BCS

REPORT

Remedial Design Package

New York State Department of Environmental Conservation
Former Binghamton Plastics Site
Site No. 7-04-024

☒ Approved ☐ Approved As Noted ☐ Resubmit With Revisions ☐ Disapproved

COMMISSIONER OF ENVIRONMENTAL CONSERVATION

James A. Moss

Designated Representative

Date 4/1/02

Universal Instruments Corporation

Binghamton, New York

March 2002

BBL®
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

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Andrew N. Johnson, P.E.
New York Professional Engineer No. 058343

Universal Instruments Corporation

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1. Introduction

This Remedial Design (RD) Package has been prepared by Blasland, Bouck & Lee, Inc. (BBL) on behalf of Universal Instruments Corporation (Universal) for the former Binghamton Plastics Site in Binghamton, Broome County, New York (Site Number 7-04-024). This document provides the remedial design information that was specified in the *Remedial Design Work Plan* submitted to the New York State Department of Environmental Conservation (NYSDEC) on April 26, 2001 in accordance with the executed Order on Consent between Universal and the NYSDEC, dated January 19, 2001.

1.1 Purpose

This document summarizes the objectives for site remediation and provides detailed descriptions for implementation of the remedial action as described in the *Pre-Design Report* (BBL, February 2002). As discussed in the *Pre-Design Report*, the remedial action to address the groundwater plume will consist of removing soil and groundwater from the most affected areas of the site. There is no further action with respect to unsaturated soil at the site. Also included and/or discussed in the RD Package are the Operation & Maintenance (O&M) Program, Contingency Plan, site-specific Health and Safety Plan, and Citizen Participation Plan.

The remainder of this report is organized into the following sections:

- Section 2 - Scope of Work – Material and Performance Specifications
- Section 3 - Operation & Maintenance Program
- Section 4 - Contingency Plan
- Section 5 - Health and Safety Plan
- Section 6 - Citizen Participation Plan

Section 2 contains the technical specifications for the excavation of the upper portion of aquifer soil within the perched groundwater zone, as well as specifications for temporary monitoring points and replacement monitoring wells to be installed once the excavation work is complete. Section 3 presents the O&M Program, which describes the groundwater sampling procedures and frequency for assessing the effectiveness of the remedial action. The Contingency Plan is included as Section 4, which presents an alternative method for dewatering the perched zone in the event that the implemented remedy fails to achieve the objectives or otherwise fails to protect human health or the environment. The site-specific Health and Safety Plan is included as Section 5 and has been revised to include the new remediation tasks so that persons at and in the vicinity of the site during remedial action construction work and during the O&M phase of the remedial action will be protected. Section 6 contains the Citizen Participation Plan for the facility that will be used during the design and construction phases of the remedial program.

1.2 Location and Description of Work

The former Binghamton Plastics Facility is located at 498 Conklin Avenue in Binghamton, Broome County, New York. The site property is approximately 2 acres in size and consists of a one-story industrial building (44,800 ft^2) with associated parking, landscaping, and storage area. The site is located in an industrial/residential setting. Flextronics International, Inc. is the current owner of the property and leased the facility to McIntosh Laboratories from the early 1990s until August 2001. The building has since remained unoccupied. After the sale of the property to Flextronics International, Inc., Universal retained responsibility for

the remediation of pre-existing environmental conditions. Figure 1 shows the site location, and the site plan is presented on Figure 2.

The groundwater remedial action consists of excavating the main source areas of the contaminant of concern (COC) plume within the perched zone to remove residual contamination in the form of phase-separated hydrocarbons (PSH), absorbed volatile organic compounds (VOCs), and contaminated groundwater. Groundwater that drains from the excavated perched-zone soil during the remedial action or that accumulates in the open excavations will be removed for off-site treatment and disposal.

1.3 Goals

As stated in the *Remedial Design Work Plan* (BBL, 2001), the goals of the remedial program at the former Binghamton Plastics Site is to meet relevant NYSDEC's Standards, Criteria, and Guidance (SCGs) and to be protective of human health and the environment. Specifically, the goals selected for this site, as described in the ROD, are:

- Eliminate, to the extent practicable, the on-site presence/off-site migration of groundwater that does not attain NYSDEC Class GA Ambient Water Quality Criteria;
- Reduce, control, or eliminate, to the extent practical, contamination that may be present in the subsurface and may be acting as a source of releases to the groundwater; and
- Eliminate, to the extent practicable, exceedances of applicable environmental quality standards related to releases of contaminants that could eventually impact surface water.

To meet these goals through the proper application of scientific and engineering principles, the following objectives have been established for the remedial action:

- Recover and dispose of non-aqueous phase liquid (NAPL) and dissolved COCs on site, as determined during site investigation;
- Excavate and dispose of or treat adversely affected soil within the perched groundwater zone on site, as determined during site investigation;
- Enhance natural degradation of COCs remaining within the perched zone; and
- Protect human health and the environment through implementation, operation, and monitoring of the remedial program.

2. Scope of Work – Material and Performance Specifications

The scope of work to be performed entails the implementation of the remedial action for the chlorinated hydrocarbon-affected groundwater in the perched aquifer that is beneath a portion of the site. A contour map of groundwater elevations in the perched zone is shown on Figure 3. An isoconcentration map showing the extent of chlorinated hydrocarbon-affected groundwater in the perched zone is shown on Figure 4. The remedial action work will include:

- Abandonment of three wells within the excavation areas;
- Excavation of specified soil and removal of accumulated groundwater and PSH from the excavation;
- Off-site transportation and disposal of groundwater and hazardous soil excavated;
- Application of Hydrogen Releasing Compound (HRC®) to the bottom of the excavation;
- Site restoration to include compacted certified clean fill and asphalt batching of non-hazardous soil excavated; and
- Installation of two replacement wells and two temporary monitoring points.

Prior to the commencement of work, the area will be photographed to document pre-existing surface conditions at the site.

2.1 Applicable Remedial Standards

The remedial criteria applicable to this remedial action are found in the NYSDEC Soil Cleanup Objectives to Protect Groundwater Quality, dated January 24, 1994 (TAGM #4046) and in the NYSDEC Spill Technology and Remediation Series (STARS) #1, dated August 1992. Other relevant criteria for managing wastes generated during remedial activity include the Resource Conservation and Recovery Act (RCRA) hazardous characteristics. The RCRA characteristics analyses (ignitability, corrosivity, reactivity, and Toxicity Characteristic Leaching Procedure [TCLP]) will be used for waste profiling, waste characterization, and waste disposal activities.

2.2 Mobilization

2.2.1 Site Preparation, Decontamination, and Spill Control

During the site preparation, temporary decontamination areas will be constructed for use throughout the duration of the excavation and restoration phases of the project. These areas will be used to contain contaminated material to the designated work area. The decontamination areas will be located to the rear of the facility as shown on Figure 5.

2.2.2 Utility Location

Underground and overhead utility lines will be identified in these areas before excavation and will be avoided to practical extent. A sanitary sewer is known to run through the excavation area designated Excavation B. This sanitary sewer line extends from the building to the main sanitary line in the center of Chambers Street (see

Figures 2, 6, and 7). This sewer line will require capping at the building and at the street; with the sewer line replaced during site restoration activities.

2.2.3 Pre-Excavation Survey

Prior to the start of work, a level survey of the project area will be performed on a 25-foot by 25-foot grid. The survey will be used in conjunction with a post-excavation survey to determine the actual extent of the excavations and to calculate final removal volumes.

2.2.4 Site Security

Site security will be maintained throughout the duration of the project. Personnel and equipment entering and leaving the work zone will be controlled. Measures to prevent access to the excavation/work area until the completion of the project will be implemented. Fencing will be installed and signs posted around excavation areas to restrict access to active work areas and when work has been stopped or during nighttime hours.

2.3 Dust Control

The project site will be maintained so as to minimize the creation and dispersion of fugitive dust. The program for suppressing fugitive dust and monitoring particulate matter will follow NYSDEC's *Technical and Administrative Guidance Memorandum #4031: Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites.* (TAGM #4031). Dust control measures will be used throughout the course of the site work, as warranted. These measures will include:

- *Applying water to roadways and work area, as needed* – The water used for dust suppression will be free of oil and other deleterious materials. Standing water and collected rainwater may be used for dust control on areas within the active excavation areas, provided runoff is contained within the areas; and
- *Covering stockpiles with plastic sheeting* – The stockpile coverings will be properly overlapped and secured to prevent the plastic sheeting from being dislodged by high winds and rain.

Dust emissions will be visually monitored throughout the period of work. Particulate monitoring for fugitive dust will be performed using real-time particulate monitors that will have automatic alarms and will detect particulate matter less than 10 microns in diameter. Fugitive dust controls will immediately be implemented if conditions warrant.

2.4 Well Abandonment

Wells DMW-1, MW-5, and MW-15, which are located in the proposed excavation areas A and B, will be abandoned prior to any excavation work on the site (see Figure 6). The wells will be abandoned in accordance with NYSDEC regulations, as specified in NYCRR Part 360-2.11 (Solid Waste Management Facilities, Hydrogeologic Reports) and consistent with the Division of Environmental Remediation's guidance document, *Groundwater Monitoring Well Decommissioning Procedures (October, 1996).* The specific procedures shall be:

- Removal of the wellhead protective covers;
- Removal of casing from the borehole; and
- Pressure sealing of the borehole with cement-bentonite grout (using a tremie pipe and packer) to within 3 feet of the surface.

2.5 Soil Excavation

An approximate planned total of 542 cubic yards will be excavated from four areas outside the west wall of Addition 1 (1962) of the facility (Figure 6). Excavation A will be a 20-foot-wide by 67-foot-long area located along the southern part of the west building wall. This area includes well DMW-1, which has been found to contain floating oil/weathered oil in recent sampling events (BBL, 2002). Excavation B will be a 20-foot-wide by 41-foot-long area located along Chambers Street and includes wells MW-5 and MW-15, the two wells containing the highest concentrations of total dissolved site-specific parameter list (SSPL) VOCs during the September 18, 2001 sampling event (BBL, 2002). Figure 4 shows the SSPL plume map generated from the data from this sampling event. Excavations C and D are located to the north and southwest of Excavation A, respectively, and will address residual PSH found in test trenches that were dug during the remedial investigation (Shield, 2000). Table 1 shows the proposed depths, areas, and volumes of the excavation areas, which are also shown on Figure 6.

Table 1. Proposed Depths, Areas, and Volumes at Excavation Areas

Excavation ID	*Location ID*	*Proposed Excavation Depth*	*Approximate Areal Extent*	*Approximate Excavation Perimeter*	*Approximate Volume*
A	DMW-1	6 ft	1340 ft^2	174 ft	298 yd^3
B	MW-5, MW-15	6 ft	820 ft^2	122 ft	182 yd^3
C	Trench 4	6 ft	180 ft^2	54 ft	40 yd^3
D	Trench 2	6 ft	100 ft^2	40 ft	22 yd^3
				Total	542 yd^3
				Contingency Factor (20%)	108 yd^3
				Total Excavation Volume (rounded)	**650 yd^3**

All excavations will extend to an approximate depth of 6 feet. The top 2 to 3 feet of soil is anticipated to be clean and will be suitable for re-use as backfill. This soil will be stockpiled separately from soils excavated from below this depth. Soils excavated from deeper than 3 feet will be field screened. Soils from deeper than 3 feet that do not show evidence of contamination will be segregated separately from soils that do show evidence of contamination. Photoionization detectors (PID) equipped with a 10.6 eV and 11.8 eV lamps will be used to screen the excavated soil. The remaining soil from 3 to 6 fee below ground surface (bgs) is presumed to be affected by COCs, and will be segregated and stockpiled separately from other excavated soil.

2.5.1 Soil Removal Methods

All soil will be removed by means and methods proposed by the contractor. Hand digging may be required to avoid damaging underground utilities. All excavated material will be handled as potentially contaminated material. All excavated material will be staged onto a 40-mil thick liner and be covered by two layers of 6-mil thick plastic (see Section 2.5.3). The plastic cover will be maintained to prevent rainfall infiltration of the stockpiled soil and contaminated runoff from the staging area.

Excavation A will be excavated in three stages to preserve the structural stability of the building. The excavated area will not extend more than 25 feet along the building wall at any one time. Once the northern section of

Excavations A is excavated, it will be backfilled in a stepwise manner as described in Section 2.8 before proceeding on to the excavation of the middle section. Similarly, the middle section will be backfilled prior to excavating the southern section. The east walls of Excavation A and D will extend vertically to the base of the building footing, and then proceed with a 1:1 slope for the remainder of the excavation depth. To preserve the integrity of Chambers Street, the west wall of Excavation B will extend vertically to the base of the asphalt and continue with a 1:1 slope for the remainder of the excavation depth. All other walls of the excavation areas will extend vertically for the full 6-foot-depth.

2.5.2 Groundwater Removal

During the excavation work, groundwater and any PSH or oil that accumulates within the open excavations by the end of the workday and/or overnight will be removed from the open excavation. The groundwater and PSH will be removed by using a vacuum truck. Any liquid draining from stockpiled soils into the bermed containment around the soil stockpiles will also be removed by use of a vacuum truck. The anticipated volume of liquid to be generated is not expected to exceed 1,500 gallons. The vacuumed liquid will be transported to an off-site treatment, storage, and disposal (TSD) facility whenever the tanker truck is filled or at the end of excavation activities.

2.5.3 Stockpiling

Separate stockpiles of excavated soils will be maintained for the clean overburden soils and the deeper COC-affected soils. Both soil-types will be stockpiled within areas with approximate dimensions of 30 feet by 100 feet. These areas will be diked and lined with two layers of 6-mil polyethylene sheeting. They will be located at the southern end of the site. Stockpiled soils will be covered with plastic to mitigate VOC vapor emissions and wind erosion. Figure 5 shows the proposed soil stockpile locations.

2.5.4 Waste Classification Sampling

The stockpiles will be characterized for waste classification to satisfy the NYSDEC's requirements for determining hazardous waste. The waste classification samples will be analyzed for NYSDEC Analytical Services Protocol (ASP) VOCs and semi-volatile organic compounds (SVOCs) using the TCLP analysis method. The sampling results will also be used to satisfy asphalt batching and/or selected TSD facility requirements. Additional parameters may be analyzed if required by the TSD facility or by the approved asphalt-batching vendor.

Soil stockpile samples will be collected following the guidance in the NYSDEC's *STARS Memo #1* (Section VI(b)). The number of samples to be collected is estimated as follows (based on assumed stockpile volumes of 220 cubic yards of surface soil and 380 cubic yards of perched-zone soil):

- For the "Clean Overburden" Stockpile – five grab samples (four VOCs and one SVOC) and five composite samples (one VOC and four SVOCs) with the composite samples consisting of four subsamples collected from each quarter of the subdivided stockpile for SVOCs (each quarter of the stockpile to produce one SVOC composite) and the VOC composite comprised of a subsample from each quarter; and
- For the "Perched-Zone Soil" Stockpile – six grab samples (four VOCs and two SVOCs) and six composite samples (two VOCs and four SVOCs) with the composite samples consisting of four subsamples collected from each quarter of the subdivided stockpile for SVOCs (each quarter of the stockpile to produce one SVOC composite) and the two VOC composites comprised of four subsamples from each half of the stockpile.

Composite samples, for both VOC and SVOC analysis, will be collected as discrete grab samples in the field with the compositing procedure performed at the laboratory assigned to perform the TCLP analyses.

Because of space constraints with parking at the site (parking area to be staging location for soil stockpiles and onsite soil treatment, if performed), it may become necessary, if the site is scheduled to become occupied and active before remediation activities are completed, for waste classification sampling to be performed in advance of the excavation work by collecting soil samples in-situ. This would be necessary so that the turnaround for waste classification analytical results does not delay the disposition of contaminated soils and prolong the period whereby a possible site owner or tenant cannot use the parking area.

Soil that fails toxic characteristic analyses, such as the TCLP, will be classified as hazardous. Soils that pass toxic characteristic analyses but exceed NYSDEC soil cleanup objectives and levels (TAGM # 4046, *Determination of Soil Cleanup Objectives and Cleanup Levels*, Tables 1 and 2 or *STARS Memo #1*, Table 2) will be classified as non-hazardous. Soils that do not exceed the contaminant concentrations listed in TAGM #4046 or STARS Memo #1 will be classified as clean.

2.5.5 Post-Excavation Sampling

Once field personnel have determined through field assessment that the excavation limits are sufficient for the remediation objectives, post-excavation soil samples will be collected as grab samples from the top portion of the excavation area sidewalls at a depth coincident with 6 inches above the water table surface. Because the depths of the excavations will be below the water table, no bottom post-excavation samples will be collected. The post-excavation sample locations will be biased, based on field judgement, towards sidewall areas that are suspected to most likely contain residual contamination (NYSDEC, at its discretion, may collect split samples and/or sample the base of the excavations during post-excavation sampling). Table 2 below summarizes the post-excavation samples that will be collected from each excavation area:

Table 2. Post-Excavation Sampling

Excavation ID	*Number of Samples*	*Sample Prefix*
Excavation A	9	PX-A
Excavation B	10	PX-B
Excavation C	3	PX-C
Excavation D	2	PX-D

Initial post-excavation samples, which will be collected as disturbed samples from the excavator bucket, will also undergo a "visual" scan for residual PSH. These soil samples will be immersed in clean water to see if a sheen develops and will be tested with a hydrophobic dye (Sudan IV) to detect residual PSH. Soil samples that fail the "visual" PSH scan will be considered to indicate that further soil removal is needed in the area from which the sample was collected. Once initial post-excavation samples pass the "visual" scan for residual PSH, verification post-excavation soil samples will be collected for analysis of VOCs and base/neutral SVOCs.

A mobile laboratory, certified for field analyses in New York State will be on-site to perform VOC SSPL analysis (United States Environmental Protection Agency [USEPA] Method 8260) on the verification post-excavation soil samples, which will be collected as undisturbed grab samples. Additionally, verification post-excavation samples will be analyzed off site by a New York State-certified laboratory for base/neutrals using

USEPA Method 8270 and the TCLP to assess compliance with New York State groundwater protection requirements (NYSDEC, *STARS Memo #1*, 1992).

The excavations will be deemed suitable for backfill when soil sidewall sample analytical results for COCs do not exceed the NYSDEC standards for impact to groundwater and residual PSH is not detected, or when a physical impediment, such as a building foundation or road, is encountered.

2.5.6 Post-Excavation Survey

A New York State-licensed surveyor will survey the final excavation perimeter boundaries in order to record the precise locations on the base map of the area of concern. Excavation depths will be estimated using a graduated pole or staff. The locations and depths of collected post-excavation samples will be field documented using a tape measure and fixed site features. Surveying techniques will be based on generally accepted engineering practices and New York State requirements.

2.6 Disposition of Generated Material

The extracted groundwater and soil classified as hazardous waste, if any, will be loaded and transported off site for disposal. Non-hazardous soil that will not be treated onsite will also be transported offsite for treatment or disposal. Non-hazardous soil that is treated onsite (asphalt batching) will be reused onsite as an asphalt base product. Excavated soil that has been classified as clean will be retained on site for re-use as backfill material.

2.7 Soil Loading, Transportation, and Off-Site Disposal

The protocols for the loading and transport of hazardous and non-hazardous soil generated during the remediation are described in the following sections.

2.7.1 Vehicle Loading

The dump trailer, truck bed, or roll off box will be equipped with a watertight liner (6 mil minimum thickness polyethylene sheeting) prior to placing the excavated soils onto the transport vehicle. The plastic liner will cover the bottom and sidewalls of the dump trailer, truck bed, or roll off box such that the edges of the liner can be folded over the soil after the vehicle has been loaded. All transport vehicles will be equipped with watertight tarps or covers. Soils that temporarily accumulate in roll off boxes or staging areas prior to off-site transportation and disposal will be covered by a tarp, synthetic liner, or other appropriate cover.

All loading will be done in a manner to avoid incidental spillage of soil during movement outside the work area. In the case of any incidental spillage, the spilled soil will be recovered, and any contaminated soil removed. The soil should not mound above the side rails of the dump trailer or bed, and should be distributed evenly throughout the transport vehicle to avoid load shifting during transport.

Soil loading into trucks will occur on an asphalt-paved surface covered with a 40-mil thick liner so that any soil dropped or spilled during loading will not come in contact with a clean native ground surface. Soil spilled on the plastic will be removed with mechanical buckets, shovels, and/or brooms, as appropriate, and be placed back in the soil stockpile from which it was taken.

All soil transportation vehicles will be decontaminated prior to exiting the project site. This procedure will consist of pressure washing or steam cleaning the transport vehicles at a vehicle decontamination station. Decontamination will focus on the tires, undercarriages, and side rails of the transport vehicle.

All vehicle decontamination rinsates will be removed from the vehicle decontamination station as needed to prevent overflow of the removal sump. Vehicle decontamination rinsates will be managed as contaminated liquids, including drumming, labeling, and staging.

The vehicle/equipment/personnel decontamination area will be located within the site parking lot where the excavated soils are to be stockpiled and where vehicle loading will be performed. The decontamination area will be located between the stockpile/loading area and Chambers Street. Within this decontamination area, separate zones will be set up for decontamination of vehicles, equipment, and personnel so that workers not directly involved with vehicle loading and decontamination are not mixed with vehicles that are being decontaminated. The decontamination area will be consist of a bermed area lined with at least a 100-mil thick synthetic liner with ingress/egress points for vehicles (rounded berms to allow for vehicle traffic).

2.7.2 Vehicle Departure

After the loading is complete, the load will be covered and the vehicle inspected. The vehicle inspection will include:

- Freeboard (i.e., soil not mounded above the side rails of the sump trailer or bed);
- Proper closure and locking of the tailgate;
- Cleanliness of the transport vehicle, with particular emphasis on the tires, undercarriage, and side rails of the vehicle;
- Security of the tarp over the dump trailer or bed; and
- Appropriate federal and state labeling and placarding.

The inspection will be documented in an inspection checklist, which will provide space for a signature and comments or notations.

2.7.3 Bills of Lading and Manifests

A bill of lading will be prepared and completed for all non-hazardous waste transport vehicles prior to departing the project site. At least one copy of the completed bill of lading will be retained by the contractor and made part of the project records. One complete copy will also be provided to Universal. The original and any copies not retained by the contractor or Universal will be provided to the driver prior to departure. The disposal of non-hazardous waste will be confirmed with load and time tickets prepared by the disposal facility and submitted to Universal. Universal will be informed on a daily basis of the number of loads and total weight shipped off site.

A hazardous waste manifest will be prepared for all hazardous waste to be transported off site. Waste will be measured by weight. Complete copies of manifests will be provided to Universal prior to the vehicle leaving the site.

All bills of lading and hazardous waste manifests will be retained as part of the project records. Copies of hazardous waste manifests and bills of lading will be included in an Appendix to the Final Remediation Certification Report.

2.8 Earthwork

Once the post-excavation results have shown that no additional soil will need to be excavated and a post-excavation sample location survey has been completed, the excavation areas will be filled in with clean fill and the upper non-contaminated soils from the site. The excavation areas will be graded to approximately pre-excavation conditions. Additionally, HRC® will be applied to the bottom of the excavation to enhance natural biodegradation of remaining COCs within the perched groundwater plume.

2.8.1 Foundation Preparation

The foundation for the fill will be prepared by leveling the excavation base as best as is practical and having the first layer of fill leveled and rolled so that the surface materials of the foundation will be as compact and well-bonded with the subsequent layers of fill. All areas to be backfilled will be proof-rolled. Any areas that are noted to pump, deflect, or be unsuitably soft will be excavated and replaced with suitable material or stabilized by other means. Backfill will not be placed on peat, sludge, marsh deposits, topsoil, or any other organic or compressible strata, or on a frozen subgrade. The areas where fill will be placed will be clean and free of debris or standing water, ice, frozen ground, or soft zones.

Prior to backfilling, Area B will have a 6 mil polyethylene impermeable liner placed along the length of the western sidewall parallel to Chambers Street to prevent groundwater from intersecting the utility trench backfill at that location.

2.8.2 HRC® Application

After the excavation foundation has been prepared, HRC® will be placed in a mixture over the base of the excavation area. The HRC® will be heated and mixed to obtain a uniform consistency within containers before application. A total of 1,500 pounds of HRC® will be added to the excavations. Approximately 540 pounds of HRC® will be added to Excavation A, 780 pounds to Excavation B, and 90 pounds each to Excavations C and D.

HRC® will be mixed with fill material using a rough proportion of 5:1 HRC® (pounds) to fill material (cubic yards). This ratio translates to one bucket of HRC® to 6 cubic yards of fill material. Fill material will be placed in the excavator bucket (capacity 1 to 1.5 cubic yards) and HRC® will be added to the fill. The excavator will place the HRC® and fill material in the excavation and mix them together while spreading the mixture within the excavation.

A Material Safety Data Sheet (MSDS) for HRC® is included with the Health and Safety Plan (Appendix A).

2.8.3 Backfill

2.8.3.1 Material and Placement

Relatively low permeability soil, such as a silt with sand and fine gravel, will be used to replace the saturated soil removed from the approximately 2 to 6 feet bgs layer. This soil will be used to retard complete reformation of the perched groundwater zone. Clean soil removed from the surface of the excavations will be reused to complete the backfilling process. The fill material used will be consistent with the following specifications (similar to Soil Class E-1):

- 50% by weight passing the No. 120 sieve and 80% passing the No. 30 sieve;

- Fraction passing the No. 30 sieve shall have a minimum plasticity index of 15; and
- Minimum Atterburg liquid limit of 30.

The volumes of the reused surface soil and clean low-permeability replacement fill materials to be used are summarized in Table 3. These quantities are based on the assumption that impacted soil is encountered 2 feet bgs.

Table 3. Quantities of Native and Replacement Fill Material

Excavation ID	*Depth*	*Length of Excavation*	*Width of Excavation*	*Approximate Volume of Fill Material*	
				Surface soil	*Clean low-permeability soil*
A	0-2 ft bgs	67 ft	20 ft	100 yd^3	---
	2-6 ft bgs	67 ft	20 ft	---	200 yd^3
B	0-2 ft bgs	41 ft	22 ft	67 yd^3	---
	2-6 ft bgs	41 ft	22 ft	---	134 yd^3
C	0-2 ft bgs	15 ft	12 ft	13 yd^3	
	2-6 ft bgs	15 ft	12 ft		26 yd^3
D	0-2 ft bgs	10 ft	10 ft	8 yd^3	
	2-6 ft bgs	10 ft	10 ft		16 yd^3
			Total	188 yd^3	376 yd^3
			Contingency factor 20%	38 yd^3	75 yd^3
			Total Fill Volume (rounded)	**225 yd^3**	**450 yd^3**

Brush, roots, sod, organic matter, and other unsuitable materials will not be placed within the fill. All unsuitable items within the fill encountered during dumping or spreading will be removed and disposed. Soil fill will be spread in horizontal uniform lifts with each lift uniformly compacted. Fill will not be placed in any part of the work area until the area has been inspected. Loose lift thickness will not exceed 8 inches. Successive layers will not be placed until the layer under construction has been properly compacted.

The fill will be maintained and protected in a satisfactory condition at all times until final completion and acceptance of the work. Any rainwater entrapped in the depression after removal of soil will be removed and pumped to the ground surface.

When placing fill against an existing slope, the slope will be properly benched not more than 5 feet into the existing slope. When fill is placed within a completed section of an excavation, the fill will be stepped back within then excavation where the fill meets the face of the next section of soil to be removed within the excavation so that subsequent fill layer can be properly keyed into the existing fill during compaction activities.

2.8.3.2 Compaction

The load-bearing fill lifts will be compacted with appropriately heavy, properly ballasted compaction equipment. All compaction equipment will be suitable to the slope and area conditions of the project site. If necessary, hand-operated compaction equipment such as mechanical tampers will be used for working in confined areas.

Each lift of soil fill will be compacted to a minimum density of 92% of its maximum dry density as determined by the Modified Proctor Test (ASTM D1557). Field density and moisture content measurements of the fill will be performed at least once for every 100 cubic yards placed using nuclear density methods (ASTM D2922 and D3017).

At the end of each day's construction activities, completed lifts will be sealed by rolling with a rubber tired or smooth-drummed roller or by back dragging with a bulldozer. All open work areas will be covered with a minimum 6-mil plastic sheeting. Areas which do not meet density requirements or are unstable under the loading of compaction equipment will be corrected by appropriate moisture control, re-compaction, or removal and replacement with additional fill.

2.9 Well Installation

Once the excavation work has been completed, two replacement wells and two temporary monitoring points will be installed to monitor the migration of COCs after the excavation.

2.9.1 Monitoring Wells

Two new monitoring wells, MW-16 and MW-17, will be installed in Excavations B and A, respectively, to replace the wells that were abandoned for the excavation work. The new wells will be constructed of 2-inch diameter, scheduled 40 PVC with 10 feet of 0.020-slot screen and finished with flush-mounted protective covers. The new wells will be installed in a pilot boring drilled with a hollow-stem auger drill rig mounted on a truck. The hollow stem augers will have a 4.25-inch inner diameter and the casing and sand filter pack will be installed through the auger flights. The wells will have a 3-foot thick bentonite seal. The wellheads will be flush-mounted, 8-inch diameter well covers set in concrete. Drill cuttings will be containerized for off-site disposal.

The new monitoring wells will be developed after installation. The monitoring wells will be developed by pumping groundwater from the well at rate sufficient to stress the well but not sufficient to cause the well to go dry. The wells will be pumped until the discharged water appears clear. Once clear water is obtained field parameters (temperature, dissolved oxygen, conductivity, pH) will be checked for stabilization. The clear water discharge will be checked for turbidity. The wells will be considered developed when field parameters are stabilized and the well water turbidity is less than 50 nephlo-turbidity units (NTUs).

The specifications for the new wells are summarized in Table 4 (construction details are shown on Figure 8A), and their locations are shown on Figure 6.

2.9.2 Temporary Monitoring Points

Two temporary monitoring points, TMP-A and TMP-B (Figure 7), will be installed in the utility trench backfill, if possible, within Chambers Street to monitor for migration of COCs. Both will be constructed of one-inch-diameter, schedule 40 PVC with 5 feet of 0.020-slot screen, and finished with flush-mounted protective covers.

The points will be installed to a depth of 10 feet bgs using a direct-push rig equipped with a 2-inch-diameter push rod. The first four feet of each temporary point installation location will be manually dug using a hand auger or post-hole digger to clear the location for utility lines. A temporary PVC casing will be used to hold the upper part of the hole open should utility line trench backfill slough into the upper part of the borehole. The temporary monitoring points will have a 3-foot thick bentonite seal. The bentonite seal and sand filter pack will

be installed in the open borehole. The wellheads will be flush-mounted, 4-inch diameter well covers set in concrete. The temporary monitoring points will be installed on the eastern edge of the street to intersect the first occurrence of trench backfill for the sanitary, storm, and water supply lines running along the length of Chambers Street. The construction details of these points are shown on Figure 8B and their specifications summarized in Table 4.

Table 4. New Well and Monitoring Point Specifications

Well ID	Location	Material	Diameter	Depth	Length of Screen
MW-17	Excavation A	PVC	2 inch	15	10 ft
MW-16	Excavation B	PVC	2 inch	15	10 ft
TMP-A	Chambers Street	PVC	1-inch	10	5 ft
TMP-B	Chambers Street	PVC	1-inch	10	5 ft

2.10 Asphalt Batching

Excavated non-hazardous subsurface soil will be either asphalt batched off site at a plant that has been approved and authorized by the NYSDEC to accept such soils for use as aggregate in the asphaltic concrete production process or the soil will be treated on site using the cold-mix asphalt process. The cold-mix asphalt process has a generic Beneficial Use Determination (BUD) from the Spill Response Program. If the cold-mix asphalt process is used on site a NYSDEC-approved and authorized vendor will be selected to perform the process of mixing the soil with liquid asphalt emulsion. This process will be performed in the rear parking areas at the site where surface soils were previously stockpiled. The asphalt base product generated will be used to pave the areas to the north and west of the building and/or be used for repaving of the driveway and parking areas at Universal's Kirkwood North Facility.

2.11 Site Restoration and Demobilization

Any collected sediment from erosion control devices and structures will be removed and disposed. Any temporary utilities, facilities, and structures will be disconnected and removed. All on-site surfaces and facilities will be restored to pre-construction conditions, including:

- Access road;
- Landscaping;
- Paving and curbing;
- Fencing and gates;
- Utilities; and
- Structures.

A final cleaning will be performed, including removal of incidental construction debris, surplus materials, rubbish, and construction facilities from the work area. A certificate of decontamination will be prepared for each piece of equipment once the equipment has been decontaminated prior to leaving the site.

2.12 Remediation Certification Report

Upon completion of the remedial action for removal of source areas and groundwater plume "hotspots", a Remediation Certification Report will be prepared for submission to NYSDEC. This report will present a summary of the remedial work performed, including the following:

- A description of the aquifer/soil excavations performed including dimensions and locations, types of material removed, volumes of material removed, and air monitoring results;
- A description of the disposition of all soil and groundwater removed from the excavations including waste classification results, offsite disposal, onsite treatment, and onsite re-use;
- A description of monitoring well abandonment and replacement;
- A description of soil and groundwater sampling results including verification (post-excavation) sample results; and
- A description of site restoration including excavation backfill and asphalt paving.

Supporting documentation will include summary data tables, figures and plates, well construction logs, hazardous waste manifests and bills of lading, soil treatment certifications, laboratory analytical reports for soil and groundwater sampling, and photographic logs.

3. Monitoring Program

A groundwater monitoring program will be implemented to assess the effectiveness of the remedial action. COC concentrations will be evaluated for the reduction in SSPL concentrations, the magnitude of SSPL concentration reductions, and for overall mass reduction. Overall mass reduction will be evaluated by comparing historical parent compound concentrations to both new parent concentrations and breakdown product concentrations. Biodegradation parameters will also be part of the analytical testing protocol.

The selected groundwater monitoring wells that will be sampled during each groundwater monitoring event are: DMW-3, MW-8, MW-9, MW-10, MW-11, MW-14, MW-16 (new), MW-17 (new), TMP-A, and TMP-B. Groundwater levels will be checked in all monitoring wells.

3.1 Field Procedures

The field procedures to be used during the groundwater monitoring events will be consistent with the previously approved *Field Sampling and Analysis Plan* (FASP) and its two parts: the *Field Sampling Plan and Quality Assurance Project Plan* (QAPP) (Appendix A) that were included in the *Remedial Investigation/Feasibility Study Work Plan* (Shield Environmental, 1998) for this site.

Water levels within the monitoring wells will be measured with a Solinst water level meter equipped with a stainless steel probe and measuring tape graduated in engineering units to 0.01 foot. The selected monitoring wells and monitoring points to be sampled will be purged by low-flow methods using bladder pumps and Teflon®-lined polyethylene tubing was used to pass groundwater from the pump to the surface. Groundwater quality parameters (pH, dissolved oxygen, conductivity, temperature, turbidity, and oxygen reduction potential) will be measured with an Horiba U-22 water quality instrument with flow-through cell.

Groundwater samples will be collected using dedicated Teflon bailers for VOCs and dissolved gases and directly from the pump tubing for inorganic parameters. One duplicate sample, one field equipment decontamination blank, and one trip blank will be collected for each sampling event.

3.2 Groundwater Sampling and Reporting Schedule

Quarterly groundwater monitoring and sampling events will be performed initially for the first year after the remedial action to determine how much COC concentrations have been reduced and to assess whether any concentration rebound occurs. After the first year, groundwater monitoring will be performed on a semi-annual basis for the second year and annually, thereafter, until groundwater remediation is completed. Groundwater remediation will be considered completed when two consecutive rounds of sampling show that COCs in the groundwater are below the NYSDEC Groundwater Standards (Tables 1 and 2 of TAGM #4046 and NYCRR Part 703-5, Table 1).

Groundwater monitoring reports describing the groundwater sampling events will be submitted to NYSDEC semi-annually for the first year and annually thereafter. These reports will provide summaries of the groundwater monitoring and sampling results, comparison of the new data to previous data (for evaluation of VOC concentrations and mass), supporting documentation (well purging data, laboratory analytical reports), tabulated data, and figures (groundwater contour maps and COC isoconcentration maps).

3.3 Laboratory Analyses

All groundwater samples will be analyzed by a New York State-certified laboratory for SSPL VOCs using USEPA Method 8260B following Contract Laboratory Protocol Statement of Work, document OLM04.2, as modified by the NYSDEC ASP dated June 2000. The SSPL target VOCs are: tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethene (1,1-DCE), cis-1,2-dichloroethene (cis-1,2-DCE), total DCE, 1,1-dichloroethane (1,1-DCA), and vinyl chloride.

In addition, biodegradation/natural attenuation parameters will be included in the testing protocol. These parameters will include reduction/oxidation indicators, such as nitrate, sulfate, sulfide, chloride, dissolved iron (II), dissolved manganese, and alkalinity; and dissolved gas end products (methane, ethane, and ethene). The inorganic parameters and dissolved gases will be analyzed using the appropriate USEPA and SW-846 methods.

QA/QC samples, such as duplicates, field blanks, and trip blanks, will be analyzed for VOCs only. Data Usability Summary Reports (DUSRs) will be provided with the reporting of analytical results.

4. Contingency Plan

This section presents a groundwater Contingency Plan conceptual design for a groundwater pump and treat system for remediation of PSH and the dissolved-phase plume area within the perched groundwater zone.

The purpose of this Contingency Plan is to provide a preliminary design for:

- The basis for preparation of a groundwater extraction and treatment system construction package should the evaluation of the modified remedy show that the plume is not being reduced, controlled, nor mitigated to the extent practicable; and
- The requirements for submittal of a System Construction Package for groundwater extraction and treatment, which will contain construction specifications and a construction schedule for the system.

This contingent remedial action of groundwater extraction and treatment will only be implemented in the event that the aquifer "hotspot" excavation and in-situ bioremediation field study fail to demonstrate effectiveness in attaining the remedial action objectives for the site.

4.1 Goals

The goals of the Contingency Plan are the same as those of the overall groundwater remediation program as described in the ROD (see Section 6, page 8 of ROD). These remediation goals, in essence, are to meet the NYSDEC's SCGs for COCs and to be protective of human health and the environment. The specific goals of the Contingency Plan for this site are:

- To reduce, control, or eliminate, to the extent practicable, the COCs present in the groundwater beneath the site;
- To reduce, control, or eliminate, to the extent practicable, the migration off site of perched groundwater affected by VOCs;
- To eliminate, to the extent practicable, exceedances of applicable environmental quality standards related to groundwater; and
- To protect human health and the environment through implementation, operation, and monitoring of the groundwater extraction and treatment system described in this Contingency Plan.

4.2 Design for Pump and Treat Contingency

The full RD for the Contingency Plan groundwater extraction and treatment system, as contained in the design package, will include the following elements:

- Placement of extraction wells;
- Preliminary design and operational flow rates;
- Design mass-loading rates and effluent goals;
- Treatment technologies to be employed prior to surface water discharge; and
- Layout of the treatment works.

The objectives of the proposed groundwater hydraulics for the pump and treat system are to:

- Collect COC-affected groundwater from the downgradient edge of the dissolved-phase plume area and from the former source area to allow VOC removal with the goal of intercepting and controlling plume migration to prevent further downgradient movement within the limits of technical practicability;
- Discharge treated groundwater to surface water to minimize the potential for spreading groundwater impacts into unaffected areas; and
- Optimize the quantity of groundwater treated such that the environmental benefit of remediating the aquifer is not offset by energy usage and waste production.

The design of the proposed groundwater extraction and treatment system was performed using existing site data. The Construction Package will include additional and more detailed information about site-specific groundwater hydraulics.

4.2.1 Extraction Wells

The location of the groundwater extraction wells is consistent with the objectives stated above. The extraction wells will remove groundwater in downgradient and source area locations within the perched groundwater zone. These wells should extract groundwater at a rate sufficient to create a capture zone that will prevent dissolved-phase COCs from moving further downgradient of the existing leading edge of the plume at concentrations greater than the NYSDEC standards. The wells should serve to intercept groundwater throughout the vertical extent of the unconfined saturated interval within the perched zone as it approaches the well barrier thereby preventing the migration of the COCs further downgradient.

The extraction scheme should consist of a single row of three wells pumping at an average combined pumping rate between 1.5 to 3.0 gallons per minute (0.5 to 1.0 gpm average from each well) and to individual extraction wells acting independently, each pumping at an estimated rate of 0.5 gpm. These flow rates are preliminary and are based on the data available at this time. In order to control groundwater and create the capture zone described above, each extraction well will be constructed with a 6-inch-diameter casing with a screened interval 10 feet in length. Each of the extraction wells will be completed to a total depth of 15 feet.

The exact locations of the proposed groundwater extraction wells will be determined in the Construction Package, should this Contingency Plan be implemented. However, the single row of wells should be located along Chambers Street along the leading downgradient edge of the plume, and the independent extraction wells should be located near the facility building in the vicinity of monitoring well DMW-1.

4.2.2 Surface Water Discharge

The extracted groundwater will be discharged after treatment to surface water through the existing stormwater discharge system on the site. The discharge of treated groundwater to surface water would occur only after all of the substantive requirements of a State Pollutant Discharge Elimination System (SPDES) permit have been met and are in place. The groundwater will be discharged to surface water for the following reasons:

- Prevent uncontrolled spreading of the plume because of a lack of sufficient groundwater hydraulic data to confidently predict the ability of the subsurface to accept the treated water and to predict resulting changes in localized groundwater gradients;

- Prevent unpredicted groundwater movement resulting from iron precipitation in infiltration wells or trenches; and
- Discharge to the publicly-owned treatment works (POTW) is unfeasible because new permits for remediation wastewater cannot be issued due to POTW capacity limits.

4.3 Basis of Design Influent and Effluent

A Basis of Design for Influent and Effluent will be developed using the available groundwater quality data from 1999 to 2002. The anticipated influent concentrations will be developed using the following methodology:

- Compilation of the groundwater quality data;
- Identifying compounds which are most important to the design of the proposed treatment works;
- Evaluating the maximum and average concentrations of the identified compounds by location and frequency of detection within the immediate area anticipated to contribute COCs to groundwater captured by the extraction well network; and
- Developing anticipated dilution factors to address the flow from the complete set of extraction wells.

The Basis of Design Effluent will show the effluent requirements that are consistent with SPDES discharge requirements and/or New York Surface Water Quality Standards.

4.4 Proposed Process Flow

The proposed treatment system consists of five primary pieces of equipment:

- An oil-water separator;
- An equalization tank (also to be used to pre-treat groundwater for vinyl chloride using chemical oxidation if vinyl chloride concentrations in groundwater indicate pre-treatment is needed);
- A low-profile air stripper;
- Vapor phase granulated activated carbon adsorption (to treat the vapor exhaust from the low profile air stripper); and
- Liquid phase granulated activated carbon adsorption (to polish the wastewater discharge from the air stripper).

Pre-engineered, packaged systems will be evaluated and one will be selected for inclusion in the construction package based on the given site constraints; anticipated influent conditions; capital and operational costs; and operation, maintenance, and monitoring requirements. Assumptions used to develop the proposed design for the treatment system, in order to meet the effluent requirements, include the following:

- The treatment system will operate continuously, 24 hours per day, 7 days per week;
- No emergency backup power is required;
- No redundancy in treatment equipment, process pumps, or piping is required;
- Process pumps will deliver a constant rate of flow (i.e., variable speed drive pumps will not be provided); and
- The system is not designed to treat compounds other than those identified in this basis of design.

4.5 Construction Package Preparation and Submittal

The proposed contingent groundwater treatment system would be constructed on the site, within a pre-treatment building to provide security and to protect the system from natural elements. The proposed treatment system will receive water from five groundwater extraction wells at a normal combined flow rate of 4 gpm (12 gpm maximum). Groundwater pumped from the extraction wells will be conveyed to the groundwater treatment system through secondary containment underground piping. Water entering the treatment system will pass through an oil-water separator and then collect in a 500-gallon equalization tank. It will then be pumped directly to the inlet of the low-profile air stripper. Treated water will be pumped from the air stripper through two carbon vessels then returned through underground piping to a hookup with a stormwater discharge catch basin located at the site or within Chambers Street. Vapor exhaust from the low profile air stripper will be blown through three GAC vessels linked in a series.

The preparation of a Construction Package for the groundwater extraction and treatment system will begin upon the NYSDEC's written notification that the Contingency Plan must be implemented because of the failure of the aquifer "hotspot" removal action and the in-situ, enhanced bioremediation field trial to meet the remediation objectives of the ROD.

Technical specifications of the groundwater extraction and treatment system will be prepared to include a detailed engineering design of the selected remedial actions, the material and schedule of the associated equipment, controls, equipment enclosure, operational monitoring systems, manifold piping, etc. A detailed set of construction drawings will also be prepared to show site plans, well and equipment details, and sections of the proposed equipment and work. An O&M Program will be developed to monitor the progress of the remedial actions and maintain optimal performance of the remedial system. The site-specific Health and Safety Plan will be modified to include system construction, operations, and maintenance tasks for the protection of persons at and in the vicinity of the site during the construction and O&M of the remedial system. It will be prepared in accordance with 29 CFR 1910 by a certified health and safety professional.

The components described above will be compiled into the Groundwater Extraction and Treatment Construction Package, which will be submitted to the NYSDEC for review and comment. This Construction Package will include the following:

- Technical Specifications for each of the Construction Divisions used, such as General Requirements, Site Work, Concrete, Finishes, Equipment, Mechanical, and Electrical;
- A List of Drawings detailing the construction of the groundwater extraction and treatment system, including but not limited to, General Site Plan, Groundwater Extraction System – Plan Sections and Details, Groundwater Extraction System – Piping Plan and Details, Groundwater Treatment Plant – Foundation Plan (Sections and Details), Groundwater Treatment Plant – Building Plan (Sections and Details), Groundwater Treatment Plant – General Arrangement, Process Flow Diagram, Piping and Instrumentation Diagram, Electrical Schematic and Panel Schedule, Electrical Plan;
- An appendix containing catalog cuts for equipment specified in the Technical Specifications and Drawings; and
- The Construction Package will be prepared by and bear the signature and seal of a professional engineer who will certify that the design was prepared in accordance with the Order on Consent (NYSDEC, 2001) and the ROD (NYSDEC, 2000).

4.6 Schedule

Work to begin implementation of the Groundwater Contingency Plan for the Binghamton site will commence immediately upon notification by NYSDEC that the Plan shall be implemented. The deliverables and their dates of submission to the NYSDEC are listed below:

- Draft System Construction Package – 45 days after notification to implement Contingency Plan
- Final System Construction Package – 15 days after approval of draft System Construction Package
- Installation of Groundwater Extraction and Treatment System – 30 days (completion) after submission of Final System Construction Package
- System Start-up – 5 days after satisfactory completion of system installation

5. Health and Safety Plan

The existing Health and Safety Plan will be revised to include the new on-site work tasks associated with the remedial action. The revised Health and Safety Plan will describe the policies and procedures to be followed by employees of BBL during implementation of the remedial action at the site. Activities to be performed by BBL will include:

- Observation and supervision of excavation work;
- Observation and supervision of soil stockpiling work;
- Observation and supervision of well abandonment work;
- Observation and supervision of well installation work;
- Collection of post-excavation and soil stockpile samples;
- Observation and supervision of soil loading and/or soil treatment;
- Observation and supervision of site restoration; and
- Other site activities as Universal's representative.

The objective of the Health and Safety Plan is to provide a mechanism for establishing safe working conditions for BBL personnel. Employees of subcontracted companies must work in accordance with their own independent Health and Safety Plan, which must comply with BBL's health and safety standards and requirements.

The Health and Safety Plan provides for a safety organization, procedures, and protective equipment that have been established based on an analysis of potential physical, chemical, and biological hazards. Specific hazard control methodologies have been evaluated and selected to minimize potential accidents or injuries.

A copy of the revised Health and Safety Plan is included as Appendix B.

6. Citizen Participation Plan

The Citizen Participation Plan will include the appropriate activities outlined in the NYSDEC's publication entitled "Citizen Participation in New York's Hazardous Waste Site Remediation Program: A Guide Book" (June 1998) and any subsequent revisions, and 6 NYCRR Part 375-1.5. The NYSDEC will is responsible for coordinating and implementing the Citizen Participation Plan. This section provides a brief summary of the Citizen Participation Plan activities that will take place as a part of the remedial action.

During the remedial investigation, a number of Citizen Participation activities were undertaken to inform and educate the public about conditions at the site and the potential remedial alternatives, including establishing a repository of documents pertaining to the site and a compiling a site mailing list that included nearby property owners, local political, officials, local media, and other interested parties. These activities will help continue the Citizen Participation activities that will be undertaken during the implementation of the remedial action at the site described in this document.

The Citizen Participation activities for the remedial action will be coordinated by the NYSDEC, and will include:

- Maintaining the document repository;
- Preparing a Fact Sheet that will be sent to the site mailing list prior to implementation of the remedial design to describe and announce the initiation of the remedial action at the site, including a summary of the NYSDEC's reasons for selecting it over other alternatives it considered and of the construction and operation requirements of that proposed remedy; and
- Holding a public meeting or public availability session, if determined to be necessary, at or near the site to provide an opportunity for the submission of oral comments on the remedial design. The NYSDEC will summarize the comments received at the public meeting and make the summary available to the public.

Once implementation of the remedial design is complete, providing to the site mailing list a notice and brief analysis of the remedy selected for implementation that includes a discussion of any significant changes from the proposed remedy as made available under the Fact Sheet, and a response to each of the significant comments, criticisms, and new data submitted to the NYSDEC.

7. References

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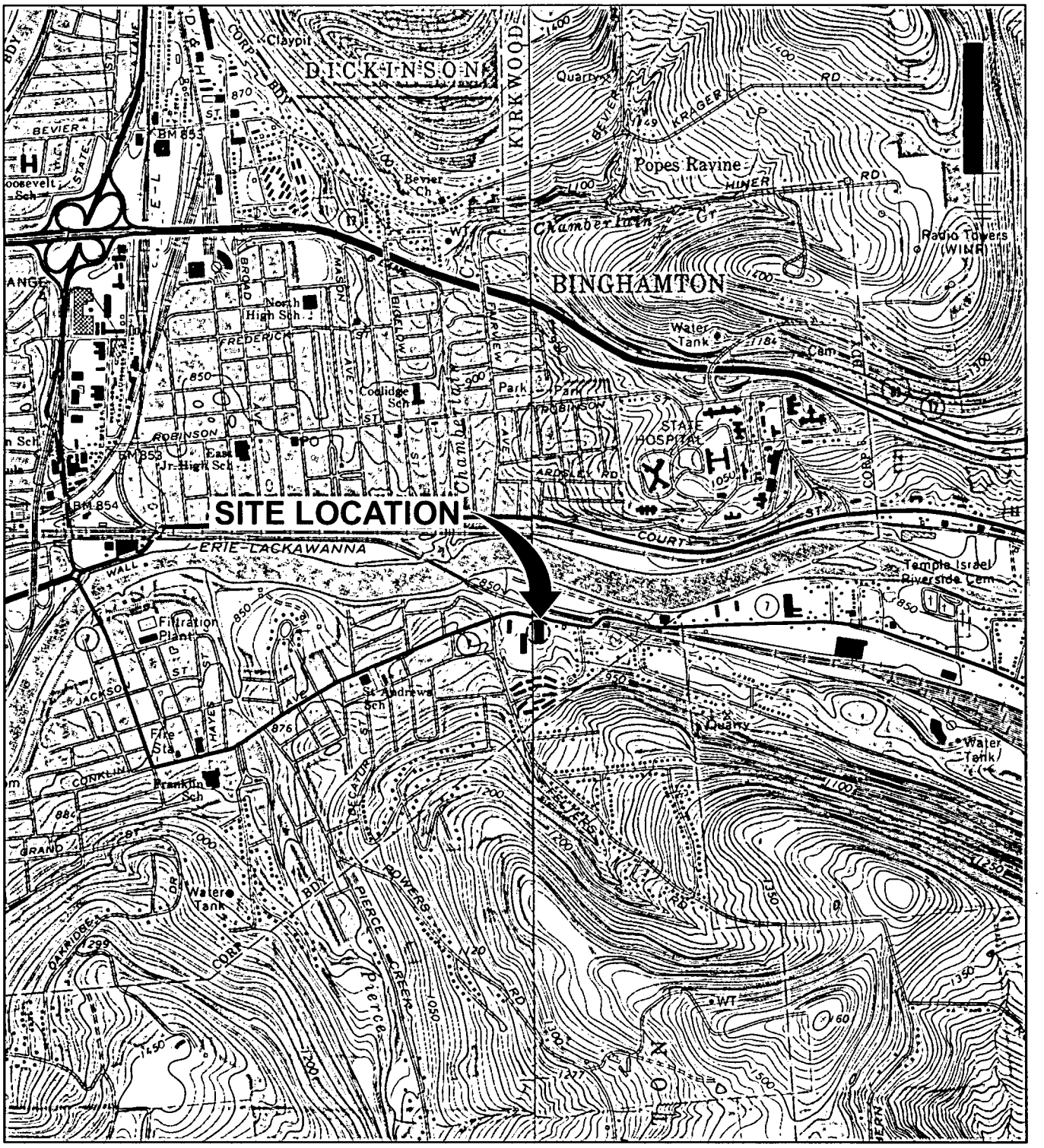
Shield Environmental Associates, Inc. October 1998. *Remedial Investigation and Feasibility Study Work Plan: Dovatron International, Former Binghamton Plastics Site.* Lexington, Kentucky.

Shield Environmental Associates, Inc. June 2000. *Remedial Investigation and Feasibility Study Reports: Dovatron International, Former Binghamton Plastics Site.* Lexington, Kentucky.

Figures



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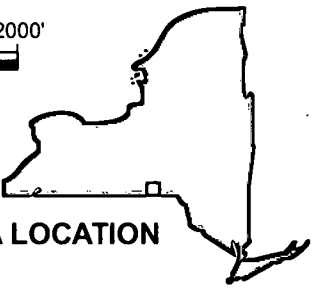


AREA LOCATION

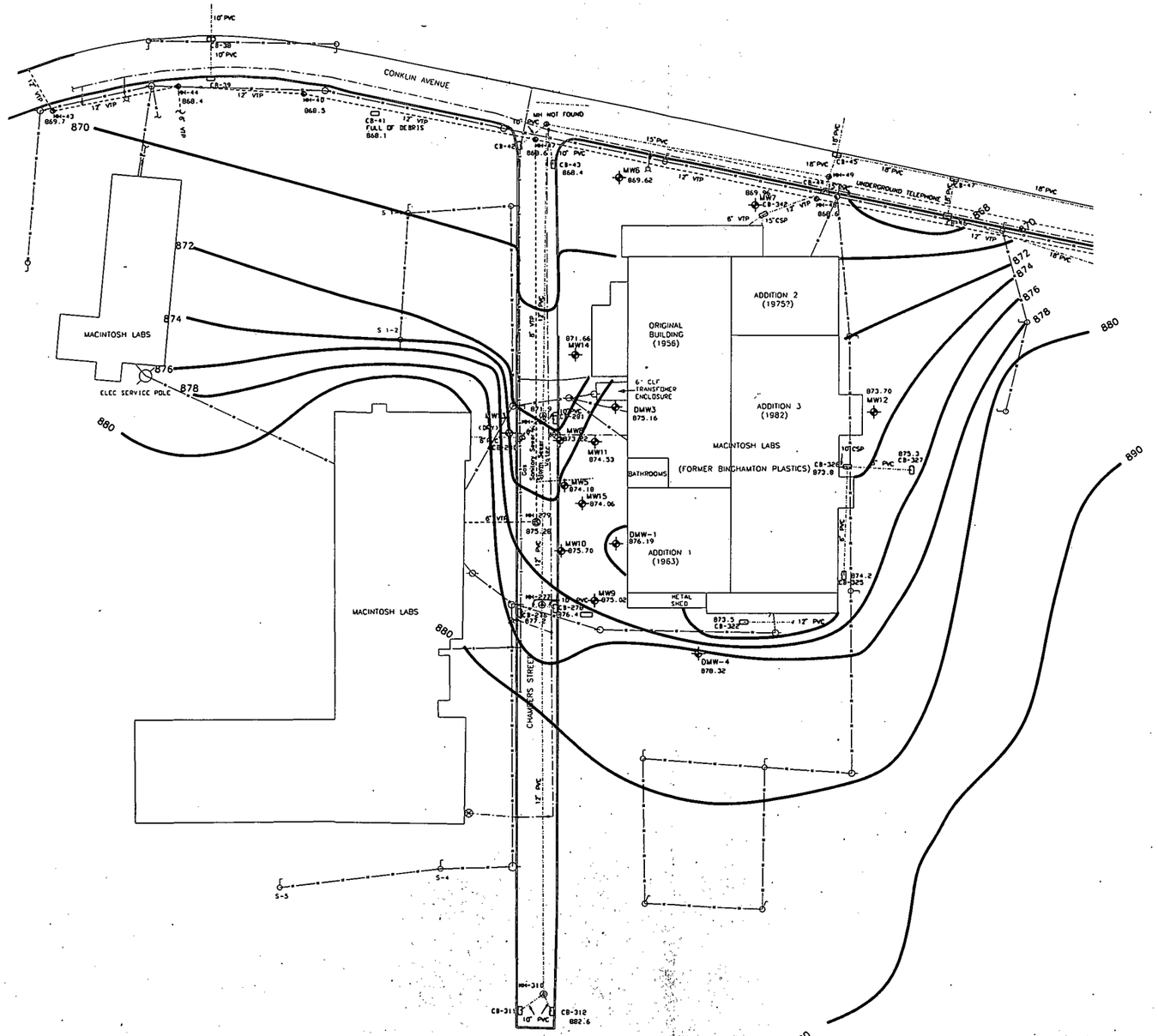
UNIVERSAL INSTRUMENTS CORPORATION
BINGHAMTON, NEW YORK

LOCATION MAP

BBL BLASLAND, BOUCK & LEE, INC. *engineers & scientists*

FIGURE 1

02/19/02 CRA-54-IY
05202006/05202n01.cdr



LEGEND

- UTILITY POLE
- UTILITY POLE W/LIGHT
- 873.32 MONITORING WELL W/ELEVATION
- 875.2 STORM MANHOLE W/ELEVATION
- 882.6 CATCH BASIN W/ELEVATION
- 868.5 SANITARY MANHOLE W/ELEVATION
- POST INDICATOR VALVE
- HYDRANT
- WATER VALVE
- GAS VALVE

NOTE:

THIS DRAWING TAKEN FROM PLATE 1 OF THE REMEDIAL INVESTIGATION REPORT DATED JUNE 2000 BY SHIELD ENVIRONMENTAL ASSOCIATES, INC. LEXINGTON, KENTUCKY.

