155
175	.157
200	.160
225	.162
250	.165
275	.167
300	.169
325	.172
350	.174
375	.176
400	.177
425	.179
450	.181
475	.182
500	.184
525	.185
550	.186
575	.187
600	.188

TETRACHLOROETHYLENE

TTE

Common Synonyms

Tetracap
Perclene
Perchloroethylene
Perk

Watery liquid
Colorless
Sweet odor

Sinks in water. Irritating vapor is produced.

Stop discharge if possible.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

Not flammable.
Poisonous gases are produced when heated.

Exposure

[illegible]

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause difficult breathing, or loss of consciousness.
[illegible]
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
Harmful if swallowed.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
[illegible]

Water Pollution

Effect of low concentrations on aquatic life is unknown.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Should be removed
Chemical and physical treatment

2. LABEL

2.1 **Category:** None
2.2 **Class:** Not pertinent

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Not listed
3.2 **Formula:** $Cl_2C=CCl_2$
3.3 **IMO/UN Designation:** 9.0/1897
3.4 **DOT ID No.:** 1897
3.5 **CAS Registry No.:** 127-18-4

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Ethereal; like chloroform; mildly sweet

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** For high vapor concentrations use approved canister or air-supplied mask; chemical goggles or face shield; plastic gloves.
5.2 **Symptoms Following Exposure:** Vapor can affect central nervous system and cause anesthesia. Liquid may irritate skin after prolonged contact. May irritate eyes but causes no injury.
5.3 **Treatment of Exposure:** INHALATION: if illness occurs, remove patient to fresh air, keep him warm and quiet, and get medical attention. INGESTION: induce vomiting only on physician's recommendation. EYES AND SKIN: flush with plenty of water and get medical attention if irritation or injury occurs.
5.4 **Threshold Limit Value:** 50 ppm
5.5 **Short Term Inhalation Limits:** 100 ppm for 30 min.
5.6 **Toxicity by Ingestion:** Grade 2; LD_{50} = 0.5 to 5 g/kg
5.7 **Late Toxicity:** None
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or throat if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 5 ppm
5.11 **IDLH Value:** 500 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** Not flammable
6.2 **Flammable Limits in Air:** Not flammable
6.3 **Fire Extinguishing Agents:** Not pertinent
6.4 **Fire Extinguishing Agents Not to be Used:** Not pertinent
6.5 **Special Hazards of Combustion Products:** Toxic, irritating gases may be generated in fires.
6.6 **Behavior in Fire:** Not pertinent
6.7 **Ignition Temperature:** Not flammable
6.8 **Electrical Hazard:** Not pertinent
6.9 **Burning Rate:** Not flammable
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** Data not available

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** Data not available
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** None
8.4 **Food Chain Concentration Potential:** None

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Dry cleaning and industrial grades: 96+%
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-X

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** ORM-A
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	0
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	1

11.3 **NFPA Hazard Classification:** Not listed

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 165.83
12.3 **Boiling Point at 1 atm:** 250°F = 121°C = 394°K
12.4 **Freezing Point:** —8.3°F = —22.4°C = 250.8°K
12.5 **Critical Temperature:** 657°F = 347°C = 620°K
12.6 **Critical Pressure:** Not pertinent
12.7 **Specific Gravity:** 1.63 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 31.3 dynes/cm = 0.0313 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** 44.4 dynes/cm = 0.0444 N/m at 25°C
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.116
12.12 **Latent Heat of Vaporization:** 90.2 Btu/lb = 50.1 cal/g = 2.10 X 10^5 J/kg
12.13 **Heat of Combustion:** Not pertinent
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** Data not available
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** Data not available

NOTES

TTE

TETRACHLOROETHYLENE

12.17 SATURATED LIQUID DENSITY		12.18 LIQUID HEAT CAPACITY		12.19 LIQUID THERMAL CONDUCTIVITY		12.20 LIQUID VISCOSITY	
Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F	Temperature (degrees F)	British thermal unit-inch per hour-square foot-F	Temperature (degrees F)	Centipoise
35	103.400	0	.198		NOT PERTINENT	55	.958
40	103.099	10	.200			60	.929
45	102.900	20	.201			65	.900
50	102.599	30	.202			70	.873
55	102.299	40	.203			75	.848
60	102.000	50	.204			80	.823
65	101.700	60	.205			85	.800
70	101.400	70	.206			90	.777
75	101.099	80	.207			95	.756
80	100.799	90	.208			100	.736
85	100.500	100	.210			105	.716
90	100.200	110	.211			110	.698
95	99.910	120	.212			115	.680
100	99.610	130	.213			120	.663
105	99.320	140	.214			125	.647
110	99.020	150	.215			130	.631
115	98.730	160	.216			135	.616
120	98.429	170	.217			140	.601
125	98.139	180	.218			145	.588
130	97.839	190	.220			150	.574
135	97.549	200	.221			155	.561
140	97.250	210	.222			160	.549
145	96.959					165	.537
150	96.669					170	.526
155	96.370					175	.515
160	96.080						

12.21 SOLUBILITY IN WATER		12.22 SATURATED VAPOR PRESSURE		12.23 SATURATED VAPOR DENSITY		12.24 IDEAL GAS HEAT CAPACITY	
Temperature (degrees F)	Pounds per 100 pounds of water	Temperature (degrees F)	Pounds per square inch	Temperature (degrees F)	Pounds per cubic foot	Temperature (degrees F)	British thermal unit per pound-F
68.02	.016	60	.236	60	.00702	0	.108
		70	.318	70	.00929	25	.110
		80	.425	80	.01216	50	.113
		90	.561	90	.01575	75	.116
		100	.732	100	.02022	100	.118
		110	.948	110	.02571	125	.120
		120	1.217	120	.03242	150	.122
		130	1.548	130	.04055	175	.125
		140	1.953	140	.05032	200	.127
		150	2.446	150	.06199	225	.129
		160	3.042	160	.07583	250	.131
		170	3.756	170	.09215	275	.132
		180	4.607	180	.11130	300	.134
		190	5.616	190	.13360	325	.136
		200	6.805	200	.15940	350	.138
		210	8.199	210	.18910	375	.139
		220	9.824	220	.22330	400	.141
		230	11.710	230	.26230	425	.142
		240	13.890	240	.30660	450	.143
		250	16.390	250	.35680	475	.144
		260	19.260	260	.41330	500	.146
		270	22.520	270	.47680	525	.147
		280	26.230	280	.54790	550	.148
						575	.148
						600	.149

m-XYLENE

XLM

Common Synonyms	Watery liquid	Colorless	Sweet odor
1, 3-Dimethylbenzene Xylol	Floats on water. Flammable, irritating vapor is produced.		

Stop discharge if possible. Keep people away.
Call fire department.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire	FLAMMABLE Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area. Wear self-contained breathing apparatus. Extinguish with foam, dry chemical, or carbon dioxide. Water may be ineffective on fire. Cool exposed containers with water.
Exposure	CALL FOR MEDICAL AID. **VAPOR** Irritating to eyes, nose, and throat. If inhaled, will cause headache, difficult breathing, or loss of consciousness. Move to fresh air. If breathing has stopped, give artificial respiration. If breathing is difficult, give oxygen. **LIQUID** Irritating to skin and eyes. If swallowed, will cause nausea, vomiting, or loss of consciousness. Remove contaminated clothing and shoes. Flush affected areas with plenty of water. IF IN EYES, hold eyelids open and flush with plenty of water. IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk. DO NOT INDUCE VOMITING.
Water Pollution	HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS. Fouling to shoreline. May be dangerous if it enters water intakes. Notify local health and wildlife officials. Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability
Evacuate area
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: m-$C_6H_4(CH_3)_2$
3.3 IMO/UN Designation: 3.2/1307
3.4 DOT ID No.: 1307
3.5 CAS Registry No.: 106-38-3

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Like benzene; characteristic aromatic

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
5.2 **Symptoms Following Exposure:** Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma; can be fatal. Kidney and liver damage can occur.
5.3 **Treatment of Exposure:** INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 **Threshold Limit Value:** 100 ppm
5.5 **Short Term Inhalation Limits:** 300 ppm for 30 min.
5.6 **Toxicity by Ingestion:** Grade 3; LD_{50} = 50 to 500 g/kg
5.7 **Late Toxicity:** Kidney and liver damage.
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 0.05 ppm
5.11 **IDLH Value:** 10,000 ppm

6. FIRE HAZARDS

6.1 **Flash Point:** 84°F C.C.
6.2 **Flammable Limits in Air:** 1.1%-6.4%
6.3 **Fire Extinguishing Agents:** Foam, dry chemical, or carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective.
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 **Ignition Temperature:** 986°F
6.8 **Electrical Hazard:** Class I, Group D
6.9 **Burning Rate:** 5.8 mm/min.
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 32

8. WATER POLLUTION

8.1 **Aquatic Toxicity:**
22 ppm/96 hr/bluegill/TL_m/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):**
0 lb/lb, 5 days; 0% (theor.), 8 days
8.4 **Food Chain Concentration Potential:** Data not available

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Research: 99.99%; Pure: 99.9%; Technical: 99.2%
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable liquid
11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 106.16
12.3 **Boiling Point at 1 atm:**
269.4°F = 131.9°C = 405.1°K
12.4 **Freezing Point:**
−54.2°F = −47.9°C = 225.3°K
12.5 **Critical Temperature:**
650.8°F = 343.6°C = 617.0°K
12.6 **Critical Pressure:**
513.8 atm = 34.95 psia = 3.540 MN/m^2
12.7 **Specific Gravity:**
0.864 at 20°C (liquid)
12.8 **Liquid Surface Tension:**
28.6 dynes/cm = 0.0286 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:**
36.4 dynes/cm = 0.0364 N/m at 30°C
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.071
12.12 **Latent Heat of Vaporization:**
147 Btu/lb = 81.9 cal/g = 3.43×10^5 J/kg
12.13 **Heat of Combustion:** −17,554 Btu/lb = −9752.4 cal/g = -408.31×10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** 26.01 cal/g
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 0.34 psia

NOTES

XLM

m-XYLENE

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
15	55.400
20	55.260
25	55.130
30	54.990
35	54.850
40	54.710
45	54.570
50	54.430
55	54.290
60	54.160
65	54.020
70	53.880
75	53.740
80	53.600
85	53.460
90	53.320
95	53.180
100	53.050

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
40	.387
50	.393
60	.398
70	.404
80	.410
90	.415
100	.421
110	.426
120	.432
130	.437
140	.443
150	.448
160	.454
170	.460
180	.465
190	.471
200	.476
210	.482

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
35	.962
40	.953
45	.944
50	.935
55	.926
60	.917
65	.908
70	.899
75	.890
80	.881
85	.873
90	.864
95	.855
100	.846

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
15	.938
20	.898
25	.862
30	.827
35	.794
40	.764
45	.735
50	.708
55	.682
60	.658
65	.635
70	.613
75	.592
80	.572
85	.554

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
	INSOLUBLE

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
60	.090
70	.127
80	.177
90	.242
100	.326
110	.434
120	.571
130	.743
140	.956
150	1.219
160	1.538
170	1.924
180	2.388
190	2.939
200	3.590
210	4.355
220	5.247
230	6.282
240	7.476
250	8.846
260	10.410

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
60	.00172
70	.00238
80	.00324
90	.00435
100	.00577
110	.00754
120	.00975
130	.01247
140	.01577
150	.01977
160	.02455
170	.03023
180	.03691
190	.04473
200	.05382
210	.06431
220	.07635
230	.09009
240	.10570
250	.12330
260	.14310

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.247
25	.260
50	.273
75	.286
100	.299
125	.311
150	.324
175	.336
200	.348
225	.360
250	.371
275	.383
300	.394
325	.406
350	.417
375	.427
400	.438
425	.449
450	.459
475	.469
500	.479
525	.489
550	.499
575	.508
600	.517

o-XYLENE

XLO

Common Synonyms
1, 2-Dimethylbenzene
Xylol

Watery liquid — Colorless — Sweet odor

Floats on water. Flammable, irritating vapor is produced.

Stop discharge if possible. Keep people away.
Call fire department.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause headache, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, or loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS, have victim drink water or milk.
DO NOT INDUCE VOMITING.

Water Pollution

Dangerous to aquatic life in high concentrations.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Issue warning-high flammability
Evacuate area
Should be removed
Chemical and physical treatment

2. LABEL

2.1 Category: Flammable liquid
2.2 Class: 3

3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Aromatic Hydrocarbon
3.2 Formula: o-$C_6H_4(CH_3)_2$
3.3 IMO/UN Designation: 3.2/1307
3.4 DOT ID No.: 1307
3.5 CAS Registry No.: 95-47-6

4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Liquid
4.2 Color: Colorless
4.3 Odor: Benzene-like; characteristic aromatic

5. HEALTH HAZARDS

5.1 Personal Protective Equipment: Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
5.2 Symptoms Following Exposure: Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma. Can be fatal. Kidney and liver damage can occur.
5.3 Treatment of Exposure: INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 Threshold Limit Value: 100 ppm
5.5 Short Term Inhalation Limits: 300 ppm for 30 min.
5.6 Toxicity by Ingestion: Grade 3; LD_{50} = 50 to 500 mg/kg
5.7 Late Toxicity: Kidney and liver damage.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 Odor Threshold: 0.05 ppm
5.11 IDLH Value: 10,000 ppm

6. FIRE HAZARDS

6.1 Flash Point: 63°F C.C.; 75°F O.C.
6.2 Flammable Limits in Air: 1.1%-7.0%
6.3 Fire Extinguishing Agents: Foam, dry chemical, or carbon dioxide
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective.
6.5 Special Hazards of Combustion Products: Not pertinent
6.6 Behavior in Fire: Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 Ignition Temperature: 869°F
6.8 Electrical Hazard: Class I, Group D
6.9 Burning Rate: 5.8 mm/min.
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: No reaction
7.3 Stability During Transport: Stable
7.4 Neutralizing Agents for Acids and Caustics: Not pertinent
7.5 Polymerization: Not pertinent
7.6 Inhibitor of Polymerization: Not pertinent
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 32

8. WATER POLLUTION

8.1 Aquatic Toxicity: >100 mg/l/96 hr/D. magna/TL_m/fresh water
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): 0 lb/lb, 5 days; 2.5% (theor.), 8 days
8.4 Food Chain Concentration Potential: Data not available

9. SHIPPING INFORMATION

9.1 Grades of Purity: Research: 99.99%; Pure: 99.7%; Commercial: 95+%
9.2 Storage Temperature: Ambient
9.3 Inert Atmosphere: No reaction
9.4 Venting: Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)
A-T-U

11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Flammable liquid
11.2 NAS Hazard Rating for Bulk Water Transportation:

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 NFPA Hazard Classification:

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 106.16
12.3 Boiling Point at 1 atm: 291.9°F = 144.4°C = 417.6°K
12.4 Freezing Point: −13.3°F = −25.2°C = 248.0°K
12.5 Critical Temperature: 674.8°F = 357.1°C = 630.3°K
12.6 Critical Pressure: 541.5 atm = 36.84 psia = 3.732 MN/m^2
12.7 Specific Gravity: 0.880 at 20°C (liquid)
12.8 Liquid Surface Tension: 30.53 dynes/cm = 0.03053 N/m at 15.5°C
12.9 Liquid Water Interfacial Tension: 36.06 dynes/cm = 0.03606 N/m at 20°C
12.10 Vapor (Gas) Specific Gravity: Not pertinent
12.11 Ratio of Specific Heats of Vapor (Gas): 1.068
12.12 Latent Heat of Vaporization: 149 Btu/lb = 82.9 cal/g = 3.47 X 10^5 J/kg
12.13 Heat of Combustion: −17,558 Btu/lb = −9754.7 cal/g = −408.41 X 10^5 J/kg
12.14 Heat of Decomposition: Not pertinent
12.15 Heat of Solution: Not pertinent
12.16 Heat of Polymerization: Not pertinent
12.25 Heat of Fusion: 30.64 cal/g
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 0.26 psia