0 50' 100'

GRAPHIC SCALE

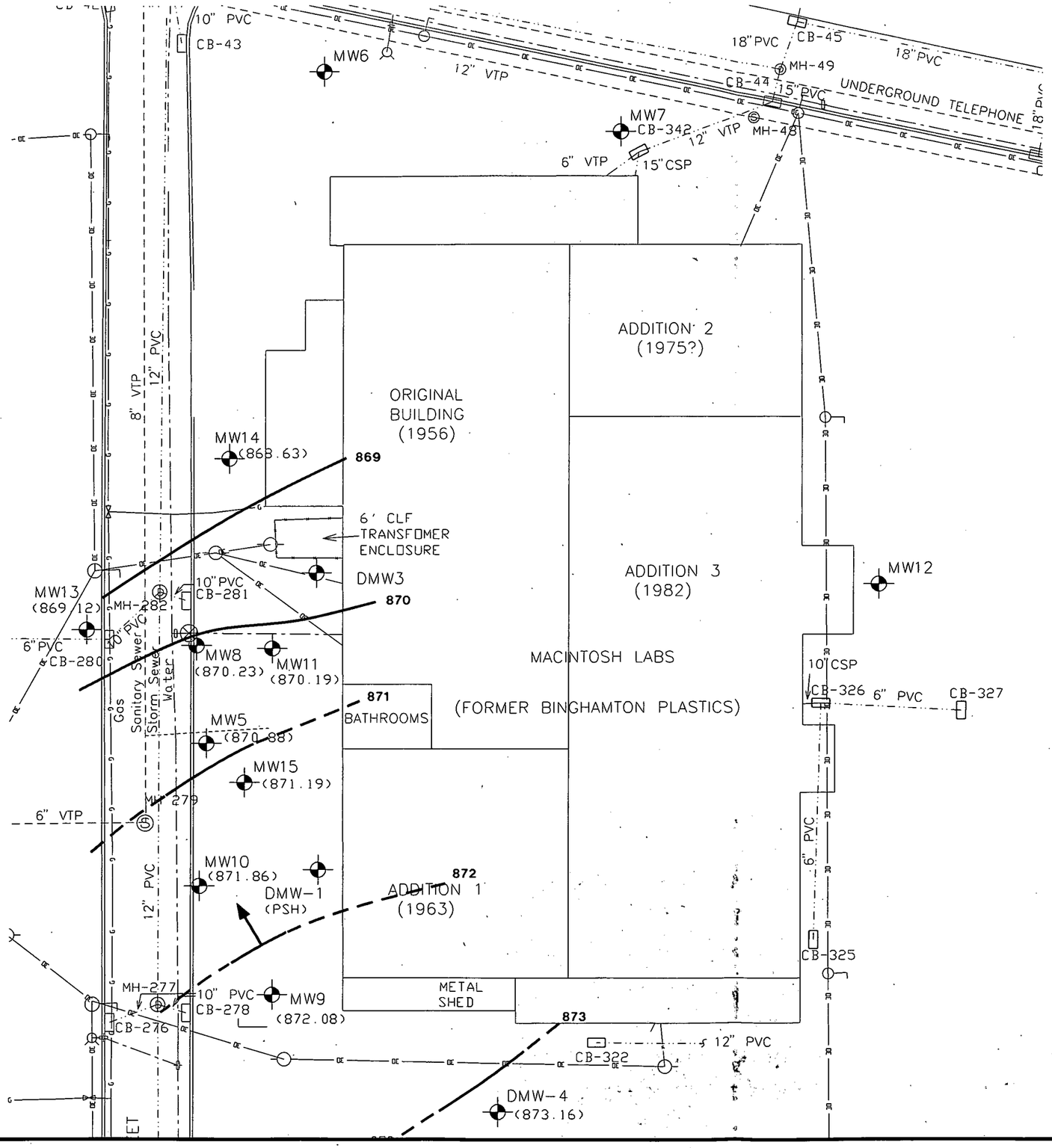
UNIVERSAL INSTRUMENTS CORPORATION
BINGHAMTON, NEW YORK
REMEDIAL DESIGN PACKAGE

EXISTING SITE TOPOGRAPHIC MAP

BBL®
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

FIGURE 2

X:
L: REF=OFF
P: PAGESET/PLT-DL
02/13/02 CRA-54-1Y
05202006/05202B03.DWG



LEGEND

- GROUNDWATER CONTOUR LINE WITH FLOW DIRECTION (DASHED WHERE INFERRED)
- UTILITY POLE
- UTILITY POLE W/LIGHT
- MONITORING WELL
- STORM MANHOLE
- CATCH BASIN
- SANITARY MANHOLE
- POST INDICATOR VALVE
- HYDRANT
- WATER VALVE
- GAS VALVE

PSH PHASE SEPARATED HYDROCARBONS

NOTE:

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0 20' 40'
GRAPHIC SCALE

UNIVERSAL INSTRUMENTS CORPORATION
BINGHAMTON, NEW YORK
REMEDIAL DESIGN PACKAGE

PERCHED GROUNDWATER CONTOUR MAP SEPTEMBER 18, 2001

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 3

X:
L: OFF=REF,SB
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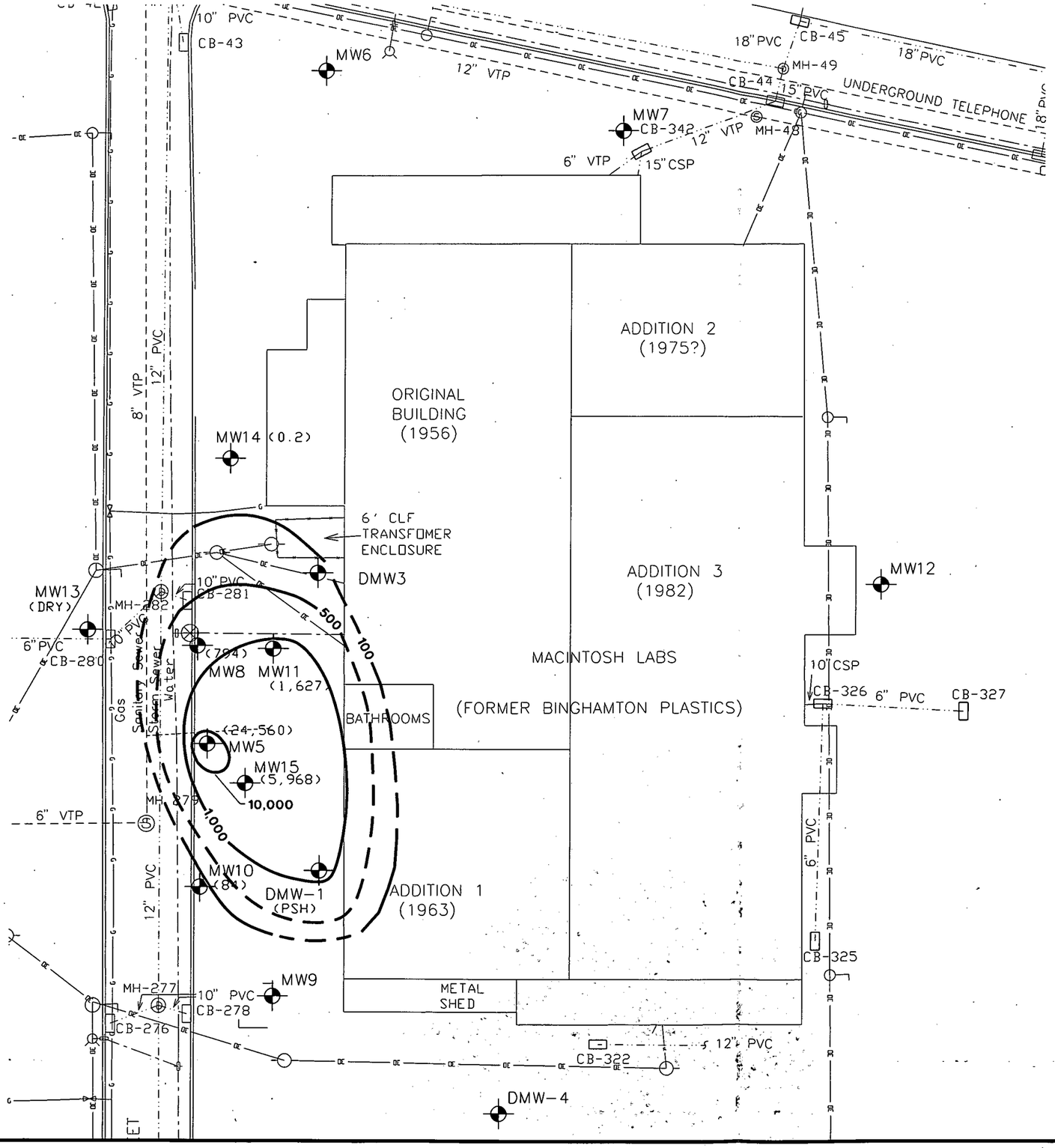
02/19/02 CRA-54-IY, TLF, IY
05202006/05202WD1.DWG



X:
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05202006/05202C01.DWG

LEGEND

500 — TOTAL SSPL CONCENTRATION CONTOUR LINE

(794) TOTAL SSPL CONCENTRATION IN MICROGRAM PER LITER (ug/L)

- UTILITY POLE
- UTILITY POLE W/LIGHT
- MONITORING WELL
- STORM MANHOLE
- CATCH BASIN
- SANITARY MANHOLE
- POST INDICATOR VALVE
- HYDRANT
- WATER VALVE
- GAS VALVE

NOTE:

THIS DRAWING TAKEN FROM PLATE 1 OF THE REMEDIAL INVESTIGATION REPORT DATED JUNE 2000 BY SHIELD ENVIRONMENTAL ASSOCIATES, INC. LEXINGTON, KENTUCKY.

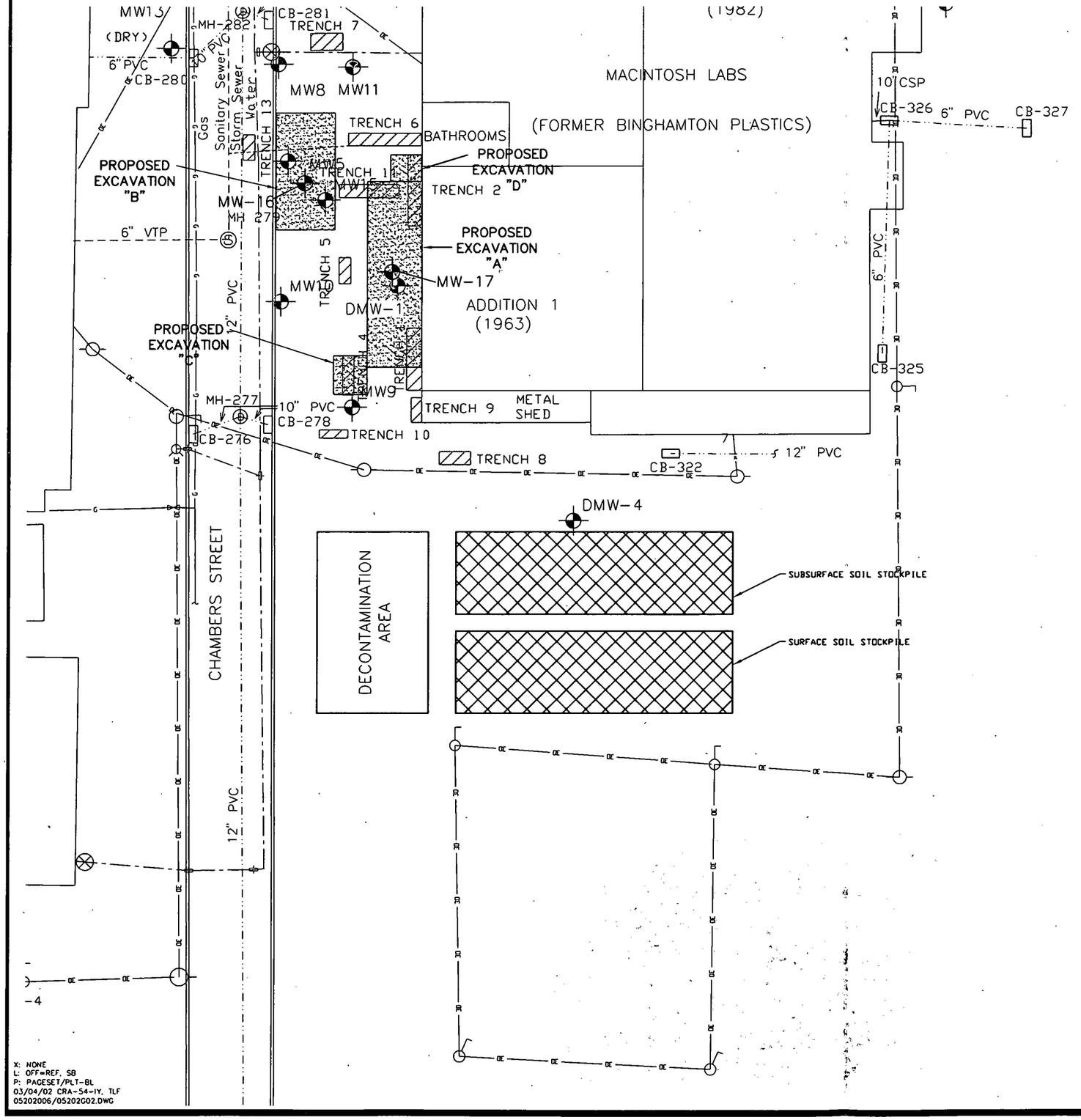
0 20' 40'
GRAPHIC SCALE

UNIVERSAL INSTRUMENTS CORPORATION
BINGHAMTON, NEW YORK
REMEDIAL DESIGN PACKAGE

PERCHED GROUNDWATER SSPL ISOPLETH MAP SEPTEMBER 18, 2001

BBL® BLASLAND, BOUCK & LEE, INC. engineers & scientists

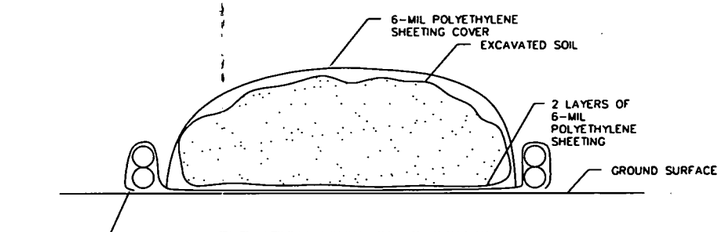
FIGURE 4



X: NONE
L: OFF=REF, SB
P: PAGESET/PLT-BL
03/04/02 CRA-54-IY, TLF
05202006/05202G02.DWG

LEGEND

- UTILITY POLE
- UTILITY POLE W/LIGHT
- MONITORING WELL
- STORM MANHOLE
- CATCH BASIN
- SANITARY MANHOLE
- POST INDICATOR VALVE
- HYDRANT
- WATER VALVE
- GAS VALVE
- PROPOSED TEMPORARY MONITORING POINTS
- PROPOSED EXCAVATION AREAS
- FORMER TRENCHES
- PROPOSED SOIL STOCKPILE LOCATIONS
- PROPOSED MONITORING WELLS



ELEVATION VIEW OF STOCKPILE
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NOTE:

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GRAPHIC SCALE

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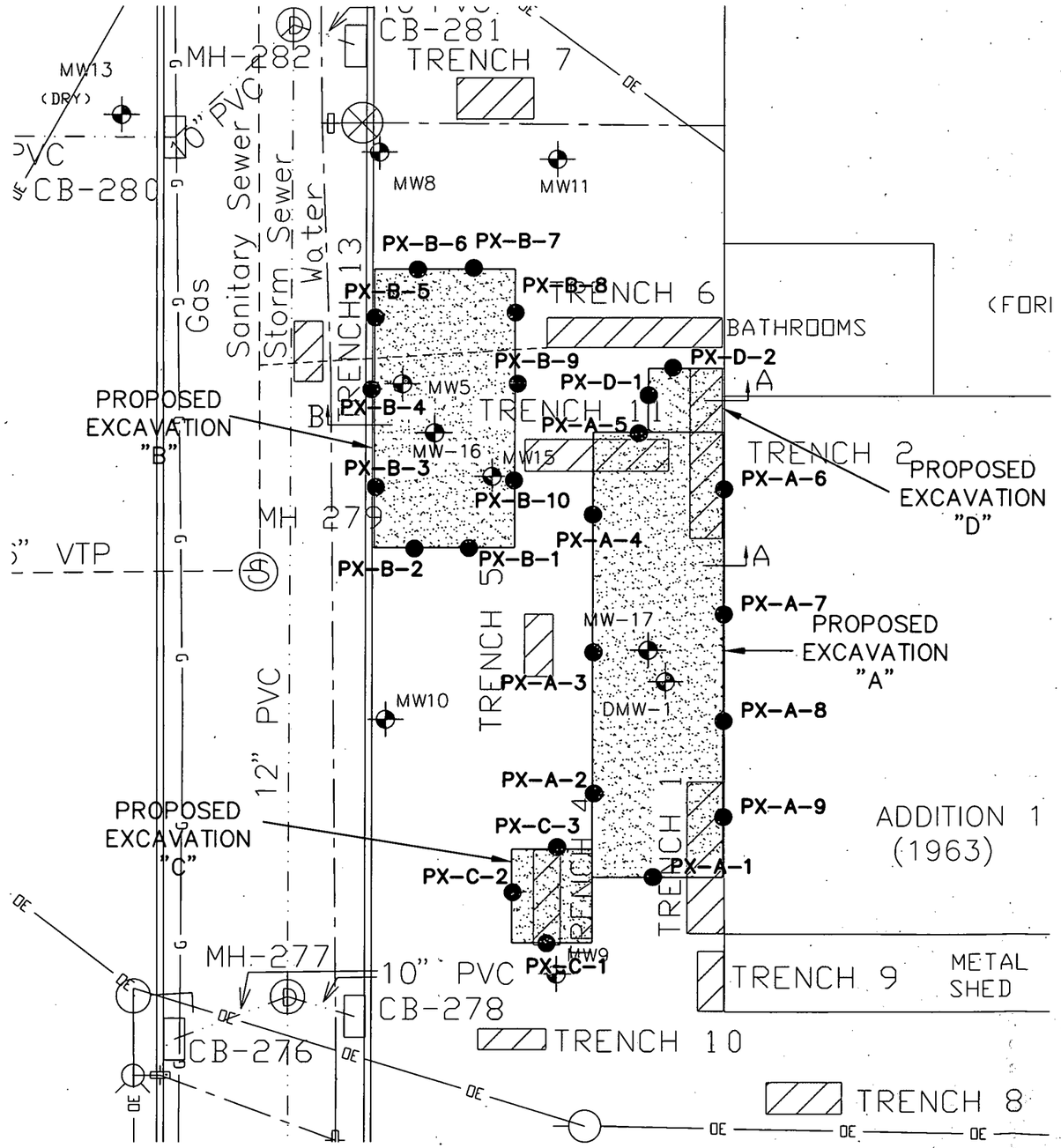
DECONTAMINATION SOIL STOCKPILE LOCATIONS AND DETAIL

BBL
BLASLAND, BOUCK & LEE, INC.
Engineers & Scientists

FIGURE
5



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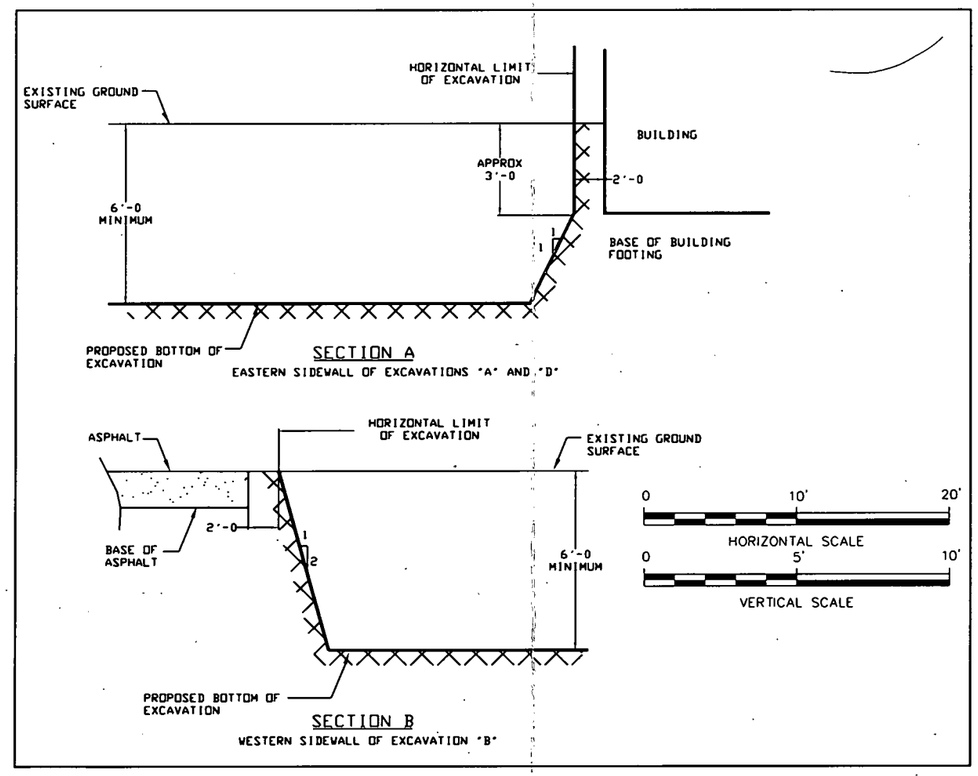
LEGEND

- UTILITY POLE
- UTILITY POLE W/LIGHT
- MONITORING WELL
- STORM MANHOLE
- CATCH BASIN
- SANITARY MANHOLE
- POST INDICATOR VALVE
- HYDRANT
- WATER VALVE
- GAS VALVE
- PROPOSED EXCAVATION AREAS
- FORMER TRENCHES
- PROPOSED MONITORING WELLS
- PROPOSED POST-EXCAVATION SAMPLE LOCATION



NOTE:

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GRAPHIC SCALE

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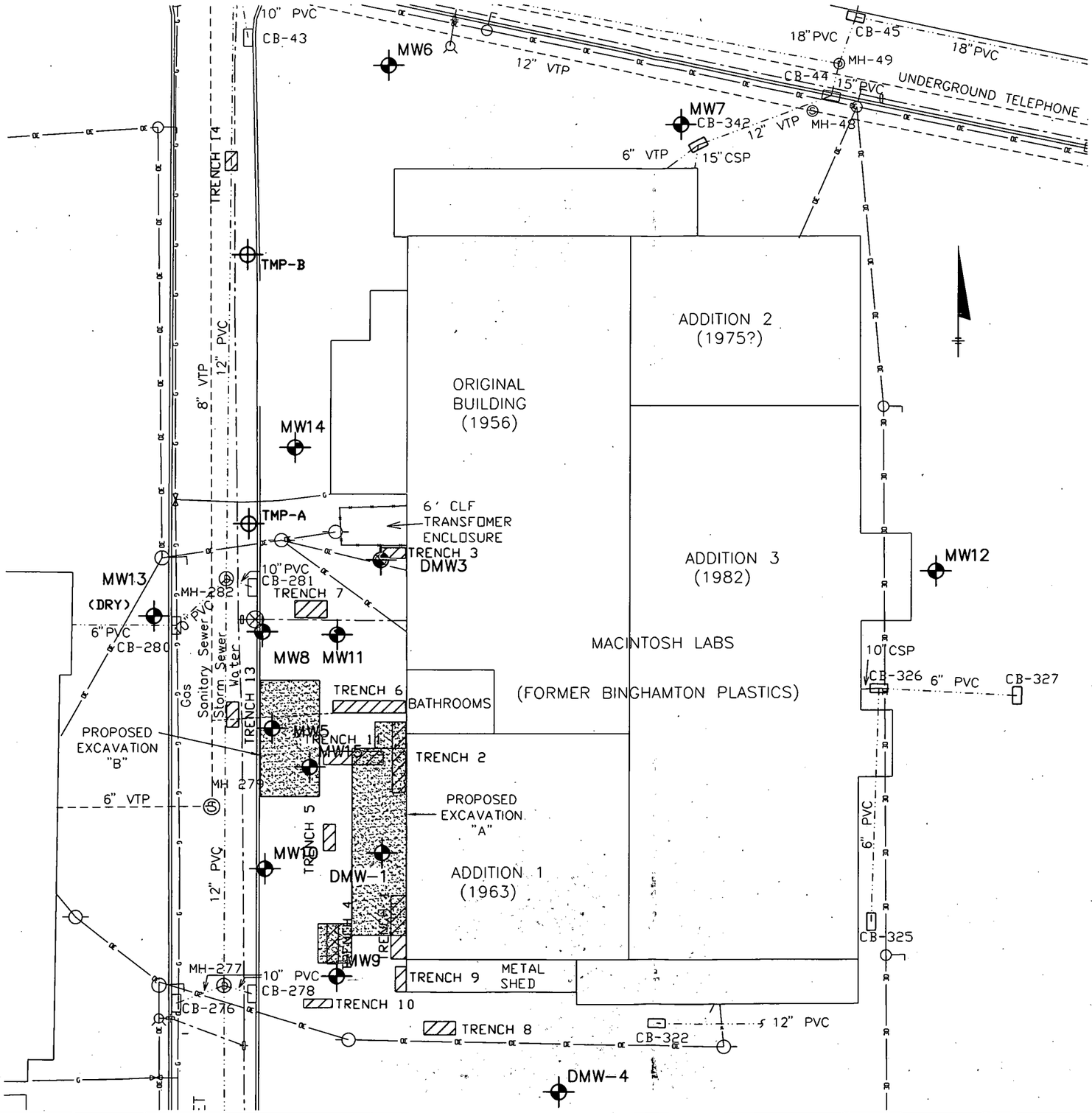
REMEDIAL DESIGN PACKAGE

PROPOSED EXCAVATION AREAS AND SIDEWALL DETAILS

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 6



LEGEND

- UTILITY POLE
- UTILITY POLE W/LIGHT
- MONITORING WELL
- STORM MANHOLE
- CATCH BASIN
- SANITARY MANHOLE
- POST INDICATOR VALVE
- HYDRANT
- WATER VALVE
- GAS VALVE
- PROPOSED TEMPORARY MONITORING POINTS
- PROPOSED EXCAVATION AREAS

NOTE:

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GRAPHIC SCALE

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PROPOSED TEMPORARY MONITORING POINT LOCATIONS AND EXCAVATION AREAS

BBL BLASLAND, BOUCK & LEE, INC. engineers & scientists

FIGURE 7

X: NONE
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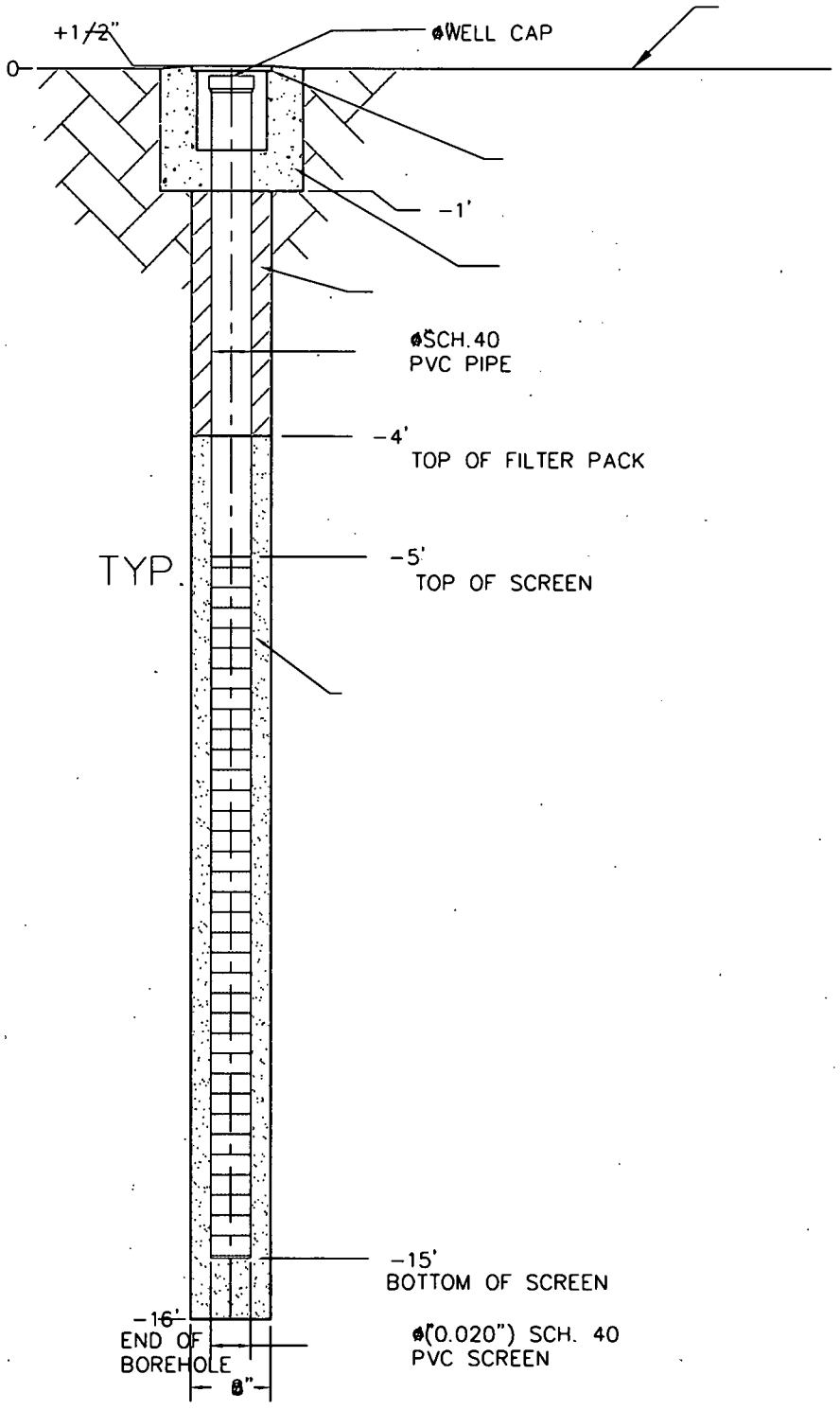

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REMEDIAL DESIGN PACKAGE

MONITORING WELL DESIGN DETAIL

BBL
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engineers & scientists

FIGURE
8a

X:
L: OFF=REF
P: PAGESET/PLT-AP
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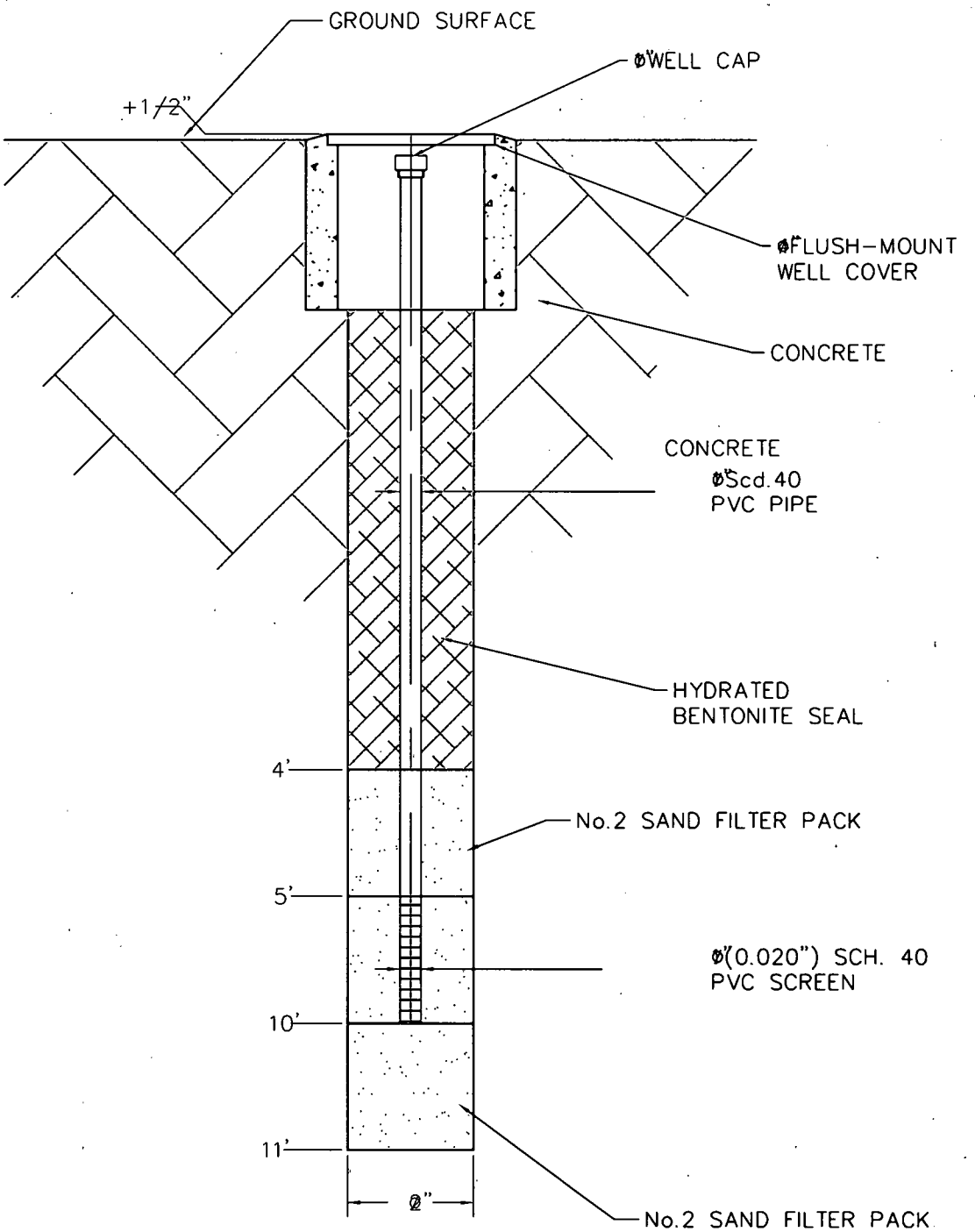

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REMEDIAL DESIGN PACKAGE

TEMPORARY MONITORING POINT DESIGN DETAIL

BBL
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engineers & scientists

FIGURE
8b

X:
L: OFF=REF
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Appendices

APPENDIX A

FIELD SAMPLING PLAN

DOVATRON INTERNATIONAL
ORDER ON CONSENT INDEX # B7-0516-97-05
SITE CODE #704024

Former Binghamton Plastics Site
498 Conklin Avenue
Binghamton, New York

Prepared by:

SHIELD ENVIRONMENTAL ASSOCIATES, INC.
Lexington, Kentucky
August 28, 1998

Job No. 396-0460

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TABLES

ATTACHMENTS

1 USEPA Low-Flow Sampling Guidance

1.0 INTRODUCTION

The Field Sampling and Analysis Plan (FSAP) for the Former Binghamton Plastics State Superfund Site, City of Binghamton, Broome County, New York, supplements information found in the Remedial Investigation/Feasibility Study (RI/FS) Work Plan. The Work Plan develops the objectives and scope of work, and defines what and how site activities will occur. The FSAP consists of two documents: the Field Sampling Plan (FSP) and the Quality Assurance Project Plan (QAPP). The FSP describes how various field sampling and analytical activities will be performed. The FSP also identifies the sampling and analytical objectives and provides detailed procedures for sample collection, handling, shipping, and analysis. Quality assurance/quality control (QA/QC) procedures are specified in the QAPP.

Since the Work Plan has delineated specific field operation procedures, the FSP will concentrate solely on specific sampling and analysis protocols. This FSP will conform, where appropriate, to the United States Environmental Protection Agency (USEPA) *Superfund Remedial Design and Remedial Action Guidance* (USEPA) 1986.

1.1 Site Location and Description

The site is located in the City of Binghamton, Broome County, New York (Figure 1). The property measures approximately 4 acres and is 700 to 800 feet south of the Susquehanna River at 498 Conklin Avenue. Figure 2 shows the site and surrounding properties.

1.2 Site History

The facility at the subject site was constructed in 1956 by Binghamton Plastics. Additions to the property were constructed in 1963, 1974, and 1982. Universal Instruments Corporation purchased the facility in the early 1980s and continued operations until Universal Instruments was taken over by Dover Electronics Corporation. In 1993, Dover Electronics was separated from Dover as a stand alone corporation named Dovatron, Inc. In 1996, Dovatron changed its name to the DII Group. The building has been occupied by McIntosh Laboratories since the late 1980s. The facility has been used as a circuit board assembly plant and is currently operated as an electronic repair facility.

The subject site consists of a large industrial building (44,800 square feet) with associated parking, landscape, and storage areas. A complete list of chemical substances used at the plant is not available; however, the use of trichloroethene (TCE) and 1,1,1-trichloroethane (1,1,1-TCA) has been substantiated.

In addition, a 1,000-gallon underground storage tank (UST) that was used to store hydraulic oil contaminated with 1,1,1-TCA and TCE, was removed in 1986. Figure 2 shows the former location of the tank and significant site features.

Shield reviewed a June 1990 letter to Hagopian Engineering Associates from the Broome County Health Department (Hagopian 1990). This letter indicated three contaminated sites were within a 1/2-mile radius of Conklin Avenue. One of those sites was identified as Binghamton Plastics Dump,

which was listed as being located at 498 Conklin Avenue. Reportedly, waste plastics and oils were thought to have been disposed of at the site. However, this information has not been substantiated.

Shield Environmental Associates, Inc. (Shield) has conducted periodic groundwater monitoring and additional site investigations that have substantiated the presence of TCE, 1,1,1-TCA, and their degradation products in the soils and groundwater at the site. The contamination appears to be isolated to a perched water zoned on the west side of the building and may have infiltrated the utility conduits in Chambers Street.

2.0 SAMPLING OBJECTIVES

2.1 General Objectives

The objectives for representative sample collection are:

- To perform sampling such that the sample taken is truly representative of the material or medium being sampled;
- To use proper sampling, sample handling, preservation, and QC techniques;
- To properly identify the collected samples and document their collection in permanent field records;
- To maintain sample chain-of-custody forms; and
- To protect the collected samples by properly packing and transporting (shipping) them to a laboratory for analysis.

This section briefly outlines only those field sampling and analysis procedures required to conduct the various site investigations during. Detailed descriptions of the procedures that will be used to accomplish these tasks are given in the following sections. The site investigation activities to be performed have been devised based upon the available data. Some adjustments to these prepared activities may be required as additional data become available or as field conditions dictate. The following sections provide specific sampling objectives for the proposed drilling, excavation/trenching, sampling, and air monitoring activities. A description of the waste sampling activities is also included in this document. The schedule for these activities is provided in the Work Plan prepared for the site entitled *Remedial Investigation/Feasibility Study Work Plan, Former Binghamton Plastics Site, City of Binghamton, Broome County, New York.*

2.2 Subsurface Soil Sampling

Soil sampling activities will be conducted using an excavator (test trenches) and a drill rig (soil borings and monitoring wells). The purpose of the sampling activities is to locate source areas and to define the extent of the site related contaminants at the study area and their existing concentrations. Procedures for soil sampling are outlined in Section 5.3 of this document.

These activities will be conducted to further evaluate the extent of the affected soils at the site; refine chemical concentrations at suspected exposure locations; and amend and modify the Health and Safety Plan (HASP) and other pertinent documents, as appropriate. The data collected will be used to further refine estimated volumes of affected soils requiring treatment.

2.3 Ground Water Sampling

All existing and newly installed monitoring wells will be sampled. The purpose of these samples is to establish the water quality in the newly installed wells and to evaluate the current contaminant concentrations in existing wells and compare them to past sampling events. Procedures for ground water sampling are outlined in Section 5.4 of this document.

The objective of the ground water sampling is to establish the extent and concentration of contaminants in the on-site and off-site ground water.. The data collected will be used to refine the extent of affected ground water.

2.4 Surface Water/Storm Water Sampling

Surface water samples will be collected from selected catch basins and catch basin outfalls on and off site. These samples will be collected to establish the presence or absence of contaminants in run-off water that passes through the storm sewer system at the site. Procedures for surface water/storm water sampling are outlined in Section 5.4 of this document.

The objective of the surface water sampling is to establish the extent and concentration of contaminants in storm water run-off. The data collected will be used to establish the presence of contaminants within the storm water utility conduits at the site.

3.0 SAMPLE LOCATION, FREQUENCY, AND DESIGNATION

Samples collected at the site and surrounding areas will be of various media, including soil, sediment, ground water, and surface water. Table 1 summarizes the sample locations, minimum frequencies, and analytes proposed for the site sampling activities. It is anticipated that the test trenches, monitoring wells, and soil borings will be located in the areas shown on Plate 1. The sampling locations will be in areas with data gaps or areas where data collection will refine existing information on the extent of areas with elevated chemical concentrations. Table 2 is a sampling summary that outlines proposed sampling locations, identification, types of samples collected, and analyses performed.

A minimum of 10 percent of the environmental samples collected will be for QA/QC purposes. These samples will be in the form of duplicate samples, spiked samples, and field and trip blanks. Additional information on QA/QC procedures is contained in the QAPP.

Each sample collected for analysis will be assigned a specific identification number. The Site Manager will oversee the numbering system so that each sample is correctly identified and no inadvertent duplications are assigned. The Site Manager will keep a Sample Identification and Tracking Log of all samples by matrix and sample location (Figure 3). Copies of all chain-of-custody forms will also be maintained in this log.

Sample identification numbers may consist of at least three separate elements:

- Sequential sample location number.
- Sample type and number.
- Sample depth, if applicable.

Sample locations will be designated by the following codes preceded by a sequential location number or predesignated identification number:

T	- Test Trench
MW	- Monitoring Well
SB	- Soil Boring
MH	- Manhole
CB	- Catch Basin
CBO	- Catch Basin Outfall

The sample types are designated with the following codes:

SS - Subsurface soil sample
GW - Ground Water Sample
SW - Surface Water Sample

4.0 SITE MANAGEMENT PLAN

This section provides general operating guidelines for work to be conducted at the site including site access, traffic control and organization of the field team. Responsibilities of each of the field team members are also indicated in this section.

4.1 Site Control

4.1.1 Site Access

The MacIntosh Laboratory facility, located on the subject site, is an active facility; therefore, site access will not be restricted. However, work zones, such as trenching areas and drilling sites, will be properly barricaded to prevent access by unauthorized personnel.

4.1.2 Traffic Control

Traffic will be restricted from active work zones using traffic cones or barricades as needed.

4.2 Project Organization and Personnel Responsibilities

Shield's project team at the site will work under the direction of the Project Director and Project Manager. Project personnel responsibilities are listed below.

- Project Director: Daniel V. Terrell III will serve as the Project Director. Mr. Terrell will be responsible for assessing and monitoring the overall project progress, approving project plans and reports, making conclusions/recommendations, and leading major briefings/meeting negotiations.

- Project Manager: Michael E. Morris, P.G., will serve as the Project Manager. Mr. Morris' responsibilities will include project team management, being the focal point for day-to-day client interactions and conducting briefings and client regulatory meetings. Mr. Morris will be responsible for project scheduling, budget monitoring, technical task integration and communications and coordination of team leaders and field efforts. He will also monitor the project for adherence to the QAPP.

- Quality Assurance Officer: Barbara Jones will serve as the Quality Assurance Officer. Ms. Jones will have the primary responsibility for overseeing and implementing the quality assurance (QA) program. She will report directly to the Project Director. In her role as Quality Assurance Officer, Ms. Jones will provide independent oversight so that overall QA procedures are in place for the project.

- Site Supervisor: Kreg Mills will be designated as the Site Supervisor. Mr. Mills will be responsible for overseeing all on-site activities. He will also interact with other field

personnel so that field efforts are successfully completed. The Site Supervisor will communicate regularly with the Project Manager concerning the project status, additional material and/or labor needs, etc., and keep a daily summary of all on-site activities.

- Site Health and Safety Officer: The Health and Safety Officer is responsible for proper operation of all safety equipment, monitoring activities during site work, selecting the necessary level of personal protection, and enforcing the HASP. Nilda Goxhaj will act as the Health and Safety Officer for this project. The Health and Safety Officer will have the authority to stop work if conditions exceed allowable limits. The Health and Safety Officer will assist other members of the field team as needed to maintain the safe operation of the field program.

- Sample Custody Officer: Kreg Mills will be the Sample Custody Officer. Mr. Mills will be responsible for the proper completion of sample custody forms as well as packing and shipping samples. He will also be responsible for notifying the analytical laboratory of sample shipments including the number and types of samples that are being shipped.

- Sampling Personnel: Sampling personnel are responsible for helping the Site Manager during sample collection. Specific responsibilities include proper sample collection, packaging, documentation, and chain-of-custody documentation until samples are released to another party for storage or transport to the analytical laboratory. Sampling personnel will also be responsible for the correct and complete decontamination of sampling equipment.

- Drilling/Excavation/Surveying Subcontractors: The drilling/excavation/surveying subcontractors are responsible for supplying all services (including labor), equipment and materials required to perform the excavation/drilling/surveying activities. The excavation subcontractors are further responsible for conducting necessary maintenance and QC of required equipment and for following decontamination procedures specified in the FSP, HASP, and QAPP. Upon completing the work, the subcontractors will be responsible for demobilizing all equipment, cleaning up any materials deposited on-site, and properly filling excavated/drilled areas as directed.

- Analytical Subcontractor: The analytical subcontractor for this portion of the project will be Quanterra Environmental Services, a full-service analytical laboratory. Quanterra will be responsible for analyzing all waste, soil, sediment, and liquid samples collected from the site. The laboratory will also be responsible for the QA/QC implementation and documentation of all analyses performed on the samples.

5.0 SAMPLING/MONITORING EQUIPMENT AND PROCEDURES

5.1 Introduction

This section of the FSP outlines the step-by-step procedures necessary to perform sampling and other field activities at the site. Site personnel should be trained and familiar with these procedures prior to sampling activities. Any questions on methodology or procedures should be addressed to the Project Director or Site Manager.

All of the site samples will be collected, preserved and stored according to laboratory and USEPA procedures. The laboratory will supply all sampling glassware or other containers necessary for sample collection. A list of equipment and decontamination procedures for sampling activities is contained in Table 3. Persons performing sampling should also be familiar with the HASP and QAPP prepared for this site. Personal Protective Equipment (PPE) levels appropriate for each site activity are contained in Table 4.

As appropriate, sampling activities will conform to the USEPA document entitled *Compendium of ERT Waste Sampling Procedures* dated January 1991 and the *Region II CERCLA Quality Assurance Manual* dated October 1989.

5.2 Air Monitoring

The purpose of the air monitoring program at the site is to establish the presence and concentrations of airborne chemicals of concern and to establish the level of worker protection needed. The following equipment may be used for air monitoring at the site: an oxygen/combustible gas indicator; a particulate monitor (Miniram); Dräger tubes; a photoionization detector (PID); and/or a flame ionization detector (FID).

5.2.1 Air Quality Monitoring

5.2.1.1 Pre-excavation Monitoring

An air quality survey will initially be conducted at the site. This survey will take place in and around the perimeter of the site to establish air quality conditions as well as conditions encountered during the sampling activities. Readings will be collected at the perimeter of the site using a calibrated oxygen/combustible gas indicator, a particulate monitor, and FID or PID at the locations shown on Plate 1. Readings will be collected 6 to 12 inches above the ground surface and at the breathing zone (approximately 5 feet above the ground surface). Readings will be recorded in a field logbook or on an air monitoring log (Figure 4) and identified so that field locations can be readily found. Table 5 provides an air monitoring equipment list.

5.2.1.2 Excavation/Drilling Monitoring

Readings will also be collected using an FID or PID, a particulate monitor, and an oxygen/combustible gas indicator throughout excavation and drilling activities. These readings will be collected continuously in the active work zone, both upwind and downwind, to assess air quality conditions. Readings should be collected in the vicinity of the breathing zone and entered/recorded

in the field logbook or air monitoring log. If readings exceed those levels specified in the HASP, PPE levels will be upgraded as appropriate.

5.3 Subsurface Soil Sampling

Subsurface soil sampling will be conducted as part of the activities described in the RI/FS Work Plan. Subsurface sampling will occur during drilling and test trench excavations.

Subsurface soil samples will be collected using one or more of the following methods or a combination of sampling techniques:

Method 1 Split spoon sampling through a hollow stem auger conducted during soil boring and monitoring well installation.

Method 2 Backhoe bucket or stainless steel hand auger in test trench excavations that exceed a depth of 4 feet.

Method 3 Stainless steel trowels for stockpiled soils and test trench excavations that do not exceed a depth of 4 feet.

It is anticipated that subsurface soil sampling activities will be carried out using Level D or B PPE, depending on site conditions and air monitoring results. Field equipment and personnel will set up in an upwind direction from the trenching/sampling areas unless field conditions dictate otherwise.

The following equipment is available for field use for soil sampling: stainless steel spoons and trowels; stainless steel shovels; stainless steel hand augers; disposable equipment; drill rigs with associated equipment (e.g., split-spoon samplers, shelby tubes); and backhoes or track-mounted excavation equipment. Table 6 provides a soil sampling equipment list.

Soil samples collected for VOC analyses will be containerized immediately. The samples should be placed in precleaned sampling containers, supplied by the laboratory, so that no headspace is left in the container after it is closed. Samples for VOC analyses must be stored at 4°C until they are received by the laboratory. Headspace analysis will be performed in the field on a separate representative portion of each sample. Each headspace analysis will be performed on equal volumes of sample placed in resealable storage bags and allowed to volatilize at ambient temperature for approximately 15 minutes.

Some compounds can be detected in the parts per billion and/or parts per trillion range. Extreme care must be taken to prevent cross-contamination of these samples. The following precautions should be taken when trace levels are of concern:

- Sample containers for source samples or samples suspected of containing high concentrations of chemicals will be placed in separate plastic bags immediately after collecting, preserving, tagging, etc.

- Highly contaminated samples will never be placed in the same ice chest with confirmatory samples. Highly contaminated samples should be enclosed in plastic bags before placing them in ice chests. Ice chests or shipping containers for source samples or samples suspected to

contain high concentrations of chemicals should be lined with clean plastic bags.

- One member of the field team will take all the notes, fill out labels, etc., while the other member performs the sampling.
- Personnel should use equipment constructed of Teflon®, stainless steel or glass that has been properly precleaned when collecting samples for trace metals or organic compound analyses. Teflon® or glass is preferred for collecting samples where trace metals are of concern. Equipment constructed of plastic or PVC will not be used to collect samples for trace organic compound analyses.

The step-by-step sampling procedures for soil sampling activities at the site are as follows:

- Review FSP, HASP, and QAPP.
- Assemble equipment.
- Calibrate FID or PID and oxygen/combustible gas indicator.
- Decontaminate equipment (see Table 3).
- Don PPE as appropriate.
- Collect soil sample using stainless steel spoon or shovel, hand auger, split spoons, shelby tubes, excavator bucket, etc., as appropriate.
- Immediately cap, seal and label a representative portion of the sample for VOC analysis; place in a cooler at 4°C.
- Place a representative portion of the sample into a container for headspace analysis.
- Place sample in appropriate containers for volatiles, semivolatiles, metals, and/or pH analyses; cap the samples, seal and label.
- Collect air readings according to the HASP.
- Note weather conditions.
- Record information in field logbook.
- Decontaminate equipment (see Table 3) and move to next sampling location.
- Backfill sample locations as appropriate.
- At the end of each day, ship or transport samples to the laboratory under chain of custody.

To prevent cross contamination, disposable gloves must be worn by sampling personnel and changed between sampling points. Table 6 contains a list of equipment necessary for soil sampling activities.

All equipment used to collect soil samples will be cleaned and repaired, if necessary, before being stored at the conclusion of field studies. Any cleaning conducted in the field or field repairs should be thoroughly documented in field records.

All contaminated samples will be clearly labeled as such when they are submitted for laboratory analyses. Any observations (odor, appearance, container labeling, etc.) made by the field team that might alert the laboratory to potential dangers or provide laboratory personnel with information on possible constituents in the samples (high concentrations) will be explained on the sample label. These observations will be explained verbally to the sample custodian or other laboratory personnel, as necessary.

The collection of auxiliary information and data is particularly important when collecting samples. Any field analyses, including those conducted with safety equipment such as FIDs, oxygen/combustible gas indicators, or approximate analyses such as those obtained with pH indicator paper, will be recorded in field logbooks. Photographs will be used extensively during sampling operations for recording this information. Documentation of field activities will be conducted by the following:

- Detailed notation in field logbooks.
- Photographs, as appropriate.
- Completion of field forms (e.g., air monitoring log, sample tracking log, etc.).
- Collection of QA samples.

Notations in field logbooks will include at a minimum:

- Time and date of field activities.
- Weather conditions.
- Names of all site personnel including regulators, subcontractors, and others.
- Clear, concise summary of field activities.
- Notation of photographs taken during field activities.
- Documentation and summary of decontamination procedures.
- Problems encountered or unusual occurrences.
- Health and safety information, as appropriate.
- Deviation from any aspects of the RI/FS Work Plan, FSP, HASP or QAPP.

5.4 Ground Water and Surface Water Monitoring/Sampling

5.4.1 Shallow Ground Water and Surface Water Sampling

If water is encountered in the test trenches, water or liquid samples will be collected from the test trenches. These samples will be collected and handled in a manner similar to surface water samples by dipping or scooping a sample into the laboratory container. Appropriate safety precautions will also be taken if it appears that the sample is leachate or free organic liquid.

A step-by-step checklist for sampling surface water and ground water encountered in catch basins and test trenches is as follows:

- Review the FSP, HASP, and QAPP.
- Assemble supplies and equipment.
- Calibrate temperature, pH, and conductivity meters, if appropriate.
- Decontaminate sampling equipment (see Table 3).
- Don PPE, as appropriate.
- Collect a sample by placing the sample container into material to be sampled or use a dipper, Kemmerer or other sampler, as needed. Sampling equipment will be constructed of stainless steel, glass or Teflon®. For volatile samples, completely fill the vials to eliminate air bubbles.
- Seal and label sample, complete chain of custody, place sample in cooler and keep at 4°C.
- Decontaminate equipment (see Table 3) and move to next sample location.
- Ship or transport samples to the laboratory under chain-of-custody documentation at the end of each day.

In addition to the sampling equipment previously mentioned, a dipper, Kemmerer or other sampler and appropriate sample jars should be at the site for liquid sampling if needed. An equipment list for surface water sampling is contained in Table 7.

5.4.2 Ground Water Sampling (Monitoring Wells)

Monitoring wells will be purged and sampled using a low-flow (minimal drawdown) ground water sampling procedure as outlined in the USEPA Ground Water Issue publication EPA/540/S-95/504. A copy of this EPA publication is contained in Attachment 1. The wells will be purged with a variable speed water pump at a rate that equals the natural recharge rate of the well. Measurements of pH, specific conductance, dissolved oxygen, redox potential, turbidity, and temperature will be collected every 3 to 5 minutes using a flow-through cell as the well is purged until all parameters have stabilized. An electronic data logger will collect and store the data. If the natural recharge rate of a well is insufficient to keep up with the minimum purge rate, the well will be purged dry and allowed to recharge a minimum of 4 hours but no more than 24 hours before sampling. After the

indicator parameters have stabilized, the water samples will be collected from the end of the discharge tube at a pumping rate of 0.1 to 0.2 L/min or less.

This method allows for the collection of a representative ground water sample by drawing water into a well at its natural recharge rate, therefore minimizing volatilization due to the cascading effect produced by drawdown. Additionally, since the submersible pump is placed within the screened interval of each well, stagnant water trapped within the riser will not mix with the ground water being sampled. For these and other reasons, the above-mentioned USEPA Ground Water Issue publication (p. 6) states that "Bailers are inappropriate devices for low-flow sampling."

The step-by-step sampling procedures for ground water sampling activities at the site are as follows:

- Review FSP, HASP, and QAPP.
- Assemble equipment.
- Decontaminate all sampling and monitoring equipment
- Calibrate flow-through cell (i.e., temperature, conductivity, redox, pH, dissolved oxygen, turbidity meter).
- Gauge each well with a ground water level indicator accurate to 0.01 feet.
- Purge each well at a rate that is equal to or less than the natural recharge rate of the aquifer until temperature, conductivity, redox, pH, dissolved oxygen, and turbidity parameters stabilize, and the ground water does not exceed 50 nephelometric turbidity units (NTUs).
- Reduce pumping rate to no more than 0.2 L/min.
- Collect ground water samples into the appropriate containers for analyses, with the proper preservative if necessary, label, and place in an iced cooler at 4°C.
- Record all information including the initial ground water level, purge rate, chemical and physical parameters, duration of purging event, etc.
- Decontaminate equipment (see Table 3) and move to the next sampling location.
- At the end of each day, ship or transport samples to the laboratory under chain of custody.

To prevent cross contamination, disposable gloves must be worn by sampling personnel and changed between sampling points. Table 7 contains a list of equipment necessary for surface water and ground water sampling activities.

All equipment used to collect water samples will be cleaned and repaired, if necessary, before being stored at the conclusion of field studies. Any cleaning conducted in the field or field repairs should be thoroughly documented in field records.

All contaminated samples will be clearly labeled as such when they are submitted for laboratory

analyses. Any observations (odor, appearance, container labeling, etc.) made by the field team that might alert the laboratory to potential dangers or provide laboratory personnel with information on possible constituents in the samples (high concentrations) will be explained on the sample label.

Notations in field logbooks will include at a minimum:

- Time and date of field activities.
- Names of all site personnel including regulators, subcontractors, and others.
- Clear, concise summary of field activities.
- Notation of photographs taken during field activities.
- Documentation and summary of decontamination procedures.
- Problems encountered or unusual occurrences.
- Health and safety information, as appropriate.
- Deviation from any aspects of the RI/FS Work Plan, FSP, HASP or QAPP.

5.4.3 Aquifer Flow Parameters Analysis (Limited Pump Tests)

Aquifer testing will be performed using a step drawdown and limited pump tests on at least two on-site wells. The purpose of the step drawdown test is to establish the maximum drawdown and pumping rate of the wells. The limited pump tests will establish the approximate hydraulic conductivity, transmissivity, and permeability of the perched aquifer. Additional information on the pump tests is contained in the RI/FS Work Plan.

The step-by-step procedures for performing the step drawdown and limited pump tests at the subject site are as follows:

- Review FSP, HASP, and QAPP.
- Decontaminate the water level indicator, submersible pump and pressure transducers/data loggers (Table 3).
- Place a pressure transducer/data logger and the submersible pump into the pumping well.
- Place a pressure transducer/data logger into adjacent observation wells.
- Set the data loggers to collect water depths in each well at 10 second intervals.
- Adjust the pumping rate of the submersible pump to maintain the maximum drawdown in the well without pumping the well dry.

- Upon determining the pumping rate required to maintain a constant flow rate and the maximum drawdown in the pumping well, discontinue pumping and allow the well to recover to the initial water level.
- When the water level in the pumping well reaches equilibrium, begin the pump test at the predetermined pumping rate.
- Each pump test will run for approximately 5 hours.
- Upon completion of the test, down load the data from the pressure transducers/data loggers onto a computer disk and remove the equipment from the pumping and observation wells.
- Decontaminate equipment (Table 3) and move to next sample location.

5.5 Field Analytical Procedures

QA procedures for field instruments (FID, PID, oxygen/combustible gas indicator, etc.) are an essential part of these standard operating procedures. To satisfy QA/QC procedures, all field analyses will be conducted in duplicate at least 10 percent of the time. A record of these duplicate analyses will be kept in field logbooks. A significant difference in the replicate analyses will result in recalibration of the instruments used, reexamination of the analytical methodology being used, or re-examination of the sampling procedures and locations.

All field analyses must be traceable to the specific individual performing the analyses and to the specific equipment used. This information will be entered into the field logbooks for all field analyses. Time records will be kept in local time and will be recorded to the nearest 5 minutes. Additional details on the QA/QC procedures are contained in the QAPP.

6.0 SAMPLE HANDLING AND ANALYSES

A NYSDOH ELAP CLP certified laboratory (Quanterra Environmental Services) approved by the NYSDEC for Superfund sites will be used for conducting analyses. When samples arrive at the laboratory, they are logged in, the chain-of-custody forms signed, and the condition of the samples recorded (e.g., any visible signs of tampering or damage).

Laboratory QA/QC procedures typically include using an extracted standard or spike as a quantitative check of the samples. Laboratory verification of any apparent discrepancies will be required prior to data submittal. More detail on these procedures is contained in the QAPP.

6.1 Sample Analysis Methods

Most of the subsurface soil and all of the sediment, surface water and ground water samples will be analyzed for site-specific parameters using USEPA SW-846 Method 8260A. The site-specific parameter list (SSPL) is as follows:

Trichloroethene (TCE)
1,1,1- Trichloroethane (1,1,1-TCA)
1,1 - Dichloroethene (1,1-DCE)
1,2 - Dichloroethene Total (1,2-DCE Total)
1,1 - Dichloroethane (1,1-DCA)
Tetrachloroethene (PCE)
Chloroethane
Vinyl Chloride

Selected soil samples included in Table 1 will be analyzed for the full Target Analyte List/Target Compound List (TAL/TCL). The samples selected for the TAL/TCL are from areas close to the source area. The TAL/TCL consists of total VOCs (Method 8260A), semivolatile organic compounds (Method 8270B), pesticides/PCBs (8080A), TAL metals (Method 6010), total cyanides (Method 9012) and mercury (Method 7471A). Samples from stockpiled soils requiring disposal will also be submitted for TCLP volatiles analysis (Table 8).

6.2 Sample Preservation Methods

Some samples require preservation immediately upon collection in the field to maintain sample integrity. All samples preserved with chemicals are to be identified with sample tags indicating they have been preserved. All chemical preservatives will be supplied by the laboratory. Preservatives required for routine sample analyses are given in 40 CFR Part 136, Table II (Table 8).

Samples that should not be preserved in the field include the following:

- Samples collected within a hazardous waste site that are known or thought to be highly contaminated with toxic materials. Barrel, closed container, spillage, or other source samples from hazardous waste sites are not to be preserved with any chemical. These samples may be preserved by placing the sample container on ice, if necessary.

- Samples that have extremely low or high pH or that may generate potentially dangerous gases if they were preserved using the procedures given in Table II (40 CFR Part 136).

- Samples for metals analyses that are shipped by air will not be preserved with nitric acid in excess of the amount specified in Table II (40 CFR Part 136).

- Samples for purgeable organic compound analyses that are shipped by air will not be preserved with hydrochloric acid in excess of the amount specified in Table II (40 CFR Part 136).

VOC samples will be containerized immediately and stored at 4°C until they are received by the laboratory. Water samples that will be analyzed for VOCs will be placed in 40-ml vials that contain the appropriate amount of hydrochloric acid (HCL). The HCL will be placed in the sample containers by the laboratory prior to shipment. The HCL will help preserve the sample by lowering the pH of the sample to <2.

If sample acidification causes effervescence, the sample must be submitted without preservation except for cooling to 4°C. This sample property must be appropriately noted when present.

6.3 Sample Containers

The sample container selection is established by the type of analyses required. Table II, 40 CFR Part 136 (Table 8) lists standard sample containers used.

6.4 Shipping Requirements

Samples may be shipped to the laboratory either by vehicles or by common carrier for overnight delivery. Samples must be shipped to the laboratory within 24 hours of collection. Samples collected at the Dover Electronics site will be classified as either environmental or hazardous material samples. Examples of environmental samples include drinking water, ground water, surface water, soil, sediment, or effluent not known to contain high concentrations of hazardous materials. Samples known to contain hazardous materials may require shipment as dangerous goods. The Project Manager will make this designation at the site.

6.5 Holding Times

The elapsed time between sample collection and the initiation of laboratory analyses must be within a specific time frame, which is dependent upon the type of analysis. Holding times for routine samples are shown in Table II, 40 CFR Part 136 (Table 8).

6.6 Sample Documentation

All sample identification, field records, and chain-of-custody records will be recorded with waterproof, nonerasable ink. If errors are made in any of these documents, field personnel will make corrections by simply crossing a single line through the error and entering the correct information. All corrections will be initialed and dated by the sampler. If possible, all corrections should be made by the individual making the error.

If stick-on labels are used to enter information onto sample tags, logbooks, or sample containers, these labels should not be able to be removed later without leaving obvious indications of the attempt. Labels should never be placed over previously recorded information. Corrections to information recorded on stick-on labels should be made as stated in the previous paragraph.

6.6.1 Sample Identification

The method of sample identification used depends on the type of sample collected. Sample identification procedures for soil, air, or water samples have been previously discussed in Section 3. Samples for in situ field analyses are those collected for specific field analyses or measurements where the data are recorded directly in bound field logbooks or recorded directly on the chain-of-custody record. Examples of such in situ field measurements and analyses include DRI readings, pH, temperature, turbidity and conductivity. Also included in this category are those field measurements or analyses such as surveying measurements that are made with field instruments or analyzers where no sample is actually collected. As much as possible, the identification procedures for in situ field analyses will conform with the labeling described in Section 3.

6.6.1.1 Sample Labels

Samples, other than those collected for in situ field measurements or analyses, are identified by using a standard sample label (Figure 5) that is attached to the sample container. The sample labels are sequentially numbered. The following information will be included on the sample label:

- Client's name.
- Job number.
- Sample identification number.
- Date and time of sample collection.
- Signature(s) of the sampler(s) or the designated sampling team leader.
- Whether the sample is preserved or unpreserved.
- General types of analyses to be conducted (parameter).
- If a sample is split with a regulatory agency or other party, sample labels with identical information should be attached to each sample container by the party receiving the split sample. Blind, duplicate, spiked or blank samples will not be identified as such, but will be given fictitious identification numbers. Complete documentation on the submission of blind samples will be recorded in bound field logbooks for future reference.

6.6.1.2 Custody Seals

Sample coolers will be sealed prior to shipment using a custody seal (Figure 6). At a minimum, the sampler will provide the following information on the custody seal:

- Site at which the sample was collected.
- Sample identification number.
- Date collected.
- Sampler's signature and organization.

6.6.2 Chain-of-Custody Procedures

The possession of samples or other physical materials will be traceable from the time they are obtained until they are received by the laboratory. A sample is in custody if:

- It is in the field investigator's or the transferee's actual possession; or
- It is in the field investigator's or the transferee's view, after being in his/her physical possession; or
- It was in the field investigator's or the transferee's physical possession and then he/she secured it to prevent tampering; or
- It is placed in a designated secure area.

6.6.2.1 Chain-of-Custody Record

The field chain-of-custody record (Figure 7) is used to record the custody of all samples collected and maintained by field sampling personnel. The chain-of-custody record also serves as a sample logging mechanism for the receiving laboratory.

The following minimum information must be supplied to complete the field chain-of-custody record:

- Project job number.
- Project name.
- All samplers and/or the sampling team leader must sign the designated signature block.
- Sample identification number, date and time of sample collection, grab or composite sample designation, the sample matrix, and a brief description of the sample location.
- The total number of sample containers and the method of preservation.
- The field sampler(s) and subsequent transferee(s) must document the transfer of the samples listed on the record in the spaces provided at the bottom of the record. One of the samplers documented under the sampler(s) section must be the person that originally relinquished the samples/evidence or a designated field sample custodian who receives and maintains samples

from sampling teams under secure conditions. Both the person relinquishing the samples and the person receiving them must sign the form; the date and time that this occurred must be documented in the proper space on the record. Usually, the last person receiving the samples or evidence should be a laboratory sample custodian or other evidence clerk.

- The remarks section at the bottom of the record is used to record airbill numbers or registered or certified mail serial numbers.

The chain-of-custody record is a legal document. Once the record is completed, it becomes an accountable document and must be maintained in the project file.

6.6.2.2 Field Custody Procedures

- To simplify the chain-of-custody record and eliminate potential litigation problems, as few people as possible should handle the sample or physical evidence during the investigation or inspection.

- The field sampler is responsible for the proper handling and custody of the samples collected until they are properly and formally transferred to another person or facility.

- Sample labels (Figure 5) will be completed for each sample using waterproof, nonerasable ink.

- All coolers will be sealed prior to shipment using a custody seal such as that shown on Figure 6.

- All samples must be documented in bound field logbooks.

- A chain-of-custody record will be completed for all samples. A separate chain-of-custody record will be used for each final destination or laboratory used for sample analysis.

6.6.2.3 Transfer of Custody and Shipment

- All samples will be accompanied by a chain-of-custody record. When transferring the possession of samples, the individual receiving the samples will sign, date, and note the time that he/she received the samples on the chain-of-custody record. This chain-of-custody record documents transfer of custody of samples from the field sampler to other persons, laboratories, or other entities.

- Samples will be properly packaged for shipment and delivered or shipped to the designated laboratory for analyses. Shipping containers will be secured by using strapping tape and custody seals. The custody seals will be placed on the containers so that they cannot be opened without breaking the seals. The seals will be signed and dated by the field sampler/team leader.

- When samples are split with any party, that party should sign the chain-of-custody record.

The original and one copy of the chain-of-custody record will be placed in a plastic bag inside the

secured shipping container when samples are shipped. One copy of the record will be retained by the field sampler or team leader. The original record will be transmitted to the field sampler or team leader after samples are accepted by the laboratory. This copy will become a part of the project file.

6.6.3 Field Records

Field sampling personnel will use only bound field logbooks for the maintenance of field records. Other bound logbooks such as bound surveyors logbooks are acceptable as long as pages cannot be removed without tearing them out.

Preferably, logbooks should be dedicated specifically to the project. The sampler's name, project name, and project code should be entered on the inside of the front cover of the logbook. All entries should be dated and the time of entry recorded. At the end of each day's activity or entry of a particular event, if appropriate, the sampler should draw a diagonal line at the conclusion of the entry and initial it indicating the conclusion of the entry or the day's activity.

All aspects of sample collection and handling as well as visual observations will be documented in the field logbooks. All sample collection equipment (where appropriate), field analytical equipment, and equipment used to make physical measurements should also be identified in field logbooks. All calculations, results, and calibration data for field sampling, field analytical, and field physical measurement equipment will also be recorded in the field logbooks. All field analyses and measurements must be traceable to the specific piece of field equipment used and to the field sampler collecting the sample, or making the measurement or analyses.

All entries in field logbooks will be dated, will be legible, and will contain accurate and conclusive documentation of an individual's project activities. Since field records are the basis for later written reports, language should be objective, factual, and free of personal notes or other terminology that might prove inappropriate. Once completed, these field logbooks become accountable documents and must be maintained as part of the project files.

6.6.4 Photographs

All photographs taken by sampling personnel will be identified on the back of the print with the following information:

- An accurate description of what the photograph shows, including the name of the facility or site and its location.
- Orientation of the photograph (e.g., looking northeast, etc.).
- Signature of the photographer.

If the photograph was taken with a Polaroid camera, the information will be entered on the back of each photograph as soon as it is taken, including the date and time of the photograph. If a 35mm camera is used, it should be equipped with an automatic date stamp. A serial-type record of each frame exposed will be kept in the bound field logbook along with the information required for each

photograph. The film will be developed, and the field sampler will then enter the required information on the prints, using the serialized photographic record from the bound field logbook to identify each photograph.

7.0 REFERENCES

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U.S. Environmental Protection Agency. October 1989. *Region II CERCLA Quality Assurance Manual.*

U.S. Environmental Protection Agency. April 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures.* Ground Water Issue, EPA/540/S-95/504

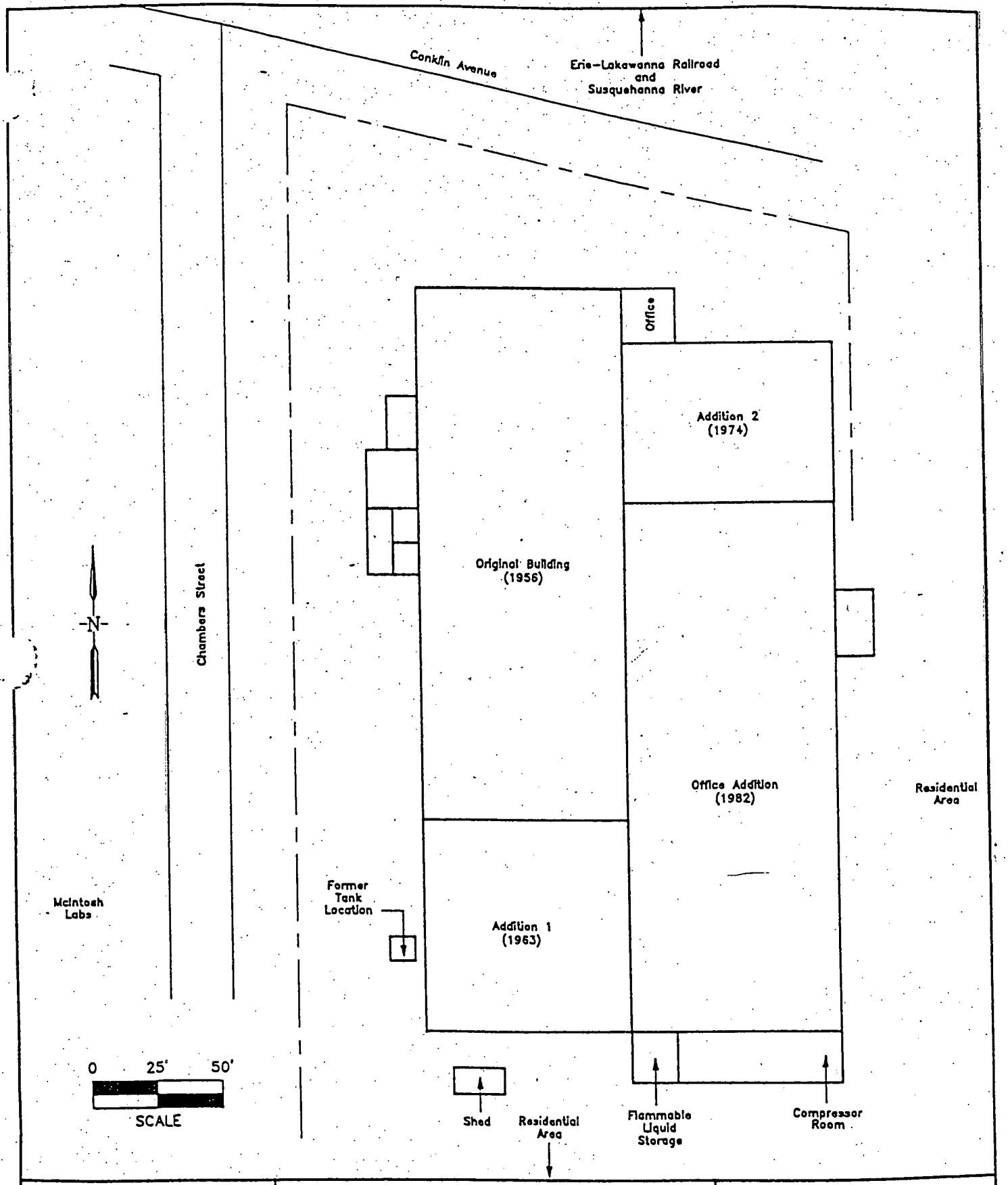
FIGURES

SOURCE: USGS Topographic Quadrangle Maps
Binghamton East, New York
1968 – Photoinspected 1976
Binghamton West, New York
1968 – Photoinspected 1976

N

0 1,000' 2,000'
SCALE

DATE: 12/2/97	FIGURE 1	**SHIELD**
DRAWN BY: P.D.H.	SITE LOCATION MAP DII – BINGHAMTON PLASTICS CONKLIN AVENUE BINGHAMTON, NEW YORK	ENVIRONMENTAL ASSOCIATES, INC.
APPROVED BY: M.M.		LEXINGTON, KENTUCKY
CLIENT NO.: 396-0460		



DATE: 1/23/98

DRAWN BY: P.D.H.

APPROVED BY: M.M.

CLIENT NO.: 396-0460

60460-

FIGURE 2

MAP SHOWING HISTORICAL SITE FEATURES AND SURROUNDING PROPERTIES
DII – BINGHAMTON PLASTICS
CONKLIN AVENUE, BINGHAMTON, NEW YORK

SHIELD

ENVIRONMENTAL ASSOCIATES, INC.

LEXINGTON, KENTUCKY

DII-BINGHAMTON PLASTICS

Sample Identification and Tracking Log

Sample Matrix of Location: ____________

SAMPLE IDENTIFICATION NUMBER	DATE SAMPLE COLLECTED	ANALYTES	C of C No.	DATE SHIPPED TO LAB	DATE ANALYSES RECEIVED	COMMENTS

DATE: 8/14/98	
DRAWN BY: JAG	
APPROVED BY: MEM	
CLIENT NO.: 396-0460	

FIGURE 3

SAMPLE IDENTIFICATION AND TRACKING LOG
DII-BINGHAMTON PLASTICS
CONKLIN AVENUE
BINGHAMTON, NEW YORK

SHIELD
ENGINEERING ASSOCIATES, INC., P.C.
LEXINGTON, KENTUCKY

C:\SHIELD\DIIBING

DII-BINGHAMTON PLASTICS

Air Monitoring Log

Location	Date	Time	Taken By	OVA (ppm)	Hnu (ppm)	Oxygen (ppm)	Carbon Monoxide (%)	Combustible Gas (% LEL)	Instrument ID No.	Notes/Other

Note : Always collect background readings upwind from the work area prior to the start of activities and record in the log book.

C:\SHIELD\DIIBING

DATE: 8/14/98

DRAWN BY: JAG

APPROVED BY: MEM

CLIENT NO.: 396-0460

FIGURE 4

AIR MONITORING LOG
DII-BINGHAMTON PLASTICS
CONKLIN AVENUE
BINGHAMTON, NEW YORK

SHIELD
ENGINEERING ASSOCIATES, INC., P.C.
LEXINGTON, KENTUCKY

SHIELD ENVIRONMENTAL ASSOCIATES, INC.
3150 Custer Drive, Suite 301, Lexington, KY 40517

Site:_____ Project:_____

Sample ID:_____

Date:_____ Time:_____

Sampler:_____ Analysis:_____

_____

C:\...\DRILLING

DATE: 8/14/98

DRAWN BY: JAG

APPROVED BY: MEM

CLIENT NO.: 396-0460

FIGURE 5

STANDARD SAMPLE LABEL
DII-BINGHAMTON PLASTICS
CONKLIN AVENUE
BINGHAMTON, NEW YORK

SHIELD
ENGINEERING ASSOCIATES, INC., P.C.
LEXINGTON, KENTUCKY

Quanterra Environmental Services

Nº 069458

Custody Seal

DATE

SIGNATURE

Quanterra Environmental Services

Nº 069458

C:\SHIELD\DIIBING

DATE: 8/14/98	FIGURE 6
DRAWN BY: MEM	CUSTODY SEAL DII–BINGHAMTON PLASTICS CONKLIN AVENUE BINGHAMTON, NEW YORK
APPROVED BY: DG	
CLIENT NO.: 396–0460	

SHIELD

ENGINEERING ASSOCIATES, INC., P.C.

LEXINGTON, KENTUCKY

SHIELD ENVIRONMENTAL ASSOCIATES, INC.

3150 CUSTER DRIVE, SUITE 301
LEXINGTON, KY 40517
PHONE (606) 271-0269
FAX (606)271-1204

PROJECT NAME _____ CONTACT NAME _____ TELEPHONE NO. _____

Samplers: Print Name		Signature									ANALYSIS									
Project No.		Composite	Grab	Date	Time	Sample Type: Water	Liquid	Oil	Solid	No. of Containers										REMARKS
SAMPLE ID	SAMPLE LOCATION																			

COMMENTS: _____

Relinquished by: (Signature)			Received by: (Signature)	Date	Time
Relinquished by: (Signature)			Received by: (Signature)	Date	Time
Dispatched by: (Signature)	Date	Time	Received for Laboratory by:	Date	Time
Method of Shipment				Date	Time

C:\SHIELD\DIIBING

DATE: 8/14/98
DRAWN BY: MEM
APPROVED BY: DG
CLIENT NO.: 396-0460

FIGURE 7

CHAIN-OF-CUSTODY RECORD
DII-BINGHAMTON PLASTICS
CONKLIN AVENUE
BINGHAMTON, NEW YORK

SHIELD
ENGINEERING ASSOCIATES, INC., P.C.
LEXINGTON, KENTUCKY

TABLES

TABLE 1
SAMPLE LOCATION AND FREQUENCY SUMMARY

Sample Location	Sample Type	Number of Samples	Analyses/Extraction
Test Trenches	Soil	1-2 samples[1]	SSPL or TCL/TAL
	Water/liquid	1 grab[2]	SSPL or TCL/TAL
Soil Borings	Soil	1-2 samples per boring	TCL/TAL
Monitoring Well	Soil	2-3 samples per well	SSPL
	Water/liquid	1 grab per well	SSPL
Surface Water Samples	Water	1 grab per sampling point	SSPL

[1] One grab sample of affected material if contamination is observed.
[2] A water sample will be collected, if present.
SSPL: Site Specific Parameter List: TCE, 1,1,1-TCA, 1,1-DCE, 1,2-DCE, 1,1-DCA, PCE, Chloroethane, Vinyl Chloride
TCL/TAL - Target Compound List/Target Analyte List

TABLE 2
SAMPLING SUMMARY

Location	Sample ID	Estimated Trench/Sample Depth	Samples	Analysis	Comments
Test Trench 1	T1-SS1 T1-SS2 T1-GW	4-6' 2-4'	grab sample grab sample grab sample	TAL/TCL TAL/TCL TAL/TCL	Sample collected from native soil Sample collected only if contamination is observed. Ground water sampled if present.
Test Trench 2	T2-SS1 T2-SS2 T2-GW	4-6' 2-4'	grab sample grab sample grab sample	SSPL SSPL SSPL	Sample collected from native soil Sample collected only if contamination is observed. Ground water sampled if present.
Test Trench 3	T3-SS1 T3-SS2 T3-GW	4-6' 2-4'	grab sample grab sample grab sample	SSPL SSPL SSPL	Sample collected from native soil Sample collected only if contamination is observed. Ground water sampled if present.
Test Trench 4	T4-SS1 T4-SS2 T4-GW	4-6' 2-4'	grab sample grab sample grab sample	TAL/TCL TAL/TCL TAL/TCL	Sample collected from native soil Sample collected only if contamination is observed. Ground water sampled if present.
Test Trench 5	T5-SS1 T5-SS2 T5-GW	4-6' 2-4'	grab sample grab sample grab sample	SSPL SSPL SSPL	Sample collected from native soil Sample collected only if contamination is observed. Ground water sampled if present.
Test Trench 6	T6-SS1 T6-SS2 T6-GW	4-6' 2-4'	grab sample grab sample grab sample	TAL/TCL TAL/TCL TAL/TCL	Sample collected from native soil Sample collected only if contamination is observed. Ground water sampled if present.
Test Trench 7	T7-SS1 T7-SS2 T7-GW	4-6' 2-4'	grab sample grab sample grab sample	SSPL SSPL SSPL	Sample collected from native soil Sample collected only if contamination is observed. Ground water sampled if present.

Table 2 (continued)

Location	Sample ID	Estimated Sample Depth	Samples	Analysis	Comments
Monitoring Well 1	MW1-GW		grab sample	SSPL	
Monitoring Well 3	MW3-GW		grab sample	SSPL	
Monitoring Well 4	MW4-GW		grab sample	SSPL	
Monitoring Well 5	MW5-GW		grab sample	SSPL	
Monitoring Well 6	MW6-GW		grab sample	SSPL	
Monitoring Well 7	MW7-GW		grab sample	SSPL	
Monitoring Well 8	MW8-GW		grab sample	SSPL	
Monitoring Well 9	MW9-GW		grab sample	SSPL	
Monitoring Well 10	MW10-GW		grab sample	SSPL	
Monitoring Well 11	MW11-GW		grab sample	SSPL	
Monitoring Well 12	MW12-GW		grab sample	SSPL	
Monitoring Well 13	MW13-GW		grab sample	SSPL	
Monitoring Well 14	MW14(SS8-10') MW14-GW	8-10'	grab sample grab sample	SSPL SSPL	Depth of sample analyzed may be altered based on field screening results.
Soil Boring 7	SB7(SS3'-5')	3'-5'	grab sample	TAL/TCL	Depth and number of samples may be altered based on field screening results.
Soil Boring 8	SB8(SS3'-5')	3'-5'	grab sample	TAL/TCL	Depth and number of samples may be altered based on field screening results.
Manhole 282	MH 282 -SW	NA	grab sample	SSPL	
Catch Basin 342	CB 342 -SW	NA	grab sample	SSPL	
Catch Basin Outfall 45	CBO 45 -SW	NA	grab sample	SSPL	

SSPL - Site Specific Parameter List: TCE, 1,1,1-TCA, 1,1-DCE, 1,2-DCE, 1,1-DCA, PCE, Chloroethane, Vinyl Chloride
NA - Not Applicable

TABLE 3
EQUIPMENT AND DECONTAMINATION PROCEDURES FOR SAMPLING EQUIPMENT

Equipment

- Containers for contaminated soil or water and equipment
- Brush for removing soil accumulations
- Tap water
- Distilled or purified water
- Alconox or other biodegradable detergent
- Brush for washing equipment
- Containers or buckets for handling wash and rinse waters
- Steam cleaner, if required
- 10% nitric acid (HNO_3)
- Acetone, methanol or hexane
- Aluminum foil

Decontamination Procedures

- Remove/brush accumulations of dirt and containerize or stockpile for disposal.
- Place sampling equipment in container with soapy water using a brush to remove any particulate matter or surface film.
- Rinse equipment thoroughly with tap water (hot water if available). Tap water may be used from any municipal water treatment system.
- Rinse with 10% nitric acid if sampling for metals. Carbon steel split spoons should be rinsed with 1% nitric acid to reduce the possibility of leaching metals.
- Tap water rinse (hot water if available).
- Acetone only rinse or methanol followed by hexane rinse when sampling for organics.
- Perform final rinse with analyte-free water. Analyte-free water must comply with requirements outlined in Section 4.6 of the QAPP.
- Air dry and wrap in aluminum foil.
- If equipment will not be used immediately, store in a clean, dry, tamperproof area.
- If equipment is grossly contaminated, additional washes and rinses may be required.
- Containerize wash waters and soils; seal and label for disposal.

Notes: Steam cleaning may be substituted for wash and rinse steps.

TABLE 3 (Continued)

Decontamination Procedures (Low-Flow Sampling Equipment)

- Prerinse: Operate pump in a deep basin containing 8-10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
- Wash: Operate pump in a deep basin containing 8-10 gallons of nonphosphate detergent solution, such as Alconox, for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes.
- Rinse: Operate pump in a deep basin containing 8-10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
- Final Rinse: Operate pump in a deep basin containing deionized/distilled water to pump out 1 to 2 gallons of this final rinse water.
- Containerize wash waters and soils; seal and label for disposal.

Monitoring instruments or other equipment that cannot be washed should be covered with plastic bags or other suitable material to prevent contamination. Sampling equipment that requires plastic tubing should be disassembled and the tubing replaced with clean tubing between samples.

TABLE 4
SUMMARY OF SITE ACTIVITIES AND PPE LEVELS

Site Activity	PPE Level*
• Subsurface soil sampling (excavation/drilling)	D+
• Ground water sampling	D
• Surface water sampling	D
• Air monitoring during excavation and/or drilling	D+
• Pilot studies	D

* PPE levels may be upgraded depending upon air monitoring results.

\+ Level D will be used for all sampling activities unless air readings indicate Level C or B is warranted.

TABLE 5
AIR MONITORING EQUIPMENT LIST

Sampling Equipment/Materials:

- FSP, HASP, and QAPP
- Site map
- FID or PID
- Oxygen/combustible gas indicator
- Calibration logs and gases
- Field logbook
- Personal protective equipment (PPE)

TABLE 6
SOIL AND SEDIMENT SAMPLING EQUIPMENT LIST

Sampling Equipment:

- FSP, HASP, and QAPP
- Personal protective equipment, as appropriate
- Decontamination equipment
- Excavator
- Drill rig
- Plastic for stockpiling
- Stainless steel spoons, scoops, and shovels
- Hand augering equipment
- Bentonite powder for sealing borings
- Disposable latex gloves
- Sample jars, seals, labels, chain-of-custody forms, and aluminum foil
- Cooler and ice
- FID or PID
- Oxygen/combustible gas indicator
- Field logbook
- Stake or marker to locate trench/boring
- Measuring tape
- Site map
- Camera

TABLE 7
GROUND WATER AND SURFACE WATER SAMPLING EQUIPMENT LIST

Sampling Equipment:

- Field Sampling and Analysis Plan, Health and Safety Plan, and Quality Assurance Project Plan
- Personal protective equipment, as appropriate
- Decontamination equipment
- Water level indicator
- Variable-rate submersible pump with Teflon® tubing
- In-line pH, redox, turbidity, dissolved oxygen, temperature meter
- Sample jars, seals, labels, chain-of-custody forms
- Cooler and ice
- Disposable latex sampling gloves
- Field log book
- Site Map
- Camera

TABLE 8
SUMMARY OF ANALYTICAL METHODS, CHEMICAL CONTAINERS, PRESERVATION METHODS AND SAMPLE VOLUMES

Compound	SW846 Method	Matrix	Container	Preservation	Amount Required	Holding Time
Total Volatile Organic Compounds and SSPL	8260A 8260A	solid aqueous	G, TFE G, TFE	cool 4°C 1:1 HCl, cool 4°C	4 oz 3 x 40 ml	10 days
Semivolatile Organic Compounds	8270B 8270B	solid aqueous	G, TFE G, TFE	cool 4°C cool 4°C	8 oz 1 L	**
Pesticides/PCBs	8080A 8080A	solid aqueous	G, TFE G, TFE	cool 4°C cool 4°C	8 oz 1 L	**
TAL Metals	6010A 6010A	solid aqueous	G,TFE P	cool 4°C HNO_3 to pH<2	4 oz 1 L	6 months
Mercury	7471A	solid aqueous	G,TFE P	cool 4°C HNO_3 to pH<2	4 oz 1L	6 months
Total Cyanide	9012 9012	solid aqueous	P P	cool 4°C HNO_3 to pH<2	4 oz 250 ml	6 months
pH		solid aqueous	P P	none required none required	4 oz 250 ml	analyze immediately
TCLP - volatiles	8260A	waste	G, TFE	cool 4°C	2x1 L	*

* TCLP - volatiles -- 14 days until extraction, 14 days extraction to analysis
** 7 days until extraction, 14 days to analysis
SSPL - Site-Specific Parameter List
G - Glass
P - Plastic
TFE - Teflon coated Lid

ATTACHMENT 1

USEPA LOW-FLOW SAMPLING GUIDANCE

United States Environmental Protection Agency | Office of Research and Development | Office of Solid Waste and Emergency Response | EPA/540/S-95/504 April 1996

EPA Ground Water Issue

LOW-FLOW (MINIMAL DRAWDOWN) GROUND-WATER SAMPLING PROCEDURES

by Robert W. Puls[1] and Michael J. Barcelona[2]

Background

The Regional Superfund Ground Water Forum is a group of ground-water scientists, representing EPA's Regional Superfund Offices, organized to exchange information related to ground-water remediation at Superfund sites. One of the major concerns of the Forum is the sampling of ground water to support site assessment and remedial performance monitoring objectives. This paper is intended to provide background information on the development of low-flow sampling procedures and its application under a variety of hydrogeologic settings. It is hoped that the paper will support the production of standard operating procedures for use by EPA Regional personnel and other environmental professionals engaged in ground-water sampling.

For further information contact: Robert Puls, 405-436-8543, Subsurface Remediation and Protection Division, NRMRL, Ada, Oklahoma.

I. Introduction

The methods and objectives of ground-water sampling to assess water quality have evolved over time. Initially the emphasis was on the assessment of water quality of aquifers as sources of drinking water. Large water-bearing units were identified and sampled in keeping with that objective. These were highly productive aquifers that supplied drinking water via private wells or through public water supply systems. Gradually, with the increasing awareness of subsurface pollution of these water resources, the understanding of complex hydrogeochemical processes which govern the fate and transport of contaminants in the subsurface increased. This increase in understanding was also due to advances in a number of scientific disciplines and improvements in tools used for site characterization and ground-water sampling. Ground-water quality investigations where pollution was detected initially borrowed ideas, methods, and materials for site characterization from the water supply field and water analysis from public health practices. This included the materials and manner in which monitoring wells were installed and the way in which water was brought to the surface, treated, preserved and analyzed. The prevailing conceptual ideas included convenient generalizations of ground-water resources in terms of large and relatively homogeneous hydrologic *units*. With time it became apparent that conventional water supply generalizations of *homogeneity* did not adequately represent field data regarding pollution of these subsurface resources. The important role of *heterogeneity* became increasingly clear not only in geologic terms, but also in terms of complex physical,

[1]National Risk Management Research Laboratory, U.S. EPA
[2]University of Michigan

Superfund Technology Support Center for Ground Water

National Risk Management Research Laboratory
Subsurface Protection and Remediation Division
Robert S. Kerr Environmental Research Center
Ada, Oklahoma

Technology Innovation Office
Office of Solid Waste and Emergency Response, US EPA, Washington, DC

Walter W. Kovalick, Jr., Ph.D.
Director

chemical and biological subsurface processes. With greater appreciation of the role of heterogeneity, it became evident that subsurface pollution was ubiquitous and encompassed the unsaturated zone to the deep subsurface and included unconsolidated sediments, fractured rock, and *aquitards* or low-yielding or impermeable formations. Small-scale processes and heterogeneities were shown to be important in identifying contaminant distributions and in controlling water and contaminant flow paths.

It is beyond the scope of this paper to summarize all the advances in the field of ground-water quality investigations and remediation, but two particular issues have bearing on ground-water sampling today: aquifer heterogeneity and colloidal transport. Aquifer heterogeneities affect contaminant flow paths and include variations in geology, geochemistry, hydrology and microbiology. As methods and the tools available for subsurface investigations have become increasingly sophisticated and understanding of the subsurface environment has advanced, there is an awareness that in most cases a primary concern for site investigations is characterization of contaminant flow paths rather than entire aquifers. In fact, in many cases, plume thickness can be less than well screen lengths (e.g., 3-6 m) typically installed at hazardous waste sites to detect and monitor plume movement over time. Small-scale differences have increasingly been shown to be important and there is a general trend toward smaller diameter wells and shorter screens.

The hydrogeochemical significance of colloidal-size particles in subsurface systems has been realized during the past several years (Gschwend and Reynolds, 1987; McCarthy and Zachara, 1989; Puls, 1990; Ryan and Gschwend, 1990). This realization resulted from both field and laboratory studies that showed faster contaminant migration over greater distances and at higher concentrations than flow and transport model predictions would suggest (Buddemeier and Hunt, 1988; Enfield and Bengtsson, 1988; Penrose et al., 1990). Such models typically account for interaction between the mobile aqueous and immobile solid phases, but do not allow for a mobile, reactive solid phase. It is recognition of this third *phase* as a possible means of contaminant transport that has brought increasing attention to the manner in which samples are collected and processed for analysis (Puls et al., 1990; McCarthy and Degueldre, 1993; Backhus et al., 1993; U. S. EPA, 1995). If such a phase is present in sufficient mass, possesses high sorption reactivity, large surface area, and remains stable in suspension, it can serve as an important mechanism to facilitate contaminant transport in many types of subsurface systems.

Colloids are particles that are sufficiently small so that the surface free energy of the particle dominates the bulk free energy. Typically, in ground water, this includes particles with diameters between 1 and 1000 nm. The most commonly observed mobile particles include: secondary clay minerals; hydrous iron, aluminum, and manganese oxides; dissolved and particulate organic materials, and viruses and bacteria. These reactive particles have been shown to be mobile under a variety of conditions in both field studies and laboratory column experiments, and as such need to be included in monitoring programs where identification of the *total* mobile contaminant loading (dissolved + naturally suspended particles) at a site is an objective. To that end, sampling methodologies must be used which do not artificially bias *naturally* suspended particle concentrations.

Currently the most common ground-water purging and sampling methodology is to purge a well using bailers or high speed pumps to remove 3 to 5 casing volumes followed by sample collection. This method can cause adverse impacts on sample quality through collection of samples with high levels of turbidity. This results in the inclusion of otherwise immobile artifactual particles which produce an overestimation of certain analytes of interest (e.g., metals or hydrophobic organic compounds). Numerous documented problems associated with filtration (Danielsson, 1982; Laxen and Chandler, 1982; Horowitz et al., 1992) make this an undesirable method of rectifying the turbidity problem, and include the removal of potentially mobile (contaminant-associated) particles during filtration, thus artificially biasing contaminant concentrations low. Sampling-induced turbidity problems can often be mitigated by using low-flow purging and sampling techniques.

Current subsurface conceptual models have undergone considerable refinement due to the recent development and increased use of field screening tools. So-called hydraulic *push* technologies (e.g., cone penetrometer, Geoprobe®, QED HydroPunch®) enable relatively fast screening site characterization which can then be used to design and install a monitoring well network. Indeed, alternatives to conventional monitoring wells are now being considered for some hydrogeologic settings. The ultimate design of any monitoring system should however be based upon adequate site characterization and be consistent with established monitoring objectives.

If the sampling program objectives include accurate assessment of the magnitude and extent of subsurface contamination over time and/or accurate assessment of subsequent remedial performance, then some information regarding plume delineation in three-dimensional space is necessary prior to monitoring well network design and installation. This can be accomplished with a variety of different tools and equipment ranging from hand-operated augers to screening tools mentioned above and large drilling rigs. Detailed information on ground-water flow velocity, direction, and horizontal and vertical variability are essential baseline data requirements. Detailed soil and geologic data are required prior to and during the installation of sampling points. This includes historical as well as detailed soil and geologic logs which accumulate during the site investigation. The use of borehole geophysical techniques is also recommended. With this information (together with other site characterization data) and a clear understanding of sampling

objectives, then appropriate location, screen length, well diameter, slot size, etc. for the monitoring well network can be decided. This is especially critical for new in situ remedial approaches or natural attenuation assessments at hazardous waste sites.

In general, the overall goal of any ground-water sampling program is to collect water samples with no alteration in water chemistry; analytical data thus obtained may be used for a variety of specific monitoring programs depending on the regulatory requirements. The sampling methodology described in this paper assumes that the monitoring goal is to sample monitoring wells for the presence of contaminants and it is applicable whether mobile colloids are a concern or not and whether the analytes of concern are metals (and metalloids) or organic compounds.

II. Monitoring Objectives and Design Considerations

The following issues are important to consider prior to the design and implementation of any ground-water monitoring program, including those which anticipate using low-flow purging and sampling procedures.

A. Data Quality Objectives (DQOs)

Monitoring objectives include four main types: detection, assessment, corrective-action evaluation and resource evaluation, along with *hybrid* variations such as site-assessments for property transfers and water availability investigations. Monitoring objectives may change as contamination or water quality problems are discovered. However, there are a number of common components of monitoring programs which should be recognized as important regardless of initial objectives. These components include:

1) Development of a conceptual model that incorporates elements of the regional geology to the local geologic framework. The conceptual model development also includes initial site characterization efforts to identify hydrostratigraphic units and likely flow-paths using a minimum number of borings and well completions;

2) Cost-effective and well documented collection of high quality data utilizing simple, accurate, and reproducible techniques; and

3) Refinement of the conceptual model based on supplementary data collection and analysis.

These fundamental components serve many types of monitoring programs and provide a basis for future efforts that evolve in complexity and level of spatial detail as purposes and objectives expand. High quality, reproducible data collection is a common goal regardless of program objectives.

High quality data collection implies data of sufficient accuracy, precision, and completeness (i.e., ratio of valid analytical results to the minimum sample number called for by the program design) to meet the program objectives. Accuracy depends on the correct choice of monitoring tools and procedures to minimize sample and subsurface disturbance from collection to analysis. Precision depends on the repeatability of sampling and analytical protocols. It can be assured or improved by replication of sample analyses including blanks, field/lab standards and reference standards.

B. Sample Representativeness

An important goal of any monitoring program is collection of data that is truly representative of conditions at the site. The term *representativeness* applies to chemical and hydrogeologic data collected via wells, borings, piezometers, geophysical and soil gas measurements, lysimeters, and temporary sampling points. It involves a recognition of the statistical variability of individual subsurface physical properties, and contaminant or major ion concentration levels, while explaining extreme values. Subsurface temporal and spatial variability are facts. Good professional practice seeks to maximize representativeness by using proven accurate and reproducible techniques to define limits on the distribution of measurements collected at a site. However, measures of representativeness are dynamic and are controlled by evolving site characterization and monitoring objectives. An evolutionary site characterization model, as shown in Figure 1, provides a systematic approach to the goal of consistent data collection.

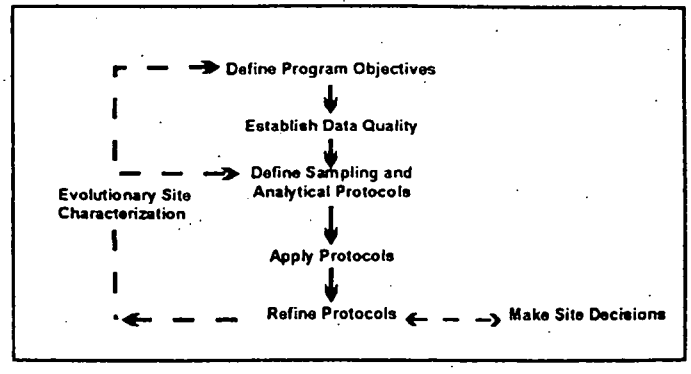


Figure 1. Evolutionary Site Characterization Model

The model emphasizes a recognition of the causes of the variability (e.g., use of inappropriate technology such as using bailers to purge wells; imprecise or operator-dependent methods) and the need to control avoidable errors.

1) Questions of Scale

A sampling plan designed to collect representative samples must take into account the potential scale of changes in site conditions through space and time as well as the chemical associations and behavior of the parameters that are targeted for investigation. In subsurface systems, physical (i.e., aquifer) and chemical properties over time or space are not statistically independent. In fact, samples taken in close proximity (i.e., within distances of a few meters) or within short time periods (i.e., more frequently than monthly) are highly auto-correlated. This means that designs employing high-sampling frequency (e.g., monthly) or dense spatial monitoring designs run the risk of redundant data collection and misleading inferences regarding trends in values that aren't statistically valid. In practice, contaminant detection and assessment monitoring programs rarely suffer these *over-sampling* concerns. In corrective-action evaluation programs, it is also possible that too little data may be collected over space or time. In these cases, false interpretation of the spatial extent of contamination or underestimation of temporal concentration variability may result.

2) Target Parameters

Parameter selection in monitoring program design is most often dictated by the regulatory status of the site. However, background water quality constituents, purging indicator parameters, and contaminants, all represent targets for data collection programs. The tools and procedures used in these programs should be equally rigorous and applicable to all categories of data, since all may be needed to determine or support regulatory action.

C. Sampling Point Design and Construction

Detailed site characterization is central to all decision-making purposes and the basis for this characterization resides in identification of the geologic framework and major hydro-stratigraphic units. Fundamental data for sample point location include: subsurface lithology, head-differences and background geochemical conditions. Each sampling point has a proper use or uses which should be documented at a level which is appropriate for the program's data quality objectives. Individual sampling points may not always be able to fulfill multiple monitoring objectives (e.g., detection, assessment, corrective action).

1) Compatibility with Monitoring Program and Data Quality Objectives

Specifics of sampling point location and design will be dictated by the complexity of subsurface lithology and variability in contaminant and/or geochemical conditions. It should be noted that, regardless of the ground-water sampling approach, few sampling points (e.g., wells, drive-points, screened augers) have zones of influence in excess of a few feet. Therefore, the spatial frequency of sampling points should be carefully selected and designed.

2) Flexibility of Sampling Point Design

In most cases *well-point* diameters in excess of 1 7/8 inches will permit the use of most types of submersible pumping devices for low-flow (minimal drawdown) sampling. It is suggested that *short* (e.g., less than 1.6 m) screens be incorporated into the monitoring design where possible so that comparable results from one device to another might be expected. *Short*, of course, is relative to the degree of vertical water quality variability expected at a site.

3) Equilibration of Sampling Point

Time should be allowed for equilibration of the well or sampling point with the formation after installation. Placement of well or sampling points in the subsurface produces some disturbance of ambient conditions. Drilling techniques (e.g., auger, rotary, etc.) are generally considered to cause more disturbance than *direct-push* technologies. In either case, there may be a period (i.e., days to months) during which water quality near the point may be distinctly different from that in the formation. Proper development of the sampling point and adjacent formation to remove fines created during emplacement will shorten this water quality *recovery* period.

III. Definition of Low-Flow Purging and Sampling

It is generally accepted that water in the well casing is non-representative of the formation water and needs to be purged prior to collection of ground-water samples. However, the water in the screened interval may indeed be representative of the formation, depending upon well construction and site hydrogeology. Wells are purged to some extent for the following reasons: the presence of the air interface at the top of the water column resulting in an oxygen concentration gradient with depth, loss of volatiles up the water column, leaching from or sorption to the casing or filter pack, chemical changes due to clay seals or backfill, and surface infiltration.

Low-flow purging, whether using portable or dedicated systems, should be done using pump-intake located in the middle or slightly above the middle of the screened interval. Placement of the pump too close to the bottom of the well will cause increased entrainment of solids which have collected in the well over time. These particles are present as a result of well development, prior purging and sampling events, and natural colloidal transport and deposition. Therefore, placement of the pump in the middle or toward the top of the screened interval is suggested. Placement of the pump at the top of the water column for sampling is only recommended in unconfined aquifers, screened across the water table, where this is the desired sampling point. Low-

flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval.

A. Low-Flow Purging and Sampling

Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen. It does not necessarily refer to the flow rate of water discharged at the surface which can be affected by flow regulators or restrictions. Water level drawdown provides the best indication of the stress imparted by a given flow-rate for a given hydrological situation. The objective is to pump in a manner that minimizes stress (drawdown) to the system to the extent practical taking into account established site sampling objectives. Typically, flow rates on the order of 0.1 - 0.5 L/min are used, however this is dependent on site-specific hydrogeology. Some extremely coarse-textured formations have been successfully sampled in this manner at flow rates to 1 L/min. The effectiveness of using low-flow purging is intimately linked with proper screen location, screen length, and well construction and development techniques. The reestablishment of natural flow paths in both the vertical and horizontal directions is important for correct interpretation of the data. For high resolution sampling needs, screens less than 1 m should be used. Most of the need for purging has been found to be due to passing the sampling device through the overlying casing water which causes mixing of these stagnant waters and the dynamic waters within the screened interval. Additionally, there is disturbance to suspended sediment collected in the bottom of the casing and the displacement of water out into the formation immediately adjacent to the well screen. These disturbances and impacts can be avoided using dedicated sampling equipment, which precludes the need to insert the sampling device prior to purging and sampling.

Isolation of the screened interval water from the overlying stagnant casing water may be accomplished using low-flow minimal drawdown techniques. If the pump intake is located within the screened interval, most of the water pumped will be drawn in directly from the formation with little mixing of casing water or disturbance to the sampling zone. However, if the wells are not constructed and developed properly, zones other than those intended may be sampled. At some sites where geologic heterogeneities are sufficiently different within the screened interval, higher conductivity zones may be preferentially sampled. This is another reason to use shorter screened intervals, especially where high spatial resolution is a sampling objective.

B. Water Quality Indicator Parameters

It is recommended that water quality indicator parameters be used to determine purging needs prior to sample collection in each well. Stabilization of parameters such as pH, specific conductance, dissolved oxygen, oxidation-reduction potential, temperature and turbidity should be used to determine when formation water is accessed during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by oxidation-reduction potential, dissolved oxygen and turbidity. Temperature and pH, while commonly used as purging indicators, are actually quite insensitive in distinguishing between formation water and stagnant casing water; nevertheless, these are important parameters for data interpretation purposes and should also be measured. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. Instruments are available which utilize in-line flow cells to continuously measure the above parameters.

It is important to establish specific well stabilization criteria and then consistently follow the same methods thereafter, particularly with respect to drawdown, flow rate and sampling device. Generally, the time or purge volume required for parameter stabilization is independent of well depth or well volumes. Dependent variables are well diameter, sampling device, hydrogeochemistry, pump flow rate, and whether the devices are used in a portable or dedicated manner. If the sampling device is already in place (i.e., dedicated sampling systems), then the time and purge volume needed for stabilization is much shorter. Other advantages of dedicated equipment include less purge water for waste disposal, much less decontamination of equipment, less time spent in preparation of sampling as well as time in the field, and more consistency in the sampling approach which probably will translate into less variability in sampling results. The use of dedicated equipment is strongly recommended at wells which will undergo routine sampling over time.

If parameter stabilization criteria are too stringent, then minor oscillations in indicator parameters may cause purging operations to become unnecessarily protracted. It should also be noted that turbidity is a very conservative parameter in terms of stabilization. Turbidity is always the last parameter to stabilize. Excessive purge times are invariably related to the establishment of too stringent turbidity stabilization criteria. It should be noted that natural turbidity levels in ground water may exceed 10 nephelometric turbidity units (NTU).

C. Advantages and Disadvantages of Low-Flow (Minimum Drawdown) Purging

In general, the advantages of low-flow purging include:

- samples which are representative of the *mobile* load of contaminants present (dissolved and colloid-associated);
- minimal disturbance of the sampling point thereby minimizing sampling artifacts;
- less operator variability, greater operator control;

- reduced stress on the formation (minimal drawdown);
- less mixing of stagnant casing water with formation water;
- reduced need for filtration and, therefore, less time required for sampling;
- smaller purging volume which decreases waste disposal costs and sampling time;
- better sample consistency; reduced artificial sample variability.

Some disadvantages of low-flow purging are:

- higher initial capital costs,
- greater set-up time in the field,
- need to transport additional equipment to and from the site,
- increased training needs,
- resistance to change on the part of sampling practitioners,
- concern that new data will indicate a *change in conditions* and trigger an *action.*

IV. Low-Flow (Minimal Drawdown) Sampling Protocols

The following ground-water sampling procedure has evolved over many years of experience in ground-water sampling for organic and inorganic compound determinations and as such summarizes the authors' (and others) experiences to date (Barcelona et al., 1984, 1994; Barcelona and Helfrich, 1986; Puls and Barcelona, 1989; Puls et. al. 1990, 1992; Puls and Powell, 1992; Puls and Paul, 1995). High-quality chemical data collection is essential in ground-water monitoring and site characterization. The primary limitations to the collection of *representative* ground-water samples include: mixing of the stagnant casing and *fresh* screen waters during insertion of the sampling device or ground-water level measurement device; disturbance and resuspension of settled solids at the bottom of the well when using high pumping rates or raising and lowering a pump or bailer; introduction of atmospheric gases or degassing from the water during sample handling and transfer, or inappropriate use of vacuum sampling device, etc.

A. Sampling Recommendations

Water samples should not be taken immediately following well development. Sufficient time should be allowed for the ground-water flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

Well purging is nearly always necessary to obtain samples of water flowing through the geologic formations in the screened interval. Rather than using a general but arbitrary guideline of purging three casing volumes prior to sampling, it is recommended that an in-line water quality measurement device (e.g., flow-through cell) be used to establish the stabilization time for several parameters (e.g., pH, specific conductance, redox, dissolved oxygen, turbidity) on a well-specific basis. Data on pumping rate, drawdown, and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

The following are recommendations to be considered before, during and after sampling:

- use low-flow rates (<0.5 L/min), during both purging and sampling to maintain minimal drawdown in the well;
- maximize tubing wall thickness, minimize tubing length;
- place the sampling device intake at the desired sampling point;
- minimize disturbances of the stagnant water column above the screened interval during water level measurement and sampling device insertion;
- make proper adjustments to stabilize the flow rate as soon as possible;
- monitor water quality indicators during purging;
- collect unfiltered samples to estimate contaminant loading and transport potential in the subsurface system.

B. Equipment Calibration

Prior to sampling, all sampling device and monitoring equipment should be calibrated according to manufacturer's recommendations and the site Quality Assurance Project Plan (QAPP) and Field Sampling Plan (FSP). Calibration of pH should be performed with at least two buffers which bracket the expected range. Dissolved oxygen calibration must be corrected for local barometric pressure readings and elevation.

C. Water Level Measurement and Monitoring

It is recommended that a device be used which will least disturb the water surface in the casing. Well depth should be obtained from the well logs. Measuring to the bottom of the well casing will only cause resuspension of settled solids from the formation and require longer purging times for turbidity equilibration. Measure well depth after sampling is completed. The water level measurement should be taken from a permanent reference point which is surveyed relative to ground elevation.

D. Pump Type

The use of low-flow (e.g., 0.1-0.5 L/min) pumps is suggested for purging and sampling all types of analytes. All pumps have some limitation and these should be investigated with respect to application at a particular site. Bailers are inappropriate devices for low-flow sampling.

1) General Considerations

There are no unusual requirements for ground-water sampling devices when using low-flow, minimal drawdown techniques. The major concern is that the device give consistent results and minimal disturbance of the sample across a range of *low* flow rates (i.e., < 0.5 L/min). Clearly, pumping rates that cause minimal to no drawdown in one well could easily cause *significant* drawdown in another well finished in a less transmissive formation. In this sense, the pump should not cause undue pressure or temperature changes or physical disturbance on the water sample over a reasonable sampling range. Consistency in operation is critical to meet accuracy and precision goals.

2) Advantages and Disadvantages of Sampling Devices

A variety of sampling devices are available for low-flow (minimal drawdown) purging and sampling and include peristaltic pumps, bladder pumps, electrical submersible pumps, and gas-driven pumps. Devices which lend themselves to both dedication and consistent operation at definable low-flow rates are preferred. It is desirable that the pump be easily adjustable and operate reliably at these lower flow rates. The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and some volatiles loss. Gas-driven pumps should be of a type that does not allow the gas to be in direct contact with the sampled fluid.

Clearly, bailers and other *grab* type samplers are ill-suited for low-flow sampling since they will cause repeated disturbance and mixing of *stagnant* water in the casing and the *dynamic* water in the screened interval. Similarly, the use of inertial lift foot-valve type samplers may cause too much disturbance at the point of sampling. Use of these devices also tends to introduce uncontrolled and unacceptable operator variability.

Summaries of advantages and disadvantages of various sampling devices are listed in Herzog et al. (1991), U. S. EPA (1992), Parker (1994) and Thurnblad (1994).

E. Pump Installation

Dedicated sampling devices (left in the well) capable of pumping and sampling are preferred over any other type of device. Any portable sampling device should be slowly and carefully lowered to the middle of the screened interval or slightly above the middle (e.g., 1-1.5 m below the top of a 3 m screen). This is to minimize excessive mixing of the stagnant water in the casing above the screen with the screened interval zone water, and to minimize resuspension of solids which will have collected at the bottom of the well. These two disturbance effects have been shown to directly affect the time required for purging. There also appears to be a direct correlation between size of portable sampling devices relative to the well bore and resulting purge volumes and times. The key is to minimize disturbance of water and solids in the well casing.

F. Filtration

Decisions to filter samples should be dictated by sampling objectives rather than as a *fix* for poor sampling practices, and field-filtering of certain constituents should not be the default. Consideration should be given as to what the application of field-filtration is trying to accomplish. For assessment of truly dissolved (as opposed to operationally *dissolved* [i.e., samples filtered with 0.45 µm filters]) concentrations of major ions and trace metals, 0.1 µm filters are recommended although 0.45 µm filters are normally used for most regulatory programs. Alkalinity samples must also be filtered if significant particulate calcium carbonate is suspected, since this material is likely to impact alkalinity titration results (although filtration itself may alter the CO_2 composition of the sample and, therefore, affect the results).

Although filtration may be appropriate, filtration of a sample may cause a number of unintended changes to occur (e.g. oxidation, aeration) possibly leading to filtration-induced artifacts during sample analysis and uncertainty in the results. Some of these unintended changes may be unavoidable but the factors leading to them must be recognized. Deleterious effects can be minimized by consistent application of certain filtration guidelines. Guidelines should address selection of filter type, media, pore size, etc. in order to identify and minimize potential sources of uncertainty when filtering samples.

In-line filtration is recommended because it provides better consistency through less sample handling, and minimizes sample exposure to the atmosphere. In-line filters are available in both disposable (barrel filters) and non-disposable (in-line filter holder, flat membrane filters) formats and various filter pore sizes (0.1-5.0 µm). Disposable filter cartridges have the advantage of greater sediment handling capacity when compared to traditional membrane filters. Filters must be pre-rinsed following manufacturer's recommendations. If there are no recommendations for rinsing, pass through a minimum of 1 L of ground water following purging and prior to sampling. Once filtration has begun, a filter cake may develop as particles larger than the pore size accumulate on the filter membrane. The result is that the effective pore diameter of the membrane is reduced and particles smaller than the stated pore size are excluded from the filtrate. Possible corrective measures include prefiltering (with larger pore size filters), minimizing particle loads to begin with, and reducing sample volume.

G. Monitoring of Water Level and Water Quality Indicator Parameters

Check water level periodically to monitor drawdown in the well as a guide to flow rate adjustment. The goal is minimal drawdown (<0.1 m) during purging. This goal may be difficult to achieve under some circumstances due to geologic heterogeneities within the screened interval, and may require adjustment based on site-specific conditions and personal experience. In-line water quality indicator parameters should be continuously monitored during purging. The water quality

indicator parameters monitored can include pH, redox potential, conductivity, dissolved oxygen (DO) and turbidity. The last three parameters are often most sensitive. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes if the above suggested rates are used. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization. The above stabilization guidelines are provided for rough estimates based on experience.

H. Sampling, Sample Containers, Preservation and Decontamination

Upon parameter stabilization, sampling can be initiated. If an in-line device is used to monitor water quality parameters, it should be disconnected or bypassed during sample collection. Sampling flow rate may remain at established purge rate or may be adjusted slightly to minimize aeration, bubble formation, turbulent filling of sample bottles, or loss of volatiles due to extended residence time in tubing. Typically, flow rates less than 0.5 L/min are appropriate. The same device should be used for sampling as was used for purging. Sampling should occur in a progression from least to most contaminated well, if this is known. Generally, volatile (e.g., solvents and fuel constituents) and gas sensitive (e.g., Fe^{2+}, CH_4, H_2S/HS^-, alkalinity) parameters should be sampled first. The sequence in which samples for most inorganic parameters are collected is immaterial unless filtered (dissolved) samples are desired. Filtering should be done last and in-line filters should be used as discussed above. During both well purging and sampling, proper protective clothing and equipment must be used based upon the type and level of contaminants present.

The appropriate sample container will be prepared in advance of actual sample collection for the analytes of interest and include sample preservative where necessary. Water samples should be collected directly into this container from the pump tubing.

Immediately after a sample bottle has been filled, it must be preserved as specified in the site (QAPP). Sample preservation requirements are based on the analyses being performed (use site QAPP, FSP, RCRA guidance document [U. S. EPA, 1992] or EPA SW-846 [U. S. EPA, 1982]). It may be advisable to add preservatives to sample bottles in a controlled setting prior to entering the field in order to reduce the chances of improperly preserving sample bottles or introducing field contaminants into a sample bottle while adding the preservatives.

The preservatives should be transferred from the chemical bottle to the sample container using a disposable polyethylene pipet and the disposable pipet should be used only once and then discarded.

After a sample container has been filled with ground water, a Teflon™ (or tin)-lined cap is screwed on tightly to prevent the container from leaking. A sample label is filled out as specified in the FSP. The samples should be stored inverted at 4°C.

Specific decontamination protocols for sampling devices are dependent to some extent on the type of device used and the type of contaminants encountered. Refer to the site QAPP and FSP for specific requirements.

I. Blanks

The following blanks should be collected:

(1) field blank: one field blank should be collected from each source water (distilled/deionized water) used for sampling equipment decontamination or for assisting well development procedures.

(2) equipment blank: one equipment blank should be taken prior to the commencement of field work, from each set of sampling equipment to be used for that day. Refer to site QAPP or FSP for specific requirements.

(3) trip blank: a trip blank is required to accompany each volatile sample shipment. These blanks are prepared in the laboratory by filling a 40-mL volatile organic analysis (VOA) bottle with distilled/deionized water.

V. Low-Permeability Formations and Fractured Rock

The overall sampling program goals or sampling objectives will drive how the sampling points are located, installed, and choice of sampling device. Likewise, site-specific hydrogeologic factors will affect these decisions. Sites with very low permeability formations or fractures causing discrete flow channels may require a unique monitoring approach. Unlike water supply wells, wells installed for ground-water quality assessment and restoration programs are often installed in low water-yielding settings (e.g., clays, silts). Alternative types of sampling points and sampling methods are often needed in these types of environments, because low-permeability settings may require extremely low-flow purging (<0.1 L/min) and may be technology-limited. Where devices are not readily available to pump at such low flow rates, the primary consideration is to avoid dewatering of

the well screen. This may require repeated recovery of the water during purging while leaving the pump in place within the well screen.

Use of low-flow techniques may be impractical in these settings, depending upon the water recharge rates. The sampler and the end-user of data collected from such wells need to understand the limitations of the data collected; i.e., a strong potential for underestimation of actual contaminant concentrations for volatile organics, potential false negatives for filtered metals and potential false positives for unfiltered metals. It is suggested that comparisons be made between samples recovered using low-flow purging techniques and samples recovered using passive sampling techniques (i.e., two sets of samples). Passive sample collection would essentially entail acquisition of the sample with no or very little purging using a dedicated sampling system installed within the screened interval or a passive sample collection device.

A. Low-Permeability Formations (<0.1 L/min recharge)

1. Low-Flow Purging and Sampling with Pumps

   a. "portable or non-dedicated mode" - Lower the pump (one capable of pumping at <0.1 L/min) to mid-screen or slightly above and set in place for minimum of 48 hours (to lessen purge volume requirements). After 48 hours, use procedures listed in Part IV above regarding monitoring water quality parameters for stabilization, etc., but do not dewater the screen. If excessive drawdown and slow recovery is a problem, then alternate approaches such as those listed below may be better.

   b. "dedicated mode" - Set the pump as above at least a week prior to sampling; that is, operate in a dedicated pump mode. With this approach significant reductions in purge volume should be realized. Water quality parameters should stabilize quite rapidly due to less disturbance of the sampling zone.

2. Passive Sample Collection

Passive sampling collection requires insertion of the device into the screened interval for a sufficient time period to allow flow and sample equilibration before extraction for analysis. Conceptually, the extraction of water from low yielding formations seems more akin to the collection of water from the unsaturated zone and passive sampling techniques may be more appropriate in terms of obtaining "representative" samples. Satisfying usual sample volume requirements is typically a problem with this approach and some latitude will be needed on the part of regulatory entities to achieve sampling objectives.

B. Fractured Rock

In fractured rock formations, a low-flow to zero purging approach using pumps in conjunction with packers to isolate the sampling zone in the borehole is suggested. Passive multi-layer sampling devices may also provide the most "representative" samples. It is imperative in these settings to identify flow paths or water-producing fractures prior to sampling using tools such as borehole flowmeters and/or other geophysical tools.

After identification of water-bearing fractures, install packer(s) and pump assembly for sample collection using low-flow sampling in "dedicated mode" or use a passive sampling device which can isolate the identified water-bearing fractures.

VI. Documentation

The usual practices for documenting the sampling event should be used for low-flow purging and sampling techniques. This should include, at a minimum: information on the conduct of purging operations (flow-rate, drawdown, water-quality parameter values, volumes extracted and times for measurements), field instrument calibration data, water sampling forms and chain of custody forms. See Figures 2 and 3 and "Ground Water Sampling Workshop -- A Workshop Summary" (U. S. EPA, 1995) for example forms and other documentation suggestions and information. This information coupled with laboratory analytical data and validation data are needed to judge the "useability" of the sampling data.

VII. Notice

The U.S. Environmental Protection Agency through its Office of Research and Development funded and managed the research described herein as part of its in-house research program and under Contract No. 68-C4-0031 to Dynamac Corporation. It has been subjected to the Agency's peer and administrative review and has been approved for publication as an EPA document. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

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Figure 2. Ground Water Sampling Log

Project _____ Site _____ Well No. _____ Date _____

Well Depth _____ Screen Length _____ Well Diameter _____ Casing Type _____

Sampling Device _____ Tubing type _____ Water Level _____

Measuring Point _____ Other Infor _____

Sampling Personnel _____

Time	pH	Temp	Cond.	Dis.O_2	Turb.	[ ]Conc			Notes

Type of Samples Collected

_____

Information: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

Figure 3. **Ground Water Sampling Log** (with automatic data logging for most water quality parameters)

Project _____ **Site** _____ **Well No.** _____ **Date** _____
Well Depth _____ **Screen Length** _____ **Well Diameter** _____ **Casing Type** _____
Sampling Device _____ **Tubing type** _____ **Water Level** _____
Measuring Point _____ **Other Infor** _____

Sampling Personnel _____

Time	Pump Rate	Turbidity	Alkalinity	[ ] Conc	Notes

Type of Samples Collected

nformation: 2 in = 617 ml/ft, 4 in = 2470 ml/ft: $Vol_{cyl} = \pi r^2 h$, $Vol_{sphere} = 4/3\pi r^3$

REVISIONS TO QUALITY ASSURANCE PROJECT PLAN (QAPP) dated August 28, 1998
As approved in Shield Environmental Associates, Inc. RI/FS Work Plan dated Aug. 28, 1998

Section 2.1 Key Personnel and Quality Assurance Responsibilities

The key personnel are changed to the following:

- Project Director – Leonard Eder, P.E. of Eder Consulting, Inc.
- Project Manager – Gregory R. Albright, R.G., C.HG. of Blasland Bouck & Lee, Inc.
- Quality Assurance Officer – D. Robert Gan, P.E. of Blasland Bouck & Lee, Inc.
- Site Supervisor – David Gwozdz of Blasland Bouck & Lee, Inc.
- Site Health and Safety Officer – David Gwozdz of Blasland Bouck & Lee, Inc.
- Sample Custody Officer – David Gwozdz of Blasland Bouck & Lee, Inc.
- The laboratory has been changed to Compuchem (Cary, NC), a NYSDOH and NYSDEC ASP-approved analytical laboratory.

Personnel QA responsibilities remain the same in each category.

QUALITY ASSURANCE PROJECT PLAN

DOVATRON INTERNATIONAL
ORDER ON CONSENT INDEX # B7-0516-97-05
SITE CODE #704024

Former Binghamton Plastics Site
498 Conklin Avenue
Binghamton, New York

Prepared by:

SHIELD ENVIRONMENTAL ASSOCIATES, INC.
Lexington, Kentucky
August 28, 1998

Job No. 395-0430

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1 Quanterra's Quality Assurance Management Plan

1.0 QUALITY ASSURANCE PROJECT PLAN

This Quality Assurance Project Plan (QAPP) sets forth the minimum protocol necessary to achieve the data quality objectives (DQOs) during the remedial investigation and feasibility study (RI/FS). The RI/FS will be conducted by Shield Environmental Associates, Inc. (Shield) at the Former Binghamton Plastics site (the site) in Broome County, New York (#7-04-024). The QAPP prepared for The DII Group will detail quality assurance/quality control (QA/QC) procedures to be followed while conducting site field sampling and analysis tasks.

Shield is committed to the performance of field investigations using procedures that will produce data that are representative of field conditions. QA is of concern to the various agencies and contractors involved in this project. A major component of a QA/QC program is direct feedback from all staff, field and laboratory personnel involved in the project. Any concerns or questions regarding project QA/QC should be directed to the Project Manager or, if appropriate, the QA Officer. Periodic reports regarding QA/QC will be made during the course of the project. At a minimum, reports regarding each major task will be prepared that document the results of any QA/QC inspections or audits. This report will include a list of any specific QA problems encountered along with recommended solutions.

The QAPP has been developed in accordance with the following documents:

- New York State Department of Environmental Conservation (NYSDEC), *Guidance for the Development of Data Usability Summary Reports* (revised on September 1997)
- NYSDEC, *Analytical Services Protocol (ASP)* (1995 Revision Guideline)
- United States Environmental Protection Agency (USEPA), *Test Methods for Evaluating Solid Waste* (SW-846), Third Edition and subsequent updates (Update III)
- USEPA, *Region II CERCLA Quality Assurance Manual* (1989)
- USEPA, *Preparing Perfect Project Plans* (1989)
- USEPA, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual* (1996)
- USEPA, *Technical Guidance Document: Construction Quality Assurance for Hazardous Waste Land Disposal Facilities* (1986)
- USEPA, *Data Quality Objectives Process for Superfund, Interim Final Guidance* (1993).

Also provided in this plan are the laboratory protocols for sample analyses.

1.1 Site Location and Description

The facility, located at 498 Conklin Avenue, Binghamton, Broome County, New York (Figure 1), is situated in an industrial/residential setting. The site is bounded by McIntosh Laboratories to the west, the Erie-Lakawanna Railroad, a public park and Susquehanna River to the north, and residential properties to the east and south.