NOTES

XLO

o-XYLENE

12.17 SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
15	56.460
20	56.330
25	56.190
30	56.050
35	55.910
40	55.770
45	55.630
50	55.490
55	55.360
60	55.220
65	55.080
70	54.940
75	54.800
80	54.660
85	54.520
90	54.380
95	54.250
100	54.110

12.18 LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
35	.389
40	.391
45	.394
50	.396
55	.398
60	.400
65	.402
70	.404
75	.406
80	.408
85	.411
90	.413
95	.415
100	.417

12.19 LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
35	1.043
40	1.035
45	1.027
50	1.018
55	1.010
60	1.002
65	.993
70	.985
75	.977
80	.969
85	.960
90	.952
95	.944
100	.935

12.20 LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
15	1.328
20	1.263
25	1.202
30	1.145
35	1.092
40	1.042
45	.995
50	.952
55	.911
60	.873
65	.836
70	.802
75	.770
80	.740
85	.712

12.21 SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
	INSOLUBLE

12.22 SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
60	.071
70	.101
80	.141
90	.194
100	.263
110	.352
120	.465
130	.609
140	.787
150	1.007
160	1.277
170	1.605
180	1.999
190	2.469
200	3.028
210	3.686
220	4.456
230	5.352
240	6.389
250	7.581
260	8.947

12.23 SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
60	.00135
70	.00188
80	.00258
90	.00349
100	.00464
110	.00611
120	.00794
130	.01021
140	.01298
150	.01634
160	.02038
170	.02520
180	.03090
190	.03759
200	.04539
210	.05443
220	.06484
230	.07674
240	.09030
250	.10560
260	.12290

12.24 IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.261
25	.274
50	.287
75	.299
100	.311
125	.323
150	.335
175	.347
200	.358
225	.370
250	.381
275	.392
300	.403
325	.414
350	.424
375	.435
400	.445
425	.455
450	.465
475	.475
500	.485
525	.494
550	.504
575	.513
600	.522

p-XYLENE

XLP

Common Synonyms
1, 4-Dimethylbenzene
Xylol

Watery liquid   Colorless   Sweet odor

Floats on water. Flammable, irritating vapor is produced.
Freezing point is 56°F.

Stop discharge if possible. Keep people away.
Call fire department.
Avoid contact with liquid and vapor.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

Fire

FLAMMABLE
Flashback along vapor trail may occur.
Vapor may explode if ignited in an enclosed area.
Wear self-contained breathing apparatus.
Extinguish with foam, dry chemical, or carbon dioxide.
Water may be ineffective on fire.
Cool exposed containers with water.

Exposure

CALL FOR MEDICAL AID.

VAPOR
Irritating to eyes, nose and throat.
If inhaled, will cause dizziness, difficult breathing, or loss of consciousness.
Move to fresh air.
If breathing has stopped, give artificial respiration.
If breathing is difficult, give oxygen.

LIQUID
Irritating to skin and eyes.
If swallowed, will cause nausea, vomiting, loss of consciousness.
Remove contaminated clothing and shoes.
Flush affected areas with plenty of water.
[illegible]
[illegible]
[illegible]
DO N[illegible]

Water Pollution

HARMFUL TO AQUATIC LIFE IN VERY LOW CONCENTRATIONS.
Fouling to shoreline.
May be dangerous if it enters water intakes.
Notify local health and wildlife officials.
Notify operators of nearby water intakes.

1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)
Issue warning-high flammability
Evacuate area
Should be removed
Chemical and physical treatment

2. LABEL

2.1 **Category:** Flammable liquid
2.2 **Class:** 3

3. CHEMICAL DESIGNATIONS

3.1 **CG Compatibility Class:** Aromatic Hydrocarbon
3.2 **Formula:** $p\text{-}C_6H_4(CH_3)_2$
3.3 **IMO/UN Designation:** 3.2/1307
3.4 **DOT ID No.:** 1307
3.5 **CAS Registry No.:** 106-42-3

4. OBSERVABLE CHARACTERISTICS

4.1 **Physical State (as shipped):** Liquid
4.2 **Color:** Colorless
4.3 **Odor:** Like benzene; characteristic aromatic

5. HEALTH HAZARDS

5.1 **Personal Protective Equipment:** Approved canister or air-supplied mask; goggles or face shield; plastic gloves and boots.
5.2 **Symptoms Following Exposure:** Vapors cause headache and dizziness. Liquid irritates eyes and skin. If taken into lungs, causes severe coughing, distress, and rapidly developing pulmonary edema. If ingested, causes nausea, vomiting, cramps, headache, and coma. Can be fatal. Kidney and liver damage can occur.
5.3 **Treatment of Exposure:** INHALATION: remove to fresh air; administer artificial respiration and oxygen if required; call a doctor. INGESTION: do NOT induce vomiting; call a doctor. EYES: flush with water for at least 15 min. SKIN: wipe off, wash with soap and water.
5.4 **Threshold Limit Value:** 100 ppm
5.5 **Short Term Inhalation Limits:** 300 ppm for 30 min.
5.6 **Toxicity by Ingestion:** Grade 3; LD_{50} = 50 to 500 mg/kg
5.7 **Late Toxicity:** Kidney and liver damage.
5.8 **Vapor (Gas) Irritant Characteristics:** Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 **Liquid or Solid Irritant Characteristics:** Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of the skin.
5.10 **Odor Threshold:** 0.05 ppm
5.11 **IDLH Value:** 10,000 pmm

6. FIRE HAZARDS

6.1 **Flash Point:** 81°F C.C.
6.2 **Flammable Limits in Air:** 1.1%-6.6%
6.3 **Fire Extinguishing Agents:** Foam, dry chemical, or carbon dioxide
6.4 **Fire Extinguishing Agents Not to be Used:** Water may be ineffective.
6.5 **Special Hazards of Combustion Products:** Not pertinent
6.6 **Behavior in Fire:** Vapor is heavier than air and may travel considerable distance to a source of ignition and flash back.
6.7 **Ignition Temperature:** 870°F
6.8 **Electrical Hazard:** Class I, Group D
6.9 **Burning Rate:** 5.8 mm/min.
6.10 **Adiabatic Flame Temperature:** Data not available
6.11 **Stoichiometric Air to Fuel Ratio:** Data not available
6.12 **Flame Temperature:** Data not available

7. CHEMICAL REACTIVITY

7.1 **Reactivity With Water:** No reaction
7.2 **Reactivity with Common Materials:** No reaction
7.3 **Stability During Transport:** Stable
7.4 **Neutralizing Agents for Acids and Caustics:** Not pertinent
7.5 **Polymerization:** Not pertinent
7.6 **Inhibitor of Polymerization:** Not pertinent
7.7 **Molar Ratio (Reactant to Product):** Data not available
7.8 **Reactivity Group:** 32

8. WATER POLLUTION

8.1 **Aquatic Toxicity:** 22 ppm/96 hr/bluegill/TL_m/fresh water
8.2 **Waterfowl Toxicity:** Data not available
8.3 **Biological Oxygen Demand (BOD):** 0 lb/lb in 5 days
8.4 **Food Chain Concentration Potential:** Data not available

9. SHIPPING INFORMATION

9.1 **Grades of Purity:** Research: 99.99%; Pure: 99.8%; Technical: 99.0%
9.2 **Storage Temperature:** Ambient
9.3 **Inert Atmosphere:** No requirement
9.4 **Venting:** Open (flame arrester) or pressure-vacuum

10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-T-U

11. HAZARD CLASSIFICATIONS

11.1 **Code of Federal Regulations:** Flammable liquid

11.2 **NAS Hazard Rating for Bulk Water Transportation:**

Category	Rating
Fire	3
Health	
Vapor Irritant	1
Liquid or Solid Irritant	1
Poisons	2
Water Pollution	
Human Toxicity	1
Aquatic Toxicity	3
Aesthetic Effect	2
Reactivity	
Other Chemicals	1
Water	0
Self Reaction	0

11.3 **NFPA Hazard Classification:**

Category	Classification
Health Hazard (Blue)	2
Flammability (Red)	3
Reactivity (Yellow)	0

12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 **Physical State at 15°C and 1 atm:** Liquid
12.2 **Molecular Weight:** 106.16
12.3 **Boiling Point at 1 atm:** 280.9°F = 138.3°C = 411.5°K
12.4 **Freezing Point:** 55.9°F = 13.3°C = 286.5°K
12.5 **Critical Temperature:** 649.4°F = 343.0°C = 616.2°K
12.6 **Critical Pressure:** 509.4 atm = 34.65 psia = 3.510 MN/m^2
12.7 **Specific Gravity:** 0.861 at 20°C (liquid)
12.8 **Liquid Surface Tension:** 28.3 dynes/cm = 0.0283 N/m at 20°C
12.9 **Liquid Water Interfacial Tension:** 37.8 dynes/cm = 0.0378 N/m at 20°C
12.10 **Vapor (Gas) Specific Gravity:** Not pertinent
12.11 **Ratio of Specific Heats of Vapor (Gas):** 1.071
12.12 **Latent Heat of Vaporization:** 150 Btu/lb = 81 cal/g = 3.4 X 10^5 J/kg
12.13 **Heat of Combustion:** —17,559 Btu/lb = —9754.7 cal/g = —408.41 X 10^5 J/kg
12.14 **Heat of Decomposition:** Not pertinent
12.15 **Heat of Solution:** Not pertinent
12.16 **Heat of Polymerization:** Not pertinent
12.25 **Heat of Fusion:** 37.83 cal/g
12.26 **Limiting Value:** Data not available
12.27 **Reid Vapor Pressure:** 0.34 psia

NOTES

XLP

p-XYLENE

12.17
SATURATED LIQUID DENSITY

Temperature (degrees F)	Pounds per cubic foot
60	53.970
65	53.830
70	53.690
75	53.550
80	53.410
85	53.270
90	53.140
95	53.000
100	52.860
105	52.720
110	52.580
115	52.440
120	52.300

12.18
LIQUID HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
60	.412
70	.418
80	.424
90	.429
100	.435
110	.440
120	.446
130	.451
140	.457
150	.462
160	.468
170	.474
180	.479
190	.485
200	.490
210	.496
220	.501
230	.507
240	.512
250	.518
260	.524
270	.529
280	.535

12.19
LIQUID THERMAL CONDUCTIVITY

Temperature (degrees F)	British thermal unit-inch per hour-square foot-F
60	.935
65	.928
70	.921
75	.914
80	.907
85	.900
90	.892
95	.885
100	.878

12.20
LIQUID VISCOSITY

Temperature (degrees F)	Centipoise
60	.678
65	.654
70	.631
75	.610
80	.590
85	.571
90	.552
95	.535
100	.519
105	.503
110	.488
115	.474
120	.460

12.21
SOLUBILITY IN WATER

Temperature (degrees F)	Pounds per 100 pounds of water
	INSOLUBLE

12.22
SATURATED VAPOR PRESSURE

Temperature (degrees F)	Pounds per square inch
60	.096
70	.135
80	.187
90	.255
100	.343
110	.456
120	.599
130	.777
140	.998
150	1.270
160	1.600
170	1.998
180	2.475
190	3.041
200	3.710
210	4.493
220	5.407
230	6.485
240	7.683
250	9.080
260	10.670

12.23
SATURATED VAPOR DENSITY

Temperature (degrees F)	Pounds per cubic foot
60	.00183
70	.00252
80	.00343
90	.00459
100	.00607
110	.00792
120	.01022
130	.01303
140	.01646
150	02059
160	.02553
170	03138
180	.03826
190	04629
200	05561
210	.06636
220	07867
230	09270
240	10860
250	.12650
260	.14670

12.24
IDEAL GAS HEAT CAPACITY

Temperature (degrees F)	British thermal unit per pound-F
0	.246
25	.259
50	.272
75	.285
100	.297
125	.309
150	.321
175	.333
200	.345
225	.357
250	.368
275	.380
300	.391
325	.402
350	.413
375	.424
400	.435
425	.445
450	.456
475	.466
500	.476
525	.486
550	.496
575	.505
600	.515

ATTACHMENT III

SAFETY GUIDELINES FOR EXCAVATIONS

EXCAVATION AND TRENCHING GUIDELINES

- Remove all surface encumbrances.
- Locate all underground installations prior to opening excavation.
- Supply means of egress so that no more than 25 feet of lateral travel is required by personnel in the excavation.
- Supply warning vests for personnel exposed to vehicular traffic.
- Utilize barricades, hand signals, or stop logs for equipment operating next to excavations and slope grade away from excavation.
- Check for hazardous atmospheres.
- Protect excavation and personnel form water accumulation.
- Check stability of adjacent structures.
- Protect personnel from loose rock or soil.
- Inspect excavations and record information from the inspection in the field log book.
- Provide for fall protection.
- Describe in detail any protective system used for personnel protection (sloping and benching of sides, support systems, or shield systems).

APPENDIX D

Addendum to the Work Plan

ADDENDUM TO WORK PLAN
RESPONSES TO THE DEPARTMENT'S COMMENTS PERTAINING TO THE WORK PLAN FOR THE IRM AT THE FORMER IMC MAGNETICS CORPORATION SITE IN WESTBURY, NEW YORK

General Comments

Comment 1

Page 3, Section 1.4 - It is stated that Anson's closure plan was unavailable for review. If this is true, why is it cited under references on page 34?

Response

The 1992 closure plan (Anson Environmental Ltd.) was in fact unavailable for HAI's review and was not cited under references (Section 5.0 of the Work Plan) on page 34. The Work Plan did cite a December 3, 1993 closure plan (Anson Environmental Ltd.), which was available for HAI's review.

Comment 2

Page 4, Section 1.5 (Hydrogeology) - It is stated that the soils beneath the site consist of granular glacial outwash deposits. It is further stated that there are no significant permeability changes down to the water table (48'-50' below grade). This is inconsistent with Anson's 1993 Closure Plan Implementation Volume 1, p.3, which reports grey, clay-like soils at a depth of 12 feet below grade at LP2-B.

Response

The "grey, clay-like soils" detected at LP2-B are located at the base of leaching pool LP2-B. This clay-like material was interpreted to be solids residual from past wastewater disposal activities, and not representative of a native soil texture. The fact that the "grey, clay-like material" contains 7,500,000 μg/kg chromium, 190,000 μg/kg lead, 21,000 μg/kg cadmium and 2,300 μg/kg mercury is indicative of a high percentage of residual solids at the base of the leaching pool. Finally, as the original function of the leaching pools is interpreted to have been promotion of efficient infiltration of fluids into the glacial outwash deposits, it is unlikely that the base of the leaching pool would have been constructed atop a clayey soil layer.

Comment 3

Page 5, Section 1.6 - Fairly detailed information is given for LP2-A and LP2-B. If available, similar information should be given for LP1A, LP1B, ST-3, LP3A, and LP3B. Are the pools empty? Do they contain sludges?