1.2 Project Objectives

The scope of work (SOW) for this aspect of the project is to provide a detailed plan for the performance of the RI/FS as dictated by the Order on Consent prepared by the NYSDEC. The ultimate goal is to develop and evaluate the appropriate remedial activities, restrict further migration of the contaminant plume into soil and ground water, minimize potential risks to human health and environment, and/or remove the source contamination. To complete the RI/FS and refine the evaluation of the appropriate remedial alternative, sampling of different media is required at the site.

The general objectives for the sampling at the site are:

- To perform sampling such that the sample taken is truly representative of the material or medium being sampled.
- To use proper sampling, sample handling, preservation, and QC techniques.
- To properly identify the collected samples and document their collection in permanent field records.
- To maintain sample chain-of-custody forms.
- To protect the collected samples by properly packing and transporting (shipping) them to a laboratory for analysis.
- To confirm that laboratory protocols and QA/QC are consistent with SW-846 methods and protocols for the NYSDEC.
- To establish the extent of elevated constituents in subsurface soils.
- To characterize the ground water and the extent of ground water contamination.
- To assess the natural attenuation process.

The data collected will be used to:

- Establish the vertical and horizontal distribution of contamination in the surface/subsurface soil and sediment.
- Identify and establish the vertical and horizontal extent of ground water contamination.
- Identify and establish the contaminant mobility and the long-term contaminant disposition.

- Establish the extent and fate of any contamination in the nearby surface water for evaluation of possible future discharges and the degree of contamination reduction expected.
- To identify the possibility/occurrence of natural attenuation and the degradation rate.
- Verify the constituents and volume of ground water requiring treatment.
- Test the efficacy of the soil/ground water treatment and/or removal scenarios.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Key Personnel And Quality Assurance Responsibilities

The project team at the site will work under the direction of the Project Director and Project Manager. Figure 2 provides a chart the showing project organization and lines of authority. Project personnel responsibilities are listed below.

- Project Director: Daniel V. Terrell III, will serve as the Project Director. Mr. Terrell will be responsible for assessing and monitoring the overall project progress, approving project plans and reports, making conclusions/recommendations, and leading major briefings/meeting negotiations.

- Project Manager: Michael E. Morris, P.G., will serve as the Project Manager. Mr. Morris' responsibilities will include project team management, being the focal point for day-to-day client interactions and conducting briefings and client regulatory meetings. Mr. Morris will also be responsible for project scheduling, budget monitoring, technical task integration and communications and coordination of team leaders and field efforts. He will also monitor the project for adherence to the QAPP.

- Quality Assurance Officer: Barbara H. Jones will serve as the Quality Assurance Officer. Ms. Jones has the primary responsibility for overseeing and implementing the quality assurance (QA) program. She reports directly to the Project Director. In her role as Quality Assurance Officer, Ms. Jones will provide independent oversight so that overall QA procedures are in place for the project.

- Site Supervisor: Kreg Mills will be designated as the Site Supervisor. Mr. Mills will be responsible for overseeing all on-site activities. He will also interact with other field personnel so that field efforts are successfully completed. The Site Supervisor will communicate regularly with the Project Manager concerning the project status, additional material and/or labor needs, etc., and keep a daily summary of all on-site activities.

- Site Health and Safety Officer: The Health and Safety Officer is responsible for proper operation of all safety equipment, monitoring activities during site work, selecting the necessary level of personal protection, and enforcing the HASP. Nilda Goxhaj will act as the Health and Safety Officer for this project. The Health and Safety Officer will have the authority to stop work if conditions exceed allowable limits. The Health and Safety Officer will assist other members of the field team as needed to maintain the safe operation of the field program.

- Sample Custody Officer: Kreg Mills will be the Sample Custody Officer. Mr. Mills will be responsible for the proper completion of sample custody forms as well as packing and shipping samples. He will also be responsible for notifying the analytical laboratory of sample shipments including the number and types of samples that are being shipped.

- Sampling Personnel: Sampling personnel are responsible for helping the Site Manager during sample collection. Specific responsibilities include proper sample collection,

packaging, documentation, and chain-of-custody documentation until samples are released to another party for storage or transport to the analytical laboratory. Sampling personnel will also be responsible for the correct and complete decontamination of sampling equipment.

- Drilling/Excavation/Surveying Subcontractors: The drilling/excavation/surveying subcontractors are responsible for supplying all services (including labor), equipment and materials required to perform the excavation/drilling/surveying activities. The excavation subcontractors are further responsible for conducting necessary maintenance and QC of required equipment and for following decontamination procedures specified in the Field Sampling Plan (FSP), HASP, and QAPP. Upon completing the work, the subcontractors will be responsible for demobilizing all equipment, cleaning up any materials deposited on-site, and properly filling excavated/drilled areas as directed.

- Analytical Subcontractor: The analytical subcontractor for this portion of the project will be Quanterra Environmental Services, a full-service analytical laboratory. Quanterra will be responsible for the analysis of all waste, soil, sediment, and liquid samples collected from the site. The laboratory will also be responsible for the QA/QC implementation and documentation of all analyses performed on the samples.

Shield will require that Quanterra comply with the following:

- Provide access to USEPA personnel and USEPA-authorized representatives to assure the accuracy of laboratory results related to the site;

- Perform all analyses according to USEPA SW-846, Third Edition, Update III or other accepted methods.

- Accepted analytical methods will consist of those methods that are documented in the NYSDEC *Analytical Service Protocol* (1995 Revision Guideline), *Contract Lab Program Statement of Work for Inorganic Analysis* (Revision 11, 1994) and *the Contract Lab Program Statement of Work for Organic Analysis* (Revision 9, 1992), and any amendments thereto.

Quanterra participates in the New York State Department of Health's (NYSDOH) Environmental Approval Program (ELAP) QA/QC program and has analyzed samples that the NYSDOH submitted to ensure that they meet the approved QA/QC requirements. Quanterra's Quality Assurance Management Plan is contained in Attachment 1. They have passed their most recent performance evaluation. See Section 7.2 for additional detail.

While all project personnel and subcontractors are responsible for adherence to specific QA/QC aspects of the project, the following laboratory personnel will be responsible for laboratory QA/QC:

- General Manager: The General Manager is responsible for evaluating the information supplied by the Operations Director. This responsibility includes the commitment to provide the leadership and financial resources necessary so that the laboratory and staff are able to offer the highest quality, scientifically sound and legally defensible data and services to clients. The General Manager reports directly to the Quanterra president.

- Operations Director: The Operations Director is responsible for planning the analytical growth and development of all laboratory sites. This individual is involved in productivity assessments for each facility and establishes the direction each will take to meet the analytical needs of the client. Additional responsibilities include seeing that all analytical programs comply with applicable regulatory requirements. The Operations Director reports to the General Manager.

- Quality Assurance Director: The QA Director establishes and directs the activities relating to analytical QA/QC at laboratory sites. This person represents the organization in all matters pertaining to QA/QC. The QA Director reports to the General Manager.

- Laboratory Director: The Laboratory Director oversees daily operations of the analytical laboratory. Responsibilities include interacting with group coordinators and project managers to coordinate the projects and workload. In addition, this person assumes responsibility for maintaining method compliance in the laboratory. The Laboratory Director interacts with the QA Manager in the laboratory and ensures the incorporation of all such requirements into daily operations. This person aids the QA Manager in addressing corrective actions and preparing the laboratory to meet certification and approval program requirements. The Laboratory Director reports to the Operations Director.

- Quality Assurance Manager: The QA Manager supervises QA/QC functions pertaining to laboratory analytical operations. These responsibilities include managing certification and approval programs, maintaining QA/QC objective data, conducting internal QA/QC audits, maintaining internal QA/QC data, and preparing and submitting any QA plans. The QA Manager is responsible for seeing that all final data meet the criteria of the QC program and reports directly to the QA Director and indirectly to the Laboratory Director.

- Project Manager: The Project Manager is responsible for the timely completion and reporting of all projects. This person ensures that the project QA objectives have been met and that project problems encountered with any facet of the laboratory have been adequately addressed. The Project Manager reports to the Laboratory Director and Customer Service Manager while coordinating activities with the Laboratory Business Development Director.

- Sample Custodian: The Sample Custodian ensures that all submitted samples are properly accepted into the laboratory in accordance with documented sample acceptance procedures and that associated sample instructions are entered into the laboratory data management system. This person examines each sample and reports on the condition, preservation, and documentation of each. The Sample Custodian reports to the Laboratory Director.

- Organic Manager: The Organic Manager implements and supervises all analytical activities pertaining to their respective analytical group. This individual is responsible for coordinating projects and associated workloads. This person also ensures that the proper QC requirements are incorporated into the daily operation of the group. This individual also participates on the Organic Technical Committee. The Organic Manager reports to the Laboratory Director.

- Inorganic Manager: The Inorganic Manager implements and supervises all analytical activities pertaining to their respective analytical group. This individual is responsible for

coordinating project and associated workloads. The Inorganic Manager also ensures that the proper QC requirements are incorporated into the daily operation of the group. The Inorganic Manager also participates on the Inorganic Technical Committee. The Inorganic Manager reports to the Laboratory Director.

- Analytical Group Coordinators: The Analytical Group Coordinators implement and supervise all analytical activities pertaining to their respective analytical groups (gas chromatogram [GC], gas chromatogram/mass spectometry [GC/MS], inorganics). They will coordinate projects and the workload while ensuring that proper QC requirements are incorporated into the daily operation. These people also review raw data and analytical results. The Analytical Group Coordinators report to their respective Group Managers.

3.0 QUALITY ASSURANCE OBJECTIVES

3.1 Data Quality Objectives

The DQO process is a "series of planning steps based upon the Scientific Method that is designed so that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application" (USEPA 1994). DQOs help to clarify study objectives, define types of data to collect, establish appropriate conditions from which to collect data, and specify levels of decision. Guidance for developing DQOs is contained in the NYSDEC's Division of Environmental Remediation's *Guidance for the Development of Data Usability Summary Reports* and the USEPA document entitled *Guidance for the Data Quality Objectives Process*, dated September 1994. This document revises and updates existing USEPA documents regarding DQOs.

DQOs are qualitative and quantitative statements that:

- Clarify the study objective.
- Define the most appropriate type of data to collect.
- Establish the most appropriate conditions from which to collect the data.
- Specify acceptable levels of decision errors that will be used as the basis for establishing the quantity and quality of data needed to support the decision.

The DQOs for soil sampling at the site are to collect additional data to define and further refine the areas with affected soil. Also, additional data will be collected during the soil sampling to identify if any of these soils are characteristically hazardous. These data will be used to verify the location of soils to be excavated/remediated and refine any estimates of affected soil volume. Visual observations will also be made during soil sample collection regarding subsurface conditions, the presence of ground water and the presence of stained and/or odorous soil.

The DQOs for ground water sampling are to collect representative ground water samples. Ground water level information will also be collected for use in constructing potentiometric surface maps as applicable. The quantitative ground water data will be used to verify the types of contaminants previously detected in ground water, the horizontal and vertical extent of contamination, the rate and extent of natural attenuation of organic compounds, and to evaluate natural attenuation parameters. These data will also be used to assess ground water treatment technologies and for the design of appropriate remedial technologies.

The DQOs for sediment sampling include the collection of data to estimate the extent of affected sediments and to evaluate the natural attenuation process at the site. The data will also be used to evaluate potential remedial options. The proposed sediment samples will be discrete samples.

The DQOs for surface water sampling will be to establish the extent and fate of any contamination in the on-site surface waters and to evaluate possible future discharges, natural attenuation processes, and potential remedial options.

The DQOs for air monitoring at the site consist of collecting qualitative data to evaluate the impacts of site activities on the surrounding air quality. Qualitative data will be used during field efforts to change or upgrade the levels of respiratory protection for site workers. Some of these data will also be used to develop specific FS documents.

The analytical DQOs for the site are summarized in Table 1. This table lists the tasks to be performed, data uses, and analytical levels.

3.2 Intended Use of The Data

The intended use of the data generated as a result of the RI at the site is summarized below.

3.2.1 Soil

- To further define the horizontal and vertical extent of soils with elevated concentrations of trichloroethene (TCE) and associated degradation products prior to site remediation activities.
- To assess the subsurface conditions along the utility lines (i.e., storm and sanitary sewer; electrical, gas and water lines; footer drains).
- To evaluate and design potential remedial options.

3.2.2 Ground Water

- To collect ground water level data for use in preparing potentiometric surface maps.
- To collect ground water contaminant concentration data for use in preparing isoconcentration surface maps for concerned compounds.
- To further assess the types of chemicals and their concentrations in ground water.
- To further assess the vertical and horizontal extent of the ground water contamination.
- To assess hydrogeological conditions and parameters through aquifer testing and to establish sufficient field data to simulate ground water modeling.
- To assess and evaluate the mobility and migration of the contaminant traveling along the flow path.
- To assess the potential ground water treatment scenarios.

3.2.3 Sediment

- To establish the presence or absence of contaminants in sediments downgradient of the site.
- To establish the degree of the contamination reduction expected, if present.
- To evaluate the natural attenuation process.

- To evaluate potential remedial options, if necessary.

3.2.4 Surface Water

- To assess water quality in nearby surface water.
- To establish the degree of contamination reduction along the flow path, if necessary.
- To evaluate potential remedial options, if necessary.

3.2.5 Air Monitoring

- To qualitatively assess the concentrations of VOCs present during site activities.
- To assess and evaluate the level of worker personal protective equipment (PPE) required.

3.3 Objectives For Accuracy, Precision, and Completeness

3.3.1 Accuracy

Accuracy measures the bias in a measurement system that is difficult to measure for the entire data collection activity. Sources of error are the sampling process, field contamination, preservation, handling, sample matrix, sample preparation and analysis techniques. Sampling accuracy may be assessed by evaluating the results of field/trip blanks. Analytical accuracy may be assessed through use of known and unknown QC samples and matrix spikes. The objective of the sampling will be to attempt to keep the trip and field blanks as close to nondetect levels as possible. For analytical data, the percent recoveries of surrogates, QC check standards and matrix spike analyses are used to evaluate the analysis accuracy. The data's accuracy will also be verified by the Quality Assurance Officer based on the NYSDEC's *Guidance for the Development of Data Usability Summary Reports*.

3.3.2 Precision

Precision is a measure of the mutual agreement among individual measurements of the sample parameters under prescribed similar conditions. The overall precision of measurement data is a mixture of sampling and analytical factors. Analytical precision is much easier to control and quantify than sampling precision. Sampling precision may be established by collecting and analyzing field replicate samples and then creating and analyzing laboratory replicates from one or more of the field samples. The analytical results from the field replicate samples provide data on overall measurement precision; analytical results from the laboratory replicates provide data on analytical precision. Subtracting the analytical precision from the measurement precision defines the sampling precision.

The analytical precision will be monitored using results from duplicate or replicate analyses of samples and from matrix spikes performed in duplicate on a given matrix. The Relative Percent Difference (RPD) is used to evaluate the precision of replicate analysis. All analytical procedures will be in compliance with the NYSDEC Analytical Services Protocol (ASP).

3.3.3 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under correct normal conditions. Completeness is the percentage of data that remains valid after a precision and accuracy determination. Field measurement techniques (Level I and II) should have nearly 100 percent completeness since invalid measurements are to be repeated until valid. Laboratory analytical techniques will follow protocol and parameters of the NYSDEC ASP.

4.0 SAMPLING PROCEDURES

This section presents methods of environmental sampling. These activities, including collection, preservation, packaging, handling, shipping, and storage of samples, will be performed in general accordance with procedures described by the following guidance documents; USEPA *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual* (1996); USEPA *Compendium of ERT Waste Sampling Procedures* (January 1991); USEPA *Compendium of ERT Ground Water Sampling Procedures* (January 1991); USEPA *Compendium of ERT Surface Water and Sediment Sampling Procedures* (1991).

The following fundamental issues will be addressed during project planning:

- Site, adjacent property, and weather conditions
- Sampling personnel
- Health and safety
- Frequency of sampling
- Equipment decontamination
- Methods of sampling to be employed
- Matrix to be sampled
- QA objectives
- Number of samples to be collected
- Volume of samples to be collected
- Analyses to be performed in the field
- Equipment calibration
- Analyses to be performed by the laboratory
- Procedures and precautions to be followed during sampling
- Methods of sample preservation and shipment
- Disposal of sampling materials
- Recordkeeping
- Chain-of-custody documentation

The following general field procedures will be used for the field investigation to be conducted by Shield personnel:

- Visit and assess the site.
- Prepare a site map that shows the locations of sample monitoring stations and other features related to the field sampling.
- Record locations of roads, utility lines, property boundaries, sensitive receptors, etc.
- Establish the matrix to be sampled, become familiar with the applicable safety precautions and practices, obtain the necessary safety equipment, and prepare the sample collection program.
- Obtain the equipment and materials necessary to perform field sampling and analyses.
- Become familiar with the overall scope of the study, sampling equipment, QA objectives, sample handling procedures, and shipping requirements.

- Calibrate all field equipment prior to and during field work according to the manufacturer's instructions and calibration procedures described in Section 6.0.
- Perform field sampling in accordance with the FSP, HASP and QAPP.
- Complete all field logs prior to leaving the field location.
- Verify that all sample containers are labeled with appropriate information. This includes project number and name, sample number, location, sampling date and time, preservatives added, and sampler's signature.
- Complete chain-of-custody records that will accompany all samples during shipment.

All exploration and sampling activity information will be documented. Documentation of sampling activities includes photographic records, subsurface drilling or trench logs, test data forms, field data collection forms, and air monitoring forms. A listing of soil and sediment sampling equipment, including restrictions for the various construction materials, is contained in Table 2.

All sample bottles and containers will be precleaned and obtained from the laboratory. All sampling activities will be documented in the field logbook. Sample containers, volumes, preservation techniques, and holding times will be consistent with USEPA SW- 846 or other applicable methods as listed in Table 3. Table 4 represents the target compound list/target analyte list (TCL/TAL) during preliminary investigation. Table 5 is a site-specific parameter list containing the nine compounds of concern. The order for sample collection at the site is as follows:

- In situ measurements (e.g., temperature, pH, conductivity, turbidity, dissolved oxygen [D.O.], and oxidation reduction potential [Redox]), if warranted
- TCL of VOCs or Site-Specific Parameter List (SSPL)
- TCL Semivolatile Organic Compounds (SVOCs)
- TCL Pesticides/Polychlorinated Biphenyls (PCBs)
- TAL of total metals

Analyses performed will be at or below the detection limits shown on Tables 4 and 5. Detailed sampling procedures are provided in the FSP prepared for this site. Table 6 provides a sampling checklist for field personnel.

4.1 Soil/Sediment Sampling Protocol

4.1.1 Soil/Sediment Sampling

Soil and sediment samples will be collected using the following equipment as appropriate:

- Stainless steel spoon
- Stainless steel scoop
- Stainless steel shovel

- Stainless steel hand auger
- Shelby tube
- Split-spoon sampler
- Direct-push sampler
- Glass or stainless steel bowls
- Coring device
- Backhoe or trackhoe

Soil and sediment samples will be analyzed for the SSPL. Other selected samples will be analyzed for TCL VOCs, TCL SVOCs, TCL Pesticides/PCBs, and TAL total metals.

4.1.2 Soil/Sediment Sampling Equipment Decontamination

Decontamination of soil, sediment, surface water, and ground water sampling equipment will be performed at a designated central staging area at the site. The soil and sediment sampling equipment will be decontaminated in the field using the following procedures:

- Upon arriving at the site, nondecontaminated equipment will be cleaned with potable water and a laboratory-grade soap solution using a brush to remove particulate matter/surface films. Water may be used from any municipal water treatment system.

- The equipment will then be rinsed thoroughly with potable water.

- The equipment will be rinsed with 10% nitric acid if sample will be analyzed for metals.

- The equipment will be rinsed with potable water.

- Acetone or methanol rinse will be used if the sample will be analyzed for organics.

- The final rinse will consist of a distilled water rinse, and the equipment will be allowed to air dry as long as possible. Air drying will be conducted only when the presence of airborne contaminants and dust particles are not suspected.

- Each piece of equipment will be enclosed in a clean, high-density polyethylene container (smaller items) or in plastic bags (larger items) for storage or transportation. Aluminum foil also may be used to wrap decontaminated sampling equipment. However, foil will not be used on samples for metals and plastic will not be used on samples to be used for organics.

- If no further sampling is to be performed, the equipment will be decontaminated as described above prior to storage.

- All sample coolers will be cleaned before use by washing the interior and exterior with a laboratory-grade soap solution and rinsing with potable water.

- Soil and sediment sampling equipment that is heavily contaminated to the point where it can not be decontaminated will be properly discarded.

- Steam cleaning will be used for large equipment such as backhoes, trackhoes, or drill rigs.

Deviations from the above procedures will be documented and justified in the daily logs or a logbook. Wastes generated during decontamination will be containerized for proper characterization and disposal, as appropriate.

4.2 Ground Water Sampling

As a part of the site activities, ground water will be sampled. Ground water samples will be collected from ground water monitoring wells during field work conducted at the site. Wells will be sampled from the least contaminated well to the most contaminated well. When sampling ground water, precautions need to be taken so that samples collected are representative of the aquifer. All sample containers will be obtained from the laboratory.

Low-flow purging and sampling technique (US. EPA 1996) will be used on all of the monitoring wells. Should it be evident that low-flow purging and sampling is not practical, then as a last resort, purging and sampling will be accomplished using either a submersible pump or disposable bailer. A minimum of three well volumes will be purged from wells prior to sampling for those wells not being sampled by low-flow purging. All samples will be collected immediately after the field parameters (i.e., pH, conductivity, D.O., turbidity, temperature, and redox) have stabilized. If wells require redevelopment prior to sampling, redevelopment will be conducted to assure that representative samples will be collected. Other equipment to be used during purging includes water level indicators; thermometers; and pH, conductivity, D.O., turbidity, and redox meters. Detailed sampling procedures are contained in the FSP.

4.3 Surface Water Sampling

Surface water samples will be collected in the shallow water from the catch basins and catch basin outfalls by submerging a disposable sample collection container. The container will be submerged by hand or by using a telescopic heavy-duty aluminum pole with an adjustable baker clamp attached to the end. During sample collection, the mouth of the jar will be positioned upstream, with sampling personnel standing downstream to avoid disturbing sediments, which could contaminate the sample. Water will be transferred from the collection container to the sample containers. Downstream samples will be collected prior to upstream samples to minimize disturbance of sediments at subsequent sampling locations. Detailed sampling procedures are contained in Field Sampling and Analysis Plan (FSAP).

4.4 Duplicate/Split Sampling Procedures

One duplicate sample will be collected for every 20 samples. Duplicate or split soil samples (except for VOC samples) will be collected from a glass or stainless steel bowl after the samples have been thoroughly mixed and homogenized. The sample will be transferred from the bowl with a stainless steel spoon to the duplicate sample containers in equal portions until the containers are full. This procedure will be conducted for each parameter group, except VOC samples, which will be collected directly from the soil or from the sampling device at approximately the same depth interval.

Duplicate soil samples will be handled the same as the other field samples and shipped to the contracted laboratory for analysis. All duplicate samples will be assigned a coded identification number that will be recorded on the Sample Tracking Log. Split samples, which will be collected upon the request of a regulatory agency, will be identified in the same way as the corresponding field sample and shipped to a separate laboratory for analysis as an external quality control check.

4.5 Trip Blank Protocol

A trip blank will accompany each cooler containing water samples to be analyzed for volatiles. Preservatives will be added, and containers will be sealed prior to shipment. The trip blank will be supplied by the laboratory and analyses of the water used will be available from the laboratory indicating that it is clean for all project parameters.

4.6 Rinseate Blank Protocol

A rinseate blank (equipment/rinseate) will be collected once per matrix sampling event (e.g., ground water sampling) upon completion of decontamination procedures. This blank will be a sample of laboratory pure water passed through the sampling equipment to test cleanliness. Analyses of the rinseate water used will be available from either the laboratory or manufacturer indicating that it is clean for all project parameters. The analytical results of the field blank are required to be below detection limits for the project as indicated in Tables 4 and 5.

4.7 Matrix Spike/Matrix Spike Duplicate Protocol

Matrix spike/matrix spike duplicate (MS/MSD) samples will be analyzed at a frequency based on the NYSDEC ASP protocol.

5.0 SAMPLE CUSTODY

Samples will be stored in a cool place away from direct sunlight. As soon as samples are collected and preserved, they will be stored in an iced cooler at 4°C. Sample shipment will be designed to protect the integrity of and prevent damage to the samples. Properly identified, sealed sample containers will be placed in fiberboard containers or picnic-type coolers. Sufficient absorbent cushioning material will be used as needed to minimize the possibility of sample container breakage. Sample containers will have a completed sample identification tag. The outside of the container will be marked "water" or "soil" sample. The specific method of shipping the samples will be at the discretion of the Project Manager. Field personnel will make sure that sample container lids are tight and secure before storing. The coolers will be sealed with strapping tape and custody seals to prevent tampering during shipment. Samples will be promptly shipped (for overnight delivery) by personal delivery, local courier service or overnight delivery courier to the appropriate laboratory to abide by sample holding times. Samples will be shipped to the laboratory within 24 hours of collection.

5.1 Chain-of-Custody Procedures

Written procedures will be followed whenever samples are collected, transferred, stored, analyzed or destroyed. The primary objective of these procedures is to create an accurate written record that can be used to trace the possession and handling of the sample from the moment of its collection through analysis and its introduction as evidence.

A sample is in someone's "custody" if:

- It is in one's actual possession; or
- It is in one's view, after being in one's physical possession; or
- It is in one's physical possession and then locked up so that no one can tamper with it; or
- It is kept in a secured area, restricted to authorized personnel only.

5.2 Sample Collection, Handling, and Identification

The number of persons involved in collecting and handling samples will be kept to a minimum. Guidelines established for sample collection, preservation and handling will be used. Field records will be completed at the time the sample is collected and will be signed or initialed, including the date and time, by the sample collector(s). Field records will contain the following information:

- Unique sampling or log number
- Date and time of sample collection
- Source of sample (including name, location, and sample type)
- Preservative used (if any)
- Analysis required
- Name of collector(s)
- Other pertinent field data

One member of the sampling team will be appointed Sample Custody Officer. Samples are turned over to the Sample Custody Officer by the team members who collected the samples. The Sample

Custody Officer documents each transaction, and the sample remains in his/her custody until it is shipped to the laboratory.

Each sample is identified by affixing a standardized sample label on the container(s). This label will contain the sample identification number, date and time of collection, source, preservative used, analysis required, and the collector's initials. If a sample label is not available, the same information will be recorded on the sample container in waterproof ink.

The sample container will then be placed in a cooler or transportation case, along with the chain-of-custody record, pertinent field records, and analysis request form as needed. The cooler or transportation case will be sealed or locked. A locked or sealed chest eliminates the need for close control of individual samples.

It is desirable to photograph the sample location to facilitate identification later. At the time the photo is taken, the photographer will record time, date, site location, and a brief description of the subject in the field logbook and in the photographic reporting data sheet as shown in Table 7. Photographs and written records will be handled in a way that chain of custody can be established.

5.3 Transfer of Custody and Shipment

When transferring the samples, the transferee must sign and record the date and time on the chain-of-custody record. Custody transfers made to a sample custodian in the field will account for each sample, although samples may be transferred as a group. Each person who takes custody must fill in the appropriate section of the chain-of-custody record. To minimize custody records, the number of custodians in the chain of possession will be minimized.

All packages sent to the laboratory will be accompanied by the chain-of-custody record and other pertinent forms. A copy of these forms will be retained by the originating office (either carbon or photocopy). Mailed packages can be registered with return receipt requested. For packages sent by common carrier, receipts will be retained as part of the permanent chain-of-custody documentation. Samples to be shipped must be packed so as not to break, and the package will be sealed or locked so that any tampering can be readily detected.

5.4 Laboratory Sample Custody

An integral part of the laboratory's QA/QC program is the establishment of and strict compliance with rigorous sample custody protocol. This protocol pertains to laboratory operations and guarantees the integrity of all samples processed and analyzed.

Upon receipt by the laboratory, the sample custodian executes the chain of custody and verifies the data contained in the sample custody records. In addition, the sample containers are checked so that the custody seal and the sample label are received in proper condition. Samples on the chain of custody are assigned one project number. Each sample of the chain of custody is assigned a unique laboratory identification number. The samples are then recorded in Quanterra's computerized Laboratory Information Management System.

Detailed laboratory sample custody procedures are contained in Attachment 1. Additional sample custody procedures are contained in Section 6.0 of the FSP.

6.0 CALIBRATION PROCEDURES

6.1 Field Calibration Procedures

The calibration of field equipment will be as specified in the operations manual for the particular piece of equipment. All equipment will be kept in good working order, and the Site Manager will be responsible for its maintenance and calibration.

Field instrument calibration, an activity that affects data quality assurance, is to be performed in accordance with the following procedures. Calibration will be performed in the field prior to each field event, at the end of each day, and following any unexpected, unusual, or suspect instrument readings. Calibration activities will occur in the support zone and upwind of field activities. Copies of the manufacturer's calibration guidance is maintained with the respective instruments.

Calibration activities will be documented in the project calibration logbook. A copy of a typical air calibration log is provided in Table 8. The calibration data will include date, time, type and name of equipment, identification or serial number, results of calibration measurements, and name(s) of personnel conducting calibration. If the calibration schedules are not maintained or the specified accuracy cannot be attained, the instrument will be withdrawn for maintenance.

The primary field measurement equipment to be used at the site includes:

- Photoionization detector (PID)
- Flame ionization detector (FID)
- Particulate Monitor (Miniram)
- Combustible gas indicator (CGI)
- Water level indicator
- YSI multiparameter sonde (temperature, pH, conductivity, D.O., redox, turbidity)

Procedures for equipment calibration are described in each of the manuals for the various equipment and specific calibration requirements will accompany each instrument. Table 9 lists QA targets for field measurements (screening methods). These targets will be used to assess the precision and accuracy of field measurements to establish when corrective actions are necessary. Table 10 indicates corrective actions to be undertaken if the acceptable criteria are not met.

6.2 Laboratory Calibration Procedures

The calibration and upkeep of laboratory equipment will be the responsibility of the Laboratory Manager or other designated, qualified personnel. All equipment and instruments used in laboratory operations for quantitative measurements are controlled by a formal calibration program.

Calibrations may be periodic or operational. These calibrations are described in operation-specific and laboratory standard operating procedures. At a minimum, these procedures will include:

- Instrument to be calibrated.
- Reference standards used for calibration.

- Calibration technique (e.g., linear, quadratic).
- Acceptable performance tolerances and corrective actions required if specifications are not met.
- Frequency of calibration.
- Calibration documentation requirements.

Whenever possible, recognized procedures such as those published by the American Society of Testing and Materials (ASTM) or the USEPA or procedures provided by manufacturers will be adopted. If established procedures are not available, a procedure will be developed considering the type of equipment, stability characteristics of the equipment, required accuracy, and the effect of operation error on the quantities measured. Additional calibration procedures are specified in the laboratory QA manual (see Attachment 1).

7.0 ANALYTICAL PROCEDURES

7.1 Field Analytical Procedures

QA procedures for field analysis and field analytical and test instrumentation calibration are an essential part of standard operating procedures. To satisfy QA/QC procedures, all field analyses will be conducted in duplicate at least 10 percent of the time. A record of these duplicate analyses will be kept in field logbooks. A significant difference in the replicate analyses will result in recalibration of the instruments used, reexamination of the analytical methodology being used, or reexamination of the sampling procedures and locations.

All field analyses must be traceable to the specific individual performing the analyses and to the specific equipment used. This information will be entered into the field logbooks for all field analyses. Time records will be kept in local time and will be recorded to the nearest 5 minutes.

A specific calibration and/or standardization plan for all field analytical equipment is presented in this subsection and includes the following information: calibration and maintenance intervals; a listing of required calibration standards; environmental conditions requiring recalibration; and use of a logbook to record calibration and maintenance data for each piece of field analytical equipment.

7.1.1 Temperature

Temperature will be measured in the field by using the YSI multiparameter sonde, and/or thermometer, thermistor, or a mechanical dial-type thermometer. The YSI 6 multiparameter sonde is equipped with precision thermistors to assure accurate temperature measurement. The temperature range for the YSI 600 multiparameter probe is -5 to +50 degrees centigrade, with 0.15 degrees centigrade of accuracy. Calibration procedures are not necessary for the thermistors in the YSI 600 unit probe. The water temperature at the sampling location will be recorded first, before measuring other water quality parameters. Temperature data will be reported to the nearest 0.5 °C.

The thermometers will be initially calibrated against a National Bureau of Standards (NBS) certified thermometer or one traceable to NBS certification. Each glass, mercury-filled thermometer will be inspected before each field trip to see that it is not cracked and does not have air spaces in the mercury column. If a mechanical, dial-type thermometer is used, it will not have a broken face cover or otherwise show damage. A cross-check with a calibrated NBS certified thermometer will be made at least semiannually. Thermistors and electronic readout units will be calibrated in the same manner. Recording thermometers will be checked for recording accuracy before each use. The recorder time scale accuracy will be checked semiannually. Before using a thermometer in the field, a visual observation will be made to verify that it has not been damaged. If a thermistor is used, the instrument will be checked against a thermometer before field use. Cross-checks and duplicate field analyses will agree to within ± 0.5 °C.

All calibration information, the names of individuals making the calibrations, and dates of calibration will be recorded. Each field calibration will be noted in the field logbook indicating the temperature readings observed. Temperature data will be reported to the nearest 0.5 °C.

7.1.2 pH

Electronic (portable) meters with provisions for temperature compensation will be used. Temperature-resistant combination electrodes will be used in conjunction with the meters. Test paper will be used only for establishing pH ranges or approximate pH values.

The pH meter or the YSI multiparameter sonde will be checked before each field trip for any mechanical or electrical failures, weak batteries and cracked or fouled electrodes. They will be checked initially with three fresh standard buffer solutions (e.g., 4, 7 and 10). All pH recorders will be checked for recording and time scale accuracy. While in the field, the meters will be calibrated daily before use with two buffers bracketing the expected sample pH. Prior to each sample collection, or in case of an apparent pH anomaly, the electrode will be checked with pH 7.0 buffer and recalibrated to the closest reference buffer. The sample will then be retested. Duplicate analyses will agree to within 0.1 standard units.

A logbook will be maintained and will contain the property number of each pH meter, all calibrations and repairs made, the name of the person making repairs, and calibration records. Measurements of pH will be reported to the nearest 0.1 standard unit.

7.1.3 Specific Conductance

A portable specific conductance meter or the YSI multiparameter sonde will be used. Each conductivity meter will be checked before every field trip. Batteries will be checked, and conductivity cells will be cleaned periodically. Before use in the field, the instrument will be checked daily with known standards. The instrument instructions will be referred to for temperature conductance calculations. Duplicate field analyses will agree to within ±3 percent.

All repairs and calibrations will be noted in the field calibration logbook. The logbook will include all calibrations and repair information along with the name of the person making the repair.

Results will be expressed in micromhos/centimeter (umhos/cm), or in microseconds/centimeter (mS/cm) for YSI sonde, corrected to 25°C. Results will be reported to the nearest ten units for readings under 1,000 umhos/cm and the nearest 100 units for readings over 1,000 umhos/cm.

7.1.4 Dissolved Oxygen

The D.O. probe of the YSI sonde will be placed in approximately one-eighth inch of water or a wet sponge in the bottom of the calibration cup. Ten minutes will be needed for the air in the calibration cup to become water saturated and for the temperature and D.O. probe to equilibrate. The current barometric pressure will be entered in mm of Hg. (Inches of Hg x 25.4 = mm Hg.) When the interface screen shows no significant change in the percent D.O. readings, the probe will be calibrated.

Prior to field use, the membrane of the D.O. meter/YSI sonde will be inspected for air bubbles and/or holes. If either exists, the membrane will be replaced. If the membrane is dry prior to use, it will be soaked in analyte-free water prior to calibration. The D.O. meter will be calibrated prior to use according to the manufacturer's instructions.

When making field measurements, care will be taken to make sure the instrument and all parts are functioning properly. The temperature and salinity compensators (if equipped) will be adjusted. The D.O. meter will be read to the nearest 0.1 ug/L. Whenever possible, D.O. will be measured in situ with a field probe. Duplicate field analysis will agree within 10%.

7.1.5 Redox Potential

Redox potential is measured electrometrically using a platinum electrode and a reference potential. Redox readings are affected by exposure to atmospheric oxygen; therefore, flow-through cells will be used.

Prior to field use, the electrode will be inspected for damage or breakage. The electrode will be calibrated at least once a day prior to use according to the manufacturer's instructions. Duplicate field analysis will agree to within ±10 mv.

7.1.6 Turbidity

The YSI multiparameter sonde or a portable turbidity meter, Hereby Water Quality Checker U-10 or equivalent, will be used to obtain measurements of turbidity. The meter will be checked prior to every trip to the field. Each check will include cleaning the turbidity cell, checking the battery charge, and checking the instrument for calibration. Prior to its initial use, the equipment will be calibrated in the field with three known standards in accordance with the procedures stated in the equipment's instruction manual. A two-point equipment calibration will be performed daily to maintain the accuracy of the tested parameter. Duplicate field analysis will agree to within ±10%.

A section in the calibration logbook will be maintained for the turbidity meter. The logbook will contain recordings of the serial numbers for the turbidity meters used, meter-specific repairs, if necessary, and all daily calibration reports. Results are expressed in Nephelometric Turbidity Units (NTUs) corrected to 25°C to the nearest whole number.

7.1.7 Ground Water Level Measurements

An electric water level indicator will be used for measuring potentiometric surface ground water levels at the site. This instrument consists of a spool of dual conductor wire with a probe attached to the end and an indicator. When the probe comes into contact with the water, the circuit is closed and a light or buzzer signals the contact. Three measurements will be averaged to the nearest 0.01 foot.

Prior to use, the probe will be inspected for damage and the instrument will be tested in a bucket of water. Batteries will be checked also. If the instrument has not been decontaminated, decontamination procedures will be followed as indicated in the FSP.

7.2 Laboratory Analytical Procedures

Analytical methods to be used during the course of this project are listed in Tables 4 and 5. Analytical procedures for these methods will be consistent with *Test Methods For Evaluating Solid Waste, USEPA SW-846, Third Edition* and subsequent updates, the NYSDEC *Analytical Laboratory Services* (1995 Revision Guideline) and the NYSDOH's ELAP protocol.

Quanterra (North Canton, Ohio) will provide chemical analytical services for this project. Quanterra offers conventional laboratory services with a particular emphasis on providing full-service analytical capabilities. The laboratory maintains a number of analytical programs designed to fulfill the needs of its clients in the technical aspects of environmental control and regulatory compliance.

Quanterra has passed the performance evaluation (PE) testing and was an active participant in the NYSDEC's ASP and the NYSDOH's ELAP. A copy of the Quanterra QA Management Plan is provided in Attachment 1. This document provides detailed information on laboratory procedures including standard operating procedures, analytical methods, detection limits, QA procedures, and QC methods used in the laboratory.

8.0 DATA REDUCTION, VALIDATION AND REPORTING

Throughout the course of the field activities at the subject site, additional samples (soil, sediment, and ground water) will be collected and analyzed to verify and validate that sampling procedures and methods generate quality, reproducible results. It is anticipated that approximately 10 percent of the field samples collected will be used for QA/QC purposes. QA/QC samples will include field blanks, trip blanks, duplicate samples as appropriate and as indicated in the SOW for this site.

An appropriate training program will also occur so that field personnel are thoroughly familiar with all sampling, decontamination, and recordkeeping procedures for the project. Personnel will be familiar with the use and calibration of all equipment. In addition to field QA/QC procedures, the laboratory will also follow a QA/QC program to maintain sample validation. QC checks are performed on a routine basis in all laboratories.

All analytical data received from the laboratory by the QA Officer will be checked for completeness and consistency with chain-of-custody documentation. Any obvious errors will be checked with field and laboratory personnel. The QA Officer will also review data to compare with field observations and measurements and investigate any obvious inconsistencies or errors. The following narrative outlines the data reduction, validation, and reporting methods to be used by Shield personnel.

8.1 Data Reduction

Field instruments for establishing pH, temperature, conductivity, D.O., redox, turbidity, flow, and total organic vapors are direct reading displays requiring no data reduction or use of equations. Laboratory data will not require data reduction; however, both field and laboratory data will be summarized in tabular format for ease of review, and duplicate analyses compared for inconsistencies.

8.2 Data Validation

8.2.1 Field Data Integrity

It is the duty of the project QA Officer to verify the integrity of the field reportable data. This involves reviewing all field logs, reviewing and checking raw data entries and calculations, checking calibration procedures, and verifying the custody integrity of all samples collected.

8.2.2 Field Data Validation

Validation of the field data will be performed by the project QA Officer and will consist of reviewing the raw data entries and the precision and accuracy of the data to establish if the field testing is within the established control limits. Corrective actions will be performed when the precision and accuracy results fall outside of the control limits.

8.2.3 Laboratory Data Validation

The principal criteria used to validate data integrity during sample collection are the following:

- Reagent blank results
- Method preparation blank results
- Calibration verification
- QC check sample results
- Surrogate spike recoveries

These measurements are made by the analyst using specific acceptance criteria. The analyst either proceeds with the analyses or takes correction action. The analyst who generates the data has the primary responsibility for the correctness and completeness of the data. The data reduction and validation steps are documented, signed, and dated by the analyst.

All data are reviewed by the senior analyst or group coordinator whose function is to provide an independent review of the data package. The review is structured so that all calibration and sample results are reviewed and 10% of the analytical results are checked back to the bench. All SW-846 recommended criteria for preparation and analysis methods will be followed.

Additional information on laboratory data validation procedures is contained in Attachment 1.

8.2.4 Project Data Validation

The Project Manager will have the responsibility of reviewing the overall project data prior to submittal to the client. The QA Officer will be responsible for reviewing and checking all field logs and chain-of-custody forms for errors in the raw data entries and calculations and for establishing if sample custody procedures were followed. The Site Manager will be responsible for checking the calibration integrity of all field instruments.

The QA Officer will be responsible for reviewing the laboratory analytical reports and validating the data contained in those reports. Each report will contain sample results, the chain-of-custody, and quality control samples including trip, field and/or rinseate blanks, laboratory method blanks and laboratory control samples, MS/MSD analyses and surrogate recovery data. Data validation will follow the NYSDEC's Division of Environmental Remediation's *Guidance for the Development of Data Usability Summary Reports*. The validation will establish whether:

- Sample holding times have been met.
- Duplicate sample concentrations were within acceptable limits.
- Equipment rinse blanks, trip blanks, and field blanks were analyte-free or below a concentration of concern.
- Detection limits were acceptable.
- Laboratory blanks were analyte-free or below a concentration of concern.
- Laboratory matrix spike recoveries were within acceptable limits.
- Obvious anomalous values were identified and addressed.

The following documents will be used for project data validation:

- NYSDEC, 1995 Revision Guideline. *Analytical Service Protocol.*
- USEPA, February 1994. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* USEPA/540/R-94-013.
- USEPA, Region III. June 1995, *Innovative Approaches to Data Validation.*
- USEPA, September 1994. *Region III Modifications to National Functional Guidelines for Organic Data Review Multi-Media, Multi-Concentration.* (OLM01.0 - OLM01.9).
- USEPA, April 1993. *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses.*
- USEPA, February 1993. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA/540/R-94-012.
- USEPA, July 1, 1988. *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses.*

Shield will classify the data as valid, useable, or unusable. Data classified as valid will have met all data quality objectives, the sample custody and field logs will be in order, the results of the analyses of the field and laboratory QC blanks will be acceptable, and other laboratory performance criteria will be acceptable.

Data classified as useable will not have met all the QA/QC. For example, sample custody may have been broken, holding times may have been slightly missed, a QC blank may have been contaminated, or the detection limit may have been elevated. These are a few examples of situations that may cause analytical data to be questionable but still useable, providing the data are used with caution.

Data that have been classified as unusable are invalid and will not be used for any purpose. Unusable data may be the result of gross laboratory error, strong analytical interferences, or other major problems associated with the data.

8.3 Data Storage

Data will be stored on electronic and hard copies within project files in Shield's offices. Individually labeled files will also be maintained for segregation of the field data, laboratory data, and assessment reports. Data will be maintained for at least 3 years and, in some instances, as long as 7 years.

Data will be indexed by client name and project number both in hard copy and within the computer system. Data files will be archived to in-house project files on computer diskettes approximately bi-annually.

9.0 INTERNAL QUALITY CONTROL

9.1 Field Quality Control

QC sampling and associated frequencies are described below.

- Trip blanks - Trip blanks are defined as samples created from analyte-free water in the laboratory, taken to the sampling site and returned unopened to the laboratory along with any volatile organic analysis (VOA) samples. The laboratory is responsible for providing and monitoring the quality of the analyte-free water. One trip blank will be placed in each cooler containing liquid samples to be analyzed for volatiles.

- Field duplicates - Field duplicates will be collected at a frequency of 5% for all matrices. The duplicates for soils/sediments will be collected, composited and then subsampled into the primary and duplicate sample containers. Soil/sediment samples for volatile analysis will be collected and placed undisturbed into sample containers.

- Equipment rinseates - Equipment rinseates are samples of the final analyte-free water rinse from equipment cleaning and are collected at the end of decontamination procedures. These samples will be collected at least once per matrix sampling event and will be analyzed for the same constituents as the samples collected that day.

- Field blanks - Field blanks are samples collected that are transported to the field and exposed to the same conditions as field samples. These samples will be collected once per matrix sampling event and analyzed for the same constituents as the samples collected that day.

- Matrix spike/matrix spike duplicate - When required by the analytical protocol, additional sample volume for the matrix spike/matrix spike duplicate will be obtained at the same sample location and collected in the appropriate sample containers as the field duplicate.

9.2 Laboratory Quality Control

The QC control samples and frequency of analysis specified in the NYSDOH- approved methods will be used as a guideline. The following QC samples will be analyzed as appropriate:

- Method blanks
- Blanks/spikes
- Surrogates
- Matrix spikes and matrix spike duplicates
- Laboratory duplicates
- Initial and continuing calibration checks

In addition, the raw data and QA/QC samples will be reviewed by the Laboratory Project Manager to identify any inconsistencies. Laboratory verification of any apparent discrepancies will be required prior to data submittal to the NYSDEC.

10.0 PERFORMANCE AND SYSTEMS AUDITS

10.1 Systems Audits

The submission to and full cooperation with systems audits by the USEPA and the NYSDEC is required if requested by the regulating agency. Such audits may include evaluation of the various components of the measurement systems to establish their proper selection and use and the evaluation of field QC procedures.

Systems audits are the responsibility of the QA Officer. A systems audit will be conducted semi-annually by reviewing selected projects that as a group use all the employed measurement systems. The audit will include supervision of drilling and sampling activities in the field. It will examine:

- A list of equipment used and the QC procedures followed.
- The use of equipment and related procedures such as decontamination, sampling, documentation, sample handling, etc., to establish if each element within an activity is functioning appropriately and according to the guidelines of appropriate methodology, and the approved QA/QC procedures.
- Calibration of field instruments.
- A list of deficiencies to correct/improve/modify the system.
- The use of qualified personnel to operate the systems.
- The field notebooks and field observations to confirm proper equipment and QC procedure compliance.
- The sample custody documentation to verify proper tracking and handling procedures.
- The corrective actions undertaken during the audit period.

Negative and inadequate responses to the audit will be discussed with the field members and correction action will be implemented.

Shield also has a Corporate QA Program Plan that establishes the general procedures, methods, and performance for field investigations so that the data collected will be representative of field conditions that are verifiable and commensurate with the objectives of each project. This document, along with site-specific QAPPs, sets for minimum protocol for field investigations. The designated QA Officer in each office maintains QA standards and verifies appropriate procedures are followed and that the staff has been adequately trained. The Corporate QA Program Plan is reviewed on an annual basis and updated as appropriate. QA officers review QA procedures on a project basis.

10.2 Performance Audits

Regular audits of field sampling and operations will be conducted by the Site Manager throughout the project to maintain the highest QA/QC standards for the project. In addition, field audits will

be performed at the beginning of various site activities (e.g., media sampling, source removal, treatability studies) to verify that field procedures are being performed in a manner consistent with QA/QC standards and that documentation of these activities is being performed. A written report of the audit will be completed, and any items in noncompliance will be dealt with immediately by the Project Manager or Site Manager. In addition, NYSDEC personnel may periodically visit the site to verify that procedures are being followed. The Project Manager will be responsible for maintaining the day-to-day procedures and methods specified in the SOW.

11.0 PREVENTIVE MAINTENANCE

Preventive maintenance is another portion of the overall QA program for field and laboratory equipment. As previously stated, the Site Manager will have responsibility for all field equipment. At a minimum, the field equipment will be checked prior to field activities to verify that all equipment is functioning properly. At this time, the Site Manager will also verify that calibration gases, liquids, etc., are stocked as appropriate and that all sampling logs and forms are available. Equipment to be used at the site will include, at a minimum, an FID or PID; an oxygen/combustible gas meter; water level meter, pH, temperature, conductivity, D.O., turbidity, and redox meters; a YSI multiparameter sonde; and a submersible pump.

Preventive maintenance will be performed and documented by the Site Manager or other field personnel with the oversight of the Site Manager. A schedule of preventive maintenance activity and frequency for all field equipment is contained in Table 11. Field instruments, sampling equipment, and accessories will be maintained in accordance with the manufacturer's recommendations and specifications, and established field practices. Maintenance will be documented in an equipment maintenance logbook that will be kept at the site and maintained by the Site Manager. It will contain the following documentation:

- List of all field instruments used by field personnel.
- Preventive maintenance schedule for each instrument (Table 11).
- Record of routine (preventive) maintenance to equipment.
- Record of nonroutine repairs to equipment.

If a field screening instrument is damaged/unusable for the proposed sampling event, the Project Manager and Site Manager will discuss and decide on a course of action from several options including:

- Postpone and reschedule sampling event until equipment is repaired.
- Delay completion and rent or purchase another piece of equipment.
- Use backup equipment.

In the event that equipment must be borrowed or rented in an emergency situation, it will be calibrated and maintained as described in this plan and in accordance with the manufacturer's instructions.

At the laboratory, preventative maintenance will be as outlined in the laboratory QA/QC manual. Laboratory instruments are monitored on a regular basis to verify that they are operating properly. Many of the instruments will undergo routine cleaning and replacement of parts by trained, qualified laboratory personnel. Larger pieces of laboratory equipment (such as chromatographs, analytical balances, Gas Chromatograph/Mass Spectrometer [GC/MS]) are maintained by commercial maintenance contracts on a regular basis. In addition, regular QA/QC checks help to identify instruments that are not working properly. Additional information on preventive maintenance for the laboratory is provided in Attachment 1.

12.0 DATA ASSESSMENT PROCEDURES

Data are assessed on a continuous basis throughout the project so that high standards are met. Precision and accuracy are maintained in the laboratory through regular analysis of QA/QC samples to verify that they fall within accuracy and precision reporting standards. All laboratory analytical data will be assessed for accuracy, precision, and completeness by the laboratory before submission of the data to Shield. Routine internal checks also will verify that samples are logged in properly, chain-of-custody forms are completed, sample holding times are not exceeded, and the appropriate documentation is being completed. Additional information on laboratory data assessment is contained in Attachment λ.

Once sample results are available, the QA Officer will review the data to assess its completeness and consistency with previous laboratory reports and procedures. Duplicate and spiked samples will be reviewed for consistency and any "outliers". If problems develop, data will be checked first for any calculation errors and, if necessary, the samples rerun.

Data will be organized in tables and figures for presentation and reporting. Senior personnel will check these data for transcription errors and accuracy. Any data calculations, modeling, etc., will be accomplished using approved methods or models. Some statistical methods may be used on the laboratory data received. Assessments and recommendations derived from the data will be reviewed and approved by senior personnel.

In addition, field data will be reviewed for completeness and accuracy by the Site Manager. As appropriate, field data will be cross checked with analytical data for consistency.

13.0 CORRECTIVE ACTIONS

Failure to meet QA/QC standards and goals will result in corrective action. If corrective action is necessary, it will be on a case-by-case basis and may take several forms including the following:

- Additional review of data
- Additional analysis of duplicate samples
- Audit of field and/or laboratory procedures
- Additional sampling or resampling effort
- Communication with site and/or laboratory personnel

Identified deficiencies will be readily corrected by the appropriate personnel, and the Project Manager will recheck the problem the next day to verify it has been corrected. The following steps will be taken if deficiencies or irregularities exist in the field and during sampling.

13.1 Field Data

Corrective actions will be performed when field precision and accuracy results are outside of the control limits listed in Table 10. If the instrument continues to perform outside of the control limits, it will be taken out of service and replaced with a backup unit. Corrective actions performed on equipment will be documented in writing and kept in an equipment maintenance file.

If split samples or audits indicate a variance from the field measurement of greater than 20%, the field instrument will be checked against an off-site instrument via a common calibration standard. Appropriate corrective action will be taken depending upon the results. These actions may include those listed in Table 10 or removing the instrument from service. The field representative conducting the field measurements will be responsible for assessing each QC measure and initiating corrective actions under the general supervision of the Site Manager. Any corrective action recommended as a result of systems audits, analysis of split samples/data, or data validation review will be initiated with the determination that the actions are scientifically justifiable.

13.2 Sampling Procedures

If deficiencies in procedures are found from internal or external audits or data validation reviews, Shield will immediately implement corrective action. The QA Officer is responsible for discussing the deficiency with the appropriate parties and implementing the appropriate corrective action before the next sampling event. The QA Officer document the corrective action implemented by a written memorandum describing the corrective action. The memorandum will be stored in a file to be maintained by the QA Officer. The Project Manager and Site Manager will each receive a copy of all corrective action memoranda.

13.3 Contracted Laboratory Corrective Action

If Shield establishes through internal or external audits or during the data validation process that a contracted laboratory has not performed according to its approved plan, it will initiate corrective actions by contacting the Laboratory Director. The analyses will be rerun to correct a deficiency, if possible. In the event that data are established invalid due to laboratory errors, the sampling will be repeated, if required, to meet the project objectives.

In the event that the laboratory fails to meet the established analytical controls, prompt corrective action will be undertaken. Whenever corrective actions are necessary, a nonconformance memo will be initiated by the Laboratory Project Manager. This memo will be approved by the QA Manager and the Laboratory Project Manager documenting the problem and the corrective action performed. The corrective action will be summarized in the project narrative of the laboratory report. This corrective action will be undertaken by the Laboratory Project Manager assigned to this project.

14.0 QUALITY ASSURANCE REPORTS

A QA report on the performance of measurements, systems, and data quality will be prepared by the QA Officer for the project. The report will involve all the work conducted by Shield and, at a minimum, it will include:

- Assessment of measurement data accuracy.
- Results of system audits.
- Significant QA problems and recommended solutions.
- Outcome of any corrective actions.

Copies of such reports will be maintained in the project files and will be available for regulatory agency review.

Reports prepared for the project will summarize the quality of data collected for each aspect of this phase of the project (e.g., media sampling, treatability study). The written summaries will include QA activities performed, deficiencies identified, and corrective actions implemented. At a minimum, QA reports will be prepared after the following sampling events:

- Preliminary soil sampling
- First ground water sampling event
- Sediment sampling
- Second ground water sampling event
- Confirmatory sampling (soil and sediment)

15.0 REFERENCES

New York State Department of Environmental Conservation, September 1997 Revision, *Guidance for the Development of Data Usability Summary Reports.*

New York State Department of Environmental Conservation, 1995 Revision Guideline, *Analytical Services Protocol (ASP).*

U.S. Environmental Protection Agency, 1986. 1992. 1993. 1994. 1995. *Test Methods for Evaluating Solid Waste*, Updates I, IIA, II, IIB. SW-846. (Third Edition).

U.S. Environmental Protection Agency, 1996. *Low-Flow (Minimal Drawdown Ground-Water Sampling Procedures.*

U.S. Environmental Protection Agency, Region IV, 1996, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual.*

U.S. Environmental Protection Agency, July 1, 1988. *Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses.*

U.S. Environmental Protection Agency, Region III. 1988 - 1994. *Region III QA Directives.*

U.S. Environmental Protection Agency, 1989. *Preparing Perfect Project Plans.* USEPA/600/9-9-89-087.

U.S. Environmental Protection Agency, January 1991. *Compendium of ERT Surface Water and Sediment Sampling Procedures.* EPA/540/P-91/005.

U.S. Environmental Protection Agency, January 1991. *Compendium of ERT Ground Water Sampling Procedures.* EPA/540/P-91/007.

U.S. Environmental Protection Agency, 1992. *Contract Lab Program Statement of Work for Organic Analysis* (Revision 9).

U.S. Environmental Protection Agency, February 1993. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review.* EPA/540/R-94-012.

U.S. Environmental Protection Agency, April 1993. *Region III Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses.*

U.S. Environmental Protection Agency, 1994. *Contract Lab Program Statement of Work for Inorganic Analysis* (Revision 11).

U.S. Environmental Protection Agency, Region III. 1994. *Sample Submission Guidelines* (Third Edition).

U.S. Environmental Protection Agency, February 1994. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review.* USEPA/540/R-94-013.

U.S. Environmental Protection Agency, September 1994. *Guidance for the Data Quality Objectives Process*. EPA QA/G-4.

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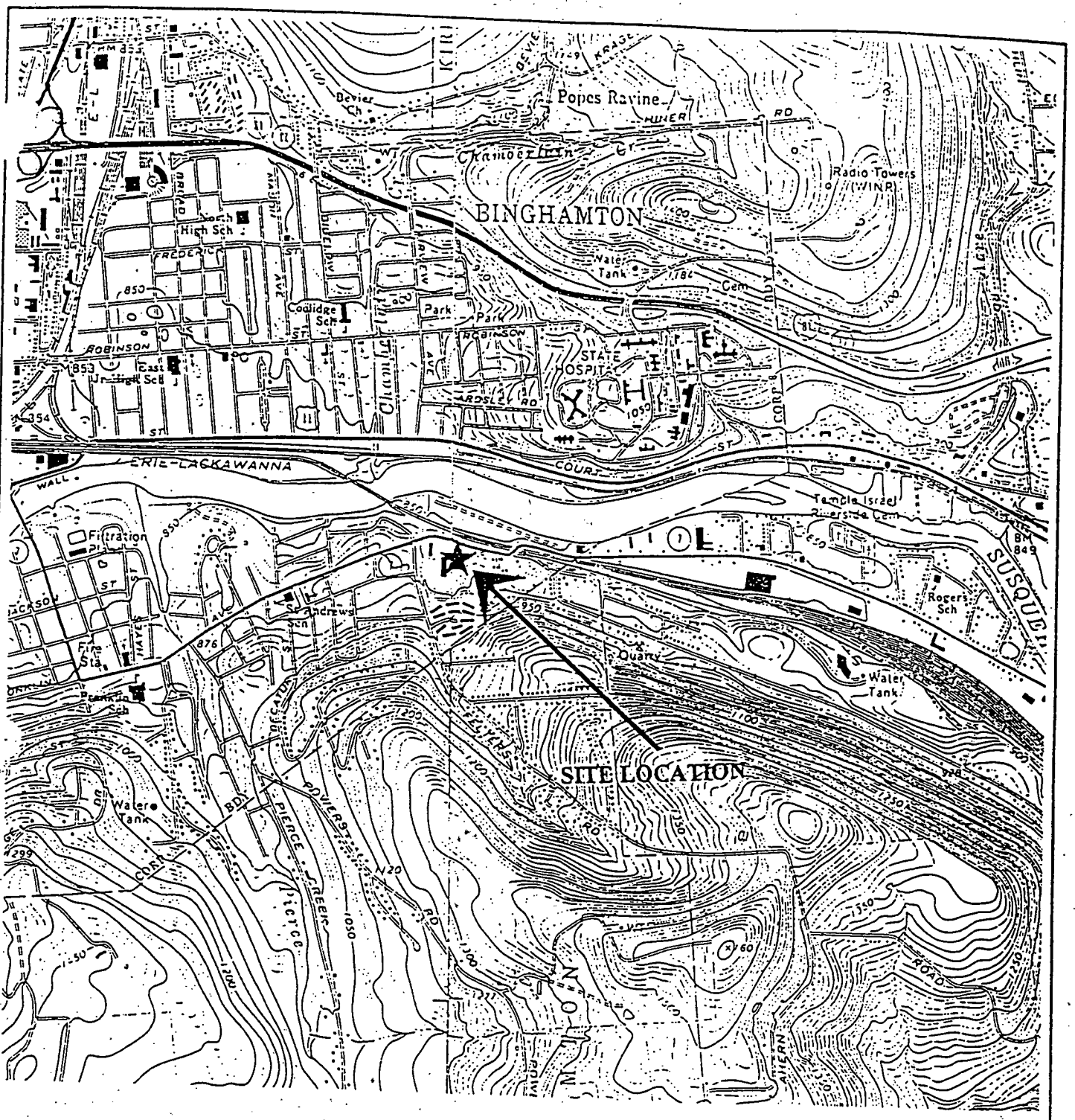
U.S. Environmental Protection Agency, Region III. June 1995. *Innovative Approaches to Data Validation.*

U.S. Environmental Protection Agency, 1996. *Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual.*

U.S. Environmental Protection Agency, *Field Screening Method Catalog*. USEPA/540/2-88-005.

FIGURES



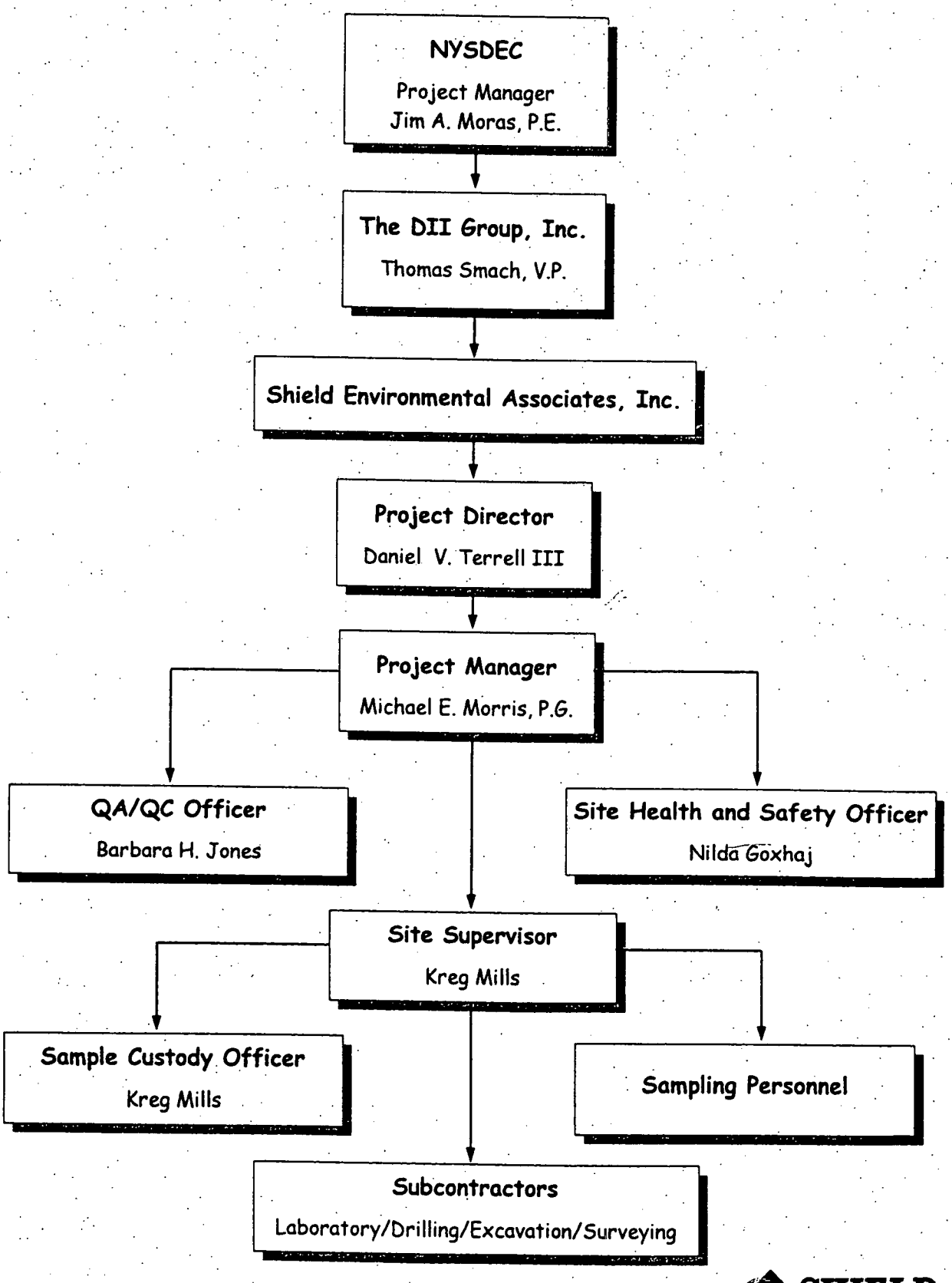
SOURCE: USGS Topographic Quadrangle Maps
Binghamton East, New York
1968 — Photoinspected 1976
Binghamton West, New York
1968 — Photoinspected 1976

N

0 1,000' 2,000'
SCALE

DATE: 12/2/97	FIGURE 1	**SHIELD**
DRAWN BY: P.D.H.	SITE LOCATION MAP DII — BINGHAMTON PLASTICS CONKLIN AVENUE BINGHAMTON, NEW YORK	ENVIRONMENTAL ASSOCIATES, INC.
APPROVED BY: M.M.		LEXINGTON, KENTUCKY
CLIENT NO.: 396-0460		

FIGURE 2
FORMER BINGHAMTON PLASTICS SITE
ORGANIZATION CHART



SHIELD
ENVIRONMENTAL ASSOCIATES, INC.

TABLES

TABLE 1
DATA QUALITY OBJECTIVES

Task	Data Uses	Analytical Level
Air monitoring	Site characterization, monitoring	I
Soil/sediment sampling		
-screening	Monitoring, site characterization	I, II
-quantitative sample*	Site characterization, engineering design	III, IV
Ground water/surface water sampling		
-screening	Monitoring, site characterization	I
-quantitative sample*	Site characterization	IV

Level I - Total organic/inorganic vapor detection using portable instruments, field test kits, field instruments

Level II - Variety of organics by GC; inorganics by AA, XRF tentative ID; analyte-specific

Level III - Organics/inorganics using EPA procedures other than CLP can be analyte-specific RCRA characteristic tests

Level IV - TCL organics/inorganics by GC/MS; AA; ICP (CLP deliverables will be provided if the analyses are questionable.)

* - During the preliminary investigation, a full list of TCL organics/ inorganics will be analyzed. The list will be reduced in specific compounds as presented in Table 5.

AA - Atomic absorption
ASTM - American Society of Testing and Materials
CLP - Contract Laboratory Program
DRI - Direct reading instrument
GC/MS - Gas chromatograph/mass spectrometer
ICP - Inductively coupled plasma
ID - Identification
TCL - Target compound list
XRF - X-ray diffraction fluorescence
RCRA - Resource Conservation and Recovery Act

TABLE 2
SAMPLING EQUIPMENT - RESTRICTIONS, MATERIALS AND APPROPRIATE USE

Equipment Use	Intended Use	Parameter Groups	Restrictions/ Precaution
SOLIDS SAMPLING - Sediments/Soils			
1. Trowel, scoop, spoon or spatula	Sampling and mixing	Inorganics, general chemistry	none
		VOCs and extractable organics	1, 2
		PCB/Pesticides	none
2. Mixing tray or bowl	Compositing or homogenizing	Inorganics, general chemistry	none
		Extractable organics	1
		PCB/Pesticides	none
3. Shovel	Sampling	Inorganics, general chemistry	none
		VOCs and extractable organics	2, 3
		PCB/Pesticides	none
4. Hand auger	Sampling	Inorganics, general chemistry	none
		VOCs and extractable organics	2, 3
		PCB/Pesticides	none
5. Split spoon	Sampling	Inorganics, general chemistry,	none
		VOCs	2, 3
		Extractable organics	3
		PCB/Pesticides	none
6. Shelby tube	Sampling	Inorganics, general chemistry,	none
		VOCs	2, 3, 4, 5
		Extractable organics	3, 5
		PCB/Pesticides	none
7. Sediment corer	Sampling	Inorganics, general chemistry,	none
		VOCs	2, 3
		Extractable organics	3
		PCB/Pesticides	none
8. Backhoe/trackhoe	Sampling	Inorganics, general chemistry,	6
		VOCs	2, 3, 6
		Extractable organics	3, 6
		PCB/Pesticides	none
LIQUIDS SAMPLING			
1. Bailer	Purging, sampling	VOCs	1, 2
		Semivolatiles	1
		Metals	1
		Inorganics, general chemistry	1
		PCB/Pesticides	none
2. Submersible Pump	Purging	VOCs	3
		Semivolatiles	3
		Metals	3
		Inorganics, general chemistry	3
		PCB/Pesticides	none
LIQUIDS SAMPLING - Surface Water			
1. Dipper	Sampling	VOCs	1, 2
		Semivolatiles	1
		Metals	1
		Inorganics, general chemistry	1
		PCB/Pesticides	none

TABLE 2 (Cont.)

Equipment Use	Intended Use	Parameter Groups	Restrictions/ Precaution
2. Kemmerer	Sampling	VOCs	2
		Semivolatiles	1
		Metals	1
		Inorganics, general chemistry	1
		PCB/Pesticides	none

Notes:

1	Will be constructed of stainless steel, Teflon® PVC, or polyethylene (tubing).
1 a	Will be constructed of internal silicon tubing and exterior polyethylene tubing.
2	Samples for volatile organics will not be taken from a composite (mixed) sample.
3	Will be constructed of stainless steel or brass.
4	When samples are sealed in the liner for transport to the laboratory, the sample for VOC analysis will be taken from the interior of the core.
5	Liners will be constructed of stainless steel or Teflon®.
6	Samples will be collected from center of bucket such that bucket does not compromise the sample.
VOCs	Volatile organic compounds
PCB	Polychlorinated Biphenyls

TABLE 3
SUMMARY OF CHEMICALS, CONTAINERS, PRESERVATION METHODS AND SAMPLE VOLUMES

Compound	Matrix	Container	Preservation	Amount Required	Holding Time
VOCs	solid	G, TFE	cool 4°C	2 oz	14 days
	aqueous	G, TFE	1:1 HCl, cool 4°C	3 x 40 ml	14 days
SVOCs	solid	G, TFE	cool 4°C	8 oz	14 ex 40 anl
	aqueous	G, TFE	cool 4°C	2 x 1 L	7 ex 40 anl
Metals	solid	P, G	cool 4°C	4 oz	6 months
	aqueous	P, G	HNO_3 to pH<2	1 L	6 months
Sulfate	aqueous	P, G	cool 4°C	1 L	28 days
Nitrate	aqueous	P, G	cool 4°C	1 L	48 hrs
Chloride	aqueous	P,G	cool 4°C	1 L	28 days
Total Organic Carbon	aqueous	G	cool 4°C	2 x 40 ml	28 days

* 180 days until extraction, 180 days extraction to analysis
** 28 days until extraction, 28 days extraction to analysis
*** 30 days recommended
ex days to extraction
anl days to analysis
G glass
TFE Teflon®
P plastic
VOCs volatile organic compounds
SVOCs semivolatile organic compounds

TABLE 4
TARGET CHEMICALS, ANALYTICAL METHODS DETECTION LIMITS

Target Compounds	Method Number	Detection Limit		Unit	
		Solid	Aqueous	Solid	Aqueous
TCL VOCs					
Chloromethane	SW-846 8260A+10 TICs	10	10	ug/kg	ug/L
Bromomethane	SW-846 8260A+10 TICs	10	10	ug/kg	ug/L
Vinyl chloride	SW-846 8260A+10 TICs	10	10	ug/kg	ug/L
Chloroethane	SW-846 8260A+10 TICs	10	10	ug/kg	ug/L
Methylene chloride	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Acetone	SW-846 8260A+10 TICs	20	20	ug/kg	ug/L
Carbon disulfide	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
1, 1-Dichloroethene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
1, 1- Dichloroethane	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
1, 2- Dichloroethene (total)	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Chloroform	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
1, 2 - Dichloroethane	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
2- Butanone	SW-846 8260A+10 TICs	20	20	ug/kg	ug/L
1,1, 1- Trichloroethane	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Carbon tetrachloride	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Bromodichloromethane	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
1, 2 - Dichloropropane	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
cis-1, 3-Dichloropropene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Trichloroethene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Dibromochloromethane	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
1,1,2-Trichloroethane	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Benzene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
trans-1,3-Dichloropropene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
BromoForm	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L

TABLE 4 (CONTINUED)
TARGET CHEMICALS, ANALYTICAL METHODS DETECTION LIMIT

Target Compounds	Method Number	Detection Limit		Unit	
		Solid	Aqueous	Solid	Aqueous
4-Methyl-2-pentanone	SW-846 8260A+10 TICs	20	20	ug/kg	ug/L
2-Hexanone	SW-846 8260A+10 TICs	20	20	ug/kg	ug/L
Tetrachloroethene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
1,1,2,2-Tetrachloroethane	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Toluene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Chlorobenzene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Ethylbenzene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Styrene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Xylenes (Total)	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
TCL SVOCs					
Phenol	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
bis(2-Chloroethyl) ether	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2-Chlorophenol	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
1,3-Dichlorobenzene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
1,4-Dichlorobenzene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
1,2-Dichlorobenzene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2-Methylphenol	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2,2'-Oxybis(1-Chloropropane)	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
4-Methylphenol	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
N-nitrosodi-n-propylamine	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Hexachloroethane	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Nitrobenzene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Isophorone	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2-Nitrophenol	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2,4-Dimethylphenol	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
bis(2-Chloroethoxy) methane	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2,4-Dichlorophenol	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
1,2,4-Trichlorobenzene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L

TABLE 4 (CONTINUED)
TARGET CHEMICALS, ANALYTICAL METHODS DETECTION LIMIT

Target Compounds	Method Number	Detection Limit		Unit	
		Solid	Aqueous	Solid	Aqueous
Naphthalene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
4-Chloroaniline	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Hexachlorobutadiene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
4-Chloro-3methylphenol	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2-Methylnaphthalene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Hexachlorocyclopentadiene	SW-846 8270B+20 TICs	1600	50	ug/kg	ug/L
2,4,6-Trichlorophenol	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2,4,5-Trichlorophenol	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2-Chloronaphthalene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2-Nitroaniline	SW-846 8270B+20 TICs	1600	50	ug/kg	ug/L
Dimethyl phthalate	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Acenaphthylene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2,6-Dinitrotoluene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
3-Nitroaniline	SW-846 8270B+20 TICs	1600	50	ug/kg	ug/L
Acenaphthene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2,4-Dinitrophenol	SW-846 8270B+20 TICs	1600	50	ug/kg	ug/L
4-Nitrophenol	SW-846 8270B+20 TICs	1600	50	ug/kg	ug/L
Dibenzofuran	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
2,4-Dinitrotoluene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Diethyl phthalate	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
4-Chlorophenyl phenyl ether	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Fluorene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
4-Nitroaniline	SW-846 8270B+20 TICs	1600	50	ug/kg	ug/L
4, 6-Dinitro-2-methylphenol	SW-846 8270B+20 TICs	1600	50	ug/kg	ug/L
N-Nitrosodiphenylamine	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
4-Bromophenyl phenyl ether	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Hexachlorobenzene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Pentachlorophenol	SW-846 8270B+20 TICs	1600	50	ug/kg	ug/L

TABLE 4 (CONTINUED)
TARGET CHEMICALS, ANALYTICAL METHODS DETECTION LIMIT

Target Compounds	Method Number	Detection Limit		Unit	
		Solid	Aqueous	Solid	Aqueous
Phenanthrene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Anthracene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Carbazole	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Di-n-butyl phthalate	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Fluoranthene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Pyrene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Butyl benzyl phthalate	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
3,3'-Dichlorobenzidine	SW-846 8270B+20 TICs	1600	50	ug/kg	ug/L
Benzo(a)anthracene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Chrysene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
bis(2-Ethylhexyl) phthalate	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Di-n-octyl phthalate	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Benzo(b) fluoranthene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Benzo(k) fluoranthene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Benzo (a) pyrene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Indeno (1,2, 3-od) pyrene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Dibenzo (a,h) anthracene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
Benzo (ghi) perylene	SW-846 8270B+20 TICs	330	10	ug/kg	ug/L
TCL Pesticides/PCBs					
alpha-BHC	SW-846 8080A	1.7	0.025	ug/kg	ug/L
beta-BHC	SW-846 8080A	1.7	0.025	ug/kg	ug/L
delta-BHC	SW-846 8080A	1.7	0.025	ug/kg	ug/L
gamma-BHC (Lindane)	SW-846 8080A	1.7	0.025	ug/kg	ug/L
Heptachlor	SW-846 8080A	1.7	0.025	ug/kg	ug/L
Aldrin	SW-846 8080A	1.7	0.025	ug/kg	ug/L
Heptachlor epoxide	SW-846 8080A	1.7	0.025	ug/kg	ug/L
Endosulfan I	SW-846 8080A	1.7	0.025	ug/kg	ug/L
Dieldrin	SW-846 8080A	3.3	0.05	ug/kg	ug/L

TABLE 4 (CONTINUED)
TARGET CHEMICALS, ANALYTICAL METHODS DETECTION LIMIT

Target Compounds	Method Number	Detection Limit		Unit	
		Solid	Aqueous	Solid	Aqueous
4, 4'-DDE	SW-846 8080A	3.3	0.05	ug/kg	ug/L
Endrin	SW-846 8080A	3.3	0.05	ug/kg	ug/L
Endosulfan II	SW-846 8080A	3.3	0.05	ug/kg	ug/L
4, 4'-DDD	SW-846 8080A	3.3	0.05	ug/kg	ug/L
Endosulfan sulfate	SW-846 8080A	3.3	0.05	ug/kg	ug/L
4,4'-DDT	SW-846 8080A	3.3	0.05	ug/kg	ug/L
Methoxychlor	SW-846 8080A	17	0.25	ug/kg	ug/L
Endrin ketone	SW-846 8080A	3.3	0.05	ug/kg	ug/L
Endrin aldehyde	SW-846 8080A	3.3	0.05	ug/kg	ug/L
alpha-Chlordane	SW-846 8080A	1.7	0.025	ug/kg	ug/L
gamma-Chlordane	SW-846 8080A	1.7	0.025	ug/kg	ug/L
Toxaphene	SW-846 8080A	83	1.25	ug/kg	ug/L
Aroclor 1016	SW-846 8080A	17	0.25	ug/kg	ug/L
Aroclor 1221	SW-846 8080A	17	0.25	ug/kg	ug/L
Aroclor 1232	SW-846 8080A	17	0.25	ug/kg	ug/L
Aroclor 1242	SW-846 8080A	17	0.25	ug/kg	ug/L
Aroclor 1248	SW-846 8080A	17	0.25	ug/kg	ug/L
Aroclor 1254	SW-846 8080A	33	0.5	ug/kg	ug/L
Aroclor 1260	SW-846 8080A	33	0.5	ug/kg	ug/L
TAL Total Metals					
Aluminum	SW-846 6010A	20	0.2	mg/kg	mg/L
Antimony	SW-846 6010A	6	0.06	mg/kg	mg/L
Arsenic	Sw846-6010A	1.0	0.01	mg/kg	mg/L
Barium	SW-846 6010A	20	0.20	mg/kg	mg/L
Beryllium	SW-846 6010A	0.5	0.005	mg/kg	mg/L
Cadmium	SW-846 6010A	0.5	0.005	mg/kg	mg/L

Target Compounds	Method Number	Detection Limit		Unit	
		Solid	Aqueous	Solid	Aqueous
Calcium	SW-846 6010A	500	5.0	mg/kg	mg/L
Chromium	SW-846 6010A	1	0.01	mg/kg	mg/L
Cobalt	SW-846 6010A	5	0.05	mg/kg	mg/L
Copper	SW-846 6010A	2.5	0.025	mg/kg	mg/L
Iron	SW-846 6010A	10	0.1	mg/kg	mg/L
Lead	SW846-6010A	0.3	0.003	mg/kg	mg/L
Magnesium	SW-846 6010A	500	5.0	mg/kg	mg/L
Manganese	SW-846 6010A	1.5	0.015	mg/kg	mg/L
Mercury	SW846-7470	100	0.2	mg/kg	ug/L
Nickel	SW-846 6010A	4	0.04	mg/kg	mg/L
Potassium	SW-846 6010A	500	5	mg/kg	mg/L
Selenium	SW846-6010A	0.5	0.005	mg/kg	mg/L
Silver	SW-846 6010A	1	0.01	mg/kg	mg/L
Sodium	SW-846 6010A	500	5	mg/kg	mg/L
Thallium	SW846-6010A	1.0	0.010	mg/kg	mg/L
Vanadium	SW-846 6010A	5	0.05	mg/kg	mg/L
Zinc	SW-846 6010A	5	0.05	mg/kg	mg/L
General Chemistry					
Nitrate	EPA 353.2	N/A	1	N/A	mg/L
Sulfate	EPA 375.4	N/A	5	N/A	mg/L
Chloride	EPA 325.2	N/A	1	N/A	mg/L
Total Organic Carbons	EPA 415.1	N/A	1	N/A	mg/L

Notes: SW-846 Test method for evaluating solid waste, physical, chemical methods
PCBs Polychlorinated Biphenyls
TIC Tentatively Identified Compounds

TABLE 5
SITE-SPECIFIC PARAMETER LIST

Target Compounds	Method Number	Detection Limit		Unit	
		Solid	Aqueous	Solid	Aqueous
VOCs					
Chloroethane	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
1,1-Dichloroethane	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
1,1-Dichloroethene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Ethylbenzene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
1,1,1-Trichloroethane	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Trichloroethene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Tetrachloroethene	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
1,2-Dichloroethene (Total)	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L
Vinyl Chloride	SW-846 8260A+10 TICs	5	5	ug/kg	ug/L

Notes: SW-846 Test method for evaluating solid waste, physical, chemical methods
TIC Tentatively Identified Compounds

TABLE 6
SAMPLING CHECKLIST

_____ Sampling equipment decontaminated

_____ Heavy equipment decontaminated

_____ Rinse blank(s) collected (if appropriate)

_____ Equipment calibrated, recorded in logbook

_____ PPE check

_____ Air quality check, recorded

_____ Sample collected (see Table 3 for sample container and volume), sealed, labeled, and placed in cooler with a completed chain of custody. Sample composited and homogenized as appropriate.

_____ Duplicates collected (if applicable)

_____ Matrix spike/matrix spike duplicates collected (if applicable)

_____ Notes and photographs recorded

_____ Marked and recorded sample location in field and map

_____ Move to next sample site

TABLE 7
PHOTOGRAPHIC REPORTING DATA SHEET

Name _____

Date _____

Time _____

Signature _____

Section No. _____
Revision No. _____
Revision Date _____

Weather Conditions _____

Photo Description _____

Photo Location _____

Notes _____

TABLE 8
AIR CALIBRATION LOG

Instrument	Serial No.	Calibration Date	Time	Calibration Gas	Name(s)	Result/Notes

Note: Check hydrogen on flame ionization detector

TABLE 9
QA TARGETS FOR SCREENING METHODS

Measurement Parameter (Field)[1]	Matrix[2]	Precision[3]	Accuracy[3]	Equivalent EPA Method No.
Conductivity*	GW/SW	±0.5%	±0.5%	120.1
Organic Vapors[4]	Soil/Air	±25%	±25%	none
Miniram Particulate Monitor	Air	±0.02 mg/m^3	±0.02 mg/m^3	none
pH*	GW/SW	±0.2 pH	±0.2 pH	150.1
Temperature*	GW/SW	±0.15°C	±0.15°C	170.1
Combustible Gas Indicator	Air	±0.1% oxygen ±1% LEL	±1.2% oxygen in 5-30% range ±0.7% oxygen in 6-23% range ±3% 0-30% LEL ±10% 30-100% LEL	none
D. O.*	GW/SW	±0.2mg/e	±0.2 mg/e	none
Redox*	GW/SW	±20mv	±20mv	none
Turbidity*	GW/SW	±5%	2 NTV	none

1 Parameters and data in this table are for point measurements in the field using field instruments.
2 GW/SW - ground water/surface water
3 Instrument manufacturer's reported degree of precision and accuracy.
4 Organic vapor measurement of soils with a flame ionization detector (FID) or photoionization detector (PID) as described in EPA document 540/2-88-005 entitled *Field Screening Method Catalog*.

* YSI Model 6920
D.O. Dissolved oxygen
LEL Lower explosive limit
NTV Nephelometric Turbidity Units

TABLE 10
CORRECTIVE ACTIONS FOR PRECISION OF FIELD MEASUREMENTS

QC Activity	Acceptable Criteria	Corrective Action
Duplicate sample pH	±0.1 pH units variance	Recalibrate instrument, remeasure
Duplicate sample temperature	±0.5°C variance	Check calibration, remeasure
Duplicate sample conductivity	±3% of scale variance	Recalibrate instrument, remeasure
Duplicate sample D.O.*	±10%	Recalibrate instrument, remeasure
Duplicate sample redox	±10 mV of reading	Recalibrate instrument, remeasure
Duplicate sample turbidity	±10% of reading	Recalibrate instrument, remeasure

* Dissolved oxygen

TABLE 11
PREVENTIVE MAINTENANCE ACTIVITY AND FREQUENCY

Instrument	Activity	Frequency
pH meter	Rinse electrode with tap water, shake dry	Monthly during storage and following each use
	Place KCL solution in protective cap	After each use
	Replace protective cap	After each use
	Refill KCL solution	When needed
	Battery check	After each use
	Clean probe	Daily
	Clean unit	After each use
Thermometer	Clean unit	After each use
Conductivity Meter	Rinse electrode with distilled water, shake dry	After each field use
	Store away from high voltage and transformers	
	Replantinization of probe	When needed
	Battery check	After each use
	Clean probe	Daily
	Clean unit	After each use
FID/PID	Clean unit	After each use
	Battery check	Before and after each use
	Fill hydrogen cylinder	Before each use
	Replace filter	Quarterly or more frequently in a dusty wet environment
Miniram Particulate Monitor	Clean unit	After each use
	Battery check	Before and after each use
Combustible Gas Indicator	Clean unit	After each use
	Battery check	Before and after each use
PPE (e.g., respirators, etc.)	Clean and restock supplies as needed	After each use
D.O. Meter	Clean probe	After each reading
	Battery check	Start and end of each day
Redox Meter	Rinse probe with distilled water, dry	Start and end of each day
	Clean probe	After each reading
	Battery check	Start and end of each day
Turbidity Meter	Rinse probe with distilled water, dry	Start and end of each day
	Clean probe	After each reading
	Battery check	Start and end of each day

Note: Malfunction of field instruments can often be attributed to weak batteries, improper measurement technique, or loose connections. Refer to individual instrument manuals for detailed maintenance information.

D.O. dissolved oxygen
FID flame ionization meter
PID photoionization meter
PPE personal protective equipment

APPENDIX B

HEALTH AND SAFETY PLAN

Dover/Universal Instruments

Former Binghamton Plastics
Binghamton, New York

March 2002

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

consultants with focus

Table of Contents

Attachments

APPROVALS AND ACKNOWLEDGMENTS

APPROVALS

I have read and approved this HASP with respect to project hazards, regulatory requirements, and BBL procedures.

Project Name: _____ Project Number: _____

_____ _____

Project Manager/Date HSO/Date

_____ _____

HSS/Date Site Supervisor/Date

ACKNOWLEDGMENTS

The final approved version of this HASP has been provided to the Site Supervisor. I acknowledge my responsibility to provide the Site Supervisor with the equipment, materials and qualified personnel to implement fully all safety requirements in this HASP. I will formally review this plan with the HS Staff every six months until project completion.

_____ _____

Project Manager Date

I acknowledge receipt of this HASP from the Project Manager, and that it is my responsibility to explain its contents to all site personnel and cause these requirements to be fully implemented. Any change in conditions, scope of work, or other change that might affect worker safety requires me to notify the Project Manager and/or the Health and Safety Representative.

_____ _____

Site Supervisor Date

HEALTH & SAFETY PLAN ACKNOWLEDGEMENT

I have read the Site-Specific Health and Safety Plan, or its contents have been presented to me, and I understand the contents and I agree to abide by its requirements.

Name (Print)	Signature	Representing	Date

1. Introduction

1.1 Objective

The objective of site activities is to conduct a remedial action at the Dover/Universal Project (Flextronics) site in Binghamton, New York.

Field activities will include:

- Mobilization;
- Abandonment of monitoring wells;
- Soil Excavation;
- Removal of groundwater and phased concentrated hydrocarbon (PCH) from the excavations;
- Application of Hydrogen Releasing Compound (HRC®) to the bottom of the excavation;
- Backfilling the excavations;
- Monitoring well installation; and
- Demobilization.

The objective of this Health and Safety Plan (HASP) is to provide a mechanism for establishing safe working conditions at the site. The safety organization, procedures, and protective equipment have been established based on an analysis of potential physical, chemical, and biological hazards. Specific hazard control methodologies have been evaluated and selected to minimize the potential of injury, illness, or other hazardous incident.

1.2 Site and Facility Description

The Dover/Universal Project (Flextronics), is located at 498 Conklin Avenue, in Binghamton, New York. The site is approximately 4 acres and is 700-800 feet south of the Susquehanna River.

The facility was first constructed in 1973, with subsequent additions built in 1978, 1982, and 1984. It has been occupied by Universal Instruments and Dover Electronics. In 1993, Dover Electronics was renamed Dovatron, Inc. (Dovatron). In 1995, Dovatron transferred its title to the facility to Universal Instruments. In 1996, Dovatron changed its name to the DII Group. The site currently serves as the corporate headquarters for Universal Instruments. The facility has reportedly been used for electronic circuit board manufacturing since 1973.

Previous on-site circuit board manufacturing processes used tetrachloroethene (PCE) as a cleaning solvent. Originally, the virgin PCE was stored in 55-gallon drums at an outer drum storage area. During the initial facility expansion, a ramp to the east-side overhead door served as the entry point for PCE drums. As production increased and the facility was again expanded, virgin PCE was stored in a 3,000-gallon aboveground storage tank that has since been removed. An aboveground 5,000-gallon waste PCE flux storage tank was also located on the site. In

March 1992, a 10,000-gallon fuel oil tank was reportedly removed from the site, and in March 1993, the aboveground PCE system was dismantled. Two 480-gallon PCE tanks were reportedly dismantled and removed from the building interior at that time. Historical handling and use of PCE has resulted in its documented presence in the soil, stormwater, and groundwater at this site.

1.3 Policy Statement

The policy of Blasland, Bouck & Lee, Inc. (BBL) is to provide a safe and healthful work environment. No aspect of operations is of greater importance than injury and illness prevention. A fundamental principle of safety management is that all injuries, illnesses, and incidents are preventable. BBL will take every reasonable step to eliminate or control hazards in order to minimize the possibility of injury, illness, or incident.

This HASP prescribes the procedures that must be followed during activities at the site. Operational changes that could affect the health and safety of personnel, the community, or the environment will not be made without the prior approval of the Project Manager (PM) and the Health and Safety Officer (HSO). This document will be reviewed periodically to ensure that it is current and technically correct. Any changes in site conditions and/or the scope of work will require a review and modification to this HASP. Such changes will be completed in the form of an addendum or a revision to the plan.

The provisions of this plan are mandatory for all BBL personnel and BBL subcontractors assigned to the project. Subcontractors may prepare their own site-specific HASPs that must meet the basic requirements of this HASP. All visitors to BBL work areas at the site must abide by the requirements of this plan.

1.4 References

This HASP complies with applicable Occupational Safety and Health Administration (OSHA) regulations, United States Environmental Protection Agency (USEPA) regulations, and BBL health and safety policies and procedures. This plan follows the guidelines established in the following:

- *Standard Operating Safety Guides*, USEPA (Publication 9285.1-03, June 1992).
- *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, NIOSH, OSHA, USCG, USEPA (86116, October 1985).
- *Title 29 of the Code of Federal Regulations* (CFR), Part 1910.
- *Title 29 of the Code of Federal Regulations* (CFR), Part 1926.
- *Pocket Guide to Chemical Hazards*, DHHS, PHS, CDC, NIOSH (1997).
- *Threshold Limit Values*, ACGIH (2001).
- *Guide to Occupational Exposure Values*, ACGIH (2001).
- *Quick Selection Guide to Chemical Protective Clothing*, Forsberg, K. and S.Z. Mansdorf, 2nd Ed. (1993).
- *Health and Safety Policies and Procedures Manual*, BBL.

1.5 Definitions

The following definitions (listed alphabetically) are applicable to this HASP:

- *Contamination Reduction Zone (CRZ)* - Area between the exclusion zone and support zone that provides a transition between contaminated and clean areas. Decontamination stations are located in this zone.
- *Exclusion Zone (EZ)* - Any portions of the site where hazardous substances are, or are reasonably suspected to be present, and pose an exposure hazard to on-site personnel.
- *Incident* - All losses, including first aid cases, injuries, illnesses, near misses, spills/leaks, equipment and property damage, motor vehicle accidents, regulatory violations, fires, and business interruptions.
- *Near Miss* - An incident in which no injury, illness, motor vehicle accident, equipment or property damage, etc., occurred, but under slightly different circumstances, could have occurred.
- *On-Site Personnel* - All BBL and subcontractor personnel involved with the project.
- *Project* - All on-site work performed under the scope of work.
- *Site* - The area described in Section 1.2, Site and Facility Description, where the work is to be performed by BBL personnel and subcontractors.
- *Support Zone (SZ)* - All areas of the site, except the EZ and CRZ. The SZ surrounds the CRZ and EZ. Support equipment and break areas are located in this zone.
- *Subcontractor* - Includes contractor personnel hired by BBL.
- *Visitor* - All other personnel, except the on-site personnel.
- *Work Area* - The portion of the site where work activities are actively being performed. This area may change daily as work progresses and includes the SZ, CRZ, and EZ. If the work area is located in an area on the site that is not contaminated, or suspected of being contaminated, the entire work area may be a SZ.

1.6 Acronyms

The following acronyms (listed alphabetically) are applicable to this HASP:

- *ACGIH* - American Conference of Governmental Industrial Hygienists
- *BBL* - Blasland, Bouck & Lee, Inc.
- *COC* - Constituent(s) of Concern
- *CRZ* - Contamination Reduction Zone
- *EZ* - Exclusion Zone

- *GFCI* - Ground Fault Circuit Interrupter
- *HASP* - Health and Safety Plan
- *HSO* - Health and Safety Officer
- *HSS* - Health and Safety Supervisor
- *II* - Incident Investigation
- *IPO* - Incident Prevention Observation
- *JSA* - Job Safety Analysis
- *LEL* - Lower Explosive Limit
- *MSDS* - Material Safety Data Sheet
- *OSHA* - Occupational Safety and Health Administration
- *PEL* - Permissible Exposure Limit
- *PFD* - Personal Floatation Device
- *PID* - Photoionization Detector
- *PM* - Project Manager
- *PO* - Project Officer
- *PPE* - Personal Protective Equipment
- *SPSA* - Safe Performance Self-Assessment
- *SS* - Site Supervisor
- *SZ* - Support Zone
- *TLV* - Threshold Limit Value
- *USCG* - United States Coast Guard
- *USEPA* - United States Environmental Protection Agency
- *VOC* - Volatile Organic Compound

2. Roles and Responsibilities

2.1 All Personnel

All BBL and subcontractor personnel must adhere to the procedures outlined in this HASP during the performance of their work. Each person is responsible for completing tasks safely, and reporting any unsafe acts or conditions to their supervisor. No person may work in a manner that conflicts with these procedures. After due warnings, the PM will dismiss from the site any person or subcontractor who violates safety procedures.

All BBL and subcontractor personnel will receive training in accordance with applicable regulations, and be familiar with the requirements and procedures contained in this HASP prior to initiating site activities. In addition, all personnel will attend an initial hazard briefing prior to beginning work at the site.

The roles of BBL personnel and subcontractors are outlined in the following sections. Key project personnel and contacts are summarized in Table 2-1.

2.2 BBL Personnel

2.2.1 Project Officer (PO)

The PO is responsible for providing resources to assure project activities are completed in accordance with this HASP, and for meeting all regulatory and contractual requirements.

2.2.2 Health and Safety Officer (HSO)

The HSO has overall responsibility for the technical health and safety aspects of the project, including review and approval of this HASP. Inquiries regarding BBL health and safety procedures, project procedures, and other technical or regulatory issues should be addressed to this individual. The HSO must approve changes or addenda to this HASP.

2.2.3 Project Manager (PM)

The PM is responsible for verifying that project activities are completed in accordance with the requirements of this HASP. The PM is responsible for confirming that the Site Supervisor (SS) has the equipment, materials, and qualified personnel to fully implement the safety requirements of this HASP, and/or that subcontractors assigned to this project meet the requirements established by BBL. It is also the responsibility of the PM to:

- Consult with the HSO on site health and safety issues;
- Verify that subcontractors meet health and safety requirements prior to commencing work;
- Review Incident Prevention Observation (IPO) forms;
- Verify that all incidents are thoroughly investigated;
- Approve, in writing, addenda or modifications of this HASP; and

- Suspend work or modify work practices, as necessary, for personal safety, protection of property, and regulatory compliance.

2.2.4 Health and Safety Supervisor (HSS)

The HSS is responsible for field health and safety issues, including the execution of this HASP. Questions in the field regarding health and safety procedures, project procedures, and other technical or regulatory issues should be addressed to this individual. The HSS will advise the PM on health and safety issues, and will establish and coordinate the project air monitoring program if one is deemed necessary (see Section 6.1, Air Monitoring). The HSS is the primary site contact on health and safety matters. It is the responsibility of the HSS to:

- Provide on-site technical assistance, if necessary;
- Participate in all incident investigations (IIs) and ensure that they are reported to the HSO and PM within 24 hours;
- Coordinate site and personal air monitoring as required, including equipment maintenance and calibration;
- Conduct site safety orientation training and safety meetings;
- Verify that BBL personnel and subcontractors have received the required physical examinations and medical certifications;
- Review site activities with respect to compliance with this HASP;
- Maintain required health and safety documents and records;
- Assist the SS in instructing field personnel on project hazards and protective procedures; and
- Review IPO forms.

2.2.5 Site Supervisor

The SS is responsible for implementing this HASP, including communicating requirements to on-site personnel and subcontractors. The SS will be responsible for informing the PM of changes in the work plan, procedures, or site conditions so that those changes may be addressed in this HASP. Other responsibilities are to:

- Consult with the HSS on site health and safety issues;
- Conduct IPOs at the site, and complete the IPO forms;
- Stop work, as necessary, for personal safety, protection of property, and regulatory compliance;
- Obtain a site map and determine and post routes to medical facilities and emergency telephone numbers;
- Notify local public emergency representatives (as appropriate) of the nature of the site operations, and post their telephone numbers (i.e., local fire department personnel who would respond for a confined space rescue);

- Observe on-site project personnel for signs of ill health effects;
- Investigate and report any incidents to the HSS;
- Verify that all on-site personnel have had applicable training;
- Verify that on-site personnel are informed of the physical, chemical, and biological hazards associated with the site activities, and the procedures and protective equipment necessary to control the hazards; and
- Issue/obtain any required work permits (hot work, confined space, etc.).

2.3 Subcontractors

Subcontractors and their personnel must understand and comply with applicable regulations and site requirements established in this HASP. Subcontractors may prepare their own site-specific HASP that must be consistent with the requirements of this HASP.

All subcontractor personnel will receive training in accordance with applicable regulations, and be familiar with the requirements and procedures contained in this HASP prior to initiating site activities. All subcontractor personnel will attend an initial hazard briefing prior to beginning work at the site. Additionally, on-site subcontractor personnel must attend and participate in the daily site safety meetings.

Subcontractors must designate individuals to function as the PM, HSO, HSS, and SS. In some firms, it is not uncommon for the duties of the HSO to be carried out by the PM. This is acceptable provided the PM has the required knowledge, training, and experience to properly address all hazards associated with the work, and to prepare, approve, and oversee the execution of the site-specific HASP. A subcontractor may designate the same person to perform the duties of both the HSS and the SS. However, depending on the level of complexity of a contractor's scope of work, it may be infeasible for one person to perform both functions satisfactorily.

2.4 All On-Site Personnel

All on-site personnel (including subcontractors) must read and acknowledge their understanding of this HASP before commencing work, and abide by the requirements of the plan. All on-site personnel shall sign the HASP Acknowledgement Form following their review of this HASP.

All BBL and subcontractor personnel will receive training in accordance with applicable regulations, and be familiar with the requirements and procedures contained in this HASP prior to initiating site activities. In addition, all on-site personnel will attend an initial hazard briefing prior to beginning work at the site and the daily safety meetings.

All on-site personnel must perform a Safe Performance Self-Assessment (SPSA) prior to beginning each work activity. The SPSA process is presented in Section 4.1.1. This process must be performed prior to beginning each activity, and must be performed after any near miss or other incident in order to determine if it is safe to proceed. On-site personnel will immediately report the following to the SS or HSS:

- Personal injuries and illnesses no matter how minor;
- Unexpected or uncontrolled release of chemical substances;

- Symptoms of chemical exposure;
- Unsafe or hazardous situations;
- Unsafe or malfunctioning equipment;
- Changes in site conditions that may affect the health and safety of project personnel;
- Damage to equipment or property;
- Situations or activities for which they are not properly trained; and
- Near misses.

2.5 Visitors

All visitors to BBL work areas must check in with the SS. Visitors will be cautioned to avoid skin contact with surfaces, soils, groundwater, or other materials that may impacted or be suspected to be impacted by constituents of concern (COC).

Visitors requesting to observe work at the site must don appropriate personal protective equipment (PPE) prior to entry to the work area and must have the appropriate training and medical clearances to do so. If respiratory protective devices are necessary, visitors who wish to enter the work area must have been respirator-trained and fit tested for a respirator within the past 12 months.

TABLE 2-1
KEY PERSONNEL

BBL Personnel		
Role	**Name**	**Address/Telephone No.**
Site Supervisor	David Gwodz	8 South River Road Cranbury, NJ 08512 (609) 860-0590
Health and Safety Supervisor	Gregory Albright	8 South River Road Cranbury, NJ 08512 (609) 860-0590
Health and Safety Officer	Jay D. Keough, CIH	8 South River Road Cranbury, NJ 08512 (609) 860-0590
Project Officer	Robert Gan, Phd.	8 South River Road Cranbury, NJ 08512 (609) 860-0590
Project Manager	Gregory Albright	8 South River Road Cranbury, NJ 08512 (609) 860-0590
Subcontractors		
Role	**Name**	**Address/Telephone No.**
Treatment system installation	Kevin Madison	57 Franklin Avenue Binghamton, New York (607) 771-7541
Client Personnel		
Title/Role	**Name**	**Address/Telephone No.**
Client/ On-Site Representative	Mark Gialanella Universal Instruments	29 Industrial Park Drive Kirkwood, New York (607) 779-7320
Key Agency Personnel		
Role	**Name**	**Address/Telephone No.**
New York State Department of Environmental Conservation	James Moras – Engineering John Grathwol – Construction	625 Broadway Albany, New York (518) 402-9761 or 9812
New York State Department of Health	Gary Robinson	217 South Salina Street, 3rd Floor Syracuse, New York (315) 426-7627

3. Project Hazards and Control Measures

3.1 Scope of Work

- Mobilization;
- Abandonment of monitoring wells;
- Soil Excavation;
- Removal of groundwater and phased concentrated hydrocarbon (PCH) from the excavations;
- Application of Hydrogen Releasing Compound (HRC®) to the bottom of the excavation;
- Backfilling the excavations;
- Monitoring well installation; and
- Demobilization.

3.2 Field Activities, Hazards, and Control Procedures

The following job safety analyses (JSAs) identify potential health, safety, and environmental hazards associated with each type of field activity. Because of the complex and changing nature of field projects, supervisors must continually inspect the site to identify hazards that may affect on-site personnel, the community, or the environment. The SS must be aware of these changing conditions and discuss them with the PM whenever these changes impact employee health, safety, the environment, or performance of the project. The SS will keep on-site personnel informed of the changing conditions, and the PM will write and/or approve addenda or revisions to this HASP as necessary.

3.2.1 Mobilization/Area Reconnaissance

Site mobilization and area reconnaissance will include establishing excavation locations, determining the location of utilities and other installations, and establishing work areas. Mobilization may also include setting up equipment and establishing a temporary site office. A break area will be set up outside of regulated work areas. Mobilization may involve clearing areas for the SZ and CRZ. During this initial phase, project personnel will walk the site to confirm the existence of anticipated hazards, and identify safety and health issues that may have arisen since the writing of this plan.

The hazards of this phase of activity are associated with heavy equipment operation, manual materials handling, installation of temporary on-site facilities, and manual site preparation.

Manual materials handling and manual site preparation may cause blisters, sore muscles, and joint and skeletal injuries; and may present eye, contusion, and laceration hazards. Installation of temporary field office and support facilities may expose personnel to electrical hazards, underground and overhead utilities, and physical injury due

to the manual lifting and moving of materials. The work area presents slip, trip, and fall hazards from scattered debris and irregular walking surfaces. Rainy weather may cause wet, muddy, slick walking surfaces, and unstable soil. Freezing weather hazards include frozen, slick, and irregular walking surfaces.

Environmental hazards include plants, such as poison ivy and poison oak; aggressive fauna, such as ticks, fleas, mosquitoes, wasps, spiders, and snakes; weather, such as sunburn, lightning, rain, and heat- or cold-related illnesses; and pathogens, such as rabies, Lyme disease, and blood-borne pathogens.

Control procedures for these hazards are discussed in Section 4, General Safety Practices.

3.2.2 Abandonment of Monitoring Wells

Three monitoring wells will be abandoned on site. This activity will include the removal of the wellhead protective covers, removal of casing from the borehole, and pressure sealing of the borehole with cement-bentonite grout (using a tremie pipe and packer) to within 3 feet of the surface.

The main hazards involved with this activity is lifting of materials and splashing the bentonite grout. While doing this activity the personnel should take special attention to **4.12 Lifting Safety.** The main hazards from bentonite include skin, eye, gastrointestinal, respiratory tract irritation, as such modified Level D Personal Protective Equipment as described in **Section 5.1.2 Modified Level D Protection.** Air monitoring will be performed in accordance with Section 6.1 Air Monitoring.

3.2.3 Removal of PSH and Groundwater from the Excavation

Removal of PSH and Groundwater from the Excavation will be completed by using a vacuum truck. The vacuum truck will be properly grounded and the wheels chocked. The operator will comply with the training as outlined in **Section 8 Training and Medical Surveillance.**

3.2.4 Excavation Hazards and Control Procedures

This task involves excavating at specified locations to remove impacted soils and debris. Excavation activities will be conducted in accordance with this section and all applicable OSHA regulations.

The physical hazards involved in the excavation of soils are related to the excavation itself and the operation of heavy equipment. The presence of overhead utilities such as power lines requires careful positioning of the excavating equipment in order to maintain a safe distance between the lines and the closest part of the equipment. The presence of underground utilities such as gas lines, power lines, water lines, and sewer pipes must be determined prior to beginning the excavation.

Excavations pose significant hazards to employees if they are not carefully controlled. There exists a chance for the excavation to collapse if it is not dug properly, sloped, benched, or shored as required by 29 CFR 1926 Subpart P. Protective systems, as required by 29 CFR 1926 Subpart P, must be utilized if the potential for hazardous cave-ins exist. The excavation also is a fall hazard, and employees must pay careful attention to what they are doing or they risk a fall into the excavation. Fall protection, as required by 29 CFR 1926 Subpart M, will be required.

Personnel are not permitted to enter excavations. All activities shall be done remotely, without entering the excavation. Access to open excavations will be restricted at all times by the use of high visibility fencing at a minimum.

Noise also may present a hazard. Heavy equipment operation frequently results in noise levels exceeding 85 dBA, requiring the use of hearing protection.

At the end of each workday, open test pit excavations will be backfilled or secured with high visibility fencing and equipment will be moved to a location away from high-voltage electrical equipment and away from routes necessary to access high-voltage electrical equipment.

Airborne concentrations of COC in the site soil and the dust from the excavation procedure pose the potential for inhalation exposure. PPE for this phase is described in Section 5, Personal Protective Equipment. Airborne particulate generation will be controlled during site excavations. Dry, dusty soil will be wetted with a water spray from a potable water source to control the generation of dust. Soil will not be wetted to a degree that will cause runoff or erosion.

Before excavation activities commence, the existence and location of underground pipe, electrical equipment, and gas lines shall be determined. This will be done, if possible, by contacting the appropriate client representative to mark the location of the lines. If the client's knowledge of the area is incomplete, an appropriate device, such as a magnetometer, will be used to locate the line. The Underground/Overhead Utility Checklist (see Attachment G) shall be used to document that nearby utilities have been marked on the ground, and that the excavation and drilling areas have been cleared. The completed checklist will be in the possession of the SS prior to commencement of any intrusive investigation.

All excavation activities shall be conducted in accordance with 29 CFR 1926 Subpart P. If excavation operations are located near underground installations, the exact location of the installations must be determined by safe and acceptable means. While the excavation is open, underground installations must be protected, supported, or removed as necessary to safeguard employees.

3.2.4.1 Inspections by a Competent Person

Daily inspections of excavations, the adjacent areas, and protective systems must be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection must be conducted by the competent person prior to the start of work and as needed throughout the shift (see attached Periodic Excavation Inspection Form in Attachment H).

Inspections also must be made after every rainstorm or other hazard-increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated. Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, exposed employees must be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.

Walkways must be provided where employees or equipment are required or permitted to cross over excavations. Guardrails which comply with 1926.502(b) must be provided. Adequate barrier protection must be provided at all remotely located excavations. All wells, pits, shafts, etc. must be barricaded or covered. Upon completion of exploration and other similar operations, temporary wells, pits, shafts, etc., must be backfilled.

3.2.4.2 Soil Classification

29 CFR 1926 Subpart P, Appendix A describes methods of classifying soil and rock deposits based on site and environmental conditions and on the structure and composition of the earth deposits. The appendix contains definitions, sets forth requirements, and describes acceptable visual and manual tests for use in classifying soils. This appendix applies when a sloping or benching system is designed in accordance with the requirements set forth in 1926.652(b)(2) as a method of protection for employees from cave-ins. This appendix also applies when timber shoring for excavations is designed as a method of protection from cave-ins in accordance with Appendix C to Subpart P of Part 1926, and when aluminum hydraulic shoring is designed in accordance with 29 CFR Subpart P Appendix D. This appendix also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in 1926.652(c), and the use of the data are predicated on the use of the soil classification system set forth in Appendix A of 29 CFR 1926.

Maximum allowable slope means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H: V). Short-term exposure means a period of time less than or equal to 24 hours that an excavation is open. Soil and rock deposits must be classified in accordance with Appendix A to Subpart P of Part 1926. The maximum allowable slope for a soil or rock deposit must be determined from Table B-1. The actual slope must not be steeper than the maximum allowable slope. The actual slope must be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope must be cut back to an actual slope which is at least horizontal to one vertical (1/2H: 1V) less steep than the maximum allowable slope. When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person must determine the degree to which the actual slope must be reduced below the maximum allowable slope, and must assure that such reduction is achieved. Surcharge loads from adjacent structures must be evaluated in accordance with 1926.651(I). Configurations of sloping and benching systems must be in accordance with 29 CFR 1926 Subpart P Appendix B.

TABLE B-1
29 CFR 1926 SUBPART P APPENDIX B
MAXIMUM ALLOWABLE SLOPES

Soil or Rock Type	Maximum Allowable Slopes (H:V)[1] for Excavations Less Than 20 Feet Deep[2]
Stable Rock	Vertical (90 degrees)
Type A[3]	¾:1 (53 degrees)
Type B	1:1 (45 degrees)
Type C	1:½ (34 degrees)

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. Sloping or benching for excavations greater than 20 feet deep must be designed by a registered professional engineer.

A short-term maximum allowable slope of 1/2H:1V (63 degrees) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth must be 3/4H:1V (53 degrees).

3.2.5 Overhead Electrical Clearances

If excavation activities are conducted in the vicinity of overhead power lines, the power to the lines must be de-energized, tested de-energized, marked up/guaranteed, and grounded or the equipment must be positioned such that no part, including excavation boom, can come within the minimum clearances as follows:

Nominal System Voltage	Minimum Required Clearance
0-50kV	10 feet
51-100kV	12 feet
101-200kV	15 feet
201-300kV	20 feet
301-500kV	25 feet
501-750kV	35 feet
751-1,000kV	45 feet

3.2.5.1 Excavation Entry Procedure

Persons entering an excavation must do so under controlled conditions. The excavation must be properly sloped, benched, or shored, and ladders or ramps must be available every 25 feet laterally in the excavation. Each entry shall have an attendant who observes the entrant(s) and is prepared to render assistance.

Duties of Workers Entering an Excavation

- Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of exposure to site contaminants;
- Communicate with the attendant as necessary to enable the attendant to monitor entrant status and to enable the attendant to alert entrants of the need to evacuate the space;
- Alert the attendant whenever:
  - the entrant recognizes any warning sign or symptom of exposure to a dangerous situation; or
  - the entrant detects a prohibited condition;
- Exit from the excavation as quickly as possible whenever:
  - an order to evacuate is given by the attendant or the supervisor;
  - the entrant recognizes any warning sign or symptom of exposure to a dangers situation; or
  - the entrant detects a prohibited condition.

Duties of Attendants

- Know the hazards that may be faced during entry, including information on the mode, signs or symptoms, and consequences of exposure to site contaminants;
- Continuously maintains a count of entrants in the excavation;

- Remains outside the excavation during entry operations until relieved by another attendant;

- Communicates with authorized entrants as necessary to monitor entrant status to alert entrants of the need to evacuate the excavation under any of the following conditions:

  - if the attendant detects a prohibited condition;
  - if the attendant detects the behavioral effects of hazard exposure in an entrant;
  - if the attendant detects a situation outside the excavation that could endanger the entrants; or
  - if the attendant cannot effectively and safely perform his duties;

Summon rescue and other emergency services if the attendant determines that entrants may need assistance to evacuate the excavation.

3.2.6 Drilling Safety

3.2.6.1 Drilling Hazards

The primary physical hazards for this activity are associated with the use of drilling equipment. Rig accidents can occur as a result of improperly placing the rig on uneven or unstable terrain, or failing to adequately secure the rig prior to the start of operations. Underground and overhead utility lines can create hazardous conditions if contacted by drilling equipment. Tools and equipment, such as elevators, cat lines, and wire rope, have the potential for striking, pinning, or cutting personnel.

Wire Rope - Worn or frayed wire rope presents a laceration hazard if loose wires protrude from the main bundle.

Cat Lines - Cat lines are used on drilling rigs to hoist material. Accidents that occur during cat line operations may injure the employee doing the rigging, as well as injure the operator. Minimal hoisting control causes sudden and erratic load movements, which may result in hand and foot injuries.

Working Surfaces - Slippery work surfaces can increase the likelihood of back injuries, overexertion injuries, and slips and falls.

Materials Handling - The most common type of accident that occurs in material handling operations is the "caught between" situation when a load is being handled and a finger or toe gets caught between two objects. Rolling stock can shift and/or fall from a pipe rack or truck bed.

3.2.6.2 Drilling Safety Procedures

Drill Crews - All drillers must possess required state or local licenses to perform such work. All members of the drill crew shall receive site-specific training prior to beginning work.

The driller is responsible for the safe operation of the drill rig, as well as the crew's adherence to the requirements of this HASP. The driller must ensure that all safety equipment is in proper condition and is properly used. The members of the crew must follow all instructions of the driller, wear all PPE, and be aware of all hazards and control procedures. The drill crews must participate in the Daily Safety Meetings and be aware of all emergency procedures.

Rig Inspection - Each day, prior to the start of work, the drill rig and associated equipment must be inspected by the driller and/or drill crew. The following items must be inspected:

- Vehicle condition;
- Proper storage of equipment;
- Condition of all wire rope and hydraulic lines;
- Fire extinguisher; and
- First aid kit.

Drill Rig Set Up - The drill rig must be properly blocked and leveled prior to raising the derrick. The wheels that remain on the ground must be chocked. The leveling jacks shall not be raised until the derrick is lowered. The rig shall be moved only after the derrick has been lowered.

Site Drilling Rules - Before drilling, the existence and location of underground pipe, electrical equipment, and gas lines will be determined. This will be done, if possible, by contacting the appropriate client representative to mark the location of the lines. If the client's knowledge of the area is incomplete, an appropriate device, such as a magnetometer, will be used to locate the line. The Underground/Overhead Utility Checklist shall be used to document that nearby utilities have been marked on the ground, and that the drill site has been cleared. The checklist shall be in the possession of the SS prior to commencement of the intrusive investigation at that point of the site (see Attachment G Underground/Overhead Utilities Checklist).

Combustible gas readings of the general work area will be made regularly (see Section 6).

Operations must be suspended and corrective action taken if the airborne flammable concentration reaches 10% of lower explosive limit (LEL) in the immediate area (a one-foot radius) of the point of drilling, or near any other ignition sources.

Under no circumstances will personnel be permitted to ride the traveling block or elevators, nor will the cat line be used as a personnel carrier.

Overhead Electrical Clearances - If drilling is conducted in the vicinity of overhead power lines, the power to the lines must be shut off or the equipment must be positioned and blocked such that no part, including cables, can come within the minimum clearances as follows:

Nominal System Voltage	Minimum Required Clearance
0-50kV	10 feet
51-100kV	12 feet
101-200kV	15 feet
201-300kV	20 feet
301-500kV	25 feet
501-750kV	35 feet
751-1,000kV	45 feet

When the drill rig is in transit, with the boom lowered and no load, the equipment clearance must be at least 4 feet for voltages less than 50kV, 10 feet for voltages of 50kV to 345kV, and 16 feet for voltages above 345kV.
Rig Set Up - All well sites will be inspected by the driller prior to the location of the rig to verify a stable surface exists. This is especially important in areas where soft, unstable terrain is common.

All rigs will be properly blocked and leveled prior to raising the derrick. Blocking provides a more stable drilling structure by evenly distributing the weight of the rig. Proper blocking ensures that differential settling of the rig does not occur.

When the ground surface is soft or otherwise unstable, wooden blocks, at least 24 inches by 24 inches and 4 inches to 8 inches thick, shall be placed between the jack swivels and the ground. The emergency brake shall be engaged, and the wheels that are on the ground shall be chocked.

Hoisting Operations - Drillers should never engage the rotary clutch without watching the rotary table, and ensuring it is clear of personnel and equipment.

Unless the drawworks is equipped with an automatic feed control, the brake should not be left unattended without first being tied down.

Auger strings or casing should be picked up slowly.

During instances of unusual loading of the derrick or mast, such as when making an unusually hard pull, only the driller should be on the rig floor; no one else should be on the rig or derrick.

The brakes on the drawworks of the drill rig should be tested by the driller each day. The brakes should be thoroughly inspected by a competent individual each week.

A hoisting line with a load imposed should not be permitted to be in direct contact with any derrick member or stationary equipment, unless it has been specifically designed for line contact.

Workers should never stand near the borehole whenever any wire line device is being run.

Hoisting control stations should be kept clean and controls labeled as to their functions.

Cat Line Operations - Only experienced workers will be allowed to operate the cathead controls. The kill switch must be clearly labeled and operational prior to operation of the cat line. The cathead area must be kept free of obstructions and entanglements.

The operator should not use more wraps than necessary to pick up the load. More than one layer of wrapping is not permitted.

Personnel should not stand near, step over, or go under a cable or cat line that is under tension.

Employees rigging loads on cat lines shall:

- Keep out from under the load;
- Keep fingers and feet where they will not be crushed;
- Be sure to signal clearly when the load is being picked up;
- Use standard visual signals only and not depend on shouting to co-workers; and
- Make sure the load is properly rigged, since a sudden jerk in the cat line will shift or drop the load.

Wire Rope - When two wires are broken or rust or corrosion is found adjacent to a socket or end fitting, the wire rope shall be removed from service or resocketed. Special attention shall be given to the inspection of end fittings on boom support, pendants, and guy ropes.

Wire rope removed from service due to defects shall be cut up or plainly marked as being unfit for further use as rigging.

Wire rope clips attached with U-bolts shall have the U-bolts on the dead or short end of the rope; the clip nuts shall be re-tightened immediately after initial load carrying use and at frequent intervals thereafter.

When a wedge socket fastening is used, the dead or short end of the wire rope shall have a clip attached to it or looped back and secured to itself by a clip; the clip shall not be attached directly to the live end.

Protruding ends of strands in splices on slings and bridles shall be covered or blunted.

Except for eye splices in the ends of wires and for endless wire rope slings, wire rope used in hoisting, lowering, or pulling loads, shall consist of one continuous piece without knot or splice.

An eye splice made in any wire rope shall have not less than five full tucks.

Wire rope shall not be secured by knots. Wire rope clips shall not be used to splice rope.

Eyes in wire rope bridles, slings, or bull wires shall not be formed by wire clips or knots.

Auger Handling - Auger sections shall be transported by cart or carried by two persons. Individuals should not carry auger sections without assistance.

Workers should not be permitted on top of the load during loading, unloading, or transferring of rolling stock.

When equipment is being hoisted, personnel should not stand where the bottom end of the equipment could whip and strike them.

Augers stored in racks, catwalks, or on flatbed trucks should be secured to prevent rolling.

3.2.6.3 Well Development

Field operations consist of developing the well after installation to remove material or contaminants from the well prior to its being placed in service. The physical hazards of these operations are primarily associated manipulation and operation of the pump and its associated equipment. Other physical hazards of this phase of activity are associated with site conditions and manual materials handling. Equipment operation may present noise hazards, vibration hazards and potential for employee contact with hot surfaces. Manual materials handling may cause blisters, sore muscles, and joint and/or skeletal injuries. The work area may present slip, trip, and fall hazards from scattered debris and wet or irregular walking surfaces. Wet weather may cause wet, muddy, and/or slick walking surfaces.

For well development, Modified Level D protection will be used unless, based upon air monitoring and site conditions during well development activities, the SS determines that a higher or lower level of protection is necessary. Air sampling may be conducted during well development to assess the potential to COC. If the results

of air monitoring indicate COC in a concentration causing concern, based on Section 6, Air Monitoring, personnel will upgrade to Level C protection. Refer to Section 6, Air Monitoring, for a description of requirements and action levels. A description of each level of PPE protection is included in Section 5 Personal Protective Equipment.

3.2.7 Groundwater Sampling/Monitoring

Groundwater sampling/monitoring will involve uncapping, purging (pumping water out of the well), and sampling/monitoring new and existing monitoring wells. A mechanical pump may be utilized to purge the wells and can be hand-, gas-, or electric-operated. Water samples taken from the wells are then placed in containers and shipped to analytical laboratory for analysis. The physical hazards of these operations are primarily associated with the sample collection methods and procedures utilized.

Hazards - Inhalation and absorption (contact) of COC are the primary routes of entry associated with groundwater sampling due to the manipulation of sample media and equipment, manual transfer of media into sample containers, and proximity of operations to the breathing zone. During the course of this project, several different groundwater sampling methodologies may be utilized based on equipment accessibility and the types of materials to be sampled. These sampling methods may include hand or mechanical bailing. The primary hazards associated with these specific sampling procedures are not potentially serious; however, other operations in the area, or the conditions under which samples must be collected may present chemical and physical hazards. The hazards directly associated with groundwater sampling procedures are generally limited to strains/sprains from hand bailing and potential eye hazards. Exposure to soil and water containing COC is also possible.

The flora and fauna of the site may present hazards of poison ivy, poison oak, ticks, fleas, mosquitoes, wasps, spiders, and snakes. The work area presents slip, trip, and fall hazards from scattered debris and irregular walking surfaces. Freezing weather hazards include frozen, slick, and irregular walking surfaces. Rainy weather may cause wet, muddy, slick walking surfaces and unstable soil.

Control - To control dermal exposure during groundwater sampling/monitoring activities, a minimum of Modified Level D protection will be worn. Air monitoring may be conducted during groundwater sampling/monitoring activities to assess the potential for exposure to airborne COC. If the results of air monitoring indicate the presence of organic vapors in a concentration causing concern, personnel will upgrade to Level C protection. Refer to Section 6, Air Monitoring, for a description of air monitoring requirements and action levels. A description of each level of personal protection is included in Section 5, Personal Protective Equipment. Control procedures for environmental and general hazards are discussed in Section 4, General Site Safety Procedures.

3.2.8 Field Soil Sampling Activities

Field sampling operations consist of the collection of soil samples for subsequent analysis and evaluation of potential site impact. The physical hazards of these operations are primarily associated with the sample collection methods and procedures utilized.