Response

Structural dimensions for LP1-A, LP1-B, ST-3, LP3-A and LP3-B were not known at the time the work plan was written and are not currently known. Results from chemical analyses conducted on soil samples collected by Anson Environmental Ltd. beneath or offset a short distance from LP1-B, ST-1, LP3-B and ST-3 are summarized on page 7 of the Work Plan. No samples were collected by Anson near LP1-A or LP3-A.

According to Anson Environmental Ltd.'s *1993 Closure Plan Implementation - Volume 1,* ST-1 contains "sediment" at its base (three feet below grade); LP2-A is "...filled with clean sand"; and LP2-B is filled with "grey, clay-like soils" to "green soil" from its base to a depth of approximately seven feet below grade. The degrees to which LP1-A, LP1-B, LP3-A, LP3-B and ST-3 are filled with soil, sediment and/or sludge were not discussed by Anson Environmental Ltd. and were not determined during HAI's July 1995 source and release identification and surveying activities as the structures were completely covered by earthen materials and contained no manholes.

Comment 4

Geoprobe locations are restricted to the immediate vicinity of the IMC building. What were the results of the dye test conducted during the summer of 1995? Do these tests indicate minimal horizontal migration? If not, it would be advisable to conduct additional geoprobes downgradient.

Response

Dye testing was conducted during the July 1995 source and release identification and surveying activities. The purpose of the testing, as indicated in section 2.4 (page 17) of the Work Plan, was to trace sewers at the facility. No dye testing was conducted to simulate fluid flow through unsaturated glacial outwash deposits.

The stratigraphy beneath the Site suggests that lateral migration of fluids would be minimal. Further, the direction of ground-water flow is not expected to influence the migration patterns of contamination in unsaturated soils until possibly just above the water table.

Comment 5

Options for remediation of metal contamination should be included.

Response

HAI believes that it is premature to state options for remediation of heavy metal contamination at this time as the depth of contamination, types and speciation of metals making up the contamination, various properties of soils containing the contamination, and background concentrations of heavy metals in soils have not been identified. This information will be obtained as part of the upcoming investigations.

The option of vacuum extraction for remediation of VOC contamination in unsaturated soils was identified in the Work Plan as this remedial approach is known to be effective for the types of VOCs detected at the Site. Further, it is known that soil vacuum extraction can be conducted down to the water table if necessary and should be effective on a wide range of soil types.

Comment 6

An additional two weeks should be allowed in the schedule after the completion of Task 4 - Interim Report - to allow for DEC review before the Vacuum Extraction Pilot Test.

Response

A revised schedule is included in Attachment A of this response document which reflects an additional two weeks for NYSDEC's review of the Interim Report (Task 4) prior to initiating the Vacuum Extraction Pilot Test.

Comment 7

The work plan should state the data quality objectives for the site and identify data uses.

Response

It is the objective of investigative activities described within the Work Plan to produce data that meet or exceed quality standards defined within the Quality Assurance Project Plan, as modified pursuant to NYSDEC's August 28, 1995 comment letter.

Data uses are described in section 1.7 (page 8) of the Work Plan, as follows:

> "Subsurface investigations will be conducted to gather sufficient data for evaluation and design of a soil vapor extraction (SVE) system, and to define the nature and vertical and horizontal extent of contaminants in the vadose zone at the Site. Specifically, a SVE pilot testing program is proposed, and, in conjunction with the subsurface investigations, is intended to provide sufficient data to implement design of a full-scale SVE system. As described in section 2.2, this Work Plan presumes that SVE will be an appropriate technology for VOC contaminant removal in the vadose zone and that a full-scale SVE system will be implemented as an IRM. The project will also gather sufficient data to evaluate the potential for metals to adversely impact ground water."

Section 2.1 (page 16) of the Work Plan states that:

> "Subsurface investigations will be conducted to more completely assess the nature and vertical and horizontal extent of VOCs and metals in the vadose zone at the Site and to gather sufficient data for design of a SVE system."

At the end of section 2.2 in the Work Plan, it is stated that: "...data will be gathered to allow evaluation of the potential for metals to adversely impact ground water."

Comment 8

Page 11, Section 1.8.3, Project Staff: Please submit the resumes of key project personnel (QA officer, H & S Officer, Etc.) to the Department for review.

Response

Resumes are provided in Attachment B of this document for the following project personnel: Project Manager (Craig Kasper, P.E.); Project Engineer (Dave Richards, P.E.); Project Hydrogeologist (Tim Douthit); Site Health and Safety Officer (Russel DiRenzo); Quality Assurance Officer (Kevin Wildman); Laboratory Project Manager (Paul Ioannides); and Technical Advisor (W. Lance Turley, P.G.).

Comment 9

Emergency telephone numbers for the DEC and the Nassau County Health Department should be included in the Health & Safety Plan.

Response

The Health & Safety Plan has been revised and now contains the Emergency telephone numbers for the NYSDEC and the Nassau County Health Department.

Comment 10

Surface soil (0-3" bgs) should be collected in order to evaluate potential exposures at ground level.

Response

Based on HAI's July 1995 source and release identification and surveying activities, approximately 95% of the Site is covered by building or asphalt, thus significantly limiting exposure potential at ground level. Furthermore, the most probable release mechanisms for contamination identified by the recent field activities are associated with subsurface structures such as the leaching pools, floor drains and sewer piping, and are not related to surface releases, which would have a greater likelihood of contaminating very shallow soils.

Of the areas not covered by asphalt or the building, there was no observed evidence of staining, stressed vegetation or the presence of a nearby release mechanism, with one exception: An isolated area of what appeared to be oil staining was noted on the sidewalk that borders the west side of the building. This staining extends to the edge of the sidewalk, indicating that the probable oil may have entered onto an adjoining grassy area (although no stressed vegetation was observed). However, as this staining is limited to a small area and will not be disturbed during field activities, exposures are not likely. Therefore, sampling of surface soil is not warranted for the proposed work.

Comment 11

Workzones: All work zones or areas of excavation must be clearly marked, and roped or fenced off to ensure that the public is kept a safe distance from site excavation or other remedial activities. Excavations must be covered during off-hours and any stockpiled soils must be covered.

Response

Work zones will be clearly marked and, if appropriate, roped or fenced off to ensure that the public is kept a safe distance from investigative activities. Soil excavation is not proposed within the Work Plan. If soil excavation is a designated within the IRM Design, appropriate public assess restrictions will be described in the design document.

Comment 12

Dust Suppression: Reasonable fugitive dust suppression techniques must be employed during all site activities which may generate dust. These dust suppression measures must be taken to maximize the potential for off-site exposures. Reference can be made to the DEC's Fugitive Dust suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites as described in DEC's Technical and Administrative Guidance Memorandum (TAGM-4031). (Copy is enclosed for your use).

Response

Investigative activities described in the Work Plan are not expected to generate fugitive dust emissions.

Comment 13

Air Monitoring: Attached is a generic Community an Monitoring Plan developed by the New York State Department of Health (NYSDOH). This plan must be implemented during excavation activities to provide a measure of protection for the down-wind community from potential releases that might occur as a direct result of work activities.

Response

Soil excavation is not proposed within the Work Plan. If soil excavation is specified as part of the IRM Design, and if necessary the Community Air Monitoring Plan will be implemented during excavation activities.

Comment 14

Prior Notification: Prior to excavation activities, notification to local police, fire and potential emergency responders be made, advising them of remedial activities and the schedule of events. In addition, prior notification should be made to the Nassau County Health Department.

Response

Soil excavation is not proposed within the Work Plan. If soil excavation is specified as part of the IRM Design, prior notification will be given to the Nassau County Health Department and local police, fire and potential emergency responders. Advisement of remedial activities and pertinent schedules will also be provided to the above entities.

QAPP Comments:

Comment 15

What criteria will be used to determine if the initial or daily calibration curves are acceptable? We recommend a correlation coefficient of greater than or equal to 0.95.

Response

The comment has been incorporated into the revised "Standard Operating Procedure for Field Analysis of Volatile Aromatic and Chlorinated Compounds by Gas Chromatography" which is located in Attachment C.

Comment 16

What criteria will be used to determine if the method blanks are acceptable? We recommend that the peak area for target compounds be less than half the area of the reported detection limit.

Response

The comment has been incorporated into the revised "Standard Operating Procedure for Field Analysis of Volatile Aromatic and Chlorinated Compounds by Gas Chromatography" which is located in Attachment C.

Comment 17

We recommend 10 percent duplicate analysis on the samples analyzed by field GC methods.

Response

The comment has been incorporated into the revised "Standard Operating Procedure for Field Analysis of Volatile Aromatic and Chlorinated Compounds by Gas Chromatography" which is located in Attachment C.

Comment 18

The resume of the field analyst for the GC analysis should be submitted to the Department for review by the QA section.

Response

The resume of the field analyst responsible for on-site GC analyses, Wilfried J. Staudt, is located in Attachment B.

Comment 19

We recommend confirmation by fixed laboratory protocols on 10 percent of the soil samples analyzed by the field GC laboratory.

Response

It is anticipated that over three hundred soil samples will be analyzed in the field laboratory. Confirmational analysis on 10 percent of these samples is excessive and will create an unnecessary financial burden. The field laboratory is equipped with laboratory grade instrumentation and all analyses will be performed by a qualified chemist with experience in gas chromatography. HAI purposes that 5 percent of the soil samples analyzed by the field GC laboratory be submitted to the fixed laboratory for confirmational analyses. The attached "Standard Operating Procedure for Field Analysis of Volatile Aromatic and Chlorinated Compounds by Gas Chromatography" has been revised to include the confirmational analysis of 5 percent of all field samples analyzed by the field laboratory.

Comment 20

Attached is a copy "QC Guidelines for GC Field Methods", which describes our recommendations for field methods.

Response

The comment has been incorporated into the revised "Standard Operating Procedure for Field Analysis of Volatile Aromatic and Chlorinated Compounds by Gas Chromatography" which is located in Attachment C. With the exception of confirmational analysis on 5 percent of field samples instead of 10% as recommended by the Department (refer to response to Comment 19).

Comment 21

The work plan should include a chart showing the number of samples to be collected, matrices, holding times, analytical protocols to be used, and anticipated QA/QC samples to be collected or analyzed.

<u>Response</u>

The Department's comment is noted. However, HAI believes that this investigation does not warrant such a chart due to the limited scope of analyses to be performed. With the exception of one air sample, the only matrix to be sampled is soil. The only QA/QC measures for this investigation will consist of equipment blanks collected from the decontaminated soil samplers and the submittal of confirmational samples to the fixed laboratory. Also, the number of samples to be collected cannot be easily estimated as the number of proposed borings may be increased or decreased in the field based upon analysis of the data collected. Additionally, the number of soil samples collected from each boring will vary with the distribution of VOCs (i.e., soil sampling within a boring will terminate after two successive soil samples exhibit no detectable VOC concentrations).

<u>Comment 22</u>

Page 22, Section 2.5.4.1, Field Laboratory Analytical Procedures: If conventional chain-of-custody procedures are not used for field samples, some form of acceptable sample tracking is necessary.

<u>Response</u>

Conventional chain-of-custody procedures will not be used because field samples will be delivered to the field laboratory immediately upon collection. All samples will be labeled with the required information at the time of collection and then be taken to the field laboratory and logged in upon delivery. It would be burdensome to complete a chain-of-custody document for each of the hundreds of samples to be analyzed on-site. All custody transfers will occur on-site and be limited to the field sampling team and the field chemist. At no time will samples be removed from the Site or custody be granted to any outside parties with the exception of samples being sent to the fixed laboratory for confirmation analyses. Conventional chain-of-custody procedures will be utilized for all samples sent to the fixed laboratory.

<u>Comment 23</u>

Page 23, Section 2.5.4.2, Fixed Laboratory Analytical Procedures: We recommended confirmatory soil sample analysis is (sic) fixed laboratory procedures on 10 percent of the samples analyzed in the field laboratory.

<u>Response</u>

Please refer to response for Comment 19.

<u>Comment 24</u>

Page 23, Section 2.5.4.2, Fixed Laboratory Analytical Procedures: Please explain how the fixed laboratory data will be used to calibrate the data from the field laboratory.

<u>Response</u>

The word "calibrate" as used in this section was poorly chosen. This section will be revised to state that data from the fixed laboratory will be used as a "point of comparison" with the data generated by the field laboratory.

Comments on Appendix A:

Comment 25

Page 4, Section 2.2.6, Sample handling and Chemical Analysis: We recommend confirmation by fixed laboratory protocols for 10 percent of the samples analyzed by the field laboratory.

Response

Please refer to response for Comment 19.

Comment 26

Page 5, Section 2.2.6, Sample Handling and Chemical Analyses: Trip blanks are required only for water samples to be analyzed for Vas. Trip blanks are not required for soil samples or samples for metals analysis.

Response

This section will be revised accordingly.

Comment 27

Page 5, Section 2.2.7, Chain of Custody: If conventual (sic) chain-of-custody procedures are not used for field samples, some form of acceptable sample tracking is necessary.

Response

Please refer to response for Comment 22.

Comment 28

SOP No. F1000, Decontamination: Acetone is unacceptable as a decontamination fluid since it is a Superfund target analyte. Hexane or methanol are acceptable.

Response

The Departments comments are noted. This text of this SOP will be revised accordingly.

ATTACHMENT A
REVISED ESTIMATED PROJECT SCHEDULE FOR THE IRM AT THE FORMER IMC MAGNETICS CORPORATION SITE IN WESTBURY, NEW YORK

Task Description	Duration of Task (weeks)	Accumulated Project Time (weeks)
Task 1 - File Review	2	2
Task 2 - Source and Release Identification and Surveying	2	4
NYSDEC Review of Work Plan[2]	4	8
Task 3 - Vadose Zone Investigation	3	11
Task 4 - Interim Report	2	13
NYSDEC Review of Interim Report[1]	2	15
Task 5 - Vacuum Extraction Pilot Test	1	16
Task 6 - Final Investigation Report	4	20
NYSDEC Review of Final Report[1]	4	24
Task 7 - IRM Design	4	28
NYSDEC Review of IRM Design[1]	4	32
Task 8 - IRM Implementation	Not Specified	Not Specified

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[2] It is assumed that this duration includes time for NYSDEC's review as well as time for IMC to address any comments and re-submit the document, if necessary. This duration may require modification based on the extent and time of NYSDEC's review.

ATTACHMENT B
RESUMES OF KEY PROJECT PERSONNEL FOR THE IRM AT THE FORMER IMC MAGNETICS CORPORATION SITE IN WESTBURY, NEW YORK

Project Manger	Craig A. Kasper, P.E.
Project Engineer	Dave Richards, P.E.
Project Hydrogeologist	Tim Douthit
Site Health & Safety Officer	Russel DiRenzo
Quality Assurance Officer	Kevin D. Wildman
Laboratory Project Manger	Paul Ioannides
Field Analyst	Wilfried J. Staudt, Ph.D.
Technical Advisor	W. Lance Turley, P.G.

CRAIG A. KASPER, P.E.

Vice President/Sr. Project Manager

Education

Bachelor of Science in Civil Engineering Ohio Northern University, 1984

Professional Experience

November 1989 - present: Project Manager, Hull & Associates, Inc.

September 1987 - November 1989: President, Kasper Environmental, Inc.

June 1984 - September 1987: Project and Design Engineer, Burgess & Niple, Ltd.