Samples of soils will be obtained to evaluate the extent of potential site impacts. Inhalation and absorption (contact) of constituents are the primary routes of entry associated with soil sampling due to the manipulation of sample and equipment, manual transfer of media into sample containers, and proximity of operations to the breathing zone. To control dermal exposure during soil sampling activities, a minimum of Modified Level D protection (see Section 5, Personal Protective Equipment) will be worn. Air sampling may be conducted during soil sampling to assess the potential for exposure to airborne constituents. If the results of air monitoring indicate the presence of organic vapors in a concentration exceeding the site action level for Modified Level D, personnel will upgrade to Level C protection. Refer to Section 6, Air Monitoring, for a description of air monitoring requirements and action levels. A description of each level of protection is included in Section 5, Personal Protective Equipment.

The collection of soil samples involves advancing test pit excavations with excavation equipment. The equipment poses a hazard if it is not properly operated. The presence of overhead utilities and underground obstacles poses a hazard if the excavator contacts them. Safety hazards and procedures associated with activities conducted around excavations are presented in the following sections.

3.2.9 Water Level Measurement Activities

At each of the monitoring wells, field personnel will obtain depth-to-water measurements using an electronic water level indicator. The hazards associated with these activities are primarily associated with the working surfaces and contact with the groundwater.

The work area may present slip, trip, and fall hazards from scattered debris and irregular walking surfaces. Rainy weather may cause wet, muddy, and slick walking surfaces, and unstable soil. For water level measurement, Modified Level D protection will be used for dermal protection unless, based on air monitoring and conditions during site activities, the HSS determines that a higher or lower protection level is necessary. Air sampling will be conducted to assess the potential for inhalation of potential contaminants. If the results of air monitoring indicate COC in a concentration causing concern, based on Section 6, Air Monitoring, personnel will upgrade to Level C protection. Refer to Section 6, Air Monitoring, for a description of requirements and action levels. A description of each level of PPE protection is included in Section 5, Personal Protective Equipment.

3.2.10 Clearing

Site clearing and subsequent construction activities involve a potential for exposure to numerous physical and health hazards. The hazards are primarily associated with the equipment used and the debris being removed.

Physical Hazards - The physical hazards involved with clearing and construction relate to work done with heavy equipment, hand tools, and the environment itself. There exists a potential for incidents involving personnel struck by or struck against powered equipment, timber, or materials, resulting in fractures, cuts, punctures, or abrasions.

Walking and working surfaces during construction activities may involve slip, trip, and fall hazards. Working at elevations may create a fall hazard.

Environmental Hazards - Overgrown areas present hazards of uneven walking surfaces, soft terrain, and biological hazards such as insects and snakes.

Working Surfaces - Uneven terrain and slippery work surfaces can increase the likelihood of back injuries, overexertion injuries, and slips and falls. All personnel should frequently inspect the area in which they are working, and keep the area as clear as possible.

Powered Equipment Operations - Site workers are exposed to serious hazards during clearing when using powered equipment. Workers may be struck by blades or by material thrown by powered equipment.

Materials Handling - The most common type of accident that occurs in material handling operations is the "caught between" situation when a load is being handled and a finger or toe gets caught between two objects. Extreme care must be taken when loading and unloading material. Proper lifting technique must be employed, and mechanical means must be used to lift objects whenever possible.

Health Hazards - Due to the type of work involved in clearing and construction activities, the primary health hazards involve repetitive motion disorders, lifting, and other ergonomic stressors. Noise may also present a hazard. Operation of heavy equipment and power actuated and pneumatic hand tools frequently results in high noise levels.

Control - Prior to initiating clearing and construction activities, the operation will be explained to all employees. Hazards will be identified and protective measures will be explained. Equipment will be inspected and in proper working condition. Employees should receive training to address the equipment, its operations, and care. Personnel should be scheduled in a manner to reduce the likelihood of performing repetitive tasks for prolonged periods. Technical assistance should be provided for large lifting tasks. Hearing protection is required for use when exposed to noise levels exceeding 85 dBA, or a level that commonly results in difficult conversation.

3.2.11 Hydrogen Release Compound (HRC®) Activities

After monitoring well installation, HRC® compound will be heated and injected into the monitoring wells. The hazards of HRC® include corrosivity, eye and skin irritation. Inhalation, ingestion, and skin absorption should be avoided. While handling HRC® Modified Level D PPE will be used, specifically polycoated tyvek suits, 10-mil nitrile gloves, and chemical splash goggles. Additionally, an eyewash station will be made available during HRC® injection activities. The material safety data sheet for HRC® is included in Attachment A Material Safety Data Sheets.

3.2.12 Equipment Decontamination

All equipment will be decontaminated before leaving the site. Personnel involved in decontamination activities may be exposed to skin contact with contaminated materials and chemicals brought to the site as part of the project work. Personnel involved in decontamination activities must wear PPE that is one level below the level worn by personnel working in the EZ.

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3.2.14 Demobilization

Demobilization involves the removal of all tools, equipment, supplies, and vehicles brought to the site. The hazards of this phase of activity are associated with boat heavy operation and manual materials handling.

Manual materials handling may cause blisters, sore muscles, and joint and skeletal injuries; and may present eye, contusion, and laceration hazards. The boat launch area presents slip, trip, and fall hazards from scattered debris and irregular walking surfaces. Rainy weather may cause wet, muddy, slick walking surfaces, and unstable soil. Freezing weather hazards include frozen, slick, and irregular walking surfaces.

Environmental hazards include plants, such as poison ivy and poison oak; aggressive fauna, such as ticks, fleas, mosquitoes, wasps, spiders, and snakes; weather, such as sunburn, lightning, rain, and heat- or cold-related illnesses; and pathogens, such as rabies, Lyme disease, and blood-borne pathogens.

Control procedures for these hazards are discussed in Section 4, General Safety Practices.

3.3 Chemical Hazards

The chemical hazards associated with site operations are related to inhalation, ingestion, and skin exposure to site COCs. Concentrations of airborne COCs during site tasks may be measurable, and will require air monitoring during certain operations. Air monitoring requirements for site tasks are outlined in Section 6.1.

Site COCs may include chloroethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethene, ethylbenzene, tetrachloroethene, 1,1,1-trichloroethane, trichloroethene, and vinyl chloride.

The potential for inhalation of site COCs is low. The potential for dermal contact with soils and groundwater containing site COCs during excavation, drilling, and sampling operations is moderate. Table 3-1 lists the chemical, physical, and toxicological properties of site COCs. Material Safety Data Sheets (MSDS) for the COCs is included in Attachment A.

Exposure to the HRC® compound is also possible; the hazards of HRC® include corrosivity, eye and skin irritation. Inhalation, ingestion, and skin absorption should be avoided. The material safety data sheet for HRC® is included in Attachment A Material Safety Data Sheets.

4. General Safety Practices

4.1 General Safety Rules

General safety rules for site activities include, but are not limited to, the following:

- At least one copy of this HASP must be in a location at the site that is readily available to personnel, and all project personnel shall review the plan prior to starting work.
- Consume or use food, beverages, chewing gum, and tobacco products only in the SZ or other designated area outside the EZ and CRZ. Cosmetics shall not be applied in the EZ or CRZ.
- Wash hands before eating, drinking, smoking, or using toilet facilities.
- Wear all PPE as required, and stop work and replace damaged PPE immediately.
- Secure disposable coveralls, boots, and gloves at the wrists and legs and ensure closure of the suit around the neck.
- Upon skin contact with materials that may be impacted by COC, remove contaminated clothing and wash the affected area immediately. Contaminated clothing must be changed. Any skin contact with materials potentially impacted by COC must be reported to the SS or HSS immediately. If needed, medical attention should be sought.
- Practice contamination avoidance. Avoid contact with surfaces either suspected or known to be impacted by COC, such as standing water, mud, or discolored soil. Equipment must be stored on elevated or protected surfaces to reduce the potential for incidental contamination.
- Remove PPE as required in the CRZ to limit the spread of COC-containing materials.
- At the end of each shift or as required, dispose of all single-use coveralls, soiled gloves, and respirator cartridges in designated receptacles designated for this purpose.
- Removing soil containing site COC from protective clothing or equipment with compressed air, shaking, or any other means that disperses contaminants into the air is prohibited.
- Inspect all non-disposable PPE for contamination in the CRZ. Any PPE found to be contaminated must be decontaminated or disposed of appropriately.
- Recognize emergency signals used for evacuation, injury, fire, etc.
- Report all injuries, illnesses, near misses, and unsafe conditions or work practices to the SS or HSS.
- Use the "buddy system" during all operations requiring Level C PPE, and when appropriate, during Modified Level D operations.

- Obey all warning signs, tags, and barriers. Do not remove any warnings unless authorized to do so.
- Use, adjust, alter, and repair equipment only if trained and authorized to do so, and in accordance with the manufacturer's directions.
- Personnel are to perform only tasks for which they have been properly trained and will advise their supervisor if they have been assigned a task for which they are not trained.
- The presence or consumption of alcoholic beverages or illicit drugs during the workday is strictly prohibited. Do not take prescription or over-the-counter drugs when assigned to tasks with the potential for absorption, inhalation, or ingestion of hazardous substances, unless given written approval by an appropriate health care professional.
- Remain upwind during site activities whenever possible.

4.1.1 Safe Performance Self-Assessment (SPSA)

All on-site personnel are required to perform a SPSA prior to beginning any activity. This three-step process requires each individual to:

- *Assess* the risk of the task to be performed. Ask the following questions:
  - What could go wrong?
  - What is the worst thing that could happen if something does go wrong?
- *Analyze* the ways the risk can be reduced. Ask the following questions:
  - Do I have all the necessary training and knowledge to do this task safely?
  - Do I have all the proper tools and PPE?
- *Act* to control the risk and perform the task safely.
  - Take the necessary action to perform the job safely.
  - Follow written procedures, and ask for assistance if necessary.

This process must be performed prior to beginning any activity, and must be performed after any near miss or other incident in order to determine if it is safe to proceed.

4.1.2 Incident Investigation

An incident is any of the following events: first aid cases, injuries, illnesses, near misses, spills/leaks, equipment and property damage, motor vehicle accidents, regulatory violations, fires, and business interruptions. All incidents shall be investigated within 24 hours and reported to the PM and the HSO.

The purpose of an II is to prevent the recurrence of a similar hazardous event. II investigates all incidents in the same manner. Using the information gathered during an II, appropriate measures will be taken to protect personnel from the hazard in question. The II form is included in Attachment B.

4.1.3 Incident Prevention Observation

The SS or the HSS will perform the IPO (see Attachment C for the IPO form). The purpose of the IPO is to identify and correct potential hazards, and to positively reinforce behaviors and practices that are correct. The SS or HSS must identify potential deviations from safe work practices that could possibly result in an incident, and take prompt corrective action. The IPO process steps are:

- Identify tasks that have the greatest potential for hazardous incidents;
- Review the standard procedure for completing the task;
- Discuss with the observed employee the task and the SS/HSS role in observing the task;
- Observe the employee completing the task;
- Reference the IPO form for criteria. Complete the form, documenting positive, as well as areas in need of improvement;
- Discuss the results of the IPO with the employee. Discuss corrective action necessary;
- Implement corrective action; and
- Communicate the results of the IPO and corrective action to the PM and the HSO.

4.1.4 Job Safety Analysis

A JSA is a tool used of identifying potential hazards and developing corrective or protective systems to eliminate the hazard. A JSA lists all the potential hazards associated with an activity. Hazards may be physical, such as lifting hazards or eye hazards, or environmental, such as weather or biological (stinging insects, snakes, etc.). Following the identification of the hazards associated with an activity, control measures are evaluated and protective measures or procedures are then instituted. JSAs are reviewed periodically to ensure that the procedures and protective equipment specified for each activity are current and technically correct. Any changes in site conditions and/or the scope of work may require a review and modification to the JSA in question. During this review process, comments on the JSA and its procedures should be obtained from personnel associated with the activity being analyzed.

4.2 Buddy System

On-site personnel must use the buddy system as required by operations. Use of the "buddy system" is required during all operations requiring Level C to Level A PPE, and when appropriate, during Level D operations. Crewmembers must observe each other for signs of chemical exposure, and heat or cold stress. Indications of adverse effects include, but are not limited to:

- Changes in complexion and skin coloration;
- Changes in coordination;
- Changes in demeanor;
- Excessive salivation and pupillary response; and

- Changes in speech pattern.

Crewmembers must also be aware of the potential exposure to possible safety hazards, unsafe acts, or non-compliance with safety procedures.

Field personnel must inform their partners or fellow crewmembers of non-visible effects of exposure to toxic materials that they may be experiencing. The symptoms of such exposure may include, but are not limited to:

- Headaches;
- Dizziness;
- Nausea;
- Blurred vision;
- Cramps; and
- Irritation of eyes, skin, or respiratory tract.

If protective equipment or noise levels impair communications, prearranged hand signals must be used for communication. Personnel must stay within line of sight of another team member.

4.3 Heat Stress

Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, etc., as well as the physical and conditioning characteristics of the individual. Since heat stress is one of the most common illnesses associated with heavy outdoor work conducted with direct solar load and, in particular, because wearing PPE can increase the risk of developing heat stress, workers must be capable of recognizing the signs and symptoms of heat-related illnesses. Personnel must be aware of the types and causes of heat-related illnesses and be able to recognize the signs and symptoms of these illnesses in both themselves and their co-workers.

Heat rashes are one of the most common problems in hot work environments. Commonly known as prickly heat, a heat rash is manifested as red papules and usually appears in areas where the clothing is restrictive. As sweating increases, these papules give rise to a prickling sensation. Prickly heat occurs in skin that is persistently wetted by unevaporated sweat, and heat rash papules may become infected if they are not treated. In most cases, heat rashes will disappear when the affected individual returns to a cool environment.

Heat cramps are usually caused by performing hard physical labor in a hot environment. These cramps have been attributed to an electrolyte imbalance caused by sweating. It is important to understand that cramps can be caused both by too much or too little salt.

Cramps appear to be caused by the lack of water replenishment. Because sweat is a hypotonic solution (plus or minus 0.3% NaCl), excess salt can build up in the body if the water lost through sweating is not replaced. Thirst cannot be relied on as a guide to the need for water; instead, water must be taken every 15 to 20 minutes in hot environments.

Under extreme conditions, such as working for 6 to 8 hours in heavy protective gear, a loss of sodium may occur. Drinking commercially available carbohydrate electrolyte replacement liquids is effective in minimizing physiological disturbances during recovery.

Heat exhaustion occurs from increased stress on various body organs due to inadequate blood circulation, cardiovascular insufficiency, or dehydration. Signs and symptoms include pale, cool, moist skin; heavy sweating;

dizziness; nausea; headache, vertigo, weakness, thirst, and giddiness. Fortunately, this condition responds readily to prompt treatment.

Heat exhaustion should not be dismissed lightly, however, for several reasons. One is that the fainting associated with heat exhaustion can be dangerous because the victim may be operating machinery or controlling an operation that should not be left unattended; moreover, the victim may be injured when he or she faints. Also, the signs and symptoms seen in heat exhaustion are similar to those of heat stroke, which is a medical emergency.

Workers suffering from heat exhaustion should be removed from the hot environment, be given fluid replacement, and be encouraged to get adequate rest.

Heat stroke is the most serious form of heat stress. Heat stroke occurs when the body's system of temperature regulation fails and the body's temperature rises to critical levels. This condition is caused by a combination of highly variable factors, and its occurrence is difficult to predict.

Heat stroke is a medical emergency. The primary signs and symptoms of heat stroke are confusion; irrational behavior; loss of consciousness; convulsions; a lack of sweating (usually); hot, dry skin; and an abnormally high body temperature, e.g., a rectal temperature of 41°C (105.8°F). If body temperature is too high, it causes death. The elevated metabolic temperatures caused by a combination of workload and environmental heat load, both of which contribute to heat stroke, are also highly variable and difficult to predict.

If a worker shows signs of possible heat stroke, professional medical treatment should be obtained immediately. The worker should be placed in a shady area and the outer clothing should be removed. The worker's skin should be wetted and air movement around the worker should be increased to improve evaporative cooling until professional methods of cooling are initiated and the seriousness of the condition can be assessed. Fluids should be replaced as soon as possible. The medical outcome of an episode of heat stroke depends on the victim's physical fitness and the timing and effectiveness of first aid treatment.

Regardless of the worker's protestations, no employee suspected of being ill from heat stroke should be sent home or left unattended unless a physician has specifically approved such an order.

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important because once someone suffers from heat stroke or exhaustion, that person may be predisposed to additional heat injuries.

Heat Stress Safety Precautions

Heat stress monitoring and work rest cycle implementation should commence when the ambient adjusted temperature exceeds 72°F. A minimum work rest regimen and procedures for calculating ambient adjusted temperature are described in Table 4-1.

TABLE 4-1
WORK/REST SCHEDULE

Adjusted Temperature[b]	Work/Rest Regimen Normal Work Ensemble[c]	Work/Rest Regimen Impermeable Ensemble
90°F (32.2°C) or above	After each 45 minutes of work	After each 15 minutes of work
87.5° - 90°F (30.8°-32.2°C)	After each 60 minutes of work	After each 30 minutes of work
82.5° - 87.5°F (28.1° - 30.8°C)	After each 90 minutes of work	After each 60 minutes of work
77.5° - 82.5°F (25.3° - 28.1°C)	After each 120 minutes of work	After each 90 minutes of work
72.5° - 77.5°F (30.8° - 32.2°C)	After each 150 minutes of work	After each 120 minutes of work

a. For work levels of 250 kilocalories/hour (Light-Moderate Type of Work)
b. Calculate the adjusted air temperature (ta adj) by using this equation: ta adj °F = ta °F + (13 x % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)
c. A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.
d. The information presented above was generated using the information provided in the American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Values (TLV) Handbook.

In order to determine if the work rest cycles are adequate for the personnel and specific site conditions, additional monitoring of individual heart rates will be conducted during the rest cycle. To check the heart rate, count the radial pulse for 30 seconds at the beginning of the rest period. If the heart rate exceeds 110 beats per minute, shorten the next work period by one third and maintain the same rest period.

Additionally, one or more of the following control measures can be used to help control heat stress and are mandatory if any site worker has a heart rate (measure immediately prior to rest period) exceeding 115 beats per minute:

- Site workers will be encouraged to drink plenty of water and electrolyte replacement fluids throughout the day.
- On-site drinking water will be kept cool (50 to 60°F).
- A work regimen that will provide adequate rest periods for cooling down will be established, as required.
- All personnel will be advised of the dangers and symptoms of heat stroke, heat exhaustion, and heat cramps.
- Cooling devices, such as vortex tubes or cooling vests, should be used when personnel must wear impermeable clothing in conditions of extreme heat.
- Employees should be instructed to monitor themselves and co-workers for signs of heat stress and to take additional breaks as necessary.
- A shaded rest area must be provided. All breaks should take place in the shaded rest area.
- Employees must not be assigned to other tasks during breaks.
- Employees must remove impermeable garments during rest periods. This includes white Tyvek®-type garments.

All employees must be informed of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress disorders.

4.4 Cold Stress

Cold stress normally occurs in temperatures at or below freezing, or under certain circumstances, in temperatures of 40°F. Extreme cold for a short time may cause severe injury to exposed body surfaces or result in profound generalized cooling, causing death. Areas of the body that have high surface area-to-volume ratio, such as fingers, toes, and ears, are the most susceptible. Two factors influence the development of a cold weather injury: ambient temperature and the velocity of the wind. For instance, 10°F with a wind of 15 miles per hour (mph) is equivalent in chilling effect to still air at 18°F. An equivalent chill temperature chart relating the actual dry bulb temperature and wind velocity is presented in Table 4-2.

TABLE 4-2
CHILL TEMPERATURE CHART

Estimated Wind Speed (in mph)	Actual Temperature Reading (°F)											
	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
	Equivalent Chill Temperature (°F)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect.)	LITTLE DANGER Maximum danger of false sense of security.				INCREASING DANGER Danger from freezing of exposed flesh within one minute.			GREAT DANGER Flesh may freeze within 30 seconds.				
	Trench foot and immersion foot may occur at any point on this chart.											

[This chart was developed by the U.S. Army Research Institute of Environmental Medicine, Natick, MA (Source: ACGIH Threshold Limit Values for Chemical Substances and Physical Agents)].

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of tissue damage associated with frostbite. Frostbite of the extremities can be categorized into:

- *Frost Nip or Incipient Frostbite* - characterized by sudden blanching or whitening of skin.
- *Superficial Frostbite* - skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- *Deep Frostbite* - tissues are cold, pale, and solid; extremely serious injury.

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. It can be fatal. Its symptoms are usually exhibited in five stages: 1) shivering; 2) apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95°F; 3) unconsciousness, glassy stare, slow pulse, and slow respiratory rate; 4) freezing of the extremities; and 5) death. Trauma sustained in freezing or sub-zero conditions requires special attention because an injured worker is predisposed to secondary cold injury. Special provisions must be made to prevent hypothermia and secondary freezing of damaged tissues in addition to providing for first aid treatment. To

avoid cold stress, site personnel must wear protective clothing appropriate for the level of cold and physical activity. In addition to protective clothing, preventive safe work practices, additional training, and warming regimens may be utilized to prevent cold stress.

Safety Precautions for Cold Stress Prevention

For air temperature of 0°F or less, mittens should be used to protect the hands. For exposed skin, continuous exposure should not be permitted when air speed and temperature results in a wind chill temperature of -25°F.

At air temperatures of 36°F or less, field personnel who become immersed in water or whose clothing becomes wet must be immediately provided with a change of clothing and be treated for hypothermia.

If work is done at normal temperature or in a hot environment before entering the cold, the field personnel must ensure that their clothing is not wet as a consequence of sweating. If wet, field personnel must change into dry clothes prior to entering the cold area.

If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work must be modified or suspended until adequate clothing is made available or until weather conditions improve.

Field personnel handling evaporative liquid (e.g., gasoline, alcohol, or cleaning fluids) at air temperatures below 40°F must take special precaution to avoid soaking of clothing or gloves with the liquids because of the added danger of cold injury due to evaporative cooling.

Safe Work Practices

Direct contact between bare skin and cold surfaces (< 20°F) should be avoided. Metal tool handles and/or equipment controls should be covered by thermal insulating material.

For work performed in a wind chill temperature at or below 10°F, workers should be under constant protective observation (buddy system). The work rate should be established to prevent heavy sweating that will result in wet clothing. For heavy work, rest periods must be taken in heated shelters and workers should be provided with an opportunity to change into dry clothing if needed.

Field personnel should be provided the opportunity to become accustomed to cold-weather working conditions and required protective clothing.

Work should be arranged in such a way that sitting or standing still for long periods is minimized.

During the warming regimen (rest period), field personnel should be encouraged to remove outer clothing to permit sweat evaporation or to change into dry work clothing. Dehydration, or loss of body fluids, occurs insidiously in the cold environment and may increase susceptibility to cold injury due to a significant change in blood flow to the extremities. Fluid replacement with warm, sweet drinks and soups is recommended. The intake of coffee should be limited because of diuretic and circulatory effects.

4.5 Biological Hazards

Biological hazards may include poison ivy, snakes, thorny bushes and trees, ticks, mosquitoes, scorpions, and other pests.

4.5.1 Tick Borne Diseases

Lyme Disease: The disease commonly occurs in summer and is transmitted by the bite of infected ticks. "Hot spots" in the United States include New York, New Jersey, Pennsylvania, Massachusetts, Connecticut, Rhode Island, Minnesota, and Wisconsin.

Erlichiosis: The disease also commonly occurs in summer and is transmitted by the bite of infected ticks. "Hot spots" in the United States include New York, Massachusetts, Connecticut, Rhode Island, Minnesota, and Wisconsin.

These diseases are transmitted primarily by the deer tick, which is smaller and redder than the common wood tick. The disease may be transmitted by immature ticks, which are small and hard to see. The tick may be as small as a period on this page.

Symptoms of Lyme disease include a rash or a peculiar red spot, like a bull's eye, which expands outward in a circular manner. The victim may have headache, weakness, fever, a stiff neck, and swelling and pain in the joints, and eventually, arthritis. Symptoms of erlichiosis include muscle and joint aches, flu-like symptoms, but there is typically no skin rash.

Rocky Mountain Spotted Fever (RMSF): This disease is transmitted via the bite of an infected tick. The tick must be attached 4 to 6 hours before the disease-causing organism (Rickettsia rickettsii) becomes reactivated and can infect humans. The primary symptom of RMSF is the sudden appearance of a moderate-to-high fever. The fever may persist for two to three weeks. The victim may also have a headache, deep muscle pain, and chills. A rash appears on the hands and feet on about the third day and eventually spreads to all parts of the body. For this reason, RMSF may be confused with measles or meningitis. The disease may cause death, if untreated, but if identified and treated promptly, death is uncommon.

Control: Tick repellant containing diethyltoluamide (DEET) should be used when working in tick-infested areas, and pant legs should be tucked into boots. In addition, workers should search the entire body every three or four hours for attached ticks. Ticks should be removed promptly and carefully without crushing, since crushing can squeeze the disease-causing organism into the skin. A gentle and steady pulling action should be used to avoid leaving the head or mouth parts in the skin. Hands should be protected with surgical gloves when removing ticks.

4.5.2 Poisonous Plants

Poisonous plants may be present in the work area. Personnel should be alerted to its presence, and instructed on methods to prevent exposure.

Control: The main control is to avoid contact with the plant, cover arms and hands, and frequently wash potentially exposed skin. Particular attention must be given to avoiding skin contact with objects or protective clothing that have touched the plants. Treat every surface that may have touched the plant as contaminated, and practice contamination avoidance. If skin contact is made, the area should be washed immediately with soap and water, and observed for signs of reddening.

4.5.3 Snakes

The possibility of encountering snakes exists, specifically for personnel working in wooded/vegetated areas. Snake venoms are complex and include proteins, some of which have enzymatic activity. The effects produced by venoms include neurotoxic effects with sensory, motor, cardiac, and respiratory difficulties; cytotoxic effects on red blood cells, blood vessels, heart muscle, kidneys, and lungs; defects in coagulation; and effects from local release of substances by enzymatic actions. Other noticeable effects of venomous snakebites include swelling, edema, and pain around the bite, and the development of ecchymosis (the escape of blood into tissues from ruptured blood vessels).

Control: To minimize the threat of snakebites, all personnel walking through vegetated areas must be aware of the potential for encountering snakes, and the need to avoid actions potentiating encounters, such as turning over logs, etc. If a snakebite occurs, an attempt should be made to safely kill the snake for identification. The victim must be transported to the nearest hospital within 30 minutes; first aid consists of applying a constriction band, and washing the area around the wound to remove any unabsorbed venom.

4.5.4 Spiders

Personnel may encounter spiders during work activities.

Two spiders are of concern, the black widow and the brown recluse. Both prefer dark sheltered areas such as basements, equipment sheds and enclosures, and around woodpiles or other scattered debris. The black widow is shiny black, approximately one inch long, and found throughout the United States. There is a distinctive red hourglass marking on the underside of the black widows body. The bite of a black widow is seldom fatal to healthy adults, but effects include respiratory distress, nausea, vomiting, and muscle spasms. The brown recluse is smaller than the black widow and gets its name from its brown coloring and behavior. The brown recluse is more prevalent in the southern United States. The brown recluse has a distinctive violin shape on the top of its body. The bite of the brown recluse is painful and the bite site ulcerates and takes many weeks to heal completely.

Control: To minimize the threat of spider bites, all personnel walking through vegetated areas must be aware of the potential for encountering these arachnids. Personnel need to avoid actions that may result in encounters, such as turning over logs, and placing hands in dark places such as behind equipment or in corners of equipment sheds or enclosures. If a spider bite occurs, the victim must be transported to the nearest hospital as soon as possible; first aid consists of applying ice packs and washing the area around the wound to remove any unabsorbed venom.

4.6 Noise

Exposure to noise over the OSHA action level can cause temporary impairment of hearing; prolonged and repeated exposure can cause permanent damage to hearing. The risk and severity of hearing loss increases with the intensity and duration of exposure to noise. In addition to damaging hearing, noise can impair voice communication, thereby increasing the risk of accidents on site.

Control: All personnel must wear hearing protection, with a Noise Reduction Rating (NRR) of at least 20, when noise levels exceed 85 dBA. When it is difficult to hear a co-worker at normal conversation distance, the noise level is approaching or exceeding 85 dBA, and hearing protection is necessary. All site personnel who may be exposed to noise must also receive baseline and annual audiograms and training as to the causes and prevention of hearing loss. Noise monitoring is discussed in Section 6.2, Noise Monitoring.

Whenever possible, equipment that does not generate excessive noise levels will be selected for this project. If the use of noisy equipment is unavoidable, barriers or increased distance will be used to minimize worker exposure to noise, if feasible.

4.7 Spill Control

All personnel must take every precaution to minimize the potential for spills during site operations. All on-site personnel shall immediately report any discharge, no matter how small, to the SS.

Spill control equipment and materials will be located on the site at locations that present the potential for discharge. All sorbent materials used for the cleanup of spills will be containerized and labeled appropriately. In the event of a spill, the SS will follow the provisions in Section 9, Emergency Procedures, to contain and control released materials and to prevent their spread to off-site areas.

4.8 Sanitation

Site sanitation will be maintained according to OSHA requirements.

4.8.1 Break Area

Breaks must be taken in the SZ, away from the active work area after site personnel go through decontamination procedures. There will be no smoking, eating, drinking, or chewing gum or tobacco in any area other than the SZ.

4.8.2 Potable Water

The following rules apply to all field operations:

- An adequate supply of potable water will be provided at each project site. Potable water must be kept away from hazardous materials or media, and contaminated clothing or equipment.
- Portable containers used to dispense drinking water must be capable of being tightly closed, and must be equipped with a tap dispenser. Water must not be consumed directly from the container (drinking from the tap is prohibited) nor may it be removed from the container by dipping.
- Containers used for drinking water must be clearly marked and shall not be used for any other purpose.
- Disposable drinking cups must be provided. A sanitary container for dispensing cups and a receptacle for disposing of used cups is required.

4.8.3 Sanitary Facilities

Access to facilities for washing before eating, drinking, or smoking, or alternate methods such as waterless hand-cleaner and paper towels will be provided.

4.8.4 Lavatory

If permanent toilet facilities are not available, an appropriate number of portable chemical toilets will be provided.

This requirement does not apply to mobile crews or to normally unattended site locations so long as employees at these locations have transportation immediately available to nearby toilet facilities.

4.9 Emergency Equipment

Adequate emergency equipment for the activities being conducted on site and as required by applicable sections of 29 CFR 1910 and 29 CFR 1926 will be on site prior to the commencement of project activities. Personnel will be provided with access to emergency equipment, including, but not limited to, the following:

- Fire extinguishers of adequate size, class, number, and location as required by applicable sections of 29 CFR 1910 and 1926;
- Industrial first aid kits of adequate size for the number of personnel on site; and
- Emergency eyewash and/or shower if required by operations being conducted on site.

4.10 Lockout/Tagout Procedures

Only fully qualified and trained personnel will perform maintenance procedures. Before maintenance begins, lockout/tagout procedures per OSHA 29 CFR 1910.147 will be followed.

Lockout is the placement of a device that uses a positive means, such as lock, to hold an energy or material-isolating device such that the equipment cannot be operated until the lockout device is removed. If a device cannot be locked out, a tagout system shall be used. Tagout is the placement of a warning tag on an energy or material isolating device indicating that the equipment controls may not be operated until the tag is removed by the personnel who attached the tag.

4.11 Electrical Safety

Electricity may pose a particular hazard to site workers due to the use of portable electrical equipment. If wiring or other electrical work is needed, a qualified electrician must perform it.

General electrical safety requirements include:

- All electrical wiring and equipment must be a type listed by Underwriters Laboratories (UL), Factory Mutual Engineering Corporation (FM), or other recognized testing or listing agency.
- All installations must comply with the National Electrical Safety Code (NESC), the National Electrical Code (NEC), or USCG regulations.
- Portable and semi-portable tools and equipment must be grounded by a multi-conductor cord having an identified grounding conductor and a multi-contact polarized plug-in receptacle.
- Tools protected by an approved system of double insulation, or its equivalent, need not be grounded. Double insulated tools must be distinctly marked and listed by UL or FM.
- Live parts of wiring or equipment must be guarded to prevent persons or objects from touching them.

- Electric wire or flexible cord passing through work areas must be covered or elevated to protect it from damage by foot traffic, vehicles, sharp corners, projections, or pinching.
- All circuits must be protected from overload.
- Temporary power lines, switchboxes, receptacle boxes, metal cabinets, and enclosures around equipment must be marked to indicate the maximum operating voltage.
- Plugs and receptacles must be kept out of water unless of an approved submersible construction.
- All extension cord outlets must be equipped with ground fault circuit interrupters (GFCI).
- Attachment plugs or other connectors must be equipped with a cord grip and be constructed to endure rough treatment.
- Extension cords or cables must be inspected prior to each use, and replaced if worn or damaged. Cords and cables must not be fastened with staples, hung from nails, or suspended by bare wire.
- Flexible cords must be used only in continuous lengths without splice, with the exception of molded or vulcanized splices made by a qualified electrician.

4.12 Lifting Safety

Using proper lifting techniques may prevent back strain or injury. The fundamentals of proper lifting include:

- Consider the size, shape, and weight of the object to be lifted. A mechanical lifting device or additional persons must be used to lift an object if it cannot be lifted safely alone.
- The hands and the object should be free of dirt or grease that could prevent a firm grip.
- Gloves must be used, and the object inspected for metal slivers, jagged edges, burrs, or rough or slippery surfaces.
- Fingers must be kept away from points that could crush or pinch them, especially when putting an object down.
- Feet must be placed far enough apart for balance. The footing should be solid and the intended pathway should be clear.
- The load should be kept as low as possible, close to the body with the knees bent.
- To lift the load, grip firmly and lift with the legs, keeping the back as straight as possible.
- A worker should not carry a load that he or she cannot see around or over.
- When putting an object down, the stance and position are identical to that for lifting; the legs are bent at the knees, and the back is straight as the object is lowered.

4.13 Ladder Safety

When portable ladders are used for access to an upper landing surface, the ladder side rails shall extend at least 3 feet (9 m) above the upper landing surface to which the ladder is used to gain access; or, when such an extension is not possible because of the ladder's length, then the ladder shall be secured at its top to a rigid support that will not deflect, and a grasping device, such as a grabrail, shall be provided to assist employees in mounting and dismounting the ladder. In no case shall the extension be such that ladder deflection under a load would, by itself, cause the ladder to slip off its support.

- Ladders shall be maintained free of oil, grease, and other slipping hazards.
- Ladders shall not be loaded beyond the maximum intended load for which they were built, nor beyond their manufacturer's rated capacity.
- Ladders shall be used only for the purpose for which they were designed.
- Non-self-supporting ladders shall be used at an angle such that the horizontal distance from the top support to the foot of the ladder is approximately one-quarter of the working length of the ladder (the distance along the ladder between the foot and the top support).
- Wood job-made ladders with spliced side rails shall be used at an angle such that the horizontal distance is one-eighth the working length of the ladder.
- Fixed ladders shall be used at a pitch no greater than 90 degrees from the horizontal, as measured to the back side of the ladder.
- Ladders shall be used only on stable and level surfaces unless secured to prevent accidental displacement.
- Ladders shall not be used on slippery surfaces unless secured or provided with slip-resistant feet to prevent accidental displacement. Slip-resistant feet shall not be used as a substitute for care in placing, lashing, or holding a ladder that is used upon slippery surfaces, including, but not limited to, flat metal or concrete surfaces that are constructed so they cannot be prevented from becoming slippery.
- Ladders placed in any location where they can be displaced by workplace activities or traffic, such as in passageways, doorways, or driveways, shall be secured to prevent accidental displacement, or a barricade shall be used to keep the activities or traffic away from the ladder.
- The area around the top and bottom of ladders shall be kept clear.
- The top of a non-self-supporting ladder shall be placed with the two rails supported equally unless it is equipped with a single support attachment.
- Ladders shall not be moved, shifted, or extended while occupied.
- Ladders shall have non-conductive siderails if they are used where the employee or the ladder could contact exposed energized electrical equipment.
- The top, top step, or the step labeled that it or any step above it should not be used as a step.

- Cross-bracing on the rear section of stepladders shall not be used for climbing unless the ladders are designed and provided with steps for climbing on both front and rear sections.

- Ladders shall be inspected by the HSO for visible defects on a daily basis and after any occurrence that could affect their safe use.

- Portable ladders with structural defects, such as, but not limited to, broken or missing rungs, cleats, or steps; broken or split rails; corroded components; or other faulty or defective components shall either be immediately marked in a manner that readily identifies them as defective, or be tagged with "Do Not Use" or similar language, and shall be withdrawn from service.

- Fixed ladders with structural defects, such as, but not limited to, broken or missing rungs, cleats, or steps; broken or split rails; or corroded components; shall be withdrawn from service.

- Ladder repairs shall restore the ladder to a condition meeting its original design criteria, before the ladder is returned to use.

- Single-rail ladders shall not be used.

- When ascending or descending a ladder, the user shall face the ladder.

- Each employee shall use at least one hand to grasp the ladder when progressing up and/or down the ladder.

- An employee shall not carry any object or load that could cause the employee to lose balance and fall.

4.14 Traffic Safety

The project site may be located adjacent to a public roadway where exposure to vehicular traffic is likely. Traffic may also be encountered as vehicles enter and exit the area. To minimize the likelihood of project personnel and activities being affected by traffic, the following procedures will be implemented.

Cones must be placed along the shoulder of the roadway starting 100 feet from the work area to alert passing motorists to the presence of personnel and equipment. A "Slow" or "Men Working" sign must be placed at the first cone. Barricades with flashing lights should be placed between the roadway and the work area.

During activities along a roadway, equipment will be aligned parallel to the roadway to the extent feasible, facing into the oncoming traffic so as to place a barrier between the work crew and the oncoming traffic. All crewmembers must remain behind the equipment and the traffic barrier.

All site personnel who are potentially exposed to vehicular traffic must wear an outer layer of orange warning garments, such as vests, jackets, or shirts. If work is performed in hours of dusk or darkness, workers will be outfitted with reflective garments either orange, white (including silver-coated reflective coatings or elements that reflect white light), yellow, fluorescent red-orange, or fluorescent yellow-orange.

The flow of traffic into and out of the adjacent business must be assessed, and precautions taken to warn motorists of the presence of workers and equipment. Where possible, vehicles should be aligned to provide physical protection of people and equipment.

5. Personal Protective Equipment

5.1 Levels of Protection

PPE is required to safeguard site personnel from various hazards. Varying levels of protection may be required depending on the levels of COC and the degree of physical hazard. This section presents the various levels of protection and defines the conditions of use for each level. A summary of the levels is presented in Table 5-1 in this section.

5.1.1 Level D Protection

The minimum level of protection that will be required of BBL personnel and subcontractors at the site will be Level D, which will be worn when site conditions or air monitoring indicates no inhalation hazard exists. The following equipment will be used:

- Work clothing as prescribed by weather;
- Steel toe work boots, meeting ANSI Z41;
- Safety glasses or goggles, meeting ANSI Z87;
- Outer gloves chosen based on COC over nitrile surgical gloves (if handling soils or groundwater);
- Hard hat, meeting ANSI Z89, when falling object hazards are present; and
- Hearing protection (if noise levels exceed 85 dBA, then hearing protection with a USEPA NRR of at least 20 dBA must be used).

5.1.2 Modified Level D Protection

Modified Level D will be used when airborne contaminants are not present at levels of concern, but site activities present an increased potential for skin contact with contaminated materials. Modified Level D consists of:

- Tyvek® coveralls (polyethylene coated Tyvek® suits for handling liquids) when skin contact with COC-impacted media is anticipated;
- Latex/PVC overboots when contact with COC-impacted media is anticipated;
- Steel toe work boots, meeting ANSI Z41;
- Safety glasses or goggles, meeting ANSI Z87;
- Face shield in addition to safety glasses or goggles when projectiles or splash hazards exist;
- Outer gloves chosen based on COC over nitrile surgical gloves;

- Hard hat, meeting ANSI Z89 when falling object hazards are present;
- Hearing protection (if noise levels exceed 85 dBA, then hearing protection with a USEPA NRR of at least 20 dBA must be used); and

5.1.3 Level C Protection

Level C protection will be required when the airborne concentration of COC reaches ½ of the OSHA Permissible Exposure Limit (PEL) or American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV). The following equipment will be used for Level C protection:

- Full-face, air-purifying respirator with appropriate cartridges for site COC;
- Polyethylene-coated Tyvek®, suit, with ankles and cuffs taped to boots and gloves;
- Outer gloves chosen based on site COC over nitrile surgical gloves;
- Steel toe work boots, meeting ANSI Z41;
- Chemical resistant boots with steel toes or latex/PVC overboots over steel toe boots;
- Hard hat, meeting ANSI Z89;
- Hearing protection (if noise levels exceed 85 dBA, then hearing protection with a USEPA NRR of at least 20 dBA must be used); and

5.2 Selection of PPE

Equipment for personal protection will be selected based on the potential for contact, site conditions, ambient air quality, and the judgment of supervising site personnel and health and safety professionals. The PPE used will be chosen to be effective against the COC present on the site.

5.3 Site Respiratory Protection Program

Respiratory protection is an integral part of employee health and safety at the site due to potentially hazardous concentrations of airborne COC. The site respiratory protection program will consist of the following (as a minimum):

- All on-site personnel who may use respiratory protection will have an assigned respirator.
- All on-site personnel who may use respiratory protection will have been fit tested and trained in the use of a full-face air-purifying respirator within the past 12 months.

- All on-site personnel who may use respiratory protection must within the past year have been medically certified as being capable of wearing a respirator. Documentation of the medical certification must be provided to the HSS, prior to commencement of site work.
- Only cleaned, maintained, NIOSH-approved respirators will be used.
- If respirators are used, the respirator cartridge is to be properly disposed of at the end of each work shift, or when load-up or breakthrough occurs.
- Contact lenses are not to be worn when a respirator is worn.
- All on-site personnel who may use respiratory protection must be clean-shaven. Mustaches and sideburns are permitted, but they must not touch the sealing surface of the respirator.
- Respirators will be inspected, and a negative pressure test performed prior to each use.
- After each use, the respirator will be wiped with a disinfectant, cleansing wipe. When used, the respirator will be thoroughly cleaned at the end of the work shift. The respirator will be stored in a clean plastic bag, away from direct sunlight in a clean, dry location, in a manner that will not distort the face piece.

5.4 Using PPE

Depending upon the level of protection selected, specific donning and doffing procedures may be required. The procedures presented in this section are mandatory if Modified Level D or Level C PPE is used. All personnel entering the EZ must put on the required PPE in accordance with the requirements of this HASP. When leaving the EZ, PPE will be removed in accordance with the procedures listed, to minimize the spread of COC.

5.4.1 Donning Procedures

These procedures are mandatory only if Modified Level D or Level C PPE is used on the site:

- Remove bulky outerwear. Remove street clothes and store in clean location;
- Put on work clothes or coveralls;
- Put on the required chemical protective coveralls;
- Put on the required chemical protective boots or boot covers;
- Tape the legs of the coveralls to the boots with duct tape;
- Put on the required chemical protective gloves;
- Tape the wrists of the protective coveralls to the gloves;
- Don the required respirator and perform appropriate fit check (Level C);
- Put hood or head covering over head and respirator straps and tape hood to facepiece (Level C); and

- Don remaining PPE, such as safety glasses or goggles and hard hat.

When these procedures are instituted, one person must remain outside the work area to ensure that each person entering has the proper protective equipment.

5.4.2 Doffing Procedures

The following procedures are only mandatory if Modified Level D or Level C PPE is required for the site. Whenever a person leaves the work area, the following decontamination sequence will be followed:

- Upon entering the CRZ, rinse contaminated materials from the boots or remove contaminated boot covers;
- Clean reusable protective equipment;
- Remove protective garments, equipment, and respirator (Level C). All disposable clothing should be placed in plastic bags, which are labeled with contaminated waste labels;
- Wash hands, face, and neck (or shower if necessary);
- Proceed to clean area and dress in clean clothing; and
- Clean and disinfect respirator for next use.

All disposable equipment, garments, and PPE must be bagged in plastic bags, labeled for disposal. See Section 7, Decontamination, for detailed information on decontamination stations.

5.5 Selection Matrix

The level of personal protection selected will be based on air monitoring of the work environment and an assessment by the SS and HSS of the potential for skin contact with COC. The PPE selection matrix is presented in Table 5-1. This matrix is based on information available at the time this plan was written. The Airborne Contaminant Action Levels in Table 6-1 should be used to verify that the PPE prescribed in these matrices is appropriate.

TABLE 5-1
PPE SELECTION MATRIX

Task	Level of Protection
Site Set-Up, SZ Work	Level D
Soil Excavation	Modified Level D/Level C
Removal of PSH	Modified Level D/Level C
Application of HRC®	Modified Level D/Level C
Backfilling of Excavation	Level D
Decontamination	Modified Level D/Level C
Demobilization	Level D

6. Air Monitoring

6.1 Air Monitoring

Air monitoring will be conducted to determine employee exposure to airborne constituents. The monitoring results will dictate work procedures and the selection of PPE. The monitoring devices to be used are an MIE Data RAM particulate monitor (or equivalent) and a Rae Systems MultiRAE detector (PIDs with a 10.2 eV and 11.8 eV lamps/oxygen/LEL/Hydrogen Sulfide Sensors). The BBL HSS will be responsible for utilizing the air monitoring results to determine appropriate health and safety precautions for BBL personnel and subcontractors.

Monitoring for oxygen, flammable vapors, hydrogen sulfide, and organic vapors will be conducted during any excavation entry.

Air monitoring will be conducted continuously with the LEL/Oxygen meter during drilling and during excavation in areas where flammable vapors or gases are suspect. All work activity must stop where tests indicate the concentration of flammable vapors exceeds 10% of the LEL at a location with a potential ignition source. Such an area must be ventilated to reduce the concentration to an acceptable level. In areas where petroleum hydrocarbons are detected, Dichloroethene detector tube readings must be taken if PID readings exceed 1ppm, and are sustained for 15 minutes in the breathing zone.

Air monitoring for fugitive dust emissions will be performed in accordance with the protocols described in the Remedial Design Package (Section 2-3, page 2-2). The project site will be maintained so as to minimize the creation and dispersion of fugitive dust. The program for suppressing fugitive dust and monitoring particulate matter will follow NYSDEC's *Technical And Administrative Guidance Memorandum #4031: Fugitive Dust Suppression and Particulate Monitoring Program At Inactive Hazardous Waste Sites* (TAGM #4031). Dust control measures will be used throughout the course of the site work, as warranted. Dust emissions will be visually monitored throughout the period of work. Particulate monitoring for fugitive dust will be performed using real-time particulate monitors that will have automatic alarms and will detect particulate matter less than 10 microns in diameter. Fugitive dust controls will immediately be implemented if conditions warrant.

Community Air Monitoring Plan

Air monitoring will include real-time air monitoring for protection of the downwind community such as, residences and businesses. Community air monitoring will be performed for VOCs and particulates. Continuous air monitoring will be performed of all ground intrusive activities and during soil stockpiling and loading, and periodic air monitoring for non-intrusive activities such as the collection of soil samples.

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

All 15-minute readings must be recorded and be available for New York State (DEC and DOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.

6.2 Noise Monitoring

Noise monitoring may be conducted as required. Hearing protection is mandatory for all employees in noise hazardous areas, such as around heavy equipment. As a general rule, sound levels that cause speech interference at normal conversation distance should require the use of hearing protection.

6.3 Monitoring Equipment Maintenance and Calibration

All direct-reading instrumentation calibrations should be conducted under the approximate environmental conditions the instrument will be used. Instruments must be calibrated before and after use, noting the reading(s) and any adjustments that are necessary. All air monitoring equipment calibrations, including the standard used for

calibration, must be documented on a calibration log or in the field notebook. All completed HS documentation/forms must be reviewed by the HSS and maintained by the SS.

All air monitoring equipment will be maintained and calibrated in accordance with the specific manufacturer's procedures. Preventive maintenance and repairs will be conducted in accordance with the respective manufacturer's procedures. When applicable, only manufacturer-trained and/or authorized personnel will be allowed to perform instrument repairs or preventive maintenance.

If an instrument is found to be inoperative or suspected of giving erroneous readings, the HSS must be responsible for immediately removing the instrument from service and obtaining a replacement unit. If the instrument is essential for safe operation during a specific activity, that activity must cease until an appropriate replacement unit is obtained. The HSS will be responsible for ensuring a replacement unit is obtained and/or repairs are initiated on the defective equipment.

6.4 Action Levels

Table 6-1 presents airborne contaminant action levels that will be used to determine the procedures and protective equipment necessary based on conditions as measured at the site.

TABLE 6-1
AIRBORNE CONTAMINANT ACTION LEVELS

Parameter	Reading	Action
Total Hydrocarbons	0 ppm to ≤ 1 ppm	Normal operations; continue hourly breathing zone monitoring
	> 1 ppm to 5 ppm	Increase monitoring frequency to every 15 minutes and use benzene Draeger tube to screen for the presence of 1,1-dichloroethene
	≥ 5 ppm to ≤ 50 ppm	Upgrade to Level C PPE; continue screening for benzene
	> 50 ppm	Stop work; investigate cause of reading
1,1-Dichloroethene	≥ 5 ppm to 10 ppm	Upgrade to Level C PPE
	> 10 ppm	Stop work; investigate cause of reading
Airborne Particulates	0 to < 7.5 mg/m^3	Normal operations; continue hourly breathing zone monitoring
	≥ 7.5 mg/m^3 to 15 mg/m^3	Initiate dust suppression measures; if suppression measures are insufficient to reduce particulates below 7.5 mg/m^3 to 15 mg/m^3, upgrade to Level C and increase monitoring frequency to every 15 minutes
Oxygen	≤ 19.5%	Stop work, evacuate confined spaces/work area, investigate cause of reading, and ventilate area
	> 19.5% to < 23.5%	Normal operations
	≥ 23.5%	Stop work, evacuate confined spaces/work area, investigate cause of reading, and ventilate area
Carbon Monoxide	0 ppm to ≤ 20 ppm	Normal operations
	> 20 ppm	Stop work, evacuate confined spaces/work area, investigate cause of reading, and ventilate area
Hydrogen Sulfide	0 ppm to ≤ 5 ppm	Normal operations
	> 5 ppm	Stop work, evacuate confined spaces/work area, investigate cause of reading, and ventilate area
Flammable Vapors (LEL)	< 10% LEL	Normal operations
	≥ 10% LEL	Stop work, ventilate area, investigate source of vapors

7. Work Zones and Decontamination

7.1 Work Zones

7.1.1 Authorization to Enter

Only personnel with the appropriate training and medical certifications (if respirators are required) will be allowed to work at the project site. The SS will maintain a list of authorized persons; only personnel on the authorized persons list will be allowed to enter the site work areas.

7.1.2 Site Orientation and Hazard Briefing

No person will be allowed in the work area during site operations without first being given a site orientation and hazard briefing. This orientation will be presented by the SS or HSS, and will consist of a review of this HASP. This review must cover the chemical, physical, and biological hazards, protective equipment, safe work procedures, and emergency procedures for the project. Following this initial meeting, daily safety meetings will be held each day before work begins.

All people entering the site work areas, including visitors, must document their attendance at this briefing, as well as the daily safety meetings on the forms included with this plan.

7.1.3 Certification Documents

A training and medical file may be established for the project and kept on site during all site operations. Specialty training, such as first aid/cardiopulmonary resuscitation (CPR) certificates, as well as current medical clearances for all project field personnel required to wear respirators, will be maintained within that file. All BBL and subcontractor personnel must provide their training and medical documentation to the HSS prior to starting work.

7.1.4 Entry Log

A log-in/log-out sheet will be maintained at the site by the SS. Personnel must sign in and out on a log sheet as they enter and leave the work area, and the SS may document entry and exit in the field notebook.

7.1.5 Entry Requirements

In addition to the authorization, hazard briefing, and certification requirements listed above, no person will be allowed in any BBL work area unless they are wearing the minimum PPE as described in Section 5, Personal Protective Equipment.

7.1.6 Emergency Entry and Exit

People who must enter the work area on an emergency basis will be briefed of the hazards by the SS. All activities will cease in the event of an emergency. People exiting the work area because of an emergency will gather in a safe area for a head count. The SS is responsible for ensuring that all people who entered the work area have exited in the event of an emergency.

7.1.7 Contamination Control Zones

Contamination control zones are maintained to prevent the spread of contamination and to prevent unauthorized people from entering hazardous areas.

7.1.7.1 Exclusion Zone

An EZ may consist of a specific work area, or may be the entire area of potential contamination. All employees entering an EZ must use the required PPE, and must have the appropriate training and medical clearance for hazardous waste work. The EZ is the defined area where there is a possible respiratory and/or contact health hazard. Cones, caution tape, or a site diagram will identify the location of each EZ.

7.1.7.2 Contamination Reduction Zone

The CRZ or transition area will be established, if necessary, to perform decontamination of personnel and equipment. All personnel entering or leaving the EZ will pass through this area to prevent any cross-contamination. Tools, equipment, and machinery will be decontaminated in a specific location. The decontamination of all personnel will be performed on site adjacent to the EZ. Personal protective outer garments and respiratory protection will be removed in the CRZ and prepared for cleaning or disposal. This zone is the only appropriate corridor between the EZ and the SZ.

7.1.7.3 Support Zone

The SZ is a clean area outside the CRZ located to prevent employee exposure to hazardous substances. Eating and drinking will be permitted in the support area only after proper decontamination. Smoking may be permitted in the SZ, subject to site requirements.

7.1.8 Posting

Work areas will be prominently marked and delineated using cones, caution tape, or a site diagram.

7.1.9 Site Inspections

The SS will conduct a daily inspection of site activities, equipment, and procedures to verify that the required elements are in place. The Safety Inspection Form in Attachment D may be used as a guide for daily inspections. A monthly IPO must also be completed and forwarded to the PM for review.

7.2 Decontamination

7.2.1 Personnel Decontamination

All personnel wearing Modified Level D or Level C protective equipment in the EZ must undergo personal decontamination prior to entering the SZ. The personnel decontamination area will consist of the following stations at a minimum:

- *Station 1*: Personnel leaving the contaminated zone will remove the gross contamination from their outer clothing and boots.

- *Station 2*: Personnel will remove their outer garment and gloves and dispose of it in properly labeled containers. Personnel will then decontaminate their hard hats, and boots with an aqueous solution of detergent or other appropriate cleaning solution. These items are then hand carried to the next station.

- *Station 3*: Personnel will thoroughly wash their hands and face before leaving the CRZ. Respirators will be sanitized and then placed in a clean plastic bag.

7.2.2 Equipment Decontamination

All vehicles that have entered the EZ will be decontaminated at the decontamination pad prior to leaving the zone. If the level of vehicle contamination is low, decontamination may be limited to rinsing of tires and wheel wells with water. If the vehicle is significantly contaminated, steam cleaning or pressure washing of vehicles and equipment may be required.

7.2.3 Personal Protective Equipment Decontamination

Where and whenever possible, single-use, external protective clothing must be used for work within the EZ or CRZ. This protective clothing must be disposed of in properly labeled containers. Reusable protective clothing will be rinsed at the site with detergent and water. The rinsate will be collected for disposal.

When removed from the CRZ, the respirator will be thoroughly cleaned with soap and water. The respirator face piece, straps, valves, and covers must be thoroughly cleaned at the end of each work shift, and ready for use prior to the next shift. Respirator parts may be disinfected with a solution of bleach and water, or by using a spray disinfectant.

8. Training and Medical Surveillance

8.1 Training

8.1.1 General

All on-site project personnel who work in areas where they may be exposed to site contaminants must be trained as required by OSHA Regulation 29 CFR 1910.120 (HAZWOPER). Field employees also must receive a minimum of three days of actual field experience under the direct supervision of a trained, experienced supervisor. Personnel who completed their initial training more than 12 months prior to the start of the project must have completed an eight-hour refresher course within the past 12 months. The SS must have completed an additional eight hours of supervisory training, and must have a current first-aid/CPR certificate.

8.1.2 Basic 40-Hour Course

The following is a list of the topics typically covered in a 40-hour HAZWOPER training course:

- General safety procedures;
- Physical hazards (fall protection, noise, heat stress, cold stress);
- Names and job descriptions of key personnel responsible for site health and safety;
- Safety, health, and other hazards typically present at hazardous waste sites;
- Use, application, and limitations of PPE;
- Work practices by which employees can minimize risks from hazards;
- Safe use of engineering controls and equipment on site;
- Medical surveillance requirements;
- Recognition of symptoms and signs which might indicate overexposure to hazards;
- Worker right-to-know (Hazard Communication OSHA 1910.1200);
- Routes of exposure to contaminants;
- Engineering controls and safe work practices;
- Components of a health and safety program and a site-specific HASP;
- Decontamination practices for personnel and equipment;
- Confined-space entry procedures; and

- General emergency response procedures.

8.1.3 Supervisor Course

Management and supervisors must receive an additional eight hours of training, which typically includes:

- General site safety and health procedures;
- PPE programs; and
- Air monitoring techniques.

8.1.4 Site-Specific Training

Site-specific training will be accomplished by on-site personnel reading this HASP, or through a thorough site briefing by the PM, SS, or HSS on the contents of this HASP before work begins. The review must include a discussion of the chemical, physical, and biological hazards; the protective equipment and safety procedures; and emergency procedures.

8.1.5 Daily Safety Meetings

Daily safety meetings will be held to cover the work to be accomplished, the hazards anticipated, the PPE and procedures required to minimize site hazards, and emergency procedures. The SS or HSS should present these meetings prior to beginning the day's fieldwork. No work will be performed in an EZ before the daily safety meeting has been held. The daily safety meeting must also be held prior to new tasks, and repeated if new hazards are encountered. The Daily Safety Meeting Log is included in Attachment E.

8.1.6 First Aid and CPR

At least one employee current in first aid/CPR will be assigned to the work crew and will be on the site during operations. Refresher training in first aid (triennially) and CPR (annually) is required to keep the certificate current. These individuals must also receive training regarding the precautions and protective equipment necessary to protect against exposure to blood-borne pathogens.

8.2 Medical Surveillance

8.2.1 Medical Examination

All personnel who are potentially exposed to site contaminants must participate in a medical surveillance program as defined by OSHA at 29 CFR 1910.120 (f).

8.2.2 Pre-placement Medical Examination

All potentially exposed personnel must have completed a comprehensive medical examination prior to assignment, and periodically thereafter as defined by applicable regulations. The pre-placement and periodic medical examinations typically include the following elements:

- Medical and occupational history questionnaire;

- Physical examination;
- Complete blood count, with differential;
- Liver enzyme profile;
- Chest X-ray, at a frequency determined by the physician;
- Pulmonary function test;
- Audiogram;
- Electrocardiogram for persons older than 45 years of age, or if indicated during the physical examination;
- Drug and alcohol screening, as required by job assignment;
- Visual acuity; and
- Follow-up examinations, at the discretion of the examining physician or the corporate medical director.

The examining physician provides the employee with a letter summarizing his findings and recommendations, confirming the worker's fitness for work and ability to wear a respirator. Documentation of medical clearance will be available for each employee during all project site work.

Subcontractors will certify that all their employees have successfully completed a physical examination by a qualified physician. The physical examinations must meet the requirements of 29 CFR 1910.120 and 29 CFR 1910.134. Subcontractors will supply copies of the medical examination certificate for each on-site employee.

8.2.3 Other Medical Examinations

In addition to pre-employment, annual, and exit physicals, personnel may be examined:

- At employee request after known or suspected exposure to toxic or hazardous materials; and
- At the discretion of the HSS, HSO, or occupational physician in anticipation of, or after known or suspected exposure to toxic or hazardous materials.

8.2.4 Periodic Exam

Following the placement examination, all employees must undergo a periodic examination, similar in scope to the placement examination. For employees potentially exposed over 30 days per year, the frequency of periodic examinations will be annual. For employees potentially exposed less than 30 days per year, the frequency for periodic examinations will be 18 months.

8.2.5 Medical Restriction

When the examining physician identifies a need to restrict work activity, the employee's supervisor must communicate the restriction to the employee and the HSS. The terms of the restriction will be discussed with the employee and the supervisor.

9. Emergency Procedures

9.1 General

Prior to the start of operations, the work area will be evaluated for the potential for fire, contaminant release, or other catastrophic event. Unusual conditions or events, activities, chemicals, and conditions will be reported to the SS/HSS immediately.

The SS/HSS will establish evacuation routes and assembly areas for the site. All personnel entering the site will be informed of this route and the assembly area.

9.2 Emergency Response

If an incident occurs, the following steps will be taken:

- The SS/HSS will evaluate the incident and assess the need for assistance and/or evacuation;
- The SS/HSS will call for outside assistance as needed;
- The SS/HSS will ensure the PM is notified promptly of the incident; and
- The SS/HSS will take appropriate measures to stabilize the incident scene.

9.2.1 Fire

In the case of a fire at the site, the SS/HSS will assess the situation and direct fire-fighting activities. The SS/HSS will ensure that the PM is immediately notified of any fires. Site personnel will attempt to extinguish the fire with available extinguishers, if safe to do so. In the event of a fire that site personnel are unable to safely extinguish with one fire extinguisher, the local fire department will be summoned.

9.2.2 Contaminant Release

In the event of a contaminant release, the following steps will be taken:

- Notify SS/HSS immediately;
- Evacuate immediate area of release;
- Conduct air monitoring to determine needed level of PPE; and
- Don required level of PPE and prepare to implement control procedures.

The SS/HSS has the authority to commit resources as needed to contain and control released material and to prevent its spread to off-site areas.

9.3 Medical Emergency

All employee injuries must be promptly reported to the HSS/SS, who will:

- Ensure that the injured employee receives prompt first aid and medical attention;
- In emergency situations, the worker is to be transported by appropriate means to the nearest urgent care facility (normally a hospital emergency room); and
- If the injured person is a BBL employee, notify Continuum Healthcare, BBL's medical surveillance consultant, as soon as possible after an injured worker has left the site. The caller should dial 1-800-229-3674 and follow the instructions for reaching the Injury Management Office. When the Case Manager answers, the caller should provide the information requested by the Case Manager.

9.3.1 Emergency Care Steps

Survey the scene. Determine if it is safe to proceed. Try to determine if the conditions that caused the incident are still a threat. Protect yourself from exposure before attempting to rescue the victim.

- Do a primary survey of the victim. Check for airway obstruction, breathing, and pulse. Assess likely routes of chemical exposure by examining the eyes, mouth, nose, and skin of the victim for symptoms.
- Phone Emergency Medical Services (EMS). Give the location, telephone number used, caller's name, what happened, number of victims, victim's condition, and help being given.
- Maintain airway and perform rescue breathing as necessary.
- Perform CPR as necessary.
- Do a secondary survey of the victim. Check vital signs and do a head-to-toe exam.