Professional Affiliations

Registered Professional Engineer (P.E. - Ohio)
Certified Professional (Ohio's Interim Voluntary Action Program)
Member of Ohio Voluntary Action Steering Committee (Overseeing Rule Development)
Member of BUSTR Rule Development Committee
National Society of Professional Engineers (NSPE)
Ohio Society of Professional Engineers (OSPE)

Seminars/Papers

Speaker at the 1994 Business and Industrial Environmental Symposium in Cincinnati, Ohio. Presented paper and participated on panel discussion regarding Senate Bill 221, Ohio's Real Estate Reuse and Cleanup Law.

Speaker at the 1994 Governmental Institutes Ohio Environmental Law Compliance Course in Columbus, Ohio. Presented paper regarding Senate Bill 221, Ohio's Real Estate Reuse and Cleanup Law.

Other papers and articles:

<u>Summary of Ohio's Voluntary Action Program</u>, October 1995 (prepared for distribution at Waste Management, Inc.'s Annual Conference, Washington DC)

<u>Phase II Property Assessment Considerations for Ohio's Voluntary Action Program</u>, October 1995 (prepared for a panel discussion at the Cleveland Bar Association's 17 Annual Real Estate Law Institute).

<u>Developing Brownfield Sites: Comparing Two Approaches (Ohio and Michigan)</u>, "Michigan Lawyers Weekly," September 1995

KEY PROJECTS

Independent Review for Issuance of No Further Action Letter Under Ohio's Voluntary Action Program - Provided independent review of a property as a Certified Professional in conjunction with Ohio's Voluntary Action Program. In anticipation of obtaining a No Further Action letter, the client requested review of data, investigations, studies, design, calculation, and other relevant information. The project involved meetings with the client, site visits, and determining additional work that would be required to prepare a No Further Action letter that will be submitted at the Client's request.

Ohio's Voluntary Action Program - As Sr. Project Manager, I am overseeing all activities being conducted for the review of previous site investigation activities and data, and performed additional investigative activities as warranted at a former industrial site in Ohio. The primary objective was to evaluate the property and determine the source of detected contamination and the significance of the concentrations. All site investigation activities were performed in compliance with ORC 3746 and in contemplation of obtaining a No Further Action letter under Ohio's VAP.

Ohio's Voluntary Action Program - Sr. Project Manager and responsible for coordinating and oversight of the review of previous site investigation activities and data, and additional investigative activities that were warranted for a former industrial site in Ohio. The primary objective was to evaluate the property and determine the source of detected contamination and the significance of the concentrations. All site investigation activities were performed in compliance with ORC 3746 and in contemplation of obtaining a No Further Action letter under Ohio's VAP.

Ohio's Voluntary Action Program - Currently assisting a municipality explore options under Ohio's Voluntary Action Program in relation to its industrial brownfield sites.

Phase II Environmental Site Assessment (as part of Indiana's Voluntary Remediation Program) - Project Manager for environmental investigation and cleanup which included a Phase II Environmental Site Assessment for a 500,000 square foot manufacturing facility and a 120-acre parcel of land, which included a detailed on-site environmental file review and installation of soil borings/monitoring wells to collect soil and ground-water samples for laboratory analysis. A remedial investigation was initiated to address contaminated soils and ground water, involving the installation of soil borings/monitoring wells to collect data for laboratory analysis and risk assessment. Additional services provided included the characterization of abandoned materials and miscellaneous debris.

Other activities at the site include the closure of a hazardous waste incinerator which includes soil sampling, decontamination of a concrete pad near the incinerator, and the preparation of the closure certification report.

RD/RA Superfund Project - Project Manager for the RD/RA at the South Municipal Well Superfund Site in Peterborough, New Hampshire. Project included pre-design field investigations, detail design of Remedial Action, and oversight of Remedial Action activities. Addressed a variety of complex contamination situations, including PCB and polycyclic aromatic hydrocarbons in wetland sediments and volatile organic compounds in soil and ground water near community well fields. Duties included overall project management, coordinating technical staff, interfacing and negotiating with the U.S. EPA, contractor oversight, regulatory compliance, and project administration.

Underground Storage Tank Investigations and Corrective Actions - Project Manager for more than 200 UST investigations and corrective actions projects for a major oil company. Projects have included UST closures and installations, soil and ground-water investigations and remedial system design and operation.

Design of New Industrial Solid Waste Landfill - Sr. Project Manager for the design of an industrial solid waste landfill consisting of two landfill areas totaling approximately 110 acres. A challenge to the landfill design was more than 50 acres of wetlands on the property; the final design disturbed less than ten acres. Conducted hydrogeologic investigations, prepared a ground water monitoring detection program, and landfill design and construction report as part of the permit application.

Corrective Measure Studies - Project Manager for two Corrective Measure Studies in Ohio to determine preferred remedial alternatives to address leachate-derived constituents in ground water. Ground-water modeling and risks to public health was conducted. The corrective measure was chosen to achieve performance standards and technical criteria, while considering practicability and cost as a primary factor.

Remedial Design for a Landfill Site - Project Manager for the Remedial Design of a landfill site in Southwest Ohio under the Superfund Program. Providing the preliminary design to define key design components which includes developing an overall surface grading plan and slope of the landfill; identifying drainage patterns and mechanisms of discharge for surface water both during and after construction; and defining components of the gas management system. Some specific tasks include the development of a work plan; site mapping; preliminary designs; cap selection; grading and drainage plans; a gas management plan; a review of ARARs, institutional controls, and site facilities; soil cover investigations; and preliminary gas extraction field testing.

Hydrogeologic Investigation - Project Manager for hydrogeologic investigation of contaminated aquifer in Northeast Ohio in response to Findings and Orders issued jointly by the Ohio EPA and BUSTR. Provided services to five entities to assist in a coordinated effort to initially characterize a potentially contaminated aquifer. The objectives include identifying the areas which may have released contaminants to the ground water, identifying contaminant patterns, and evaluating potential source removal actions or other appropriate interim actions to mitigate immediate and substantial threats. As part of the project, a work plan, health and safety plan, and field sampling and analysis plan have been developed and submitted to Ohio EPA.

Preparation of a CERCLA Removal Action for a Chemical Manufacturing Facility - Project Manager for the preparation of a removal action at a chemical repackaging and plating facility in conjunction with unilateral administrative orders issued by U.S. EPA Region IV. Contaminants found at the site include various plating chemicals and organics. Tasks to be completed include initiating and directing all activities in compliance with the orders which include securing and stabilizing the site to prevent future releases; sampling, analyzing, and disposing of waste materials; implementing necessary site control measures; completing all preliminary site investigation activities; and controlling the source of existing and/or threatened releases. Reports that will be prepared and submitted for approval include a work plan, health and safety plan, quality assurance and sampling plan, and a final report.

Environmental Site Assessment of a Chemical Packaging Facility - Project Manager for an environmental site assessment of a chemical packaging facility, formerly utilized for plastic manufacturing, including a complete Phase I assessment and subsurface sampling and analysis of the soils in the vicinity of two former aboveground storage tank farms, underground storage tanks, and material processing areas.

Environmental Site Assessment for Mixed-Use Property - Project Manager for an environmental site assessment involving an extensive site history review for a mixed-use property (manufacturing, retail, and residential). This involved interacting with regulatory agencies, conducting interviews with the owners, performing site reconnaissance, aerial photo interpretation and sampling building materials including asbestos. Phase II test pits were installed and soil samples were collected and screened. Solvent contamination was identified through laboratory analysis of a test pit soil sample. The extent of contamination was delineated by further sampling.

Environmental Site Assessment of Quarrying Operations - Project Manager for Phase I and II Environmental Site Assessment of five quarrying operations in Ohio and Pennsylvania. The sites ranged from 60 to 970 acres. The project involved a comprehensive research of site histories; aerial photo interpretation; administrative and environmental regulatory agency interviews; interviews with present and former employees; review of the potential existence of wetlands; evaluation of landfill siting criteria; and soil and water sampling and analysis.

Remediation Demonstration Project - Project Manager for an on-going demonstration project funded through U.S. EPA to evaluate an innovative remediation system to cleanup up petroleum contaminated soil and water. The goal is to evaluate the effectiveness of the remediation technique and share the information within the industry to help improve this technology. Innovative technologies incorporated into the project include vapor extraction and ground-water sparging. The project has involved initial site investigations, design of the remediation system and continual oversight of system maintenance and performance.

Environmental Risk Management Surveys - Project Manager for Environmental Risk Management Surveys for manufacturing and industrial facilities throughout the United States and Mexico. Project tasks include the development of process, environmental management, and regulatory burden profiles for each facility, a site visit and audit of each facility, and the preparation and presentation of a comprehensive risk management assessment and strategy.

Wastewater Treatment Plant (Ohio) - Engineer responsible for the design of an automotive manufacturer's wastewater plant improvements in northern Ohio. Responsibilities included building layout and design, pump evaluation and process piping design, preparing technical specifications and a bid package. Process included oil separation, chemical additional, sludge thickening, and sludge dewatering.

DAVID L. RICHARDS, P.E.

Project Engineer

Areas of Expertise

environmental engineering, civil engineering, industrial and municipal wastewater treatment, structural engineering, corrective action, ground-water treatment design, landfill gas recovery, UST inspections, removal and remediation

Education

Bachelor of Science Civil Engineering, Ohio Northern University, 1986.

OSHA 1910.120, 40-Hour Health and Safety Training Program - 1990

Radiation Safety and Use of Nuclear Gauges Certification - 1991

Hazardous Waste Regulations, Columbus State Community College - 1993

Professional Experience

September 1990 - present: Project Engineer, Hull & Associates, Inc.

June 1986 - September 1990: Project and Design Engineer, Burgess & Niple, Ltd.

Honors

Tau Beta Pi - National Engineering Honor Fraternity
Phi Kappa Phi - National Honor Society

Seminars

Solid Waste Association of North America (SWANA), Fifteenth Annual Landfill Gas Symposium, 1992

In Situ Treatment of Contaminated Soil and Water, presented by Air and Waste Management Association in conjunction with USEPA, 1992

Chemineer Mixer Seminar, Columbus, Ohio, 1990

Liquid Storage Tank Installation Seminar, Madison, Wisconsin, 1989

Flygt Submersible Pump Seminar, Columbus, Ohio, 1989

Papers

Explosive Gas Migration Control at the Huron County Landfill, Huron County, Ohio - 1993

Professional Registration

Registered Professional Engineer - Ohio

List of clients, references, and specific project histories available if requested.

DAVID L. RICHARDS, P.E.
Project Engineer

KEY PROJECTS

Remedial Design for a Landfill Site (Ohio) - Project engineer for the Remedial Design of a landfill site in southwest Ohio under the Superfund program (CERCLA). Responsibilities include developing a plan to control landfill gas migration, conducting gas extraction field testing, and designing a gas collection and treatment system. The gas collection and treatment system will include approximately forty gas extraction wells and associated piping, an enclosed flare station, and condensate collection and treatment equipment and facilities. The design of the gas management system will require coordination with regrading and capping of the landfill.

Pilot Testing and System Design for Active Landfill Gas Recovery (Ohio and Pennsylvania) - Prepared work plans and conducted field pilot testing to determine the feasibility of, and if appropriate, develop design parameters for active landfill gas recovery at solid waste landfills. Field work consisted of evaluating gas quality at various gas extraction rates, evaluating the area of vacuum influence, and determining optimal extraction well flowrates and spacing. Full-scale design and construction of a gas collection system and flare station at one of these sites has been completed.

Soil Vapor Extraction (Ohio, Michigan, New Hampshire) - Prepared work plans and conducted soil vapor extraction (SVE) pilot tests at several leaking petroleum underground storage tank sites, including a Superfund site contaminated with chlorinated hydrocarbons. The SVE pilot systems consisted of multiple extraction wells and monitoring probes, a portable vacuum blower, and vapor phase carbon treatment systems. The vapor extraction system was operated in conjunction with ground-water sparging at several sites. Work consisted of evaluating various gas extraction rates, collecting gas samples for laboratory analysis, and preparing engineering reports to present the results of pilot testing. Developed full-scale system designs based on data collected during the pilot tests.

Remedial Design at Superfund Site (New Hampshire) - Project engineer for remedial design and remedial action (RD/RA) at a Superfund site in New Hampshire (CERCLA). The design included preparation of plans, specifications, and bid documents for a ground-water pumping system consisting of six extraction wells and approximately 5000 lineal feet of forcemains; a 600 gallon per minute ground-water treatment plant; approximately 2500 lineal feet of gravity sewer; a soil vapor extraction and ground-water sparging system; and wetland sediment excavation, disposal, and restoration procedures. Also provided construction management services during RA which included shop drawing review, coordination of field personnel providing on-site construction observation, quality control, and system start-up.

Soil Gas Survey (Michigan) - Prepared work plan and conducted field work for a soil gas survey at a leaking underground petroleum storage tank site to determine the extent of impacted soil and ground-water. The survey encompassed a 60,000 square foot area and consisted of twenty sampling locations to depths of up to 18 feet. Samples were collected in tedlar bags and analyzed on-site using a portable gas chromatograph.

Leachate Storage Facility (Michigan) - Project engineer for the design of a leachate storage facility at a sanitary landfill in Michigan. Design consisted of two leachate manhole pumping stations; approximately 600 lineal feet of forcemains; two twelve-thousand gallon fiberglass storage tanks; an eight-hundred square foot building; a level control system; and other associated equipment.

Landfill Leachate Treatment (Ohio) - Performed engineering study for a 25,000 gpd leachate pretreatment system at a sanitary landfill in western Ohio including negotiations with the city POTW to determine pretreatment requirements.

Underground Storage Tank Removal (Ohio) - Prepared plans and specifications, bid documents, permit applications, and sampling and analysis plans for removal of several underground storage tanks at various sites. Also collected soil and ground-water samples for laboratory analysis, performed sample screening using an organic vapor analyzer (OVA), and prepared closure documentation reports.

Site Investigations (Ohio) - Conducted investigations at numerous sites in response to leaking underground petroleum storage tanks including review of site history, petroleum underground storage tank fund requirements, regulatory compliance issues, and further investigations to determine the extent of impacted soils and ground water. Further investigations included installation of soil boring/monitoring wells, soil and ground-water sampling, geophysical investigations, and soil gas surveys.

Remedial Action Plans (Ohio) - Prepared Remedial Action Plans for numerous sites in response to leaking underground petroleum storage tanks. Work included performance of conventional and vacuum enhanced ground-water pumping tests, soil vapor extraction tests, and ground-water sparging tests to evaluate these alternatives. Remedial Action Plans included a summary of previous investigations, evaluation of cleanup criteria and objectives, evaluation of remedial action alternatives, and conceptual design of full-scale remediation systems.

Wastewater Lagoon Closure (Ohio) - Project engineer for the closure of two 3.5 million gallon wastewater lagoons for automobile manufacturer in northern Ohio. Developed a phased construction approach to isolate the lagoons from storm and cooling water flows prior to closure. Design included an open channel flow system to handle an average flow of 3,500 gpm and procedures for lagoon closure and placement of final backfill.

Municipal Water Treatment Plant (Ohio) - Performed a preliminary engineering study to investigate alternatives for handling and disposal of spent filter backwash water and waste lime sludge for this 2.0 mgd water treatment plant. Upon completion of the study, developed detailed plans and specifications to install a 40,000 gallon reinforced concrete backwash holding tank, a dual-celled earthen waste lime sludge lagoon with a compacted clayey soil liner, transfer pumps, and miscellaneous piping.

Industrial Wastewater Treatment (Ohio) - Assisted in the design of several industrial wastewater treatment systems. Responsibilities included physical plant layout, construction cost estimates, gravity hydraulic design, pumping system design, and miscellaneous structural and mechanical designs.

Prestressed Concrete Design (Ohio and Pennsylvania) - Structural design of various precast, prestressed concrete structures including two prisons, a health spa, and several two-story parking garages. Responsible for coordinating design efforts with precast concrete supplier.

Water Diversion System (Ohio) - Prepared plans and specifications for improvements of an Erie Canal aqueduct consisting of three 36-inch pipes which span 120 feet across the St. Marys River. Design included an upstream spillway with control gates and a downstream overflow flume to divert flow to the river during high water conditions.

Municipal Wastewater Treatment Plant (Ohio) - Performed structural design for several municipal wastewater treatment plants. Design consisted of reinforced concrete structures including buildings, pump stations, rectangular and circular tanks, and other miscellaneous structures.

BIO

Timothy L. Douthit
LAND TECH REMEDIAL, INC.
31 Dubon Court
Farmingdale, New York 11735
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email: Compuserve: 74003,677

EDUCATION

State University of New York at Stony Brook **Stony Brook, New York**
Master of Science degree, Geochemistry, 1990
Thesis: "A Geochemical Analysis of the Irish Waulsortian Limestone: Implications for the Strontium Isotopic Composition of Lower Carboniferous Seawater".

University of Michigan **Ann Arbor, Michigan**
Bachelor of Science degree, Geology, 1984

RELEVANT EXPERIENCE

As manager of Land Tech Remedial, Inc.'s Farmingdale, New York office, Mr. Douthit is directly involved in all aspects of petrochemical release management, including assessment, remediation feasibility testing, regulatory negotiation and closure. Mr. Douthit's primary interests include the understanding, development and ultimate implementation of innovative and alternative remedial approaches. Recent projects include the advocacy and application of risk-based corrective action (RBCA), refinement of air sparging techniques, risk assessment utilizing computer-based dissolved phase contaminant fate and transport modeling and the field documentation in-situ bioremediation at petrochemical release sites. Mr. Douthit is also a member of the ASTM Task Group on Remediation by Natural Attenuation (RNA).

PUBLICATIONS

Douthit, T.L., Meyers, W.J. and Hanson, G.N. (1993) Non-monotonic variation of seawater ^{87}Sr/^{86}Sr across the Ivorian/Chadian boundary (Mississippian, Osagean): Evidence from marine cements within the Irish Waulsortian Limestone. Journal of Sedimentary Petrology, Vol. 63, No. 3, p. 139 -149.

Schoonen, M.A.A. and Douthit, T.L. (1992) Experimental determination of the solubility product of dolomite (abs.). Goldschmidt Conference, May 8 - 10, 1992.

Douthit, T.L., Meyers, W.J. and Hanson, G.N. (1990) Structure in the secular variation of seawater $^{87}Sr/^{86}Sr$ for the Ivorian/Chadian (Osagean, lower Carboniferous) (Abs.). 13th International Sedimentological Congress, Nottingham, England. Abstracts of Papers, p. 139.

Payne, R.E., Novick, N.J., Douthit, T.L., Brown, J.A., and Anderson, D.N. (in press) An evaluation of field methods for measuring indicators of intrinsic bioremediation of petroleum hydrocarbons in groundwater. Proceedings, NGWA Conference, Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection and Restoration, Houston Texas, Nov. 28 - December 1, 1995.

Novick, N.J., Payne, R.E., and Douthit, T.L. (in press) A practical approach for evaluating intrinsic bioremedation of petroleum hydrocarbons in groundwater. Proceedings, NGWA Conference, Petroleum Hydrocarbons and Organic Chemicals in Groundwater: Prevention, Detection and Restoration, Houston, Texas, November 28 - December 1, 1995.

Novick, N.J., Payne, R.E., and Douthit, T.L. (in press) Evaluating intrinsic bioremediation of petroleum hydrocarbons at service station sites. Annual American Chemical Society, Industrial and Engineering Chemistry Session, Special Symposium on Emerging Technologies in Hazardous Waste Management, Atlanta, Georgia, September 17 - September 20, 1995.

RUSSELL J. DIRIENZO, P.G.

36 Garnet Road
Roxbury, Connecticut
(203) 350-2670

Objective To obtain a project management position within an environmental consulting firm which offers expanded opportunities for advanced development of management and technical expertise.

Profile

Over six years experience as a Senior Project Geologist performing environmental compliance activities for numerous industrial and commercial clients. Project experience includes site assessments under the Land Transfer Act, Superfund, and RCRA; development and implementation of groundwater monitoring programs; permit application preparation for industrial waste and stormwater discharges; preparation of waste minimization and hazardous waste management plans; and supervision of underground storage tank removal. Responsible for marketing, sales, and proposal preparation for a variety of environmental compliance activities.

Project management responsibilities include liaison between industrial clients and regulatory agencies, preparation of comprehensive environmental assessment/remedial investigation reports, preparation of site specific health and safety plans and design and implementation of soil/groundwater remediation programs.

Work History

1986 - Present	Senior Project Geologist Bird Environmental Technologies (formerly YWC Technologies)
1985 - 1986	Independent Restaurant Consultant
1980 - 1984	Manager, Fitzwilly's Restaurant, Bridgeport, CT

Education

M.S., Environmental Science, University of New Haven, 1992
B.A., Geology, University of New Hampshire, 1980

Certification and Professional Affiliations

- Registered Professional Geologist, 1993
- 40 hour and 8 hour OSHA 29 CFR 1910.120 training for hazardous waste site management
- Member; Association of Groundwater Scientists and Engineers
- Member; Connecticut Groundwater Association
- Certified Science Teacher, State of Connecticut

References and Writing Samples: *Available upon request.*

RUSSELL DIRIENZO

Profile

Mr. Dirienzo has over five years experience involving the performance of environmental compliance activities for numerous industrial and commercial clients. Typical project tasks include site assessments (Land Transfer Act, Superfund, RCRA, Clean Water Act, etc.), development and implementation of groundwater monitoring programs, permit application preparation for industrial waste and stormwater discharges, preparation of waste minimization and hazardous waste management plans and supervision of underground storage tank removals. Project responsibilities include liaison between industrial clients and regulatory agencies, preparation of comprehensive environmental assessment/remedial investigation reports, preparation of site specific health and safety plans and design and implementation of soil/groundwater remediation programs.

Project Experience

Environmental Consultant, Confidential Client. As a Senior Project Geologist in Bird Technologies Engineering Division, Mr. Dirienzo is responsible for the environmental compliance program for an industrial manufacturer in Connecticut. Initial tasks involved performance of a detailed environmental audit and associated groundwater monitoring program.

Transfer Act Site Assessment (TASA), Curtis Packaging Corporation. Mr. Dirienzo designed and implemented a TASA assessment to determine the degree and extent of known groundwater contamination on the site. This assessment utilized the installation and subsequent sampling of monitoring wells, and aquifer pump tests. Mr. Dirienzo's study ultimately proved that on-site groundwater contamination was manageable. This resulted in the lending institution providing financing, and the successful realization of the project objective: the transfer of a significant share of company stock.

Transfer Act Site Assessment (TASA), Cornwall Patterson Company. Mr. Dirienzo was successful in obtaining CTDEP approval for a TASA site assessment at an industrial property in Bridgeport, Connecticut. In his capacity as an environmental consultant for the company, and as liaison between the company and the CTDEP, Mr. Dirienzo aided the company in determining which was the proper TASA form for submittal to the CTDEP so that final approval could be achieved.

Environmental Consultant, Roehr Chemical Company, Queens, NY.
Mr Dirienzo has performed environmental consulting services for this chemical manufacturing company for the past four years. Services include: the development and implementation of a site assessment program, site closure program and regulatory permitting. Mr. Dirienzo is currently designing a soil vapor extraction system to remediate contaminated soils identified during the site closure program. Mr. Dirienzo is also responsible for project coordination with the New York State Department of Environmental Conservation.

Mr. Dirienzo has over seven years of experience involving the development and implementation of Remedial Investigations/ Feasibility Studies (RI/FS) at several superfund and PCB disposal sites. Recently, Mr. Dirienzo was involved with the development of a consent order agreement between the New York Department of Environmental Protection (NYDEC) and Roehr Chemicals Inc. (NYDEC Site #241014). The agreement culminated in the completion of a remedial measures plan (RMP) which protected human health and the environment while placing an unnecessary finacial burden on the client . Mr. Dirienzo was also instrumental in developing and implementing a RI/FS plan for the Brunswick Site (CERCLIS # CTD983870916) located in Milford, Connecticut which will most likely result in a "No Further Remedial Action Planned" (NFRAP) site disposition. Mr. Dirienzo also supervised all field activities at the Solvents Recovery Services Superfund Site in Southington, Connecticut and developed a remediation plan for PCB disposal sites located in Medford, Massachusetts and Southington, Connecticut.

1. Brunswick Site, Milford, Connecticut . LTR was contacted by a large development firm to respond to the listing of one of their properties on a superfund data base refered to as CERCLIS as a "site to be investigated" by the Environmental Protection Agency (EPA). The listing was due to a preliminary assessment (PA) performed by the State of Connecticut Department of Environmental Protection (CTDEP) which indicated that the site had a potential to score above the cut-off score for a national priorities list (NPL) site listing. LTR developed a remedial investigation plan working closely with the federal and state agencies which culminated in a preliminary "No Further Remedial Action Planned" NFRAP) site deposition. The client was able to lease the site after only six months of LTR involvement .

Francini Company. Reference: Mr. Peter Francini

2. Aceto Corporation, Queens, New York: Aceto contacted LTR as a consultant on all phases of the facility closure of a subsidiary, Roehr Chemicals Inc.. Roehr Chemicals Inc. was a manufacturer of pharmaceutical intermediates until the facility closure in 1991. Data obtained during the closure assessment indicated the release of xylenes from a receptor pit located beneath the floor of the site building. LTR was instrumental is developing a consent order agreement between New York Department of Environmental Protection (NYDEC) and Roehr Chemicals Inc. (NYDEC Site #241014). LTR convinced the NYDEC to allow a remediation plan which protected human and environmental health without demolishing the site building by installing a soil vapor extraction system inside of the building. The project includes a Citizen Participation Plan and a final closure plan.

Aceto Corporation. Reference: Mr. Arnold Frankel

KEVIN D. WILDMAN

Environmental Scientist

Areas of Expertise

construction certification, quality control/quality assurance, risk assessment, environmental assessment, biological survey/studies, sampling, remedial design/remedial action

Education

Bachelor of Science in Biology, Ohio Northern University, 1989

OSHA 1910.120, 40-Hour Hazardous Materials Safety Course, 1990

OSHA 1910.120, Eight-Hour Health & Safety Refresher Course, 1991, 1992, 1993

Certified Training, Radiation Safety and use of Nuclear Gauges, 1989

Risk Assessment, Short Course, The University of Wisconsin-Milwaukee, October 1993

Risk Based Corrective Action Course, August 1995

Professional Experience

January 1993 - present: Environmental Scientist, Hull & Associates, Inc.

July 1989 - December 1992: Biologist, Hull & Associates, Inc.

List of clients, references, and specific project histories available if requested.

KEY PROJECTS

Remedial Design/Remedial Action (New Hampshire) - Quality Assurance Officer for RD/RA at the South Municipal Water Well Superfund Site in Peterborough, New Hampshire. Project includes implementing pre-design field investigations, completing detail design of Remedial Action, and oversight of Remedial Action activities. Duties include; coordination of field activities with laboratory, review and maintenance of data generated, Chain-of-Custody control, enforcing provision's of the Quality Assurance Project Plan, and auditing field sampling and decontamination activities. Specific tasks include preparation of Quality Assurance Project Plan and the selection of field sampling and analytical methods required to meet project data quality objectives. (Project in progress.)

CERCLA Removal Action (Tennessee) - Quality Assurance Officer for removal action at a plating facility under administrative orders issued by U.S. EPA Region IV. Project includes waste materials inventory, waste characterization disposal, and initial site investigation. Responsibilities include preparation and implementation of Quality Assurance Project Plan, laboratory coordination, and data review and maintenance (Project in progress).

Corrective Measures Study (Ohio) - Prepared detailed Human Health Risk Assessment as part of a Corrective Measures Study for a landfill. Project included; data evaluation, selection of chemicals of concern, identification of exposure pathways, characterization of carcinogenic and non-carcinogenic risks to human receptors, and an overview of potential ecological impacts on a nearby river.

Risk Assessment (Various Projects) - Prepared Human Health Risk Assessments for facilities with residual petroleum contamination from USTs. Projects include: data evaluation, selection of chemicals of concern, identification of exposure pathways, characterization of carcinogenic and non-carcinogenic risks to human receptors, and alternate cleanup standards.

Landfill Construction Certification (Ohio and Michigan) - Supervised and participated in construction certification for various landfill expansion and closure projects. Experience includes certification of recompacted clay liners, installation of various synthetic liners and geo-textiles, and vegetative cover thickness.

Environmental Assessment (Pennsylvania) - Participated in an environmental assessment for a property transfer involving nine sites. Responsible for observation, documentation, and sampling of potential environmental liabilities. Coordinated analysis with the laboratory and assimilated raw data for report.

Surface Water Study (Michigan) - Participated in study to determine environmental impact (if any) of landfilling activities on nearby river. Work included sample site selection, placement of artificial substrates for sampling of periphyton and benthic macroinvertebrates, and the collection of substrates.

Biological Survey (Ohio) - Participated in biological survey of Hardin Co. Participated in ornithological, entomological, and herpetological field surveys. Supervised ichthylogicical component of stream survey using an electro-shocker system. Responsibilities included sample site selection, sampling plan, coordinated the classification of samples in laboratory using taxonomic keys.

Quality Assurance/Quality Control (Various Projects) - Responsibilities include: auditing and approving laboratories to be used, preparation of site specific quality assurance plans/sampling and analysis plans, selection of appropriate analytical methodology, coordination of field activities with laboratories, and review of final analytical results.

Paul Ioannides
Regional General Manager
New Jersey/Lehigh Valley Divisions

EDUCATION

Ph.D. Candidate	Rutgers University
M.S. Environmental Science	Long Island University
B.S. Biology	Albany State University

PROFESSIONAL EXPERIENCE

Regional General Manager Laboratory Resources, Inc.	July 1994 - Present
General Manager Laboratory Resources, Inc.	March 1993 - June 1994
Vice President GP Environmental Services Inc.	June 1990 - March 1993
Manager - Dept. of Organic Analysis Accutest Laboratories	September 1987 - June 1990
Senior Environmental Scientist International Technology Corp.	1986 - 1987
GC/MS Specialist Princeton Aqua Science	1984 - 1986
Environmental Scientist Chemtech Consulting Group	1982 - 1983

QUALIFICATIONS

Mr. Ioannides brings over 13 years of experience in the environmental testing industry. He is an expert in organic analysis particularly GC/MS analysis.

RESPONSIBILITIES

In the capacity of Regional General Manager, Mr. Ioannides has overall P & L responsibility for the New Jersey and Lehigh Valley Divisions'. He also keeps in close contact with all clients to ensure their analytical needs are met.

CURRICULUM VITAE - WILFRIED J. STAUDT, Ph.D.