Treat other conditions as necessary. If the victim can be moved, take him/her to a location away from the work area where EMS can gain access.

9.4 First Aid - General

All persons must report any injury or illness to their immediate supervisor or the SS. Trained personnel will provide first aid. Injuries and illnesses requiring medical treatment must be documented. The SS and HSS must conduct an II as soon as emergency conditions no longer exist and first aid and/or medical treatment has been ensured. IIs must be completed and submitted to the PM within 24 hours after the incident.

If first-aid treatment is required, first aid kits are kept at the CRZ. If treatment beyond first aid is required, the injured person(s) should be transported to the medical facility. If the injured person is not ambulatory, or shows any sign of not being in a comfortable and stable condition for transport, then an ambulance/paramedics should be summoned. If there is any doubt as to the injured worker's condition, it is best to let the local paramedic or ambulance service examine and transport the worker.

9.4.1 First Aid - Inhalation

Any employee complaining of symptoms of chemical overexposure as described in Section 4, General Site Safety Procedures, will be removed from the work area and transported to the designated medical facility for examination and treatment.

9.4.2 First Aid - Ingestion

Call EMS and consult a poison control center for advice. If available, refer to the MSDS for treatment information. If the victim is unconscious, keep them on their side and clear the airway if vomiting occurs.

9.4.3 First Aid - Skin Contact

Project personnel who have had skin contact with contaminants will, unless the contact is severe, proceed through the CRZ, to the wash area. Personnel will remove any contaminated clothing, and then flush the affected area with water for at least 15 minutes. The worker should be transported to the medical facility if he/she shows any sign of skin reddening, irritation, or if he/she requests a medical examination.

9.4.4 First Aid - Eye Contact

Project personnel who have had contaminants splashed in their eyes or who have experienced eye irritation while in the EZ, must immediately proceed to the eyewash station in the CRZ. Do not decontaminate prior to using the eyewash. Remove whatever protective clothing is necessary to use the eyewash. Flush the eye with clean running water for at least 15 minutes. Arrange prompt transport to the designated medical facility.

9.5 Reporting Injuries, Illnesses, and Near Miss Incidents

Injuries and illnesses, however minor, will be reported to the SS immediately. The SS will complete an injury report and submit it to the HSO and the PM within 24 hours.

Near miss incidents are situations in which no injury or property damage occurred, but under slightly different circumstances an injury or property damage could have occurred. Near misses are caused by the same factors as injuries; therefore, they must be reported and investigated in the same manner. A SPSA must be done immediately after an injury, illness, near miss, or other incident to determine if it is safe to proceed with the work.

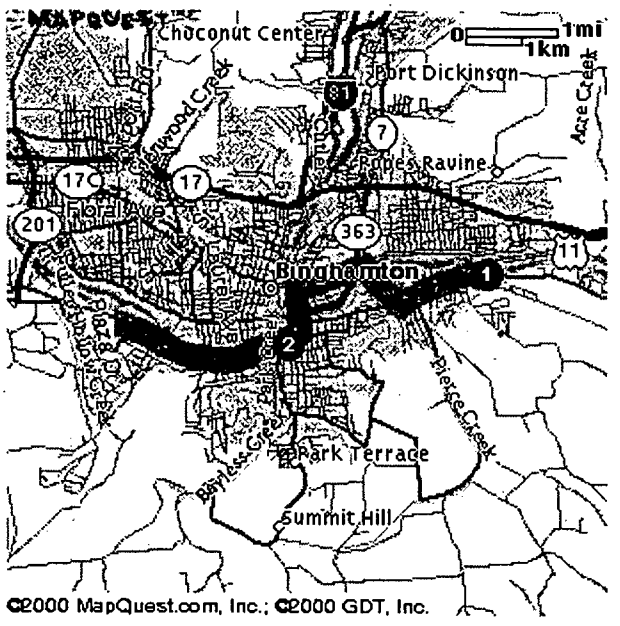
9.6 Emergency Information

The means to summon local public response agencies such as police, fire, and ambulance will be reviewed in the daily safety meeting. These agencies are identified in Table 9-1.

TABLE 9-1
EMERGENCY CONTACTS

Agency	Telephone No.
Fire	911
Police	911
Ambulance	911
Hospital Binghamton General Hospital 10 Mitchell Ave, Binghamton, NY 13903	(607) 762-2200

9.6.1 Directions to Hospital



1. Start out going West on NY-7 towards BURR AVE by turning right. 1.8
2. Turn LEFT onto US-11 N. 0.8
3. Turn LEFT onto NY-434 W. 2.6
4. Turn LEFT. 0.0
5. Turn LEFT onto NY-434 E. 1.9

THE HSS MUST CONFIRM THE DRIVING DIRECTIONS TO THE HOSPITAL AND THE AVAILABILITY OF EMERGENCY CARE.

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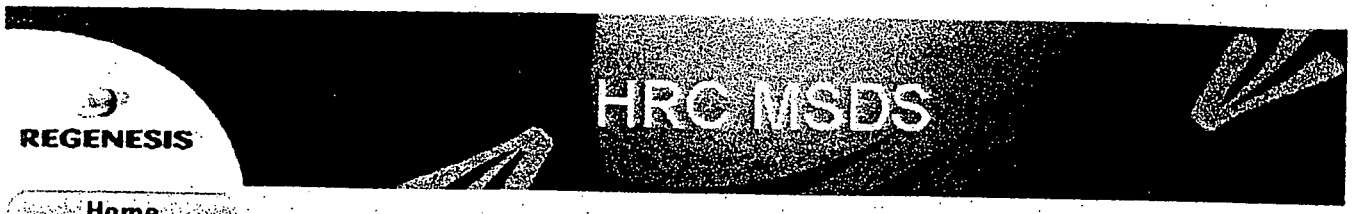
ATTACHMENT A
MATERIAL SAFETY DATA SHEETS



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Conferences
Ordering
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Instructions
Address Update
Links Page

MATERIAL SAFETY DATA SHEET

Last Revised: March 1, 2001

****

Section 1 - Material Identification

****

Supplier: Regenesis Bioremediation Products
1011 Calle Sombra
San Clemente, CA 92673
Telephone: (949) 366-8000
Facsimile: (949) 366-8090

Chemical Name: Propanoic acid, 2-[2-[2-(2-hydroxy-1-oxopropoxy)-1-oxopropoxy]-1-oxopropoxy]-1,2,3-propanetriyl ester

Chemical Family: Organic Chemical

Trade Name: Glycerol tripolylactate

Product Name: Hydrogen Release Compound® (HRC®)

****

Section 2 - Hazardous Ingredients

****

CAS #: 201167-72-8

One should anticipate the potential for eye irritation and skin irritation with large scale exposure or in sensitive individuals.

****

Section 3 - Physical Data

****

Melting Point: NA

Boiling Point: ND

Flash Point: ND

Density: 1.347

Solubility: Acetone and DMSO

Appearance: Amber semi-solid

Odor: Not detectable

Vapor Pressure: None

****

Section 4 - Fire and Explosion Hazard Data

****

Extinguishing Media: Carbon Dioxide, Dry Chemical Powder or Appropriate Foam.

Water may be used to keep exposed containers cool.

For large quantities involved in a fire, one should wear full protective clothing and a N approved self contained breathing apparatus with full face piece operated in the pressu demand or positive pressure mode as for a situation where lack of oxygen and excess l present.

****

Section 5 - Toxicological Information

****

Acute Effects: May be harmful by inhalation, ingestion, or skin absorption.

May cause irritation. To the best of our knowledge, the chemical, physical, and toxico properties of the glycerol tripolylactate have not been investigated. Listed below are th toxicological information for glycerol and lactic acid.

RTECS#: MA8050000

Glycerol

Irritation data: SKN-RBT 500 MG/24H MLD 85JCAE-,207,1986

EYE-RBT 126 MG MLD BIOFX* 9-4/1970

EYE-RBT 500 MG/24H MLD 85JCAE-,207,1986

Toxicity data: ORL-MUS LD50:4090 MG/KG FRZKAP (6),56,1977

SCU-RBT LD50:100 MG/KG NIIRDN 6,215,1982

ORL-RAT LD50:12600 MG/KG FEPRA7 4,142,1945

IHL-RAT LC50: >570 MG/M3/1H BIOFX* 9-4/1970

IPR-RAT LD50: 4420 MG/KG RCOCB8 56,125,1987

IVN-RAT LD50:5566 MG/KG ARZNAD 26,1581,1976

IPR-MUS LD50: 8700 MG/KG ARZNAD 26,1579,1978

SCU-MUS LD50:91 MG/KG NIIRDN 6,215,1982

IVN-MUS LD50: 4250 MG/KG JAPMA8 39,583,1950

ORL-RBT LD50: 27 GM/KG DMDJAP 31,276,1959

SKN-RBT LD50:>10GM/KG BIOFX* 9-4/1970

IVN-RBT LD50: 53 GM/KG NIIRDN 6,215,1982

ORL-GPG LD50: 7750 MG/KG JIHTAB 23,259,1941

Target Organ data: Behavioral (headache), gastrointestinal (nausea or vomiting), Pater effects (spermatogenesis, testes, epididymis, sperm duct), effects of fertility (male fert index, post-implantation mortality).

RTECS#: OD2800000

Lactic acid

Irritation data: SKN-RBT 5MG/24H SEV 85JCAE -,656,86

EYE-RBT 750 UG SEV AJOPAA 29,1363,46

Toxicity data: ORL-RAT LD50:3543 MG/KG FMCHA2-,C252,91

SKN-RBT LD50:>2 GM/KG FMCHA2-,C252,91

ORL-MUS LD50: 4875 MG/KG FAONAU 40,144,67

ORL-GPG LD50: 1810 MG/KG JIHTAB 23,259,41

ORL-QAL LD50: >2250 MG/KG FMCHA2-,C252,91

Only selected registry of toxic effects of chemical substances (RTECS) data is present here. See actual entry in RTECS for complete information on lactic acid and glycerol.

****

Section 6 - Health Hazard Data

****

Handling: Avoid continued contact with skin.

Avoid contact with eyes.

In any case of any exposure which elicits a response, a physician should be consulted immediately.

First Aid Procedures:

Inhalation: Remove to fresh air. If not breathing give artificial respiration. In case of la breathing give oxygen. Call a physician.

Ingestion: No effects expected. Do not give anything to an unconscious person. Call a physician immediately.

Skin Contact: Flush with plenty of water. Contaminated clothing may be washed or dr cleaned normally.

Eye contact: Wash eyes with plenty of water for at least 15 minutes lifting both upper lower lids. Call a physician.

****

Section 7 - Reactivity Data

****

Conditions to Avoid: Strong oxidizing agents, bases and acids

Hazardous Polymerization: None known

Further Information: Hydrolyses in water to form Lactic Acid and Glycerol.

****

Section 8 - Spill, Leak or Accident Procedures

****

After Spillage or Leakage: Neutralization is not required. This combustible material m burned in a chemical incinerator equipped with an afterburner and scrubber.

Disposal: Laws and regulations for disposal vary widely by locality. Observe all appli regulations and laws. This material, may be disposed of in solid waste. Material is rea degradable and hydrolyses in several hours.

No requirement for a reportable quantity (CERCLA) of a spill is known.

****

Section 9 - Special Protection or Handling

****

Should be stored in plastic lined steel, plastic, glass, aluminum, stainless steel, or reinf fiberglass containers.

Protective Gloves: Vinyl or Rubber

Eyes: Splash Goggles or Full Face Shield

Area should have approved means of washing

eyes.

Ventilation: General exhaust.

Storage: Store in cool, dry, ventilated area.

Protect from imcompatible materials.

****

Section 10 - Other Information

****

This material will degrade in the environment by hydrolysis to lactic acid and glycerol

Materials containing reactive chemicals should be used only by personnel with approp chemical training.

The information contained in this document is the best available to the supplier as of t of writing. Some possible hazards have been determined by analogy to similar classes material. No separate tests have been performed on the toxicity of this material. The it this document are subject to change and clarification as more information becomes av

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**** SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION ****

MSDS Name: Bentonite
Catalog Numbers:
B235 500, B235-500, B235500, NC9602357, XXB2355LB
Synonyms:
Bentonite magma, Southern bentonite, tixoton, volclay, volclay bentonite BC, Wilkinite
Company Identification: Fisher Scientific
1 Reagent Lane
Fairlawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

**** SECTION 2 - COMPOSITION, INFORMATION ON INGREDIENTS ****

CAS#	Chemical Name	%	EINECS#
1302-78-9	BENTONITE	100	215-108-5

Hazard Symbols: None Listed.
Risk Phrases: None Listed.

**** SECTION 3 - HAZARDS IDENTIFICATION ****

EMERGENCY OVERVIEW

Appearance: cream.
Caution! The toxicological properties of this material have not been fully investigated. May cause eye and skin irritation. May cause respiratory and digestive tract irritation. May cause cancer based on animal studies.
Target Organs: None.

Potential Health Effects

Eye:
May cause eye irritation.

Skin:
May cause skin irritation. Chronic inhalation may cause lung changes, chest pain, breath shortness, and bronichitis.

Ingestion:
Ingestion of large amounts may cause gastrointestinal irritation. The toxicological properties of this substance have not been fully investigated.

Inhalation:
May cause respiratory tract irritation. The toxicological properties of this substance have not been fully investigated.

Chronic:
May cause cancer according to animal studies. Chronic inhalation may cause lung changes, chest pain, breath shortness, and bronichitis.

**** SECTION 4 - FIRST AID MEASURES ****

Eyes:
Flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper and lower eyelids. Get medical aid.
Skin:
Flush skin with plenty of soap and water for at least 15 minutes while removing contaminated clothing and shoes. Get medical aid if irritation develops or persists.
Ingestion:
If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid.
Inhalation:
Remove from exposure to fresh air immediately. Get medical aid if cough or other symptoms appear.
Notes to Physician:
Treat symptomatically and

**** SECTION 5 - FIRE FIGHTING MEASURES ****

General Information:
As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear.
Extinguishing Media:
For small fires, use water spray, dry chemical, carbon dioxide or chemical foam.
Autoignition Temperature:Not available.
Flash Point: Not available.
Explosion Limits, lower:Not available.
Explosion Limits, upper:Not available.
NFPA Rating: Not published.

**** SECTION 6 - ACCIDENTAL RELEASE MEASURES ****

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks:
Vacuum or sweep up material and place into a suitable disposal container. Avoid generating dusty conditions.

**** SECTION 7 - HANDLING and STORAGE ****

Handling:
Use with adequate ventilation. Avoid contact with skin and eyes. Avoid ingestion and inhalation.
Storage:
Store in a cool, dry place. Store in a tightly closed container.

**** SECTION 8 - EXPOSURE CONTROLS, PERSONAL PROTECTION ****

Engineering Controls:
Use adequate ventilation to keep airborne concentrations low.

Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
BENTONITE	none listed	none listed	none listed

OSHA Vacated PELs:

BENTONITE:
No OSHA Vacated PELs are listed for this chemical.

Personal Protective Equipment

Eyes:
Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.

Skin:
Wear appropriate gloves to prevent skin exposure.

Clothing:
Wear appropriate protective clothing to minimize contact with skin.

Respirators:
Follow the OSHA respirator regulations found in 29CFR 1910.134 or European Standard EN 149. Always use a NIOSH or European Standard EN 149 approved respirator when necessary.

**** SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES ****

Physical State:	Solid
Appearance:	cream
Odor:	odorless
pH:	Not available.
Vapor Pressure:	Not available.
Vapor Density:	Not available.
Evaporation Rate:	Not applicable.
Viscosity:	Not available.
Boiling Point:	Not available.
Freezing/Melting Point:	Not available.
Decomposition Temperature:	Not available.
Solubility in water:	Insoluble in water.
Specific Gravity/Density:	Not available.
Molecular Formula:	Not applicable.
Molecular Weight:	0

**** SECTION 10 - STABILITY AND REACTIVITY ****

Chemical Stability:
Stable under normal temperatures and pressures.
Conditions to Avoid:
Moisture.
Incompatibilities with Other Materials:
None reported.
Hazardous Decomposition Products:
Irritating and toxic fumes and gases.
Hazardous Polymerization: Has not been reported.

**** SECTION 11 - TOXICOLOGICAL INFORMATION ****

RTECS#:
CAS# 1302-78-9: CT9450000
LD50/LC50:
Not available.
Carcinogenicity:
BENTONITE -
Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology:
Experimental tumorigenic data has been reported.

Teratogenicity:
No data available.
Reproductive Effects:
No data available.
Neurotoxicity:
No data available.
Mutagenicity:
No data available.
Other Studies:
No data available.

**** SECTION 12 - ECOLOGICAL INFORMATION ****

**** SECTION 13 - DISPOSAL CONSIDERATIONS ****

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste.
US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: None listed.

**** SECTION 14 - TRANSPORT INFORMATION ****

US DOT
No information available
Canadian TDG
No information available.

**** SECTION 15 - REGULATORY INFORMATION ****

US FEDERAL
TSCA
CAS# 1302-78-9 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA
Section 302 (RQ)
None of the chemicals in this material have an RQ.
Section 302 (TPQ)
None of the chemicals in this product have a TPQ.
Section 313
No chemicals are reportable under Section 313.
Clean Air Act:
This material does not contain any hazardous air pollutants.
This material does not contain any Class 1 Ozone depletors.
This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
None of the chemicals in this product are listed as Hazardous Substances under the CWA.
None of the chemicals in this product are listed as Priority Pollutants under the CWA.

None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

BENTONITE is not present on state lists from CA, PA, MN, MA, FL, or NJ.

California No Significant Risk Level:

None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols: Not available.

Risk Phrases:

Safety Phrases:

WGK (Water Danger/Protection)

CAS# 1302-78-9: No information available.

United Kingdom Occupational Exposure Limits

Canada

CAS# 1302-78-9 is listed on Canada's DSL List.

This product has a WHMIS classification of Not controlled..

CAS# 1302-78-9 is not listed on Canada's Ingredient Disclosure List.

Exposure Limits

**** SECTION 16 - ADDITIONAL INFORMATION ****

MSDS Creation Date: 12/12/1997 Revision #2 Date: 8/02/2000

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no way shall the company be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if the company has been advised of the possibility of such damages.

Material Safety Data Sheet Collection
Genium Publishing Corp.
1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

Ethyl Chloride
MSDS 538
ETH3350

Section 1 - Chemical Product and Company Identification 54

Material Name: Ethyl Chloride **CAS Number:** 75-00-3
Chemical Formula: C_2H_5Cl
Structural Chemical Formula: H_3CCH_2Cl
Synonyms: AETHYLCHLORID; AETHYLCHLORIDE; AETHYLIS; AETHYLIS CHLORIDUM; ANODYNON; CHELEN; CHLOORETHAAN; CHLORENE; CHLORETHYL; CHLORIDUM; CHLOROAETHAN; CHLOROETHANE; CHLORURE D'ETHYLE; CHLORYL; CHLORYL ANESTHETIC; CLORENE; CLORETILO; CLOROETANO; CLORURO DI ETILE; DUBLOFIX; ETHANE,CHLORO-; ETHER CHLORATUS; ETHER CHLORIDUM; ETHER HYDROCHLORIC; ETHER MURIATIC; ETHYL CHLORIDE; ETYLU CHLOREK; HYDROCHLORIC ETHER; KELENE; MONOCHLORETHANE; MONOCHLOROETHANE; MURIATIC ETHER; NARCOTILE
General Use: Used in manufacture of tetraethyl lead, ethylcellulose, dyes, drugs and perfumes. Used as a refrigerant, alkylating agent, anesthetic, analytical reagent, solvent for phosphorus,sulfur, fats, oils, resins and waxes; insecticides.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
ethyl chloride	75-00-3	>98

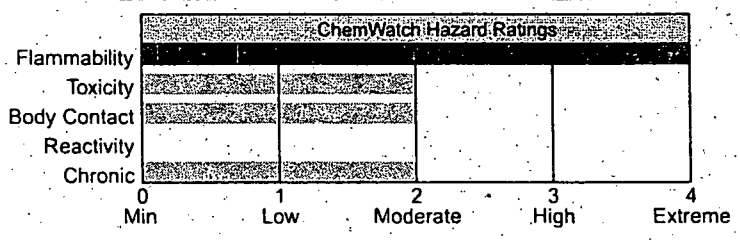
OSHA PEL
TWA: 1000 ppm; 2600 mg/m^3.

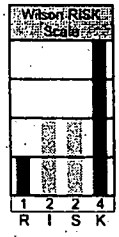
NIOSH REL
No data found.

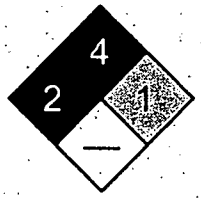
ACGIH TLV
No data found.

IDLH Level
3800 ppm; LEL.

Section 3 - Hazards Identification







Fire Diamond

ANSI Signal Word
Danger!

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless gas; ethereal, slightly pungent. Irritating to eyes/skin/respiratory tract. Compressed gas which can cause frostbite. Also causes: upon exposure to high concentrations: CNS depression, cardiac arrythmias, abdominal cramps. Flammable.

Potential Health Effects

Primary Entry Routes: inhalation, skin absorption
Target Organs: respiratory system, cardiovascular system
Acute Effects
Inhalation: The vapor is highly discomforting to the upper respiratory tract and lungs and may be harmful if inhaled. Acute intoxication by halogenated aliphatic hydrocarbons appears to take place over two stages. Signs of a reversible narcosis are evident in the first stage and in the second stage signs of injury to organs may become evident. A single organ alone is (almost) never involved.

Depression of the central nervous system is the most outstanding effect of most halogenated aliphatic hydrocarbons. Inebriation and excitation, passing into narcosis, is a typical reaction. In severe acute exposures there is always a danger of death from respiratory failure or cardiac arrest due to a tendency to make the heart more susceptible to catecholamines (adrenalin).

Ethyl chloride administered to humans at 1.3%, 1.9%, 2.5% and 3.36% produced intoxication which increased with dose. Incoordination began at 2.5%.

At 3.36%, noisy talkativeness and incoordination was followed by cyanosis, nausea and vomiting during recovery.

Memory loss began at 1.9% and increased at increasing doses.

Death occurred in guinea pigs exposed to 4%.

12% for 1 minute produced complete loss of equilibrium, a running movement, and scratching. Abdominal walls appeared to distend and a convulsive action of the intestines was observed. After 15-20 minutes struggling became less violent and respiration became shallow, rapid and of a convulsive type.

Death occurred in 30-40 minutes. At 2% and above ethyl chloride produced congestion, edema and hemorrhage of the lungs, congestion of the intestines with blood-filled contents, dilated hearts with degenerated musculature, congested brains, pancreas and suprarenals (often with hemorrhage), liver congestion with degeneration and slight edema and slight degeneration of the spleen and kidneys. Dogs anesthetised with ethyl chloride showed increased sensitivity to administered adrenalin

Eye: The vapor is highly discomforting to the eyes, may be to the upper respiratory tract following absorption, may cause chemical burns and is capable of causing pain and severe conjunctivitis.

Corneal injury may develop, with possible permanent impairment of vision, if not promptly and adequately treated.

Vaporizing liquid causes rapid cooling and contact may cause cold burns, frostbite.

Skin: The liquid is discomforting to the skin.

Toxic effects may result from skin absorption.

Exposure limits with "skin" notation indicate that vapor and liquid may be absorbed through intact skin. Absorption by skin may readily exceed vapor inhalation exposure. Symptoms for skin absorption are the same as for inhalation. Contact with eyes and mucous membranes may also contribute to overall exposure and may also invalidate the exposure standard.

Vaporizing liquid causes rapid cooling and contact may cause cold burns, frostbite.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.

The liquid is discomforting to the gastrointestinal tract and may be harmful if swallowed.

Ingestion may result in nausea, abdominal irritation, pain and vomiting.

Carcinogenicity: NTP - Not listed; IARC - Group 3, Not classifiable as to carcinogenicity to humans; OSHA - Not listed; NIOSH - Not listed; ACGIH - Class A3, Animal carcinogen; EPA - Not listed; MAK - Class B, Justifiably suspected of having carcinogenic potential.

Chronic Effects: Male rats exposed via inhalation at 15000 ppm for 6 hours/day for 102 weeks, showed a significant increase in the numbers of benign and malignant epithelial tumors of the skin. Malignant astrocytomas of the brain were observed in exposed female animals.

Mice exposed at 15000 ppm for 6 hours/day, 5 days per week for 100 weeks showed an increase in alveolar and bronchiolar neoplasms of the lung in males and carcinomas of the uterus for the females. Hepatocellular neoplasms were present in both sexes. Nephropathy (characterized by scattered foci of tubular regeneration and minimal glomerulosclerosis) occurred in female mice and keryomegaly of the renal tubular cells increased in both sexes.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.

Lay patient down. Keep warm and rested.

If available, administer medical oxygen by trained personnel.

If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor, without delay.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.

Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.

Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: In case of cold burns (frost-bite): Bathe the affected area immediately in cold water for 10 to 15 minutes, immersing if possible and without rubbing.

Do not apply hot water or radiant heat. Apply a clean, dry dressing.

Transport to hospital or doctor.

Ingestion: Contact a Poison Control Center.

Do NOT induce vomiting. Give a glass of water.

Avoid giving milk or oils.

Avoid giving alcohol.

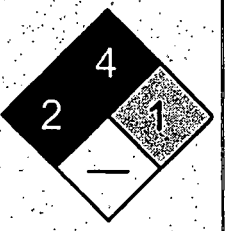
After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treat symptomatically.

Do not administer sympathomimetic drugs as they may cause ventricular arrhythmias.

Section 5 - Fire-Fighting Measures

Flash Point: -50 °C Closed Cup
Autoignition Temperature: 519 °C
LEL: 3.8% v/v
UEL: 15.4% v/v
Extinguishing Media: Alcohol stable foam.
Bromochlorodifluoromethane (BCF) (where regulations permit).
Dry chemical powder.
Carbon dioxide.
Water spray or fog.



Fire Diamond

General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are highly flammable.
Severe fire hazard when exposed to heat, flame and/or oxidizers.
Vapor forms an explosive mixture with air.
Severe explosion hazard, in the form of vapor, when exposed to flame or spark. Vapor may travel a considerable distance to source of ignition.
Heating may cause expansion/decomposition with violent rupture of containers.
On combustion, may emit toxic fumes of carbon monoxide (CO).
Other combustion products include phosgene and hydrogen chloride.
Fire Incompatibility: Reacts explosively with magnesium, zinc or potassium, sodium or their alloys.
Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear full body protective clothing with breathing apparatus. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
Fight fire from a safe distance, with adequate cover.
If safe to do so, switch off electrical equipment until vapor fire hazard is removed.
Do not extinguish burning gas.
If safe to do so, stop flow of gas.
If flow of gas cannot be stopped, leave gas to burn.
Use water delivered as a fine spray to control the fire and cool adjacent area.
Do not approach cylinders suspected to be hot.
Cool fire-exposed containers with water spray from a protected location.
If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills:
1. Avoid breathing vapor and any contact with liquid or gas. Protective equipment including respirator should be used.
2. Do NOT enter confined spaces were gas may have accumulated.
3. Shut of all sources of possible ignition and increase ventilation.
4. Clear area of personnel.
5. Stop leak only if safe to so do.
6. Remove leaking cylinders to safe place. Release pressure under safe controlled conditions by opening valve.
7. Keep area clear of personnel until gas has dispersed.

Large Spills:
1. Clear area of all unprotected personnel and move upwind.
2. Contact fire department and advise them of the location and nature of hazard.
3. May be violently or explosively reactive.
4. Wear full body clothing with breathing apparatus.
5. Prevent by any means available, spillage from entering drains and waterways.
6. Consider evacuation.
7. Shut off all possible sources of ignition and increase ventilation.
8. No smoking or bare lights within area.
9. Use extreme caution to prevent violent reaction.
10. Stop leak only if safe to so do.
11. Water spray or fog may be used to disperse vapor.
12. Do NOT enter confined space where gas may have collected.
13. Keep area clear until gas has dispersed.

Keep area clear of personnel until gas has dispersed.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use good occupational work practices.
Avoid breathing vapors and contact with skin and eyes.

Avoid contact with incompatible materials.
Avoid smoking, bare lights or ignition sources.
Avoid sources of heat.
Avoid physical damage to containers.
Wear protective clothing and gloves when handling containers.
Use in a well-ventilated area.
Keep containers securely sealed when not in use.
Prevent concentration in hollows and sumps. DO NOT enter confined spaces until atmosphere has been checked.
Vapor may travel a considerable distance to source of ignition.
DO NOT transfer gas from one cylinder to another.
Ground all lines and equipment.
Vapor may ignite on pumping or pouring due to static electricity.

Recommended Storage Methods: Check that containers are clearly labeled.
Packaging as recommended by manufacturer.
Cylinder fitted with valve protector cap.
Ensure the use of equipment rated for cylinder pressure.
Ensure the use of compatible materials of construction.
Cylinder valve must be closed when not in use or when empty.
Cylinder must be properly secured either in use or in storage.
WARNING: Suckback into cylinder may result in rupture.
Use back-flow preventive device in piping.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Local exhaust ventilation usually required.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection. NIOSH-approved self contained breathing apparatus (SCBA) may be required in some situations.
Provide adequate ventilation in warehouse or closed storage area.

Personal Protective Clothing/Equipment

Eyes: Close fitting gas tight goggles. Full face shield.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: PVA gloves.

Respiratory Protection:
Exposure Range >1000 to <3800 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range 3800 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Note: odor threshold unknown

Other: Overalls. Eyewash unit.
Ensure there is ready access to a safety shower.

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless gas at room temperature. Colorless, volatile liquid when compressed or at low temperatures. Ether-like odor. Burning taste. Soluble in alcohol and ether.

Physical State: Compressed gas
Vapor Pressure (kPa): 133.32 at 20 °C
Vapor Density (Air=1): 2.23
Formula Weight: 64.51
Specific Gravity (H_2O=1, at 4 °C): 0.92 at 0 °C(liq)
Water Solubility: 0.574 g/100 ml in water at 20 °C
Evaporation Rate: Not applicable
pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: 12.3 °C (54 °F) at 760 mm Hg
Freezing/Melting Point Range: -138.7 °C (-217.66 °F)
Volatile Component (% Vol): 100

Section 10 - Stability and Reactivity

Stability/Polymerization: Product is considered stable under normal storage and handling conditions. Hydrolyzes with water to produce toxic and corrosive oxidizing materials. Hazardous polymerization will not occur.
Storage Incompatibilities: Avoid reaction with oxidizing agents.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Inhalation (rat) LC_{50}: 160,000mg/m^3/2h
Inhalation (mouse) LC_{50}: 146,000 mg/m^3/2h

IRRITATION
Nil reported

See NIOSH, *RTECS* KH 7525000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released to the atmosphere, the dominant environmental fate process will be reaction with photochemically generated hydroxyl radicals, estimated half-life of about 40 days. If released to surface water, volatilization will be the dominant process as half-lives ranging from 1.1-5.6 days have been predicted for representative bodies of water. In groundwater, where volatilization may not be able to occur, hydrolysis may be the most important removal mechanism. The hydrolysis half-life has been estimated to be 38 days at 25 °C. Very limited biodegradation data suggest that it may be biodegradable, but insufficient data are available to estimate the relative importance of biodegradation in the environment. Aquatic bioconcentration, adsorption, direct photolysis, and oxidation are not important. If released to soil, it will evaporate rapidly where release to air is possible. It is susceptible to significant leaching.
Ecotoxicity: No data found.
Henry's Law Constant: estimated at 0.00848
BCF: none
Octanol/Water Partition Coefficient: log K_{ow} = 1.43
Soil Sorption Partition Coefficient: K_{oc} = estimated at 143

Section 13 - Disposal Considerations

Disposal: Follow applicable federal, state, and local regulations.
Evaporate or incinerate residue at an approved site.
Return empty containers to supplier.
Ensure damaged or non-returnable cylinders are gas-free before disposal.
Recycle containers if possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: ETHYL CHLORIDE
Hazard Class: 2.1
ID No.: 1037
Packing Group: None
Label: Flammable Gas[2]

Additional Shipping Information:

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Not listed
CERCLA 40 CFR 302.4: Listed per CWA Section 307(a) 100 lb (45.35 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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Material Safety Data Sheet Collection
Genium Publishing Corp.
1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

Acetylene Dichloride
MSDS 703
DIC4500

Section 1 - Chemical Product and Company Identification 54

Material Name: Acetylene Dichloride
CAS Number: 540-59-0
Chemical Formula: $C_2H_2Cl_2$
Structural Chemical Formula: ClCH=CHCl
Synonyms: ACETYLENE DICHLORIDE; CIS-ACETYLENE DICHLORIDE; TRANS-ACETYLENE DICHLORIDE; 1,2-DCE; 1,2-DICHLOR-AETHEN; 1,2-DICHLOROETHENE; 1,2-DICHLOROETHYLENE; CIS-TRANS-1,2-DICHLOROETHYLENE; DICHLORO-1,2-ETHYLENE; SYM-DICHLOROETHYLENE; TRANS-DICHLOROETHYLENE; DIOFORM; ETHENE,1,2-DICHLORO-; ETHYLENE,1,2-DICHLORO-
General Use: Solvent for organic materials, dye extraction, perfumes, lacquers, thermoplastics and organic syntheses. The trans-isomer being a "universal solvent" is more widely used than either the cis-isomer or the mixture.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
acetylene dichloride	540-59-0	>98

OSHA PEL
TWA: 200 ppm; 790 mg/m^3.

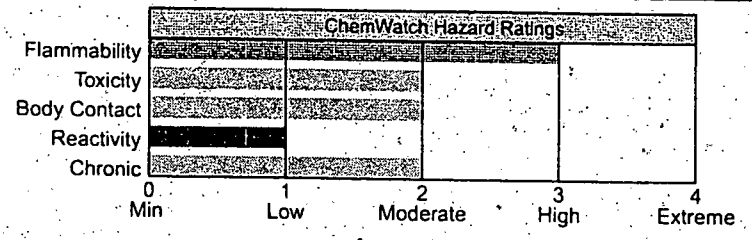
NIOSH REL
TWA: 200 ppm; 790 mg/m^3.

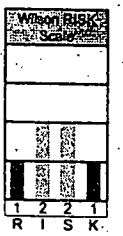
DFG (Germany) MAK
TWA: 200 ppm; 790 mg/m^3.

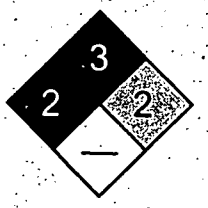
ACGIH TLV
No data found.

IDLH Level
1000 ppm.

Section 3 - Hazards Identification







Fire Diamond

ANSI Signal Word
Warning!


Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless liquid; pleasant odor. Irritating to eyes/skin/respiratory tract. Also causes: narcosis, nausea, tremor, weakness, CNS depression, epigastric cramps. Can form explosive mixtures in air. Flammable.

Potential Health Effects

Primary Entry Routes: inhalation, ingestion, skin contact, eye contact.
Target Organs: central nervous system (CNS), eyes, respiratory system
Acute Effects
Inhalation: There is a single report of an industrial poisoning, a fatality caused by the inhalation of a vapor in a small enclosure.
Acute intoxication by halogenated aliphatic hydrocarbons appears to take place over two stages. Signs of a reversible narcosis are evident in the first stage and in the second stage signs of injury to organs may become evident. A single organ alone is (almost) never involved.
Depression of the central nervous system is the most outstanding effect of most halogenated aliphatic hydrocarbons. Inebriation and excitation, passing into narcosis, is a typical reaction. In severe acute exposures there is always a danger of death from respiratory failure or cardiac arrest due to a tendency to make the heart more susceptible to catecholamines (adrenalin).

The most important effects of exposure are narcosis and irritation of the central nervous system. Liver responses may occur after repeated narcotic doses and involves fatty liver degeneration.

Vapor exposure may produce central nervous system depression or in milder exposures, nausea, vomiting, weakness, tremor and epigastric cramps.

Recovery is usually rapid. In rats, single and repeated inhalation exposures to 200 ppm acetylene dichloride and its isomers lead to temporary inhibition of mixed function oxidase system (MFO), fatty infiltration of the liver and morphological alterations to the lung. The cis isomer which is more readily taken up by liver tissue is a more potent inhibitor of rat MFO whereas at higher concentrations the trans-isomer is twice as strong a CNS depressant (rats and humans).

Eye: The vapor when concentrated has pronounced eye irritation; this gives some warning of high vapor concentrations. If eye irritation occurs seek to reduce exposure with available control measures, or evacuate area.

Exposure to the trans isomer at 2200 ppm caused burning of the eyes, vertigo, nausea.

Reversible corneal clouding has been described in exposures to acetylene dichloride

Skin: The liquid may produce skin discomfort following prolonged contact.

Defatting and/or drying of the skin may lead to dermatitis. The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.

Ingestion: The liquid is discomforting to the gastrointestinal tract and toxic if swallowed.

Considered an unlikely route of entry in commercial/industrial environments.

Carcinogenicity: NTP - Not listed; IARC - Not listed; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Not listed; MAK - Not listed.

Chronic Effects: The material may accumulate in the human body and progressively cause tissue damage.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.

Lay patient down. Keep warm and rested.

If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.

Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.

Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).

Wash affected areas thoroughly with water (and soap if available).

Seek medical attention in event of irritation.

Ingestion: Contact a Poison Control Center.

Do NOT induce vomiting. Give a glass of water.

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

Note to Physicians: Treatment should follow that practiced in carbon tetrachloride exposures.

1.Acute exposures to carbon tetrachloride present, initially, with CNS depression followed by hepatic and renal disfunction.

2.Respiratory depression and cardiac dysrhythmias are an immediate threat to life.

3.Since a major fraction of absorbed carbon tetrachloride is exhaled in first hour, good tidal volumes should be maintained in severely poisoned patients; hyperventilation may be an additional therapeutic modality.

4.Ipecac syrup, lavage, activated charcoal or catharsis may all be used in the first 4 hours.

5.Since reactive metabolites may cause hepatorenal toxicity, administration of N-acetyl-L-cysteine may reduce complications.

Experience with this therapy is limited.

Section 5 - Fire Fighting Measures

Flash Point: 2 °C

Autoignition Temperature: 460 °C

LEL: 9.7% v/v

UEL: 12.8% v/v

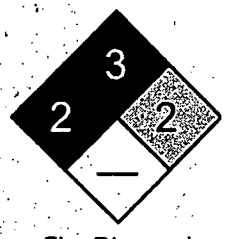
Extinguishing Media: Foam, dry chemical powder, BCF (where regulations permit), carbon dioxide.

Water spray or fog - Large fires only.

General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are highly flammable.

Severe fire hazard when exposed to heat, flame and/or oxidizers.

Vapor forms an explosive mixture with air.



Fire Diamond

Severe explosion hazard, in the form of vapor, when exposed to flame or spark. Vapor may travel a considerable distance to source of ignition.
Heating may cause expansion/decomposition with violent rupture of containers.
On combustion, may emit toxic fumes of carbon monoxide (CO). Other combustion products include hydrogen chloride and phosgene.
Fire Incompatibility: Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.
Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
Fight fire from a safe distance, with adequate cover.
If safe, switch off electrical equipment until vapor fire hazard removed.
Use water delivered as a fine spray to control the fire and cool adjacent area. Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protective location.
If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.
Large Spills: Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
No smoking, bare lights or ignition sources. Increase ventilation.
Stop leak if safe to do so. Water spray or fog may be used to disperse/absorb vapor. Contain spill with sand, earth or vermiculite.
Use only spark-free shovels and explosion proof equipment.
Collect recoverable product into labeled containers for recycling.
Absorb remaining product with sand, earth or vermiculite.
Collect solid residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains.
If contamination of drains or waterways occurs, advise emergency services.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
Avoid smoking, bare lights or ignition sources.
Avoid contact with incompatible materials.
When handling, DO NOT eat, drink or smoke.
Keep containers securely sealed when not in use. Avoid physical damage to containers. Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.
Recommended Storage Methods: Check that containers are clearly labeled.
Packaging as recommended by manufacturer.
DO NOT use aluminum or galvanized containers.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Local exhaust ventilation usually required.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection. NIOSH-approved self contained breathing apparatus (SCBA) may be required in some situations.
Provide adequate ventilation in warehouse or closed storage area.

Personal Protective Clothing/Equipment

Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Butyl rubber gloves; Neoprene gloves.

Respiratory Protection:
Exposure Range >200 to <1000 ppm: Air Purifying, Negative Pressure, Half Mask
Exposure Range 1000 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Cartridge Color: black

Other: Overalls. Barrier cream. Eyewash unit.

Glove Selection Index:
VITON.....C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless liquid with pleasant chloroform-like odor. A mixture of isomers typically comprising 60% cis-form and 40% trans-form.

Physical State: Liquid
Vapor Pressure (kPa): 36.66 at 20 °C
Vapor Density (Air=1): >1
Formula Weight: 96.94
Specific Gravity (H_2O=1, at 4 °C): 1.28
Water Solubility: 0.4% by weight
pH: Not applicable
pH (1% Solution): Not applicable
Boiling Point Range: 47.78 °C (118 °F)
Freezing/Melting Point Range: -50 °C (-58 °F)

Section 10 - Stability and Reactivity

Stability/Polymerization: Product is considered stable. Hazardous polymerization will not occur.
Storage Incompatibilities: Avoid reaction with oxidizing agents.
Acetylene dichloride in contact with solid caustic alkalies or their concentrated solutions will form chloracetylene which ignites in air.
Distillation of ethanol containing 0.25% of the halocarbon with aqueous sodium hydroxide gave a product which ignited in air.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (rat) LD_{50}: 770 mg/kg
Intraperitoneal (mouse) LD_{50}: 2000 mg/kg

IRRITATION
Skin (rabbit): 100 mg/24h - mod

See NIOSH, *RTECS* KV 9360000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released on soil, it should evaporate readily and leach in soil very slowly. Biodegradation should occur. If released into water, it will be lost mainly through volatilization (half life 3 hr in a model river). Biodegradation, adsorption to sediment, and bioconcentration to aquatic organisms should not be significant. In the atmosphere, cis- and trans- will be lost by reaction with photochemically produced hydroxyl radicals (half lives 8 and 3.6 days, respectively) and scavenged by rain. Because it is relatively long lived in the atmosphere, considerable dispersal from source area should occur.
Ecotoxicity: No data found.
Henry's Law Constant: 0.00408
BCF: calculated at 15
Octanol/Water Partition Coefficient: log K_{ow} = calculated at 1.86
Soil Sorption Partition Coefficient: K_{oc} = 36 to 49

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.
Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: 1,2-DICHLOROETHYLENE
Hazard Class: 3.1
ID No.: 1150
Packing Group: II
Label: Flammable Liquid[3]

Additional Shipping Information:

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Not listed
CERCLA 40 CFR 302.4: Not listed
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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Material Safety Data Sheet Collection
Genium Publishing Corp.
1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

1,1-Dichloroethane
MSDS 830
ETH8150

Section 1 - Chemical Product and Company Identification 54

Material Name: 1,1-Dichloroethane
CAS Number: 75-34-3
Chemical Formula: $C_2H_4Cl_2$
Structural Chemical Formula: Cl_2CHCH_3
Synonyms: AETHYLIDENCHLORID; ASYMMETRICAL DICHLOROETHANE; CHLORINATED HYDROCHLORIC ETHER; CHLORURE D'ETHYLIDENE; CLORURO DI ETILIDENE; 1,1-DICHLOORETHAAN; 1,1-DICHLORAETHAN; 1,1-DICHLORETHANE; 1,1-DICHLOROETHANE; ALPHA ALPHA DICHLOROETHANE; DICHLOROETHANE,1,1-; 1,1-DICLOROETANO; ETHANE,1,1-DICHLORO-; ETHYLIDENE CHLORIDE; 1,1-ETHYLIDENE DICHLORIDE; ETHYLIDENE DICHLORIDE
General Use: Extraction solvent, fumigant.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
1,1-dichloroethane	75-34-3	>99

OSHA PEL
TWA: 100 ppm; 400 mg/m^3.

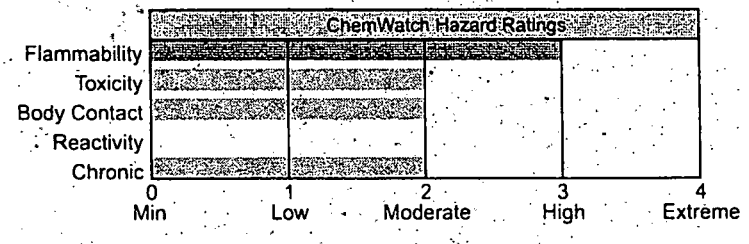
NIOSH REL
TWA: 100 ppm; 400 mg/m^3.

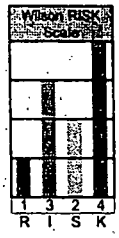
DFG (Germany) MAK
TWA: 100 ppm; 400 mg/m^3.

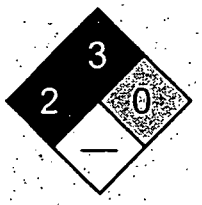
ACGIH TLV
No data found.

IDLH Level
3000 ppm.

Section 3 - Hazards Identification







Fire Diamond

ANSI Signal Word
Danger!


Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless liquid; chloroform odor. Irritating to eyes/skin/respiratory tract. Also causes: dizziness, coughing, staggering, disturbed vision, irregular heartbeat, unconsciousness, coma, pulmonary edema. Chronic: rash, neurological effects. Flammable.

Potential Health Effects

Primary Entry Routes: inhalation, skin contact
Target Organs: skin, central nervous system (CNS), liver, kidneys
Acute Effects

Inhalation: The vapor is discomforting to the upper respiratory tract and lungs.

1,1-dichloroethane is reported to produce salivation, sneezing and coughing in exposed workers. In the few cases of reported intoxication the anticipated anesthetic effects have been observed with associated dizziness, nausea and vomiting. In severe or fatal cases hepatic and renal injury has been described.

Acute intoxication by halogenated aliphatic hydrocarbons appears to take place over two stages. Signs of a reversible narcosis are evident in the first stage and in the second stage signs of injury to organs may become evident. A single organ alone is (almost) never involved.

Depression of the central nervous system is the most outstanding effect of most halogenated aliphatic hydrocarbons. Inebriation and excitation, passing into narcosis, is a typical reaction. In severe acute exposures there is always a danger of death from respiratory failure or cardiac arrest due to a tendency to make the heart more susceptible to catecholamines (adrenalin).

Eye: The liquid is moderately discomforting to the eyes and is capable of causing a mild, temporary redness of the conjunctiva (similar to wind-burn), temporary impairment of vision and/or other transient eye damage/ulceration.

Skin: The liquid is discomforting to the skin and is capable of causing skin reactions which may lead to dermatitis from repeated exposures over long periods or if exposure is prolonged.
The liquid may cause more severe response, even a burn, if exposure is prolonged.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.
The liquid is discomforting to the gastrointestinal tract and harmful if swallowed. Ingestion may result in nausea, pain, vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis.

Carcinogenicity: NTP - Not listed; IARC - Not listed; OSHA - Not listed; NIOSH - Not listed; ACGIH - Class A4, Not classifiable as a human carcinogen; EPA - Class C, Possible human carcinogen; MAK - Not listed.

Chronic Effects: Prolonged or continuous skin contact with the liquid may cause defatting with drying, cracking, irritation and dermatitis following.
Excessive exposure may cause kidney injury; liver injury is not likely.
Birth defects are unlikely. Even exposures having an adverse effect on the mother should have no effects on the fetus.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.
Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).
Wash affected areas thoroughly with water (and soap if available).
Seek medical attention in event of irritation.

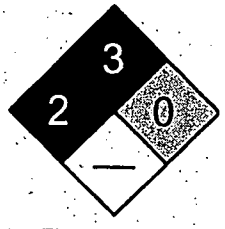
Ingestion: Contact a Poison Control Center.
Do NOT induce vomiting. Give a glass of water.
Avoid giving milk or oils.
Avoid giving alcohol.

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

Note to Physicians: Treat symptomatically. For ingestion, consider gastric lavage.
Do not administer sympathomimetic drugs as they may cause ventricular arrhythmias.

Section 5 - Fire-Fighting Measures

Flash Point: 13.889 °C Open Cup
Autoignition Temperature: 458 °C
LEL: 5.6% v/v
UEL: 11.4% v/v



Fire Diamond

Extinguishing Media: Foam, dry chemical powder, BCF (where regulations permit), carbon dioxide.
Water spray or fog - Large fires only.

General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are highly flammable.
Severe fire hazard when exposed to heat, flame and/or oxidizers.
Vapor forms an explosive mixture with air.
Severe explosion hazard, in the form of vapor, when exposed to flame or spark. Vapor may travel a considerable distance to source of ignition.
Heating may cause expansion/decomposition with violent rupture of containers.
On combustion, may emit toxic fumes of carbon monoxide (CO). Other combustion products include hydrogen chloride, phosgene and carbon dioxide (CO_2).

Fire Incompatibility: Avoid reaction with strong oxidizing agents, alkalis, amines, aluminum and its alloys.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
Fight fire from a safe distance, with adequate cover.
If safe, switch off electrical equipment until vapor fire hazard removed.
Use water delivered as a fine spray to control the fire and cool adjacent area. Avoid spraying water onto liquid pools.

Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protective location.
If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.
Large Spills: Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
No smoking, bare lights or ignition sources. Increase ventilation.
Stop leak if safe to do so. Water spray or fog may be used to disperse/absorb vapor. Contain spill with sand, earth or vermiculite.
Use only spark-free shovels and explosion proof equipment.
Collect recoverable product into labeled containers for recycling.
Absorb remaining product with sand, earth or vermiculite.
Collect solid residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains.
If contamination of drains or waterways occurs, advise emergency services.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
Avoid smoking, bare lights, heat or ignition sources.
When handling, DO NOT eat, drink or smoke.
Vapor may ignite on pumping or pouring due to static electricity.
DO NOT use plastic buckets. Ground and secure metal containers when dispensing or pouring product. Use spark-free tools when handling.
Avoid contact with incompatible materials.
Keep containers securely sealed. Avoid physical damage to containers.
Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.
Recommended Storage Methods: Metal can; metal drum. Metal safety cans.
Packing as supplied by manufacturer.
Plastic containers may only be used if approved for flammable liquid.
Check that containers are clearly labeled and free from leaks.
DO NOT use aluminum containers.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Local exhaust ventilation usually required.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection. NIOSH-approved self contained breathing apparatus (SCBA) may be required in some situations.
Provide adequate ventilation in warehouse or closed storage area.
Personal Protective Clothing/Equipment
Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.
Hands/Feet: Wear chemical protective gloves, eg. PVC. Wear safety footwear.
Respiratory Protection:
Exposure Range >100 to <3000 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range 3000 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Note: poor warning properties

Other: Overalls. PVC apron. PVC protective suit may be required if exposure severe. Eyewash unit. Ensure there is ready access to a safety shower.

Glove Selection Index:

VITON.....C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless, neutral, volatile mobile liquid with a chloroform odor and a sweet taste similar to saccharin. Mixes with alcohol, ether, acetone and benzene.

Physical State: Liquid
Vapor Pressure (kPa): 24.34 at 20 °C
Vapor Density (Air=1): 3.42
Formula Weight: 98.96
Specific Gravity (H_2O=1, at 4 °C): 1.174
Water Solubility: 0.5 g/100 ml water at 20 °C
Evaporation Rate: 11.6 (BuAc=1)

pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: 57.3 °C (135 °F)
Freezing/Melting Point Range: -96.9 °C (-142.42 °F)
Volatile Component (% Vol): 100

Section 10 - Stability and Reactivity

Stability/Polymerization: Product is considered stable. Hazardous polymerization will not occur.
Storage Incompatibilities: Avoid storage with strong oxidizing agents, alkalis, amines, aluminum and its alloys.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (rat) LD_{50}: 725 mg/kg
Inhalation (rat) LC_{Lo}: 16000 ppm/4h
Equivocal tumorigenic agent by RTECS criteria.

IRRITATION
Nil reported

See NIOSH, *RTECS* KI 0175000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released on land, it will rapidly volatilize, although it may also leach into groundwater where its fate is unknown. Bioconcentration in aquatic organisms will not be important. If released in water it will be removed by volatilization with a half-life of 6-9 days, 5-8 days, and 24-32 hr, respectively in a typical pond, lake, or river. In the atmosphere, it will degrade (half-life 62 days) by reaction with photochemically produced hydroxyl radicals, and it will be scavenged by rain.

Ecotoxicity: LC_{50} Lepomis macrochirus (bluegill) 550 ppm/96 hr, static bioassay in fresh water at 23 °C; mild aeration applied after 24 hr (no specific isomer; LC_{50} Poecilia reticulata (guppies) 202 ppm/7 days. /Conditions of bioassay not specified; TLm Lagodon rhomboides (pinperch) 160 mg/l/24 hr. /Conditions of bioassay not specified; TLm Artemia salina (brine shrimp) 320 mg/l/24 hr. /Conditions of bioassay not specified

BCF: estimated at 1.3
Biochemical Oxygen Demand (BOD): 0.05 g/g, 10 days
Octanol/Water Partition Coefficient: log K_{ow} = 1.9
Soil Sorption Partition Coefficient: K_{oc} = estimated at 43

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.
Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: 1,1-DICHLOROETHANE **Additional Shipping Information:**
Hazard Class: 3.1
ID No.: 2362
Packing Group: II
Label: Flammable Liquid[3]

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U076 Toxic Waste
CERCLA 40 CFR 302.4: Listed per RCRA Section 3001; per CWA Section 307(a) 1000 lb (453.5 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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Material Safety Data Sheet Collection
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1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

Vinylidene Chloride
MSDS 708
DIC4450

Section 1 - Chemical Product and Company Identification 54

Material Name: Vinylidene Chloride
CAS Number: 75-35-4
Chemical Formula: $C_2H_2Cl_2$
Structural Chemical Formula: $H_2C=CCl_2$
Synonyms: 1,1-DICHLOROETHYLENE; ASYM-DICHLOROETHYLENE; CHLORURE DE VINYLIDENE; 1,1-DCE; 1,1-DICHLOROETHENE; 1,1-DICHLOROETHENE (9CI); AS-DICHLOROETHYLENE; ETHENE,1,1-DICHLORO-; ETHYLENE,1,1-DICHLORO-; SCONATEX; VDC; VINYLIDENE CHLORIDE; VINYLIDENE CHLORIDE (II); VINYLIDENE CHLORIDE (INHIBITED); VINYLIDENE CHLORIDE MONOMER; VINYLIDENE CHLORIDE(II); VINYLIDENE CHLORIDE,INHIBITED; VINYLIDENE CHLORIDE,MONOMER; VINYLIDENE DICHLORIDE; VINYLIDINE CHLORIDE
General Use: Reactive monomer in manufacture of vinylidene polymer plastics and copolymers.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
vinylidene chloride	75-35-4	>98

OSHA PEL
No data found.

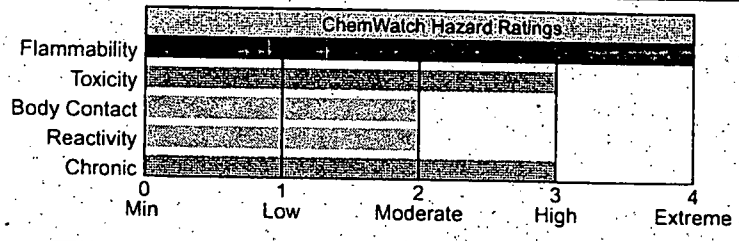
NIOSH REL
No data found.

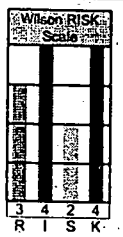
DFG (Germany) MAK
TWA: 2 ppm; 8 mg/m^3.

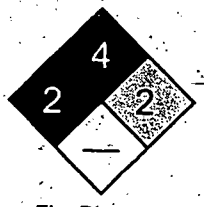
OSHA PEL Vacated 1989 Limits
TWA: 1 ppm; 4 mg/m^3.

ACGIH TLV
No data found.

Section 3 - Hazards Identification







Fire Diamond

ANSI Signal Word
Danger!


Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless liquid; sweet odor. Irritating. Also causes: narcosis, drunkenness, unconsciousness, conjunctivitis, transient corneal injury, iritis. Chronic: hepatic/renal dysfunction. Flammable. Combustion by-products include phosgene and hydrogen chloride.

Potential Health Effects

Primary Entry Routes: inhalation
Target Organs: skin, eyes, central nervous system (CNS), liver, kidneys
Acute Effects

Inhalation: Depression of the central nervous system is the most outstanding effect of most halogenated aliphatic hydrocarbons. Inebriation and excitation, passing into narcosis, is a typical reaction. In severe acute exposures there is always a danger of death from respiratory failure or cardiac arrest due to a tendency to make the heart more susceptible to catecholamines (adrenalin).
Vapor concentrations of 400 ppm are said to induce symptoms of drunkenness leading to unconsciousness.

Extensive hemorrhagic centrolobular liver necrosis was seen in rats 6 hours after a 4-hour exposure to 200 ppm.

Eye: The liquid is highly discomforting to the eyes and is capable of causing pain and severe conjunctivitis.
Corneal injury may develop, with possible permanent impairment of vision, if not promptly and adequately treated.
The vapor when concentrated has pronounced eye irritation; this gives some warning of high vapor concentrations. If eye irritation occurs seek to reduce exposure with available control measures, or evacuate area.

Skin: The liquid may produce skin discomfort following prolonged contact.
Defatting and/or drying of the skin may lead to dermatitis.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.
The liquid is highly discomforting to the gastrointestinal tract and toxic if swallowed.
Ingestion may result in nausea, pain, vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis.
A single oral dose of 500 mg/kg elicited extensive liver enzyme changes.
Acute intoxication by halogenated aliphatic hydrocarbons appears to take place over two stages. Signs of a reversible narcosis are evident in the first stage and in the second stage signs of injury to organs may become evident, a single organ alone is (almost) never involved.

Carcinogenicity: NTP - Not listed; IARC - Group 3, Not classifiable as to carcinogenicity to humans; OSHA - Not listed; NIOSH - Listed as carcinogen; ACGIH - Class A3, Animal carcinogen; EPA - Class C, Possible human carcinogen; MAK - Class B, Justifiably suspected of having carcinogenic potential.

Chronic Effects: The material may accumulate in the human body and progressively cause tissue damage.
Chronic solvent inhalation exposures may result in nervous system impairment and liver and blood changes.
Vinylidene chloride is toxic to the liver and kidneys. After exposure to 48 ppm continuously for 90 days, liver damage was evident in rats and deaths occurred among monkeys and guinea pigs. In this study only rats showed evidence of renal (kidney) tubular injury.
It is proposed that vinylidene chloride may undergo microsomal oxidation to produce oxiranes. These are highly reactive and covalently bind to nucleic acids producing mutations and possibly cancers. The monohalogenated alkenes are thought be more carcinogenic than their dihalogenated counterparts.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.
Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).
Wash affected areas thoroughly with water (and soap if available).
Seek medical attention in event of irritation.

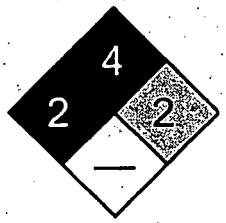
Ingestion: Contact a Poison Control Center.
Do NOT induce vomiting. Give a glass of water.
Avoid giving milk or oils.
Avoid giving alcohol.

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

Note to Physicians: Treatment that is employed in carbon tetrachloride exposures follows:
1.Acute exposures to carbon tetrachloride present, initially, with CNS depression followed by hepatic and renal disfunction.
2.Respiratory depression and cardiac dysrhythmias are an immediate threat to life.
3.Since a major fraction of absorbed carbon tetrachloride is exhaled in first hour, good tidal volumes should be maintained in severely poisoned patients; hyperventilation may be an additional therapeutic modality.
4.Ipecac syrup, lavage, activated charcoal or catharsis may all be used in the first 4 hours.
5.Since reactive metabolites may cause hepatorenal toxicity, administration of N-acetyl-L-cysteine may reduce complications.
Experience with this therapy is limited.

Section 5 - Fire-Fighting Measures

Flash Point: -16.111 °C Open Cup
Autoignition Temperature: 570 °C
LEL: 7.3% v/v
UEL: 16% v/v
Extinguishing Media: Foam, dry chemical powder, BCF (where regulations permit), carbon dioxide.
Water spray or fog - Large fires only.
General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are highly flammable.
Severe fire hazard when exposed to heat, flame and/or oxidizers.
Vapor forms an explosive mixture with air.
Severe explosion hazard, in the form of vapor, when exposed to flame or spark. Vapor may travel a considerable distance to source of ignition.
Heating may cause expansion/decomposition with violent rupture of containers.
On combustion, may emit toxic fumes of carbon monoxide (CO). Other combustion products include hydrogen chloride and phosgene.
Fire Incompatibility: Avoid any contamination of this material as it is very reactive and any contamination is potentially hazardous. Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.
Polymerization may occur at elevated temperatures.
Polymerization may be accompanied by generation of heat as exotherm.
Process is self accelerating as heating causes more rapid polymerization.
Exotherm may cause boiling with generation of acrid, toxic and flammable vapor.
Polymerization and exotherm may be violent if contamination with strong acids, amines or catalysts occurs.
Polymerization and exotherm of material in bulk may be uncontrollable and result in rupture of storage tanks.
Polymerization may occur if stabilizing inhibitor becomes depleted by aging.
Stabilizing inhibitor requires dissolved oxygen to be present in liquid for effective action.
Specific storage requirements must be met for stability on ageing and transport.
Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
Fight fire from a safe distance, with adequate cover.
If safe, switch off electrical equipment until vapor fire hazard removed.
Use water delivered as a fine spray to control the fire and cool adjacent area. Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protective location.
If safe to do so, remove containers from path of fire.