Land Tech Remedial, Inc.
31 Dubon Court
Farmingdale, N.Y. 11735
Phone: (516) 935-1300
Fax: (516) 694-4075

EDUCATION

Ph.D. Geochemistry	State University of NY at Stony Brook	8/90 - 2/95
M.S. Geology	Philipps-University/Marburg, Germany	7/85 - 2/89
B.S. Geology	Philipps-University/Marburg, Germany	10/83 - 6/85

EXPERIENCE

ENVIRONMENTAL GEOCHEMISTRY	**Environmental Geochemist, Land Tech Remedial, Inc.** Heading of LTR's mobile laboratory program with emphasis on field analysis of volatile aromatic and chlorinated components by gas chromatography.	*4/95 - ongoing*
RESEARCH	**Research Assistant, SUNY Stony Brook** ☞ Geochemistry of natural waters and carbonate minerals. ☞ Modeling of interaction parameters of complex anions at the water/crystal interface.	*8/90 - 2/95*
	Research Assistant, Phillips-University/Germany	*7/87 - 2/89*
	Research Assistant, BEB Oil Company/Germany	*2/88 - 4/88*
CONSULTING	**Exxon Production Research,** Houston, TX	*5/91 - 8/91*
	Mobil Research, Princeton, NJ.	*8/94 - 10/94*
ANALYTICAL EXPERTISE	Gas Chromatography, spectrophotometry, ion chromatography, direct current plasma spectrometry, X-ray diffractometry, electron probe micro-analysis.	

TEACHING	Teaching Assistant, SUNY Stony Brook Teaching Assistant, Phillips-University/Germany	8/90 - 5/91 10/85 - 7/87
TRAINING	Training of visiting faculty, postdocs and junior graduate students in geochemical analysis of natural waters and carbonate minerals.	
AWARDS	Excellence of poster presentation: Society of Economic Paleontologists and Mineralogists, 1992 Annual Meeting Calgary Canada.	

PUBLICATIONS

REEDER, R.J., LAMBLE, G.M., LEE, J-F., and STAUDT, W.J. (1994). *Geochim. et Cosmochim. Acta,* Vol. **58**, 5639-5646.

STAUDT, W.J., REEDER, R.J., and SCHOONEN, M.A.A., (1993). *Geochim. et Cosmochim. Acta*, Vol. **58**, 2087-2098.

STAUDT, W.J., and SCHOONEN, M.A.A., (in press). *American Chemical Society:* "Geochemical Transformations of Sedimentary Sulfur."

STAUDT, W.J., SCHOONEN, M.A.A., and MEYERS, W.J. (submitted). *Journal of Sedimentary Research.*

PRESENTATIONS

STAUDT, W.J. and SCHOONEN, M.A.A., 1994. *American Chemical Society,* National Meeting. Washington, DC.

STAUDT, W.J., HEMMING, N.G., MEYERS, W.J., and SCHOONEN, M.A.A., 1994. *American Association of Petroleum Geologists,* Annual Convention, Denver.

STAUDT, W.J., REEDER, R.J., and SCHOONEN, M.A.A., 1993. *National Synchrotron Light Source annual Report.*

STAUDT, W.J., REEDER, R.J., and SCHOONEN, M.A.A., 1993. *Geological Society of America,* National Meeting, Boston.

STAUDT, W.J., OSWALD, E.J. and SCHOONEN, M.A.A., 1992. *American Association of Petroleum Geologists,* Annual Convention, Calgary.

OSWALD, E.J., PACKMOHR, B., STAUDT, W.J., SCHOONEN, M.A.A., REEDER, R.J. and MEYERS, W.J., 1992. *American Association of Petroleum Geologists,* Annual Convention, Calgary.

W. LANCE TURLEY, P.G.

Senior Hydrogeologist/Geophysicist

Areas of Expertise

project management, hydrogeologic investigation, expert witness testimony, geotechnical investigation, landfill site selection, ground-water monitoring network design, surface geophysics, borehole geophysics, remedial investigation, environmental property assessments, well field investigations, construction certification, environmental permitting, surface hydrology, administrative responsibilities

Education

Bachelor of Science in Geology, Central Missouri State University, Warrensburg, Missouri, 1985

Master of Science, Geology, University of Toledo, including a thesis titled "An Evaluation of the use of Surface Geophysics to Identify Selected Siting Criteria and Design Parameters for a Proposed Solid Waste Landfill in Richland County, Ohio," 1992.

Professional Experience

January 1989 - present: Sr. Hydrogeologist/Geophysicist, Hull & Associates, Inc.

January 1988 - January 1989: Hydrogeologist/Geophysicist, Hull & Associates, Inc.

October 1987 - December 1987: Geophysical Technician, Hull & Associates, Inc.

August 1985 - May 1987: Graduate Teaching Assistant, University of Toledo Geology Department

May 1981 - September 1981: Oil Field Driller's Assistant, Dotson & Son, Inc.

Honors

Order of Omega - National Undergraduate Honorary Society
Sigma Gamma Epsilon - National Honorary Society for Earth Sciences

Seminars and Training

OSHA 1910.120, 40-Hour Health and Safety training program, 1988 and Eight-hour Refresher Course, 1989-1995

OSHA 1910.20, Eight-Hour supervisors course, 1990

“Options for Texas”, Municipal Solid Waste Seminar, 1993, 1994, 1995

"Pollution Prevention Training Workshop on Preparing Source Reduction and Waste Minimization Plans", Texas Water Commission , 1992

"Government Environmental Contracting Seminar", Federal Publications, Inc., 1993

"Convex 92", Petroleum Equipment Institute, 1992

"Outdoor Action Conference", National Water Well Association, 1990

Basic training course on Radiation Safety and Use of Nuclear Gauges, 1988

Papers/ Publications

"Using Selected Geophysical Methods for Identifying Solid Waste Landfill Siting Criteria", Presentation at the 25th Annual Meeting of the North-Central Section of the Geological Society of America, April, 1991 (with Donald J. Stierman).

"Preliminary Risk Assessment for a Proposed Municipal Well Field", Presentation at the Ohio Section of the American Water Works Association's 57th Annual Convention, September, 1990 (with William Petruzzi).

"Investigation of a Leaking UST Near a Municipal Well Field", Presentation at Ohio's 14th Annual Inland Spills Conference, September, 1990.

"A Well Field Risk Assessment", Proceedings from the American Institute of Hydrology 1990 Spring Meeting - Minimizing Risk to the Hydrologic Environment, March, 1990 (with Kevin K. Wolka and William Petruzzi).

Professional Affiliations

Registered Professional Geologist - Kentucky
Registered Environmental Professional - Texas Registry of Environmental Professionals
National Ground Water Association
Association of Ground Water Scientists and Engineers
Air and Waste Management Association
American Society for Testing and Materials - Committee on Environmental Fates (and Biological Effects)

List of clients, references, and specific project histories available if requested.

W. LANCE TURLEY, P.G.
Senior Hydrogeologist/Geophysicist

KEY EXPERIENCE

Texas Voluntary Cleanup Program - Project Manager for Phase I and Phase II investigations at commercial and industrial facilities. Projects included identification of potential release mechanisms and source areas, delineation of soil and ground-water contamination, evaluation of qualitative risk, and recommendation of remedial approaches.

Environmental Property Assessments - Managed and participated in a number of assessments for property transfer, industrial property development and landfill expansion. Tasks include records research, client negotiations, field sampling and report documentation.

Remedial Design/Remedial Action - Project Hydrogeologist for the RD/RA at the South Municipal Well Superfund Site in Peterborough, New Hampshire. Project included: Pre-design field investigations, detailed design of Remedial Action, and oversight of Remedial Action activities. Duties included general project management of hydrogeologic activities, coordinating technical staff, interfacing with the U.S. EPA, contractor oversight and scheduling of field activities. Specific tasks included delineating VOC contamination in the vadose zone and ground water, conducting and interpreting long-duration pumping tests, participating in development of a vacuum extraction and ground-water sparging system, instituting and evaluating a ground-water extraction system (including ground-water flow modeling of multiple pumping scenarios), developing Environmental Monitoring Plans and preparing Work Plans and reports. (Project in progress.)

Litigation Support - Provided litigation support for plaintiff seeking recompense from insurance carriers for costs incurred remediating ground water at a federal Superfund site; primary testimony pertained to contaminant release mechanisms and volumes of contaminants having entered and discharged from the affected aquifer. Participated in field forensic studies, and provided reports and exhibits, and testimony in depositions and federal court.

Landfill Site Search and Development - Project Manager for a multi-phased hydrogeological evaluation of a 300 acre potential landfill site. Participated in feasibility studies to select a candidate site based on regional geology, transportation access and population distribution. Supervised developing a work plan for the exploratory assessment and preliminary monitoring of the site. Supervised drilling of numerous exploratory borings, installation of monitoring wells and piezometers, and completion of in-situ hydraulic conductivity studies. Interpreted collected data, made recommendations on site suitability, and prepared hydrogeologic study reports for Ohio EPA as part of the Permit-to-Install application. Participated in public information meetings and helped with incorporating hydrogeologic interpretations into engineering design of the landfill.

Geotechnical Investigation - Supervised drilling of geotechnical borings and USCS/vertical permeability analyses of soils for a landfill expansion. Interpreted results and made recommendations on the suitability of on-site soils for natural liner and construction material.

Hydrogeologic Characterization for Residual Waste Landfill Closure - Project manager for compilation of work plan and completion of field work for characterizing site stratigraphy and the ground-water flow regime at a captive industrial landfill. Completed a hydrogeologic report documenting findings and participated in planning and negotiations with Ohio EPA for characterization of leachate for landfill classification per OAC 3745-30.

Ground-Water Monitoring Network Design - Based on hydrogeologic characterization completed per OAC 3745-06, designed a ground-water monitoring network for a solid waste landfill situated above a multi-aquifer site. Incorporated hydrogeologic characterization and monitoring network design into a PTI for closure of an existing area and expansion of a new area.

Explosive Gas Planning and System Investigation - Completed hydrogeologic evaluations for numerous solid waste landfills, including formulation of geologic cross-section and ground-water flow maps and delineation of potential explosive gas migration pathways. Installed explosive gas monitoring probes and punchbar stations at several landfills and completed initial rounds of sampling and documentation.

Spill Remediation - Project manager for cleanup of a petroleum spill at a demolition landfill. Project included completing a remedial work plan, characterization of excavated contaminated soils, confirmation of cleanup based on statistically-based sampling plan, completion of a remediation report and direct correspondence with the client and Michigan DNR.

Treatment Plant Feasibility Study - Project manager for a hydrogeologic investigation to identify potential sources of VOC contamination and background concentrations relating to proposed treatment plant operation at a municipal well field. Development of the study included presentations at city council meetings. Study consisted of observation well installation and sampling, long-duration pumping test, flow and transport computer monitoring, and evaluation of potential air concerns for plant.

Well Field Impact Assessment- Used solute transport modeling and chemical and hydrogeologic data to determine potential impact of a localized contaminant plume from a solid waste landfill on a proposed municipal well field. The evaluation incorporated a human health risk assessment incorporating a standard Michigan and Federal guidelines.

Site Assessment for Leaking Underground Fuel Storage Tank - Project manager for conducting preliminary site review and soil gas testing. Developed plan for monitoring site, installed monitoring wells, and sampled water and soil for analytical testing. Submitted report with data summary and interpretations to Michigan DNR.

Municipal Well Field Upgrade- Reviewed local hydrogeology, conducted long-duration pump test at existing wells, installed upgrade well and established appropriate pumping rates for municipal well field.

Ground-water Modeling - Conducted initial flow modeling for UST cleanup sites for appropriate configuration of ground-water extraction systems.

Municipal Well Field Study - Determined the presence of transmissive fractures in limestone aquifer using gamma and caliper logging. Successfully established appropriate pump placement.

Seismic Survey - Conducted seismic refraction survey to determine lateral limits of fill, fill depth, base characteristics, and bedrock depth for a sanitary landfill. Conducted confirmation investigation showing accuracy of geophysical techniques.

Magnetometer Survey - Used a magnetometer on a pre-surveyed grid to locate abandoned oil wells at a proposed sanitary landfill expansion site. Arranged for proper abandonment of the wells through ODNR's Idle and Orphaned Oil/Gas Well program.

Remedial Action - Conducted field investigations and designed a remedial alternative for a leachate seep and destructive methane generation at a sanitary landfill.

Test Facility Certification - Supervised and participated in certifying the recompaction of clay for impermeable liners at a surface water test facility. Supervised data assimilation and report for the facility's certification.

ATTACHMENT C
REVISED SOP FOR FIELD GC ANALYSIS OF VOCS FOR THE IRM AT THE FORMER IMC MAGNETICS CORPORATION SITE IN WESTBURY, NEW YORK

Land Tech Remedial, Inc., Analytical Services

Standard Operating Procedure for Field Analysis of Volatile Aromatic and Chlorinated Compounds by Gas Chromatography

The purpose of this document is to outline the procedures employed by Land Tech Remedial, Inc's (LTR) Analytical Services for the analysis of volatile aromatic and chlorinated components by field gas chromatograpy.

Start-up Procedure

The gas chromatograph instrument performance check includes scrupulous cleaning of the photo-ionization detector lamp window, visual inspection of column, leak testing of connections, checking and setting of gas flow rates, setting of column temperature and integration parameters and replacement of the injector port septum. The analytical balance is calibrated using a certified 100 g weight, and the constant temperature water bath is set to 25° C and verified. All information including the temperature inside the lab and outside weather conditions are recorded.

GC Instrument Calibration

To assess potential contamination in the GC system, sample treatment, reagents and glassware, a method and a deionized water blank is run prior to initial calibration. The method blank determines if any components were retained on the column from a previous run, whereas the water blank is an aliquot of deionized water prepared and analyzed following the identical procedure used for samples. Blank runs are considered acceptable only if peak areas for target components are less than 50% of their respective detection limits.

Following method and water blanks, a three-point calibration curve, which covers the routine working range, is established. The slope and y-intercept of a first order linear regression of this calibration curve must lie within 20% of an established seven-point calibration, and must have a correlation coefficient of >0.95. Retention times of target components are determined and recorded for each standard run. An additional mid-point calibration standard is run after every tenth sample or daily (whichever is more frequent). Standard concentrations must lie within 20% of the accepted calibration value. Additional method and deionized water blanks are run after calibration standards and after samples with constituent concentrations above the calibrated linear range.

Sample Analysis

Each received sample is recorded by the analyst based on the sample ID, depth of sampling interval, and time of collection. Water samples are immediately placed in the constant temperature water bath for at least 30 minutes. A 10 cc disposable B & D luer lock syringe is then inserted through the septum to withdraw 10 cc of sample solution. The vial is kept in an inverted position and shaken thoroughly for 2 minutes. The vial, with 10 ml of headspace, is then returned to the water bath for at least 5 minutes to reach thermal and phase equilibrium. At the time of analysis, 100 uL of the sample gas phase are withdrawn using a gas-tight glass syringe, and directly injected into the column of the gas chromatograph. Soil samples are opened under the hood to prevent contamination of the laboratory's interior, and approximately 4 g (net weight) of sample are weighed into a tared 20 ml vial. About 10 ml of reagent grade methanol are added to the sample and the mixture shaken for two minutes. Using a disposable pipette, approximately 1 ml of the methanol extract is withdrawn and diluted with deionized water in a 40 ml screw cap septum vial and subsequently treated and analyzed using the same methodology as described above for a water sample. Exact weights of sample, methanol, and deionized water are recorded to ± 0.01 g and used to calculate the sample dilution factor.

After each run the sample chromatogram is carefully interpreted by the analyst and integration constraints for every target component are thoroughly evaluated. A hard copy and a computer data file is generated including the following information: Sample identification, client and project ID, date and time of analysis, operator, carrier gas flow rate, column temperature parameters and detector channel(s), column type, length and diameter, and temperature in the mobile lab and outside weather conditions.

Duplicate Sample Analysis: The reproducibility of sample runs is determined by the analysis of two aliquots of a single sample. Duplicate analysis is determined for at least 10% of samples run daily and serves as an internal check on sampling techniques, analytical accuracy, and precision.

External laboratory Confirmation: To detect any possible deviation from highest quality data, 5% of all field samples are sent to a certified laboratory for confirmatory analysis by GC or GC/MS.

APPENDIX E

Well Logs and Analytical Results for the Existing On-site Monitoring Wells

NMB
NMB (USA) Inc.

Reg

RECEIVED
2/20/96

File
NMB

February 13, 1996

Chittibabu Vasudevan, Ph.D., P.E.
Chief, Remedial Section A
Bureau of Eastern Remedial Action
Division of Hazardous waste Remediation
New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-7010

re: IMC Magnetics (I-30-043A)

Dear Dr. Vasudevan:

Pursuant to your request for additional information regarding ground-water monitoring wells at the 570 Main Street property, I have reviewed my files and am forwarding the following:

- a schematic showing the approximate locations of wells MW-1, MW-2, and MW-3;[1]
- summary geologic logs for each of the wells; and
- a table summarizing the results of sampling of various wells, including MW-1, MW-2, and MW-3; and

I note that all the above were provided to me by Anson Environmental Ltd. ("Anson") in the form I have forwarded them to you. The work was performed by Anson, and pre-dates my involvement in the project. This is, I believe, the entirety of non-privileged documents in my possession relating to these wells.

Please do not hesitate to call if you have any questions or require any additional information.

Sincerely,

Chris M. Rawnsley

CMR/cmr:enc.imcw017

cc: Marriane Mancino-Theide, Esq., P&M
Craig Kasper, P.E., HAI

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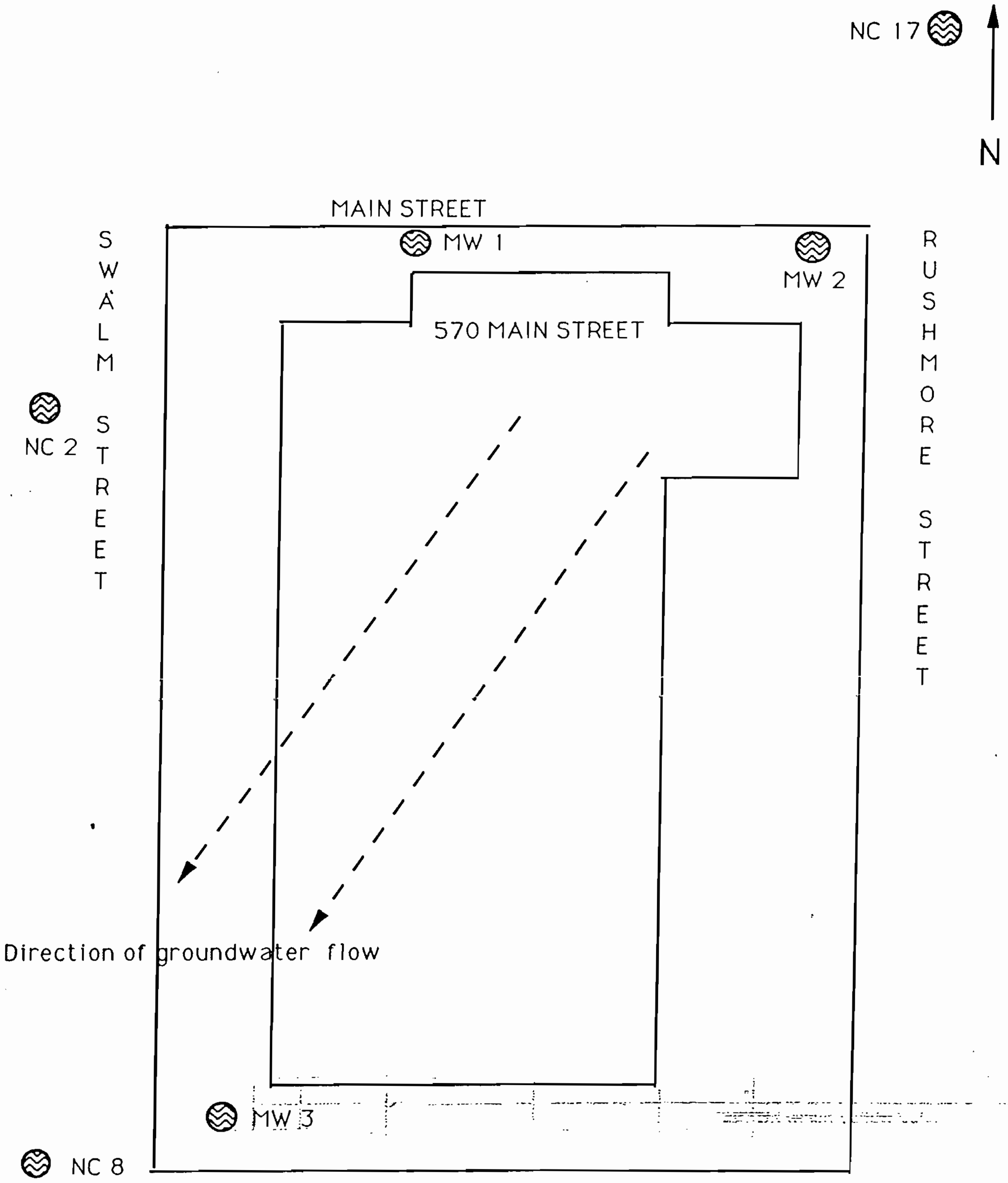
[1] The precise location should be included on the site survey included with IMC Magnetics' draft work plan.



NOT TO SCALE

● Sampling Locations

The reported direction of groundwater flow in the site vicinity is to the southwest

SAMPLING LOCATIONS

ANSON ENVIRONMENTAL LTD.

ANSON ENVIRONMENTAL LTD.

GEOLOGIC LOG

STUDY		BORING		SAMPLER
Study No.:	92061	**Boring No.:**	1	**Type: Hollow stem auger**
Project:	IMC Magnetics	**Location:**	Westbury	**Hammer:**
Date:	4/26/94	**Depth:**	65'	**Fall:**
Driller:	Miller Env.	**G.W. Elev.:**	55'	**Sample Interval: 5'**

No.	Rec.	Sample Interval	Blows/6"	Depth	Sample Description
1				0'	Yellowish brown color.
				-	sub rounded very coarse shape
				-	poorly sorted and very moist
				-	OVM reading = 0.00
				-	
				5'	Yellowish brown color
				-	sub rounded very coarse shape
				-	poorly sorted and very moist
				-	OVM reading = 0.00
				-	
				10'	Brownish yellow color
				-	sub rounded coarse
				-	well sorted some pebbles
				-	OVM reading = 0.00
				-	
				15'	Brownish yellow color
				-	sub rounded very coarse
				-	poorly sorted, some pebbles
				-	OVM reading = 0.00
				-	
				20'	Brownish yellow color
				-	sub rounded coarse shape
				-	poorly sorted, some pebbles
				-	OVM reading not detected
				-	
				25'	Brownish yellow color
				-	sub rounded shape
				-	well sorted, coarse to medium sand
				-	OVM reading not detected
				-	
				30'	Brownish yellow color
				-	sub rounded
				-	well sorted, coarse to medium sand
				-	OVM reading not detected
				-	
				35'	Brownish yellow color

					rounded shape
					well sorted, medium sized sand
					OVM reding not detected
				40'	Brownish yellow color
					rounded
					Poorly sorted, medium sand
					some clay
					OVM reading not detected
				45'	Brownish yellow color
					Round shape
					well sorted, medium sand
					OVM reading not detected
				50'	Brownish yellow color
					round shape
					well sorted, medium sand
					clay very hard, stuck to augers
					OVM reading not detected
				55'	Brownish yellow color
					Round shape
					well sorted, medium sand
					OVM reading not detected
				60'	Brownish yellow color
					Round shape
					well sorted, medium to coarse sand
					OVM reading not detected
				65'	Bottom of well

ANSON ENVIRONMENTAL LTD.

GEOLOGIC LOG

STUDY		BORING		SAMPLER
Study No.:	92061	**Boring No.:**	2	**Type: Hollow stem auger**
Project:	IMC Magnetics	**Location:**	Westbury	**Hammer:**
Date:	4/26/94	**Depth:**	65'	**Fall:**
Driller:	Miller Env.	**G.W. Elev.:**	55'	**Sample Interval: 5'**

No.	Rec.	Sample Interval	OVM Reading	Depth	Sample Description
2			0	0'	Light brownish yellow color
				-	poorly sorted
				-	medium sand and pebbles
				-	sub angular shape
				-	not very moist
			ND	5'	yellowish brown color
				-	poorly sorted
				-	very coarse sand
				-	sub angular shape
				-	
			ND	10'	yellowish brown color
				-	well sorted with pebbles
				-	medium to coarse sand
				-	sub angular shape
				-	some moisture
			ND	15'	Yelowish Brown color
				-	poorly sorted with pebbles
				-	very coarse sand
				-	sub angular shape
				-	some soil moisture
			ND	20'	Yellowish brown color
				-	poorly sorted with pebbles
				-	very coarse sand
				-	sub angular shape
				-	some soil moisture
			ND	25'	Brownish yellow color
				-	poorly sorted with pebbles
				-	very coarse to medium sand type
				-	sub rounded shape
				-	soil moisture
			ND	30'	Brownish yellow color
				-	well sorted with pebbles
				-	coarse to very coarse sand
				-	sub rounded shape
				-	soil moisture
			ND	35'	Brownish yellow color

					poorly sorted with pebbles
					very coarse sand
					sub rounded shape
					soil moisture
			ND	40'	Yellow color
					well sorted some pebbles
					medium to coarse sand
					sub rounded shape
					soil moisture
			ND	45'	Yellow color
					well sorted
					medium to fine sand
					sub rounded shape
					soil moisture
			ND	50'	Yellow color
					well sorted
					fine to very fine sand
					sub rounded shape
					soil moisture
			ND	55'	Yellow color
					well sorted
					fine to very fine sand
					sub rounded shape
					soil moisture
			ND	60'	Yellow color
					well sorted
					very fine sand
					sub rounded shape
					soil moisture
			ND	65'	bottom of well

ANSON ENVIRONMENTAL LTD.

GEOLOGIC LOG

STUDY		BORING		SAMPLER
Study No.:	92061	**Boring No.:**	3	**Type: Hollow stem auger**
Project:	IMC Magnetics	**Location:**	Westbury	**Hammer:**
Date:	4/27/94	**Depth:**	65'	**Fall:**
Driller:	Miller Env.	G.W. Elev.:	55'	**Sample Interval: 5'**

No.	Rec.	Sample Interval	OVM Reading	Depth	Sample Description
3			0	0'	Coarse sand
				-	Dark brown color
				-	some pebbles
				-	
				-	
			ND	5'	coarse sand
				-	yellow brown color
				-	pebbles, poorly sorted sand
				-	
				-	
			ND	10'	coarse sand, yellow brown color
				-	pebbles
				-	poorly sorted sand
				-	
				-	
			ND	15'	coarse sand
				-	dark yellow to brownish color
				-	some pebbles poorly sorted
				-	
				-	
			ND	20'	coarse sand
				-	yellowish brown color
				-	some pebbles poorly sorted sands
				-	
				-	
			ND	25'	coarse sand
				-	yellowish brown color
				-	some pebbles poorly sorted sands
				-	
				-	
			ND	30'	coarse sand
				-	dark yellow brown
				-	pebbles and poorly sorted
				-	
				-	
			ND	35'	coarse sand

					yellow brown color
					pebbles and poorly sorted
			ND	40'	coarse sand
					yellow brown color
					some pebbles and poorly sorted
			ND	45'	medium sand
					brownish yellow color
					well sorted
			ND	50'	medium sand
					brownish yellow color
					well sorted
			ND	55'	medium sand
					light yellow brown in color
					well sorted
			ND	60'	medium sand
					pale brown
					well sorted
			ND	65'	bottom of well

IMC Magnetics Corp.
570 Main Street
Westbury, NY

TABLE 1

	Concentrations in µg/L (ppb)						
	Upgradient Wells			**Downgradient Wells**			**NYSDEC-MCL**
Volatile Organic Compounds	**NC-17**	**MW 1**	**MW 2**	**NC2**	**NC8**	**MW 3**	**(ppb)**
Trichlorofluoromethane	ND	ND	ND	ND	ND	4	5
trans-1,2-Dichloroethene	ND	ND	ND	50	ND	ND	5*
cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	47	
Chloroform	ND	ND	ND	ND	ND	9	5
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	2	5
Trichloroethene	9	460	7	1500	48	52	5
Tetrachloroethene	3	140	8	780	49	71	5
Toluene	ND	ND	ND	ND	2	ND	5
Naphthalene	2	ND	ND	ND	ND	ND	50
Total Volatile Compounds	14	600	15	2330	99	185	
Inorganic Analysis		**Concentrations in mg/L (ppm)**					**(ppm)**
Arsenic	0.01	ND	ND	ND	0.008	0.015	0.025
Barium	0.17	0.092	0.074	0.079	0.21	0.46	1.00
Chromium	0.02	ND	ND	0.04	0.02	0.83	0.05
Mercury	0.002	ND	ND	0.0005	0.006	0.001	0.002
Lead	0.099	ND	ND	0.029	0.28	0.042	0.025

NYSDEC-MCL=New York State Department of Environmental Conservation Maximum Contaminant Level

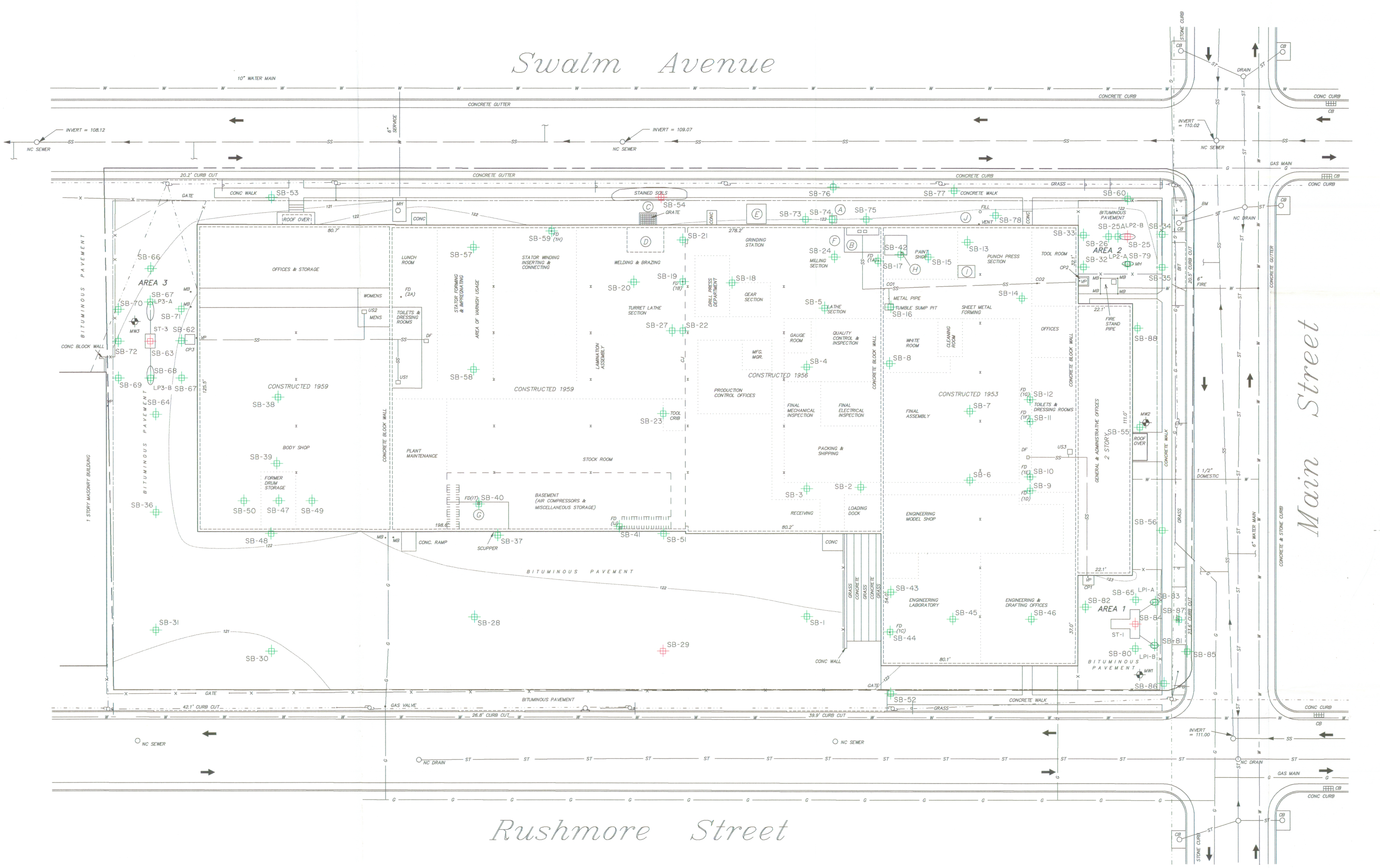
*=a total MCL for both cis and trans isomers together

Sampling performed May 6, 1994

cwa
2/13/96

APPENDIX F

Revised Sampling Location Map



LEGEND:

	UTILITY POLE WITH GUY WIRE
MB ●	METAL BUMPER
	HYDRANT
	TRAFFIC SIGN
CP1	CLEAN-OUT PIT FOR SANITARY SEWER
BIT	BITUMINOUS PAVEMENT
CO1	CLEAN-OUT
	MONITORING WELL
○ LP	LEACHING POOL
☐ ST	SEPTIC TANK
US1	UTILITY SINK
DF	DRINKING FOUNTAIN
VP	VENT PIPE
CB	CATCH BASIN
MH	MANHOLE
CJ	CONSTRUCTION JOINT
→	TRAFFIC FLOW
⊗	WATER VALVE
I •	COLUMNS
122	CONTOUR LINE
	OVERHEAD WIRES
ST	STORM SEWER
SS	SANITARY SEWER
G	GAS LINE
W	WATER LINE
	PROPERTY LINE
X	CHAIN LINK FENCE
NC SEWER	NEW CASTLE SANITARY SEWER
NC DRAIN	NEW CASTLE STORM SEWER
BM	BENCHMARK "⊡" CUT ON CATCH BASIN. ELEVATION = 121.59' NASSAN COUNY DATUM
MW-1	RIM ELEV. = 122.52' TOP OF RISER ELEV. = 121.98'
MW-2	RIM ELEV. = 122.65' TOP OF RISER ELEV. = 122.33'
MW-3	RIM ELEV. = 121.24' TOP OF RISER ELEV. = 120.84'
SB-1	GEOPROBE SAMPLING STATION.
SB-1	GEOPROBE LOCATIONS WHERE GROUND-WATER SAMPLES WERE COLLECTED.

ITEMS:

- Ⓐ FORMER LOCATION OF A 500-GALLON PERCHLOROETHYLENE STORAGE TANK
- Ⓑ FORMER CHEMICAL LAB
- Ⓒ FORMER TRANSFORMER VAULT ACCESS
- Ⓓ FORMER TRANSFORMER VAULT
- Ⓔ PAD-MOUNTED TRANSFORMER
- Ⓕ FORMER SOLVENT DEGREASING AREA
- Ⓖ FORMER HAZARDOUS MATERIAL STORAGE ROOM
- Ⓗ PAINT SPRAY BOOTH
- Ⓘ OVEN
- Ⓙ LOCATION OF UST

FLOOR DRAINS (FD):

1A DRY-WELL TYPE, BELIEVED TO BE A CONDENSATE DRAIN, OPEN BORE-HOLE FROM FORMER GEOPROBE NEXT TO THIS DRAIN.
1B DRY-WELL TYPE, OPEN BORE-HOLE FROM FORMER GEOPROBE IN AND NEXT TO DRAIN.
1C DRY-WELL TYPE
1D DRY-WELL TYPE, CURRENTLY A CONDENSATE DRAIN
1E DRY-WELL TYPE
1F DRY-WELL TYPE, BELIEVED TO BE A CONDENSATE DRAIN.
1G DRY-WELL TYPE, BELIEVED TO BE A CONDENSATE DRAIN
1H DRY-WELL TYPE
1I DRY-WELL TYPE, BASEMENT
1J DRY-WELL TYPE, BASEMENT
2A ACCESS TO GROUNDING CLAMP ON DOMESTIC WATER SUPPLY LINE

NOTES:

1. ALSO KNOWN AS LOTS 1 THRU 21 & 63 THRU 75 BLOCK 73 ON THE SECOND MAP OF NEW CASSEL.
2. ELEVATIONS REFER TO NASSAU COUNTY DATUM.
3. LOCATION OF UNDERGROUND UTILITIES COMPILED FROM AVILABLE RECORDS – NOT GUARANTEED.
4. GROSS PROPERTY AREA 85,000 SF, 1.951 AC.
5. LOCATIONS OF SEPTIC TANKS AND LEACHING POOLS IN AREAS 1, 2, AND 3 ARE ESTIMATED.
6. THIS DRAWING REPRODUCED FROM AN ELECTRONIC DRAWING FILE RECEIVED FROM IVAN CZIPOTT, P.L.S., HICKSVILLE, N.Y. IN SEPTEMBER 1995 TITLED "SURVEY OF SECTION 11, BLOCK 73, LOTS 1-21 & 63-65 NASSAU COUNTY LAND & TAX MAP". HAI MAKES NO GUARANTEES TO THE ACCURACY OF THIS DRAWING AND IT SHOULD BE USED FOR INFORMATIONAL PURPOSES ONLY.
7. ITEMS IN BLUE WERE OBTAINED FROM AN UNDATED IMC MAGNETICS OPERATIONAL SITE PLAN.

NMB\3030D009
06/04/96SCHOONOV

DRAFT

Hull & Associates, Inc.
6130 Wilcox Road
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LAYOUT	REVISIONS
DRAWN	
CHECKED	
SCALE 1" = 20'	NMB 004

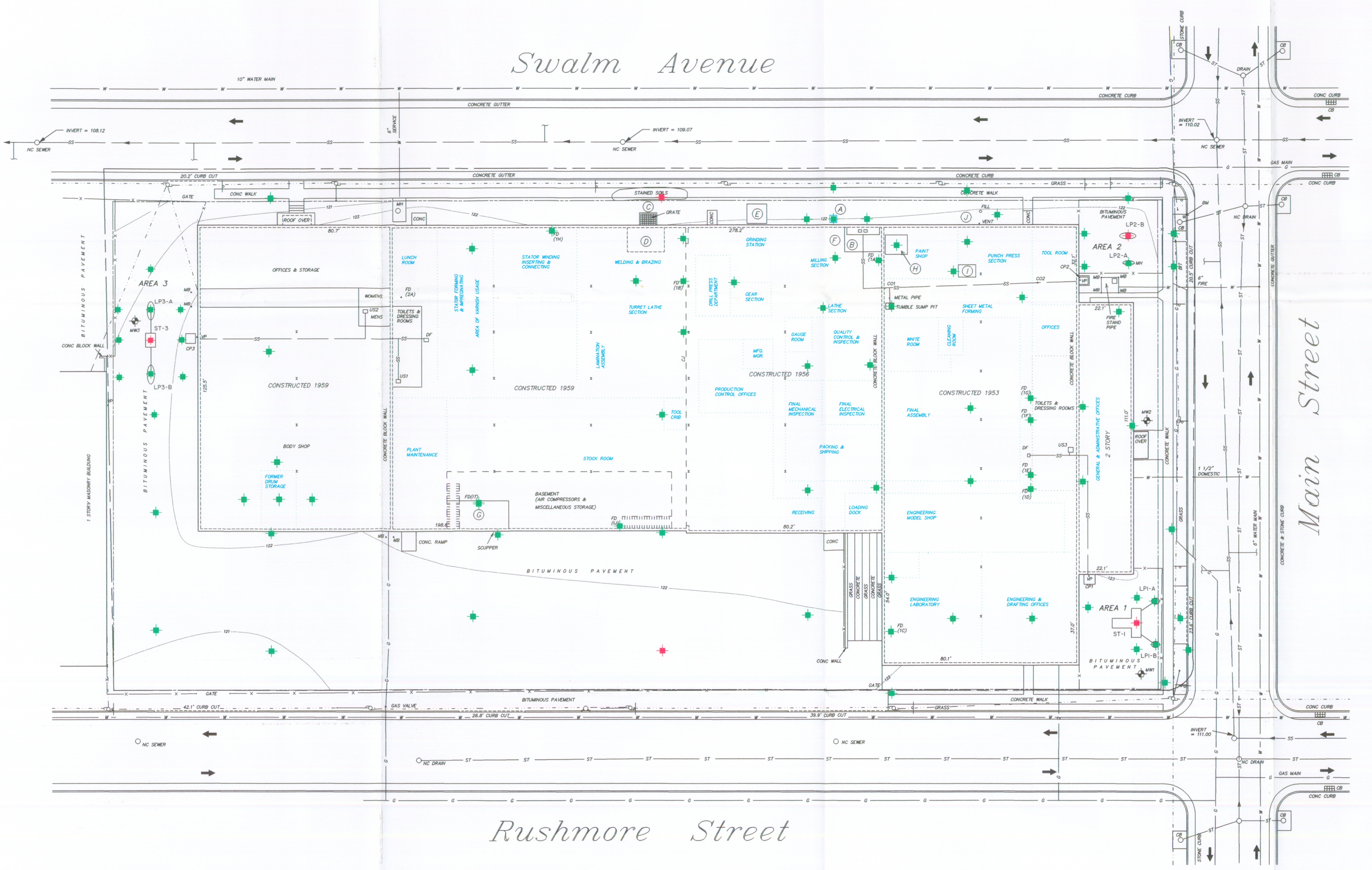
Hull & Associates, Inc.
Dublin, Ohio

FORMER IMC MAGNETICS CORP. MANUFACTURING FACILITY
INTERIM REMEDIAL MEASURE

SITE PLAN

WESTBURY, NEW YORK

DATE:
JUNE 1996



LEGEND:

	UTILITY POLE
MB ●	METAL BUMPER
	WITH GUY WIRE
	HYDRANT
	TRAFFIC SIGN
CP1	CLEAN-OUT PIT FOR SANITARY SEWER
BIT	BITUMINOUS PAVEMENT
CO1	CLEAN-OUT
	MONITORING WELL
○ LP	LEACHING POOL
□ ST	SEPTIC TANK
US1	UTILITY SINK
DF	DRINKING FOUNTAIN
VP	VENT PIPE
CB	CATCH BASIN
MH	MANHOLE
CJ	CONSTRUCTION JOINT
→	TRAFFIC FLOW
●	WATER VALVE
x ▪	COLUMNS
122	CONTOUR LINE
	OVERHEAD WIRES
ST	STORM SEWER
SS	SANITARY SEWER
G	GAS LINE
W	WATER LINE
	PROPERTY LINE
X	CHAIN LINK FENCE
NC SEWER	NEW CASTLE SANITARY SEWER
NC DRAIN	NEW CASTLE STORM SEWER
BM	BENCHMARK "□" CUT ON CATCH BASIN. ELEVATION = 121.59' NASSAU COUNY DATUM
MW-1	RIM ELEV. = 122.52' TOP OF RISER ELEV. = 121.98'
MW-2	RIM ELEV. = 122.65' TOP OF RISER ELEV. = 122.33'
MW-3	RIM ELEV. = 121.24' TOP OF RISER ELEV. = 120.84'
🟩	PROPOSED GEOPROBES SAMPLING STATION.
🟥	GEOPROBE LOCATIONS WHERE GROUND-WATER SAMPLES WILL BE COLLECTED. LOCATIONS MAY BE MODIFIED BASED ON FIELD OBSERVATIONS AND DATA.

LOCATIONS ARE APPROXIMATE AND MAY BE MODIFIED BASED ON STRUCTURES, UTILITIES, DIFFERING FIELD CONDITIONS, ETC.

ITEMS:

- Ⓐ FORMER LOCATION OF A 500-GALLON PERCHLOROETHYLENE STORAGE TANK
- Ⓑ FORMER CHEMICAL LAB
- Ⓒ FORMER TRANSFORMER VAULT ACCESS
- Ⓓ FORMER TRANSFORMER VAULT
- Ⓔ PAD-MOUNTED TRANSFORMER
- Ⓕ FORMER SOLVENT DEGREASING AREA
- Ⓖ FORMER HAZARDOUS MATERIAL STORAGE ROOM
- Ⓗ PAINT SPRAY BOOTH
- Ⓘ OVEN
- Ⓙ LOCATION OF UST

FLOOR DRAINS (FD):

1A	DRY-WELL TYPE, BELIEVED TO BE A CONDENSATE DRAIN, OPEN BORE-HOLE FROM FORMER GEOPROBE NEXT TO THIS DRAIN.
1B	DRY-WELL TYPE, OPEN BORE-HOLE FROM FORMER GEOPROBE IN AND NEXT TO DRAIN.
1C	DRY-WELL TYPE
1D	DRY-WELL TYPE, CURRENTLY A CONDENSATE DRAIN
1E	DRY-WELL TYPE
1F	DRY-WELL TYPE, BELIEVED TO BE A CONDENSATE DRAIN.
1G	DRY-WELL TYPE, BELIEVED TO BE A CONDENSATE DRAIN
1H	DRY-WELL TYPE
1I	DRY-WELL TYPE, BASEMENT
1J	DRY-WELL TYPE, BASEMENT
2A	ACCESS TO GROUNDING CLAMP ON DOMESTIC WATER SUPPLY LINE

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LAYOUT	REVISIONS
	3-19-96
DRAWN	
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SCALE 1" = 20'	NMB 004

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Dublin, Ohio

FORMER IMC MAGNETICS CORP. MANUFACTURING FACILITY
INTERIM REMEDIAL MEASURE

PROPOSED SAMPLING LOCATION SITE PLAN

WESTBURY, NEW YORK

DATE:
NOVEMBER 1995

NMB\3030D008
03/19/96 SCHOONOV