Fire Diamond

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.
Large Spills: Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
No smoking, bare lights or ignition sources. Increase ventilation.
Stop leak if safe to do so. Water spray or fog may be used to disperse/absorb vapor. Contain spill with sand, earth or vermiculite.
Use only spark-free shovels and explosion proof equipment.
Collect recoverable product into labeled containers for recycling.
Absorb remaining product with sand, earth or vermiculite.
Collect solid residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains.
If contamination of drains or waterways occurs, advise emergency services.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Material contains a stabilizer / polymerization inhibitor system that provides workable but not indefinite shelf life.
Storage at higher temperatures and long term storage may result in polymerization with solidification. In larger quantities e.g. 200 l drums this may result in generation of heat (exotherm); which may release highly irritating hot vapor. Do not open hot exotherming drums - cool externally with water to avoid vapor release.
Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
Avoid smoking, bare lights, heat or ignition sources.
When handling, DO NOT eat, drink or smoke.
Vapor may ignite on pumping or pouring due to static electricity.
DO NOT use plastic buckets. Ground and secure metal containers when dispensing or pouring product. Use spark-free tools when handling.
Avoid contact with incompatible materials.
Keep containers securely sealed. Avoid physical damage to containers.
Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.
Recommended Storage Methods: Metal can; metal drum. Packing as recommended by manufacturer.
Check all containers are clearly labeled and free from leaks.
DO NOT use aluminum or galvanized containers.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area. Local exhaust ventilation usually required.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection. NIOSH-approved self contained breathing apparatus (SCBA) may be required in some situations.
Provide adequate ventilation in warehouse or closed storage area.
Personal Protective Clothing/Equipment
Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.
Hands/Feet: Barrier cream and Butyl rubber gloves or Nitrile rubber gloves.
Safety footwear.
Respiratory Protection:
Exposure Range >5 to 250 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range >250 to 5000 ppm: Supplied Air, Constant Flow/Pressure Demand, Full Face
Exposure Range >5000 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Note: poor warning properties
Other: Overalls. Eyewash unit.
Glove Selection Index:
PVA .....A
VITON C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless highly flammable liquid with pleasant chloroform-like odor. Soluble in organic solvents. Presence of a stabilizing inhibitor prevents / retards peroxide formation.

Physical State: Liquid
Vapor Density (Air=1): >1
Formula Weight: 96.94
Specific Gravity (H_2O=1, at 4 °C): 1.2129
Water Solubility: 0.04% by weight
Evaporation Rate: Fast
pH: Not applicable
pH (1% Solution): Not applicable
Boiling Point Range: 31.7 °C (89 °F) at 760 mm Hg
Freezing/Melting Point Range: -122.5 °C (-188.5 °F)

Section 10 - Stability and Reactivity

Stability/Polymerization: May form explosive peroxides on standing or following concentration by distillation.
Review of stocks and testing for peroxide content by given tested procedures at 3-monthly intervals is recommended, together with safe disposal of peroxidic samples.
Peroxide containing residues can often be rendered innocuous by pouring into an excess of sodium carbonate solution.
Presence of a stabilizing inhibitor prevents/retards peroxide formation.
Stable under controlled storage conditions provided material contains adequate stabilizer/polymerization inhibitor.
Bulk storages may have special storage requirements.
In absence of inhibitor and in the presence of air, vinylidene chloride rapidly absorbs oxygen with formation of a violently explosive peroxide.
Peroxides initiate vinylidene chloride polymerization, producing insoluble polymer which absorbs peroxide. This results in separated polymer with concentrate of peroxide. In the dry state and 15% or more peroxide present this is readily detonated by heat or shock.
Hindered phenols are suitable inhibitors to prevent peroxidation.

Storage Incompatibilities: WARNING: Long standing in contact with air and light may result in the formation of potentially explosive peroxides.
Avoid any contamination of this material as it is very reactive and any contamination is potentially hazardous.
Explosion hazard may follow contact with incompatible materials.
Contamination with polymerization catalysts - peroxides, persulfates, oxidizing agents - also strong acids, strong alkalies, will cause polymerization with exotherm - generation of heat. Polymerization of large quantities may be violent - even explosive.
Light or water tend to promote self-polymerization.
Haloalkenes are highly reactive. Some of the more lightly substituted lower members are highly flammable; many members of the group are peroxidizable and polymerizable.
When stored at between -40 and 25 C in the absence of an inhibitor and in the presence of air, vinylidene chloride rapidly absorbs oxygen with the formation of a violently explosive peroxide. This peroxide initiates polymerization to produce an insoluble polymer which adsorbs the peroxide. Separation of the polymer in the dry state must be avoided since if more than 15% of the peroxide is present, the polymer may be detonatable by slight shock or friction.
Hindered phenols have been used to prevent peroxidation. Reaction products with ozone are particularly dangerous.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (rat) LD_{50}: 200 mg/kg
Inhalation (human) TC_{Lo}: 25 ppm
Inhalation (rat) LC_{50}: 6350 ppm/4h

IRRITATION
Nil reported

See NIOSH, *RTECS* KV 9275000, for additional data.

Section 12 - Ecological Information

Environmental Fate: Once in the atmosphere it will degrade rapidly by photooxidation with a half-life of 11 hours in relatively clean air or under 2 hours in polluted air. If spilled on land, part will evaporate and part will leach into the groundwater where its fate is unknown, but degradation is expected to be slow based upon microcosm studies. It would not be expected to bioconcentrate into fish.

Ecotoxicity: LC_{50} Cyprinodon variegatus (sheepshead minnow) 249 mg/l/24 hr, 48 hr, 72 hr, 96 hr in a static bioassay using sea water; EC_{50} Skeletonema costatum (alga) > 712,000 ug/l/96 hr, Toxic effects: Inhibition chlorophyll synthesis; reduced cell counts. /Conditions of bioassay not specified; LC_{50} Lepomis macrochirus (bluegill) 74 mg/l at 24 hr & 96 hr, temp at 21-23 °C, water hardness 32-48 mg/l (calcium carbonate), pH 6.7-7.8, dissolved oxygen concentration 7.0-8.8 mg/l (static bioassay); LC_{50} Mysidopsis bahia (mysid shrimp) > 798 mg/l/24 hr, 48 hr, 72 hr; 224 mg/l/96 hr in a static bioassay using seawater; LC_{50} Menidia beryllina (inland silverside) 250 ppm/96 hr in a static bioassay in synthetic seawater at 23 °C with mild aeration

Henry's Law Constant: 2.61×10^{-2}

BCF: not significant.

Octanol/Water Partition Coefficient: log K_{ow} = 1.48

Soil Sorption Partition Coefficient: K_{oc} = estimated at 150

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.

Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: VINYLIDENE CHLORIDE, INHIBITED **Additional Shipping Information:**
Hazard Class: 3.1
ID No.: 1303
Packing Group: I
Label: Flammable Liquid[3]

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U078 Toxic Waste
CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4); per RCRA Section 3001; per CWA Section 307(a) 100 lb (45.35 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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Material Safety Data Sheet Collection
Genium Publishing Corp.
1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

Ethylbenzene
MSDS 385
ETH3050

Section 1 - Chemical Product and Company Identification 54

Material Name: Ethylbenzene
CAS Number: 100-41-4
Chemical Formula: C_8H_{10}
Structural Chemical Formula: $C_6H_5 \cdot C_2H_5$
Synonyms: AETHYLBENZOL; BENZENE,ETHYL-; EB; ETHYL BENZENE; ETHYLBENZEEN; ETHYLBENZENE; ETHYLBENZOL; ETILBENZENE; ETYLOBENZEN; PHENYLETHANE
General Use: Used in the manufacture of cellulose acetate, styrene and synthetic rubber; solvent or diluent; component of automotive and aviation gasoline.
Component of many petroleum hydrocarbon solvents, thinners.
The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
ethylbenzene	100-41-4	>95

OSHA PEL
TWA: 100 ppm; 435 mg/m^3.

OSHA PEL Vacated 1989 Limits
TWA: 100 ppm; 435 mg/m^3;
STEL: 125 ppm; 545 mg/m^3.

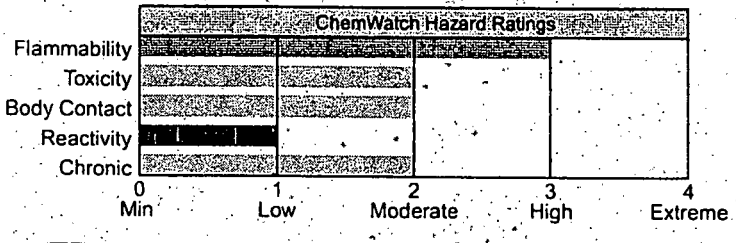
ACGIH TLV
No data found.

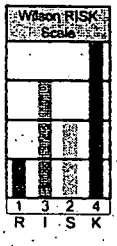
NIOSH REL
TWA: 100 ppm; 435 mg/m^3.
STEL: 125 ppm; 545 mg/m^3.

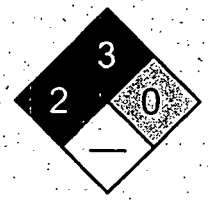
IDLH Level
800 ppm; LEL.

DFG (Germany) MAK
TWA: 100 ppm; 440 mg/m^3.

Section 3 - Hazards Identification







Fire Diamond

ANSI Signal Word
Warning!


Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless liquid; pungent odor. Irritating to eyes/skin/respiratory tract. Also causes: chest constriction, vertigo, narcosis, cramps, respiratory paralysis. Chronic: fatigue, sleepiness, headache, blood disorders, lymphocytosis. Flammable.

Potential Health Effects

Primary Entry Routes: inhalation, skin contact, eye contact
Target Organs: eyes, respiratory system, skin, central nervous system (CNS), blood
Acute Effects
Inhalation: The vapor is discomforting to the upper respiratory tract.
Inhalation hazard is increased at higher temperatures.

Acute effects from inhalation of high concentrations of vapor are pulmonary irritation, including coughing, with nausea; central nervous system depression - characterized by headache and dizziness, increased reaction time, fatigue and loss of coordination.

If exposure to highly concentrated solvent atmosphere is prolonged this may lead to narcosis, unconsciousness, even coma and possible death.

Inhalation of vapor may aggravate a pre-existing respiratory condition such as asthma, bronchitis, emphysema.

When humans were exposed to the 100 and 200 ppm for 8 hours about 45-65% is retained in the body. Only traces of unchanged ethyl benzene are excreted in expired air following termination of inhalation exposure.

Humans exposed to concentrations of 23-85 ppm excreted most of the retained dose in the urine (mainly as metabolites).

Guinea pigs that died from exposure had intense congestion of the lungs and generalized visceral hyperemia. Rats exposed for three days at 8700 mg/m^3 (2000 ppm) showed changes in the levels of dopamine and noradrenaline in various parts of the brain.

Eye: The liquid is highly discomforting to the eyes and is capable of causing a mild, temporary redness of the conjunctiva (similar to wind-burn), temporary impairment of vision and/or other transient eye damage/ulceration.

The vapor is discomforting to the eyes.

The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

Two drops of the material in to the conjunctival sac produced only slight irritation of the conjunctival membrane but no corneal injury.

Skin: The liquid is discomforting to the skin if exposure is prolonged and is capable of causing skin reactions which may lead to dermatitis.

The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.

The mean rate of absorption of liquid ethyl benzene applied to 17.3 cm2 area of the forearm of seven volunteers for 10-15 minutes was determined to be 38 mg/cm2/hr. Immersion of the whole hand in aqueous solutions of ethyl benzene (112-156 mg/l) for 1 hour yielded mean absorption rates of 118 and 215.7 ug/cm2/hr. The rate of absorption is thus greater than that of aniline, benzene, nitrobenzene, carbon disulfide and styrene.

Repeated application of the undiluted product to the abdominal area of rabbits (10-20 applications over 2-4 weeks) resulted in erythema, edema and superficial necrosis. The material did not appear to be absorbed through the skin in sufficient quantity to produce outward signs of toxicity.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.

The liquid may produce considerable gastrointestinal discomfort and may be harmful or toxic if swallowed. Ingestion may result in nausea, pain and vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis.

Carcinogenicity: NTP - Not listed; IARC - Not listed; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Class D, Not classifiable as to human carcinogenicity; MAK - Not listed.

Chronic Effects: Chronic solvent inhalation exposures may result in nervous system impairment and liver and blood changes.

Prolonged or continuous skin contact with the liquid may cause defatting with drying, cracking, irritation and dermatitis following.

Industrial workers exposed to a maximum level of ethyl benzene of 0.06 mg/l (14 ppm) reported headaches and irritability and tired quickly. Functional nervous system disturbances were found in some workers employed for over 7 years whilst other workers had enlarged livers.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.

Lay patient down. Keep warm and rested.

If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.

Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.

Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).

Wash affected areas thoroughly with water (and soap if available).

Seek medical attention in event of irritation.

Ingestion: Rinse mouth out with plenty of water. DO NOT induce vomiting.

Observe the patient carefully. Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious.

Give water (or milk) to rinse out mouth. Then provide liquid slowly and as much as casualty can comfortably drink.

Transport to hospital or doctor without delay.

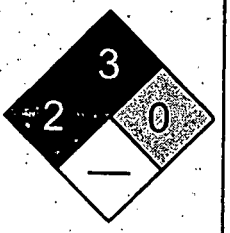
After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For acute or short-term repeated exposures to petroleum distillates or related hydrocarbons:

1. Primary threat to life from pure petroleum distillate ingestion and/or inhalation is respiratory failure.
2. Patients should be quickly evaluated for signs of respiratory distress (e.g. cyanosis, tachypnea, intercostal retraction, obtundation) and given oxygen. Patients with inadequate tidal volumes or poor arterial blood gases (pO_2 <50 mm Hg or pCO_2 >50 mm Hg) should be intubated.
3. Arrhythmias complicate some hydrocarbon ingestion and/or inhalation and electrocardiographic evidence of myocardial injury has been reported; intravenous lines and cardiac monitors should be established in obviously symptomatic patients. The lungs excrete inhaled solvents, so that hyperventilation improves clearance
4. A chest x-ray should be taken immediately after stabilization of breathing and circulation to document aspiration and detect the presence of pneumothorax.
5. Epinephrine (adrenalin) is not recommended for treatment of bronchospasm because of potential myocardial sensitization to catecholamines.
   Inhaled cardioselective bronchodilators (e.g. Alupent, Salbutamol) are the preferred agents, with aminophylline a second choice.
6. Lavage is indicated in patients who require decontamination; ensure use of cuffed endotracheal tube in adult patients.

Section 5 - Fire-Fighting Measures

Flash Point: 12.8 °C Closed Cup
Autoignition Temperature: 432 °C
LEL: 1.6% v/v
UEL: 7% v/v



Fire Diamond

Extinguishing Media: Foam, dry chemical powder, BCF (where regulations permit), carbon dioxide.
Water spray or fog - Large fires only.

General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are flammable.
Moderate fire hazard when exposed to heat or flame.
Vapor forms an explosive mixture with air.
Moderate explosion hazard when exposed to heat or flame.
Vapor may travel a considerable distance to source of ignition.
Heating may cause expansion or decomposition leading to violent rupture of containers.
On combustion, may emit toxic fumes of carbon monoxide (CO).
May emit clouds of acrid smoke.

Fire Incompatibility: Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
If safe, switch off electrical equipment until vapor fire hazard removed.
Use water delivered as a fine spray to control fire and cool adjacent area.
Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protected location.
If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.

Large Spills: Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
No smoking, bare lights or ignition sources. Increase ventilation.
Stop leak if safe to do so. Water spray or fog may be used to disperse/absorb vapor. Contain spill with sand, earth or vermiculite.
Use only spark-free shovels and explosion proof equipment.
Collect recoverable product into labeled containers for recycling.
Absorb remaining product with sand, earth or vermiculite.
Collect solid residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains.

If contamination of drains or waterways occurs, advise emergency services.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid generating and breathing mist. Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
Avoid smoking, bare lights, heat or ignition sources.
When handling, DO NOT eat, drink or smoke.
Vapor may ignite on pumping or pouring due to static electricity.
DO NOT use plastic buckets. Ground and secure metal containers when dispensing or pouring product. Use spark-free tools when handling.
Avoid contact with incompatible materials.
Keep containers securely sealed. Avoid physical damage to containers.
Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.
Recommended Storage Methods: Metal can; metal drum. Packing as recommended by manufacturer.
Check all containers are clearly labeled and free from leaks.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: CARE: Use of a quantity of this material in confined space or poorly ventilated area, where rapid build-up of concentrated atmosphere may occur, could require increased ventilation and/or protective gear. Use in a well-ventilated area.
General exhaust is adequate under normal operating conditions.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection.
Provide adequate ventilation in warehouse or closed storage areas.
Personal Protective Clothing/Equipment
Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.
Hands/Feet: Barrier cream with polyethylene gloves or Nitrile gloves.
Protective footwear.
Respiratory Protection:
Exposure Range >100 to <800 ppm: Air Purifying, Negative Pressure, Half Mask
Exposure Range 800 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Cartridge Color: black
Other: Overalls. Eyewash unit.
Glove Selection Index:

VITON	A
TEFLON	A

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Clear highly flammable liquid; floats on water. Aromatic solvent odor. Soluble in alcohol, benzene, carbon tetrachloride and ether.

Physical State: Liquid
Vapor Pressure (kPa): 1.333 at 25.9 °C
Vapor Density (Air=1): 3.66
Formula Weight: 106.17
Specific Gravity (H_2O=1, at 4 °C): 0.8670 at 20 °C
Water Solubility: 0.01% by weight
Evaporation Rate: Fast
pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: 136.2 °C (277 °F) at 760 mm Hg
Freezing/Melting Point Range: -95 °C (-139 °F)
Volatile Component (% Vol): 100

Section 10 - Stability and Reactivity

Stability/Polymerization: Hazardous polymerization will not occur.

Storage Incompatibilities: Avoid storage with oxidizers.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (rat) LD_{50}: 3500 mg/kg
Inhalation (human) TC_{Lo}: 100 ppm/8h
Inhalation (rat) LC_{Lo}: 4000 ppm/4h
Intraperitoneal (mouse) LD_{50}: 2642 mg/kg~
Dermal (rabbit) LD_{50}: 17800 mg/kg~

IRRITATION
Skin (rabbit): 15 mg/24h mild
Eye (rabbit): 500 mg - SEVERE

Liver changes, utheral tract, effects on fertility, specific developmental abnormalities (musculoskeletal system) recorded.
NOTE: Substance has been shown to be mutagenic in various assays, or belongs to a family of chemicals producing damage or change to cellular DNA.

See NIOSH, *RTECS* DA 0700000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released to the atmosphere, it exist predominantly in the vapor phase based on its vapor pressure where it will photochemically degrade by reaction with hydroxyl radicals (half-life 0.5 to 2 days) and partially return to earth in rain. It will not be subject to direct photolysis. Releases into water will decrease in concentration by evaporation and biodegradation. The time for this decrease and the primary loss processes will depend on the season, and the turbulence and microbial populations in the particular body of water. Representative half-lives are several days to 2 weeks. Some may be adsorbed by sediment but significant bioconcentration in fish is not expected to occur based upon its octanol/water partition coefficient. It is only adsorbed moderately by soil. It will not significantly hydrolyze in water or soil.

Ecotoxicity: LC_{50} Cyprinodon variegatus (sheepshead minnow) 275 mg/l 96 hr in a static unmeasured bioassay; LC_{50} Pimephales promelas (fathead minnow) 12.1 mg/l/96 hr (confidence limit 11.5 - 12.7 mg/l), flow-through bioassay with measured concentrations, 26.1 °C, dissolved oxygen 7.0 mg/l, hardness 45.6 mg/l calcium carbonate, alkalinity 43.0 mg/l; Toxicity threshold (cell multiplication inhibition test): Pseudomonas putida (bacteria) 12 mg/l ; LC_{50} Palaemonetes pugio (grass shrimp, adult) 14,400 ug/l/24 hr in a static unmeasured bioassay; LC_{50} Palaemonetes pugio (grass shrimp, larva) 10,200 ug/l/24 hr in a static unmeasured bioassay; Toxicity threshold (cell multiplication inhibition test): Microcystis aeruginosa (algae) 33 mg/l; Scenedesmus quadricauda (green algae) > 160 mg/l

Henry's Law Constant: 8.44×10^{-3}

BCF: goldfish 1.9

Biochemical Oxygen Demand (BOD): theoretical 2.8%, 5 days

Octanol/Water Partition Coefficient: log $K_{ow} = 3.15$

Soil Sorption Partition Coefficient: $K_{oc} = 164$

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.
Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: ETHYLBENZENE
Additional Shipping Information: PHENYL ETHANE
Hazard Class: 3.1
ID No.: 1175
Packing Group: II
Label: Flammable Liquid [3]

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Not listed
CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4); per CWA Section 307(a) 1000 lb (453.5 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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Genium Publishing Corp.
One Genium Plaza
Schenectady, NY 12304-4690
(518) 377-8854

Material Safety Data Sheet Collection

Fuel Oil No. 2

MSDS No. 469

Date of Preparation: 10/81 Revision: B, 3/98

Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Fuel oil no. 2
Chemical Formula: Unspecified or Variable
CAS Number: 68476-30-2
Synonyms: #2 home heating oil; API no. 2 fuel oil; diesel oil; gas oil; home heating oil no. 2; number 2 burner fuel; number 2 fuel oil
Derivation: Residue from distillation (straight run or cracked) of crude oil.
General Use: Used as a fuel in atomizing burners for domestic and industrial heating, in engines of heavy units (ships, trucks, trains), as a source of synthesis gas, in drilling muds, and for mosquito control (coats breeding waters).
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Fuel oil no. 2, ca 100% vol (complex mixture (< 95%) of paraffinic, olefinic, naphthenic, and aromatic hydrocarbons)
Trace Impurities: water and sediment (< 0.05% vol), carbon residue (< 0.35%), ash (< 0.01% wt), sulfur (< 0.7% wt) and benzene (< 100 ppm).

OSHA PEL
As petroleum distillates
8-hr TWA: 500 ppm (2000 mg/m^3)

ACGIH TLV
As diesel fuel
Notice of impending change (1997):
TWA: 100 mg/m^3, *Skin*

NIOSH REL
As petroleum distillates
10-hr TWA: 350 mg/m^3
Ceiling (15 min): 1800 mg/m^3

IDLH Level
As petroleum distillates
1,100 ppm

DFG (Germany) MAK
None established

Section 3 - Hazards Identification

ANSI Signal Word: Warning!

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Fuel oil no. 2 is an amber to brown, slighty viscous liquid with a petroleum odor. It can be irritating to the skin and respiratory tract. This low viscosity fuel oil presents a significant aspiration hazard following ingestion, which can result in chemical pneumonitis and respiratory failure. Also Causes: vomiting, diarrhea, central nervous system (CNS) depression, increased rate of respiration, rapid heart beat, and cyanosis (blue coloration of the skin caused by oxygen deficiency). Fuel oil no. 2 can be an environmental hazard if spilled. This flammable liquid is a moderate fire hazard. When heated to decomposition, it will emit acrid smoke and irritating fumes.

Wilson Risk Scale	
R	1
I	2
S	2
K	2

HMIS	
H	1*
F	2
R	0
PPE†	

*Chronic effects
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion
Target Organs: Skin, CNS, cardiovascular system (CVS), respiratory system, mucous membranes
Acute Effects
Inhalation: Respiratory tract irritation, headache, dizziness, euphoria, nausea, increased respiration rate, tachycardia (excessively rapid heart beat), cyanosis, stupor, convulsions, and unconsciousness can result from inhalation of fuel oil no. 2 mist.
Eye: Contact may result in irritation.
Skin: Contact may cause irritation.
Ingestion: Gastrointestinal irritation, vomiting, diarrhea, and in severe cases, CNS depression, progressing to coma and death, can result. Since intestinal absorption of longer chain hydrocarbons is minimal, aspiration into lungs following ingestion is a more significant exposure route; it may result in transient CNS depression, hemorrhaging and pulmonary edema, progressing to renal (kidney) involvement, chemical pneumonitis, and respiratory failure.
Carcinogenicity: IARC lists distillate (light) fuel oils as Group 3 (not classifiable as to carcinogenicity to humans). ACGIH lists a notice of impending change for diesel fuels as TLV-A3 (Animal carcinogen). NTP and OSHA do not list fuel oil no. 2 as a carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: None reported.

Chronic Effects: Prolonged and repeated skin contact can cause dermatitis, irritate the hair follicles and may block the (oil) sebaceous glands, producing a rash of acne pimples, usually on the arms and legs. Repeated exposures producing CNS effects may lead to permanent nervous system damage.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. Consult a physician or ophthalmologist if pain and/or irritation develop.

Skin Contact: Quickly remove contaminated clothing. Rinse with flooding amounts of water followed by washing the exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. *Do not* induce vomiting unless the poison control center advises otherwise.

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

Note to Physicians: Gastric lavage for treatment of ingestion is contraindicated due to aspiration hazard. Administer charcoal slurry cathartic (30 g/240 mL diluent). In cases of severe aspiration pneumonitis, consider monitoring arterial blood gases and obtain chest x-ray.

Section 5 - Fire-Fighting Measures

Flash Point: 136 °F (57.78 °C)

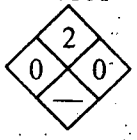
Flash Point Method: CC

Autoignition Temperature: 494 °F (257 °C)

LEL: 0.6% v/v

UEL: 7.5% v/v

NFPA



Flammability Classification: OSHA Class II Combustible Liquid.

Extinguishing Media: Use dry chemical, carbon dioxide, foam, water fog or spray. Water may be ineffective in putting out a fire involving fuel oil no. 2, and a solid water stream may spread the flames; however, a water spray may be used to cool fire-exposed containers, and flush spills away from ignition sources.

Unusual Fire or Explosion Hazards: Can form explosive mixtures in air. In still air, the heavier-than-air vapors of fuel oil no. 2 may travel along low-lying surfaces to distant sources of ignition and flash back to the material source. Containers may explode in heat of fire.

Hazardous Combustion Products: Heating fuel oil no. 2 to decomposition can produce thick acrid smoke and irritating fumes.

Fire-Fighting Instructions: If tank, rail car or tank truck is involved in fire isolate for 1/2 mile (800 m). *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: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). All equipment used when handling the product must be grounded. *Do not* touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. Isolate area for at least 80-160 ft (25-50 m) in all directions. Water spray or fire fighting foam may suppress vapor, but may not prevent ignition in closed spaces. Use natural barriers or oil spill control booms to confine oil slicks on surface water.

Small Spills: Absorb fuel oil no. 2 with vermiculite, earth, sand or similar material.

Large Spills

Containment: For large spills, consider downwind evacuation of at least 1000 ft (300 m). Dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways.

Cleanup: Ground all equipment. Spills can be absorbed with materials such as peat, activated carbon, polyurethane foam, or straw. Sinking agents, gelling agents, dispersants, and mechanical systems can also be used to treat oil spills. Use clean non-sparking tools to collect absorbed material.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor or mist inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations as low as possible. Wear protective gloves (or use barrier cream) and clothing (see Sec. 8). Keep away from heat and ignition sources. Ground and bond all containers during transfers to prevent static sparks. Use non-sparking tools to open and close containers.

Storage Requirements: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (See Sec. 10). Periodically inspect stored materials. Equip drums with self-closing valves, pressure vacuum bungs, and flame arrestors.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.106) for a Class II Combustible Liquid.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Enclose operations and/or provide local exhaust ventilation at the site of chemical release designed for flammable vapors/mists. Where possible, transfer fuel oil no. 2 from drums or other storage containers to process containers. Minimize sources of ignition in surrounding low-lying areas.

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. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), use an SCBA.
Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres. If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets of Viton™ or nitrile rubber, if possible, or alternatively, polyvinyl chloride, chlorinated polyethylene or neoprene to prevent skin contact. Butyl rubber may degrade after contact and is not recommended. Wear protective eyeglasses 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

Appearance and Odor: Amber to brown, slightly viscous; petroleum odor

Odor Threshold: 0.082 ppm

Formula Weight: N/A

Specific Gravity (H_2O=1, at 4 °C): 0.8654 at 59 °F (15 °C)

Water Solubility: Slightly soluble

Boiling Point: 450 °F (232 °C)

Freezing Point: -50.8 °F (-46 °C)

Viscosity: 268 centistoke at 100 °F (37.8 °C)

Surface Tension: 25 dynes/cm, estimated

Henry's Law Constant (H): 29 to 68 atm-m^3/mole at 77 °F (25 °C), estimated

Octanol/Water Partition Coefficient: log K_{ow} = 8.2 to 9.7

Soil Sorption Coefficient (K_{oc}): $1x10^4$, estimated

Section 10 - Stability and Reactivity

Stability: Fuel oil no. 2 is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include strong oxidizing agents.

Conditions to Avoid: Heat and ignition sources.

Hazardous Decomposition Products: Thermal oxidative decomposition of fuel oil no. 2 can produce various hydrocarbons, hydrocarbon derivatives, partial oxidation products (carbon dioxide (CO_2), carbon monoxide (CO), sulfur dioxide (SO_2)).

Section 11 - Toxicological Information

Toxicity Data:*

Skin Effects:
Rabbit, skin, standard Draize test: 500 mg/24 hr, resulted in moderate irritation.

Acute Dermal Effects:
Rabbit, skin, LD: > 5 g/kg

Acute Oral Effects:
Rat, oral, LD_{50}: 12 g/kg

Eye Effects:
Rabbit, eye, standard Draize test: 100 mg/30 seconds, resulted in mild irritation.

Section 11 - Toxicological Information - *continued*

Toxicity Data:*

Tumorigenicity:
Mouse, skin: 243 g/kg/97 weeks, administered intermittently, caused skin and appendage tumors (carcinogenic by RTECS criteria).

Multiple Dose Toxicity Data:
Rabbit, skin: 100 mL/kg/12 days, continuously, caused irritative dermatitis, weight loss or decreased weight gain, and death.

* See NIOSH, *RTECS* (LS8930000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Juvenile American shad, TLm/24 hr: 200 ppm; bluegill, LC_{50} = 95 mg/L/96 hr; carp, LC_{50} = 8.2 mg/L/24 hr; pumpkin seed, LC_{50} = 1.9 mg/L/24 hr. Through its coating action, this material can pose a hazard to aquatic biota including water birds, plankton, algae and fish.

Environmental Fate: Based on a calculated BCF ($1.02x10^4$ to $1.4x10^4$), bioconcentration could be an important environmental fate process; however, it may be limited for the chief components of fuel oil no. 2 due to metabolism.

Environmental Degradation: It may biodegrade in water and soil, or volatilize from water (half-life of 4.4- 4.8 hours from a model river) and moist soil surfaces, but adsorption may attenuate the rate of these processes. In the atmosphere, fuel oil no. 2 will rapidly degrade by reaction with photochemically produced hydroxyl radicals (estimated half-life 1 day or less).

Soil Adsorption/Mobility: A high Koc indicates significant sorption and low mobility in the soil column.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Material may be sprayed into an incinerator. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Fuel oil (1, 2, 4, 5 or 6)
Shipping Symbols: D
Hazard Class: 3
ID No.: NA1993
Packing Group: III
Label: Flammable Liquid
Special Provisions (172.102): B1

Packaging Authorizations
a) **Exceptions:** 173.150
b) **Non-bulk Packaging:** 173.203
c) **Bulk Packaging:** 173.242

Quantity Limitations
a) **Passenger, Aircraft, or Railcar:** 60 L
b) **Cargo Aircraft Only:** 220 L

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** –

Section 15 - Regulatory Information

EPA Regulations:
Classified as a RCRA Hazardous Waste (40 CFR 261.21), Characteristic of Ignitability
RCRA Hazardous Waste Number: D001
Listed as a CERCLA Hazardous Substance (40 CFR 302.4), Unlisted Hazardous Waste, Characteristic of Ignitability, per RCRA Section 3001
CERCLA Final Reportable Quantity (RQ), 100 lb (45.4 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1, as petroleum distillates)

Section 16 - Other Information

References: 1, 73, 103, 136, 190, 223, 230, 231

Prepared By..... HM Spliethoff, MS
Industrial Hygiene Review..... PA Roy, MPH, CIH
Medical Review..... T Thoburn, MD, MPH

Genium Publishing Corp.
One Genium Plaza
Schenectady, NY 12304-4690
(518) 377-8854

Material Safety Data Sheet Collection

Naphthalene

MSDS No. 624

Date of Preparation: 11/87 Revision: A, 9/97

Section 1 - Chemical Product and Company Identification 50

Product/Chemical Name: Naphthalene
Chemical Formula: $C_{10}H_8$
CAS Number: 91-20-3
Synonyms: Albocarbon; camphor tar; Dezodorator; Mighty 150; moth balls; moth flakes; naftalen (Polish); naphthalin; naphthaline; naphthalinum; naphthene; NTM; tar camphor; white tar
Derivation: From coal tar; from petroleum fractions after various catalytic processing operations.
General Use: Used as a moth repellent, an antiseptic, toilet bowl deodorant, heat transfer agent, fungicide, smokeless powder, cutting fluid, lubricant, wood preservative; an intermediate for naphthol, phthalic anhydride, chlorinated naphthalenes, Tertralin, Decalin, naphthyl and naphthol derivatives, and dyes; in synthetic resins, synthetic tanning, textile chemicals, scintillation counters, and emulsion-breakers.
Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Naphthalene, ca 100% wt. Grade: By melting point, 165 °F (74 °C) min (crude) to greater than 174 °F (79 °C) (refined); scintillation 176-177 °F (80-81 °C)

OSHA PELs	ACGIH TLVs	NIOSH RELs	IDLH Level
8-hr TWA: 10 ppm (50 mg/m³); *Vacated 1989 Final Rule Limit:* 15-min. STEL: 15 ppm (79 mg/m³)	TWA: 10 ppm (52 mg/m³) STEL: 15 ppm (79 mg/m³)	10-hr TWA: 10 ppm (50 mg/m³); 15-min. STEL: 15 ppm (75 mg/m³)	500 ppm

DFG (Germany) MAK
10 ppm (50 mg/m³)

Section 3 - Hazards Identification

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Naphthalene is a white crystalline solid with a 'moth ball' or coal-tar odor. It is toxic by ingestion. Irritating to skin, eyes, and respiratory system. Naphthalene is a combustible solid. Dust may form explosive mixtures in air if subjected to an ignition source.

Wilson Risk Scale	
R	1
I	3
S	2*
K	2

*Skin absorption

HMIS	
H	2†
F	2
R	0
PPE‡	

†Chronic Effects
‡Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, skin absorption, skin and/or eye contact
Target Organs: Blood (red blood cell effects), eyes, skin, central nervous system (CNS), liver and kidneys
Acute Effects
Inhalation: Vapor inhalation causes headache, confusion, nausea, sometimes vomiting, loss of appetite, extensive sweating, dysuria (painful urination), hematuria (blood in the urine), and hemolysis (destruction of red blood cells).
Eye: Irritation, conjunctivitis, and corneal injury upon prolonged contact.
Skin: Irritation and hypersensitivity dermatitis.
Ingestion: Unlikely. However, ingestion causes irritation of the mouth and stomach, hemolytic anemia with hepatic and renal lesions and vesical congestion, kidney failure, hematuria, jaundice, depression of CNS, nausea, vomiting, abdominal pain, blue face, lips, or hands, rapid and difficult breathing, headache, confusion, excitement, malaise, fever, perspiration, urinary tract pain, dizziness, convulsions, coma, and death. Symptoms may appear 2 to 4 hours after exposure.
Carcinogenicity: IARC, NTP, and OSHA do not list naphthalene as a carcinogen. EPA-D, Not Classifiable as to Human Carcinogenicity; MAK-B, Justifiably suspected of having carcinogenic potential; TLV-A4, Not Classifiable as a Human Carcinogen.
Medical Conditions Aggravated by Long-Term Exposure: Diseases of the blood, liver and kidneys; individuals with a hereditary deficiency of the enzyme glucose-6-phosphate dehydrogenase in red blood cells are particularly susceptible to the hemolytic properties of naphthalene metabolites.
Chronic Effects: May cause optical neuritis, corneal injuries, cataracts, kidney damage.
Other: There are two reports of naphthalene crossing the placenta in humans.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed. Contact a physician immediately if symptoms of systemic poisoning are present.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician or ophthalmologist if pain, irritation, swelling, or photophobia persist.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area thoroughly with soap and water. For reddened or blistered skin, consult a physician. Contact a physician immediately if symptoms of systemic poisoning are present.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Contact a physician immediately.

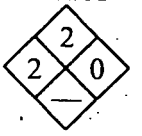
After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Obtain baseline CBC, electrolytes, liver and renal function rests, glucose-6-phosphatase dehydrogenase level, urinalysis, and benzidine dipstick to check for hemoglobinuria. Urinary metabolite, 1-naphthol or mercapturic acid, may help confirm the diagnosis.

Section 5 - Fire-Fighting Measures

Flash Point: 174 °F (79 °C); 190 °F (88 °C)
Flash Point Method: OC; CC
Burning Rate: Data not found.
Autoignition Temperature: 979 °F (526 °C)
LEL: 0.9% v/v
UEL: 5.9% v/v

NFPA



Flammability Classification: Combustible solid

Extinguishing Media: Use dry chemical, foam, carbon dioxide (CO_2), or water spray. Water or foam may cause frothing. Use water spray to keep fire-exposed containers cool.

Unusual Fire or Explosion Hazards: Volatile solid that gives off flammable vapors when heated. Dust may explode in air if an ignition source is provided.

Hazardous Combustion Products: Toxic vapors including carbon monoxide.

Fire-Fighting Instructions: Move containers from the fire area if it can be done without risk. Otherwise cool fire-exposed containers until well after the fire is extinguished. *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. Wear full protective clothing (see Sec. 8). Structural clothing is permeable, remain clear of smoke, water fall out, and water run off.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources. Isolate and ventilate area, deny entry, stay upwind. Stop leak if you can do it without risk. Use spark-proof tools and explosion proof equipment. Cleanup personnel should wear personal protective equipment to protect against exposure (see Sec. 8).

Small Spills: *Do not* sweep! Carefully scoop up or vacuum (with a HEPA filter). Absorb liquid spill with an inert, noncombustible absorbent such as sand or vermiculite.

Large Spills

Containment: For large spills, dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: To avoid vapor inhalation use only with ventilation sufficient to reduce airborne concentrations to nonhazardous levels. Avoid skin and eye contact. Wear personal protective clothing and equipment to prevent any contact with skin and eyes (see Sec. 8). Practice good personal hygiene procedures to prevent inadvertently ingesting this material.

Storage Requirements: Store in tightly closed, explosion-proof containers in a cool, well-ventilated area away from heat, ignition sources, and incompatibles (see Sec. 10). May be stored under nitrogen gas. Protect containers against physical damage. Use monitoring equipment to measure the extent of vapor present in any storage facility containing naphthalene because of potential fire and explosion hazards.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Where feasible, enclose operations to avoid vapor and dust dispersion into the work area. Ventilate at the site of chemical release. During the fractional distillation of naphthalene and in any operation entailing the heating or volatilization of naphthalene, enclosed apparatus should be employed.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Educate workers about the health and safety hazards associated with naphthalene. Train in work practices which minimize exposure. Consider preplacement and periodic medical exams with emphasis on the eyes, skin, liver, kidneys, CBC (RBC count, WBC count, differential count of a stained smear, hemoglobin, and hematocrit), and urinalysis including at a minimum specific gravity, albumin, glucose, and a microscopic examination on centrifuged sediment.

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. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Teflon® is recommended. *Do not* use butyl rubber, natural rubber, neoprene or polyvinyl chloride. Wear chemical dust-proof safety goggles and face shield, 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 naphthalene 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: Crystalline solid

Appearance and Odor: White, volatile flakes, cakes, cubes, spheres, or powder; strong coal-tar or moth ball odor

Odor Threshold: 0.084 ppm to 0.3 ppm

Vapor Pressure: 0.05 mm Hg at 68 °F (20 °C); 1.0 mm Hg at 127 °F (53 °C)

Formula Weight: 128.2

Density: 1.145 g/cm^3 at 68 °F (20 °C)

Saturated Vapor Concentration: 100 ppm at 77 °F (25 °C) (approx.)

Water Solubility: Insoluble [31.7 mg/L at 68 °F (20 °C)]

Other Solubilities: Benzene, absolute alcohol; very soluble in ether, chloroform, carbon disulfide, hydronaphthalenes, fixed and volatile oils

Boiling Point: 424 °F (218 °C)

Melting Point: 176 °F (80.2 °C)

Volatility: Volatilizes appreciably at room temperature; volatile with steam

Octanol/Water Partition Coefficient: log K_{ow} = 3.30

Section 10 - Stability and Reactivity

Stability: Naphthalene is stable at room temperature in closed containers under normal storage and handling conditions. It volatilizes at room temperature.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include aluminum chloride, benzoyl chloride, chromic acid, chromium trioxide, oxidizers. Explosive reaction with dinitrogen pentaoxide. Melted naphthalene will attack some forms of plastics.

Conditions to Avoid: Exposure to heat and ignition sources, incompatibles.

Hazardous Decomposition Products: Thermal oxidative decomposition of naphthalene can produce toxic fumes including carbon monoxide.

Section 11- Toxicological Information

Toxicity Data:*

Acute Effects:

Human (child), oral, LD_{Lo}: 100 mg/kg

Man, unreported, LD_{Lo}: 74 mg/kg

Rat, oral, LD_{50}: 490 mg/kg

Reproductive Effects:

Rat, oral: 4500 mg/kg administered on gestational days 6-15 produced fetotoxicity and other developmental abnormalities.

Section 11- Toxicological Information, *continued*

Toxicity Data:*

Acute Effects: *continued*
Mouse, oral, LD_{50}: 533 mg/kg
Rat, inhalation, LC_{50}: >340 mg/m^3 produced lacrimation and somnolence.

Genetic Effects:
Hamster, ovary: 15 mg/L induced sister chromatid exchange.

Tumorigenicity:
Mouse, inhalation: 30 ppm/6 hr/2 yr administered intermittently produced toxic effects: tumorigenic - neoplastic by RTECS criteria; lungs, thorax, or respiration - tumors.

Skin Effects:
Rabbit, skin, open Draize test: 495 mg produced mild irritation.

Eye Effects:
Rabbit, eye, standard Draize test: 100 mg produced mild irritation.

*See *NIOSH RTECS* (QJ0525000) for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: *Oncorhynchus gorbuscha* (pink salmon): 1.37 ppm/96 hr at 39 °F (4 °C). *Pimephales promelas* (fathead minnow): 7.76 mg/L/24 hr.

Environmental Fate: If released to the atmosphere, naphthalene rapidly photodegrades with a half-life of 3-8 hr. Volatilization, photolysis, adsorption, and biodegradation are important loss mechanisms for naphthalene discharged into water. Depending on local conditions, the half-lives range from a couple of days to a few months. If released on land, it is adsorbed moderately to soil, undergoes biodegradation; but in some cases biodegradation may still occur if conditions are aerobic. Bioconcentration occurs to a moderate extent, but is a temporary problem since depuration and metabolism readily proceed in aquatic organisms.

Section 13 - Disposal Considerations

Disposal: Consider rotary kiln or fluidized bed incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Container Cleaning and Disposal: Handle empty containers carefully as hazardous residues may still remain.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Naphthalene, crude or Naphthalene, refined
Shipping Symbols: Not listed
Hazard Class: 4.1
ID No.: UN1334
Packing Group: III
Label: FLAMMABLE SOLID
Special Provisions (172.102): A1

Packaging Authorizations
a) **Exceptions:** 173.151
b) **Non-bulk Packaging:** 173.213
c) **Bulk Packaging:** 173.240

Quantity Limitations
a) **Passenger, Aircraft, or Railcar:** 25 kg
b) **Cargo Aircraft Only:** 100 kg

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** Not listed

Section 15 - Regulatory Information

EPA Regulations:
Listed as a RCRA Hazardous Waste (40 CFR 261.33). Hazardous Waste Number: U165
Listed as a CERCLA Hazardous Substance (40 CFR 302.4) specific per RCRA, Sec. 3001; CWA, Sec. 311 (b)(4); CWA, Sec. 307(a); CAA, Sec. 112
CERCLA Final Reportable Quantity (RQ), 100 lb (45.4 kg)
Listed as a SARA Toxic Chemical (40 CFR 372.65)
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Air Contaminant (29 CFR 1910.1000, Table Z-1, Z-1-A): Not listed

Section 16 - Other Information

References: 73, 99, 103, 124, 139, 140, 167, 168, 179, 190, 196, 197, 200, 220

PC-W6

Prepared By.....S Fleming, BS/MJ Wurth, BS
Industrial Hygiene Review.....DJ Wilson, CIH
Medical Review.....G Kelafant, MD

Material Safety Data Sheet Collection
Genium Publishing Corp.
1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

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Perchloroethylene
MSDS 313
TET2750

Section 1 - Chemical Product and Company Identification 54

Material Name: Perchloroethylene
Chemical Formula: C_2Cl_4
CAS Number: 127-18-4
Structural Chemical Formula: $Cl_2C=CCl_2$
Synonyms: ANKILOSTIN; ANTISAL 1; ANTISOL 1; CARBON BICHLORIDE; CARBON DICHLORIDE; CZTEROCHLOROETYLEN; DIDAKENE; DILATIN PT; DOW-PER; ENT 1,860; EPA PESTICIDE CHEMICAL CODE 078501; ETHENE,TETRACHLORO-; ETHYLENE TETRACHLORIDE; ETHYLENE,TETRACHLORO-; FEDAL-UN; NEMA; PCE; PER; PERAWIN; PERC; PERCHLOORETHYLEEN,PER; PERCHLOR; PERCHLORAETHYLEN,PER; PERCHLORETHYLENE; PERCHLORETHYLENE,PER; PERCHLOROETHYLENE; PERCLENE; PERCLENE D; PERCLOROETILENE; PERCOSOLV; PERCOSOLVE; PERK; PERKLONE; PERSEC; TETLEN; TETRACAP; TETRACHLOORETHEEN; TETRACHLORAETHEN; TETRACHLORETHYLENE; TETRACHLOROETHENE; 1,1,2,2-TETRACHLOROETHYLENE; TETRACHLOROETHYLENE; TETRACLOROETENE; TETRAGUER; TETRALENO; TETRALEX; TETRAVEC; TETROGUER; TETROPIL
General Use: Used as a drycleaning solvent, a vapor-degreasing solvent; a drying agent for metals and certain other solids. Used also as a heat transfer medium and in the manufacture of fluorocarbons.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
perchloroethylene	127-18-4	100

OSHA PEL
TWA: 100 ppm; STEL: 200 ppm; from Table Z-2. Other Values: 300 mg/m^3; 5 min peak 3hr ppm.

OSHA PEL Vacated 1989 Limits
TWA: 25 ppm; 170 mg/m^3.

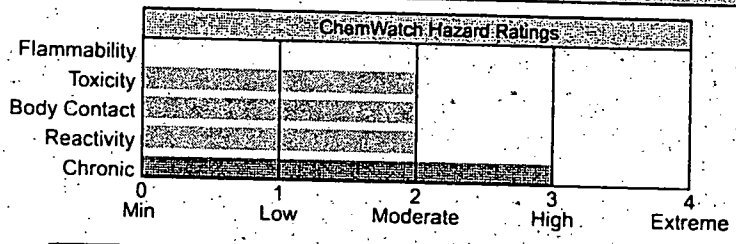
ACGIH TLV
No data found.

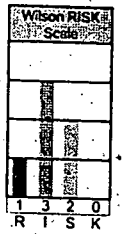
NIOSH REL
No data found.

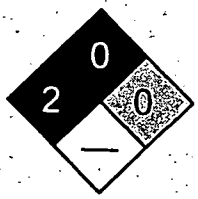
IDLH Level
150 ppm.

DFG (Germany) MAK
TWA: 50 ppm; 345 mg/m^3.

Section 3 - Hazards Identification







Fire Diamond

ANSI Signal Word
Caution

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless liquid; ether-like odor. Irritating to eyes/skin/respiratory tract. Also causes: headache, dizziness, CNS depression, incoordination, slurred speech. Chronic: liver/kidney damage; possible cancer hazard based on animal studies.

Potential Health Effects

Primary Entry Routes: inhalation, skin contact, eye contact

Target Organs: liver, kidneys, eyes, upper respiratory system, skin, central nervous system (CNS)

Acute Effects

Inhalation: Acute intoxication by halogenated aliphatic hydrocarbons appears to take place over two stages. Signs of a reversible narcosis are evident in the first stage and in the second stage signs of injury to organs may become evident. A single organ alone is (almost) never involved.
The vapor is highly discomforting to the upper respiratory tract and lungs.
Inhalation hazard is increased at higher temperatures.
Anesthetic and narcotic effects (with dulling of senses and odor fatigue) are a consequence of exposure to chlorinated solvents.
Individual response varies widely; odor may not be considered objectionable at levels which quickly induce central nervous system effects.
High vapor concentrations may give a feeling of euphoria. This may result in reduced responses, followed by rapid onset of unconsciousness, possible respiratory arrest and death.
Accidental high level exposure has produced lightheadedness, unconsciousness and liver and kidney damage in workers. In at least two cases such exposures were fatal. Subjects exposed to 106 ppm in laboratory studies experienced slight eye irritation; dizziness and sleepiness were reported at 216 ppm; at exposures of 280 ppm or 600 ppm for 10 minutes there was a loss of motor coordination. In another study subjects exposed for 7 hours at 101 ppm complained of eye irritation and subjective symptoms such headache, drowsiness and sleepiness.

Eye: The liquid may produce eye discomfort and is capable of causing temporary impairment of vision and/or transient eye inflammation, ulceration Eye contact may cause lachrymation (tears) and burning sensation.
The vapor is highly discomforting to the eyes.
The material may be irritating to the eye, with prolonged contact causing inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

Skin: The liquid is highly discomforting to the skin if exposure is prolonged and may cause drying of the skin, which may lead to dermatitis.
Toxic effects may result from skin absorption.
Absorption by skin may readily exceed vapor inhalation exposure.
Symptoms for skin absorption are the same as for inhalation.
Bare unprotected skin should not be exposed to this material.
The material may accentuate any pre-existing skin condition.
The material may produce severe skin irritation after prolonged or repeated exposure, and may produce a contact dermatitis (nonallergic).
This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis.
Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.
Prolonged contact is unlikely, given the severity of response, but repeated exposures may produce severe ulceration.
Industrial experience shows localized skin irritation. Prolonged dermal contact can cause chemical burns and blistering.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.
The liquid is highly discomforting and toxic if swallowed and may be fatal if swallowed in large quantity.
Ingestion may result in nausea, abdominal irritation, pain and vomiting.
When used in the treatment of hookworm (4.5 to 6.5 gm orally) the only adverse effect is inebriation. Transient hepatotoxicity in patients given single oral doses of up to 5 mL have been recorded.

Carcinogenicity: NTP - Class 2B, Reasonably anticipated to be a carcinogen, sufficient evidence of carcinogenicity from studies in experimental animals; IARC - Group 2B, Possibly carcinogenic to humans; OSHA - Not listed; NIOSH - Listed as carcinogen; ACGIH - Class A3, Animal carcinogen; EPA - Not listed; MAK - Class B, Justifiably suspected of having carcinogenic potential.

Chronic Effects: Prolonged or continuous skin contact with the liquid may cause defatting with drying, cracking, irritation and dermatitis following.
Workers inhaling 232 to 385 ppm for 8 hours/day, 5 days/week for 2 to 6 years have shown abnormal hepatic function, including cirrhosis, with lightheadedness, headache, malaise and dizziness.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.
Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).
Wash affected areas thoroughly with water (and soap if available).

Seek medical attention in event of irritation.
Ingestion: Contact a Poison Control Center.
Do NOT induce vomiting. Give a glass of water.
Avoid giving milk or oils.
Avoid giving alcohol.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Treat symptomatically.
Do not administer sympathomimetic drugs as they may cause ventricular arrhythmias.
For acute or short-term repeated exposures to perchloroethylene:
Tetrachloroethylene/perchlorethylene is well absorbed through the lungs with peak levels more important than duration in determining blood concentration.
Lungs excrete most of the absorbed tetrachloroethylene in an unchanged state; about 3% is converted by the liver to form trichloracetic acid and subsequently excreted by the kidney. Exhaled material has a biological half-life of 65 hours.
INHALATION:
The treatment of acute inhalation exposures is supportive with initial attention directed to evaluation/support of ventilation and circulation.
As with all hydrocarbons care must be taken to reduce the risk of aspiration by proper positioning and medical observation.
INGESTION:
1.The ingestion level at which emesis should be induced is difficult to predict in the absence of extensive human studies.
2.The role of charcoal and cathartics remains uncertain.

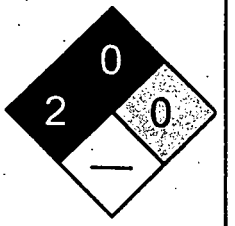
BIOLOGICAL EXPOSURE INDEX - BEI
These represent the determinants observed in specimens collected from a healthy worker who has been exposed at the Exposure Standard (ES or TLV):

Determinant	Index	Sampling Time	Comments
Perchloroethylene in end-exhaled air	10 ppm	Prior to last shift of work-week	
Perchloroethylene in Blood	1 mg/L	Prior to last shift of work-week	
Trichloroacetic acid in urine	7 mg/L	End of work-week	NS,SQ

NS: Non-specific determinant; also seen after exposure to other materials
SQ: Semi-quantitative determinant - Interpretation may be ambiguous; should be used as a screening test or confirmatory test.

Section 5 - Fire-Fighting Measures

Flash Point: Nonflammable
Autoignition Temperature: 490 °C
LEL: 1.8% v/v
UEL: 11.5% v/v at 740 mm Hg 160 °C
Extinguishing Media: Use extinguishing media suitable for surrounding area.
General Fire Hazards/Hazardous Combustion Products: Nonflammable liquid. However vapor will burn when in contact with high temperature flame. Ignition ceases on removal of flame.
May form a flammable/explosive mixture in an oxygen enriched atmosphere. Heating may cause expansion/vaporization with violent rupture of containers. Decomposes on heating and produces corrosive fumes of hydrochloric acid, carbon monoxide and small amounts of toxic phosgene.



Fire Diamond

Fire Incompatibility: Avoid mixing with strong alkalis or powdered metals, particularly zinc as ignition may result.
Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
Wear breathing apparatus plus protective gloves for fire only. Prevent, by any means available, spillage from entering drains or waterways.
Use fire fighting procedures suitable for surrounding area.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protected location.
If safe to do so, remove containers from path of fire.

Equipment should be thoroughly decontaminated after use.

Section 6 - Accidental Release Measures

Small Spills: Clean up all spills immediately.
Wear protective neoprene gloves and chemical goggles.
If risk of overexposure exists, wear NIOSH-approved respirator.
Wipe up and absorb small quantities with vermiculite or other absorbent material.
DO NOT discharge into sewer or waterways.
Place spilled material in clean, dry, sealable, labeled container.
Large Spills: Minor hazard. Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
No smoking, bare lights or ignition sources. Increase ventilation.
Stop leak if safe to do so. Contain spill with sand, earth or vermiculite.
Collect recoverable product into labeled containers for recycling.
Absorb remaining product with sand, earth or vermiculite.
Collect solid residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains.
If contamination of drains or waterways occurs, advise emergency services.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid generating and breathing mist. Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
DO NOT allow material to contact humans, exposed food or food utensils.
Avoid contact with incompatible materials.
When handling, DO NOT eat, drink or smoke.
Keep containers securely sealed when not in use. Avoid physical damage to containers. Always wash hands with soap and water after handling. Work clothes should be laundered separately.
Launder contaminated clothing before reuse.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.
Recommended Storage Methods: Check that containers are clearly labeled. Glass container.
Heavy gauge metal packages/heavy gauge metal drums.
Avoid storage with zinc, galvanized or diecast metal (including bungs).
DO NOT use aluminum or galvanized containers.
Packaging as recommended by manufacturer.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: CARE: Use of a quantity of this material in confined space or poorly ventilated area, where rapid build-up of concentrated atmosphere may occur, could require increased ventilation and/or protective gear. Use in a well-ventilated area.
Local exhaust ventilation may be required for safe working, i.e., to keep exposures below required standards; otherwise, PPE is required.
If inhalation risk exists, wear NIOSH-approved organic-vapor respirator or air supplied breathing apparatus.
Personal Protective Clothing/Equipment
Eyes: Chemical goggles. Full face shield.
Hands/Feet: Neoprene gloves; Viton gloves.
PVA gloves.
PVC gloves.
Protective footwear.
Respiratory Protection:
Exposure Range >100 to <150 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range 150 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Note: poor warning properties.
Other: Overalls. Eyewash unit. Ensure there is ready access to an emergency shower.

Glove Selection Index:

PE/EVAL/PE	A
VITON/CHLOROBUTYL	A
VITON/NITRILE	A
VITON	A
PVA	A
CPE	A
NITRILE	B
TEFLON	B
NITRILE+PVC	C
SARANEX-23 2-PLY	C
SARANEX-23	C
PVC	C
BUTYL	C
NEOPRENE	C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless liquid, with a chloroform-like odor. Extremely stable, resists hydrolysis. Miscible with alcohol, ether and oils.

Physical State: Liquid
Vapor Pressure (kPa): 2.11 at 22 °C
Vapor Density (Air=1): 5.83
Formula Weight: 165.82
Specific Gravity (H_2O=1, at 4 °C): 1.63 at 15 °C
Water Solubility: 0.02% by weight
Evaporation Rate: 0.09 Ether=1

pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: 121 °C (250 °F) at 760 mm Hg
Freezing/Melting Point Range: -19 °C (-2.2 °F)
Volatile Component (% Vol): 100

Section 10 - Stability and Reactivity

Stability/Polymerization: Product is considered stable and hazardous polymerization will not occur.
Storage Incompatibilities: Avoid reaction with oxidizing agents. Segregate from strong alkalis.
Haloalkenes are highly reactive. Some of the more lightly substituted lower members are highly flammable; many members of the group are peroxidizable and polymerizable.
The presenceof 0.5% trichloroethylene as an impurity caused generation of dichloroacetylene during unheated drying over solid sodium hydroxide.
Subsequent fractional distillation produced an explosion.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (rat) LD_{50}: 2629 mg/kg
Inhalation (man) LD_{Lo}: 2857 mg/kg
Inhalation (human) TC_{Lo}: 96 ppm/7 hrs
Inhalation (man) TC_{Lo}: 280 ppm/2 hrs
Inhalation (man) TC_{Lo}: 600 ppm/10 min
Inhalation (rat) LC_{Lo}: 34200 mg/m^3/8 hr

IRRITATION
Skin (rabbit): 810 mg/24h -SEVERE
Eye (rabbit): 162 mg -mild

See NIOSH, *RTECS* KX 3850000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If it is released to soil, it will be subject to evaporation into the atmosphere and to leaching to the groundwater. Biodegradation may be an important process in anaerobic soils based on laboratory tests with methanogenic columns. Slow biodegradation may occur in groundwater where acclimated populations of microorganisms exist. If released to water, it will be subject to rapid volatilization with estimated half-lives ranging from <1 day to several weeks. It will not be expected to significantly biodegrade, bioconcentrate in aquatic organisms or significantly adsorb to sediment. It will not be expected to significantly hydrolyze in soil or water under normal environmental conditions. If released to the atmosphere, it will exist mainly in the gas-phase and it will be subject to photooxidation with estimates of degradation time scales ranging from an approximate half-life of 2 months to complete degradation in an hour. Some in the atmosphere may be subject to washout in rain based on the solubility in water.

Ecotoxicity: LC_{50} Tanytarsus dissimilis (midge) 30, 840 ug/l/48 hr, static bioassay; LC_{50} Poecilia reticulata (guppy) 18 ppm/7 days /Conditions of bioassay not specified; LC_{50} Daphnia magna (water flea) 18 mg/l/48 hr, static bioassay, at 22 °C; LC_{50} Salmo gairdneri (rainbow trout) 5 mg/l/96 hr, static bioassay at 12 °C
Henry's Law Constant: 2.87×10^{-2}
BCF: fathead minnow 38.9
Biochemical Oxygen Demand (BOD): none
Octanol/Water Partition Coefficient: log $K_{ow} = 3.40$
Soil Sorption Partition Coefficient: $K_{oc} = 209$

Section 13 - Disposal Considerations

Disposal: Reclaim solvent at an approved site.
Allow absorbed spillage to evaporate in an open top container, away from habitation.
Incinerate residue at an approved site.
Used containers should be left upside down with bungs out.
Return containers to drum reconditioner or recycler.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: TETRACHLOROETHYLENE
Additional Shipping Information: PERCHLOROETHYLENE
Hazard Class: 6.1(b)
ID No.: 1897
Packing Group: III
Label: Harmful[6]

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U210 Toxic Waste
CERCLA 40 CFR 302.4: Listed per RCRA Section 3001; per CWA Section 307(a) 100 lb (45.35 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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Material Safety Data Sheet Collection
Genium Publishing Corp.
1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

Trichloroethylene
MSDS 312
TRI2710

Section 1 - Chemical Product and Company Identification 54

Material Name: Trichloroethylene
CAS Number: 79-01-6
Chemical Formula: C_2HCl_3
Structural Chemical Formula: ClCH=CCl_2
Synonyms: ACETYLENE TRICHLORIDE; ALGYLEN; ANAMENTH; BENZINOL; BLACOSOLV; BLANCOSOLV; CECOLENE; CHLORILEN; 1-CHLORO-2,2-DICHLOROETHYLENE; CHLORYLEA; CHLORYLEA,CHORYLEN,CIRCOSOLV,CRAWHASPOL,DOW-TRI,DUKERON,PER-A-CLOR,TRIAD,TRIAL,TRI-PLUS M,VITRAN; CHLORYLEN; CHORYLEN; CIRCOSOLV; CRAWHASPOL; DENSINFLUAT; 1,1-DICHLORO-2-CHLOROETHYLENE; DOW-TRI; DUKERON; EPA PESTICIDE CHEMICAL CODE 081202; ETHENE,TRICHLORO-; ETHINYL TRICHLORIDE; ETHYLENE TRICHLORIDE; ETHYLENE,TRICHLORO-; FLECK-FLIP; FLOCK FLIP; FLUATE; GEMALGENE; GERMALGENE; LANADIN; LETHURIN; NARCOGEN; NARKOGEN; NARKOSOID; NIALK; NSC 389; PERM-A-CHLOR; PERM-A-CLOR; PETZINOL; PHILEX; TCE; THRETHYLEN; THRETHYLENE; TRETHYLENE; TRI; TRIAD; TRIAL; TRIASOL; TRICHLOORETHEEN; TRICHLOORETHYLEEN,TRI; TRICHLORAETHEN; TRICHLORAETHYLEN,TRI; TRICHLORAN; TRICHLOREN; TRICHLORETHENE; TRICHLORETHYLENE; TRICHLORETHYLENE,TRI; TRICHLOROETHENE; 1,1,2-TRICHLOROETHYLENE; TRICHLOROETHYLENE; TRICHLOROETHYLENE; 1,2,2-TRICHLOROETHYLENE; TRI-CLENE; TRICLENE; TRICLORETENE; TRICLOROETILENE; TRIELENE; TRIELIN; TRIELINA; TRIELINE; TRIKLONE; TRILEN; TRILENE; TRILINE; TRIMAR; TRIOL; TRI-PLUS; TRI-PLUS M; VESTROL; VITRAN; WESTROSOL
General Use: Mainly used for vapor degreasing; solvent in textile and electronics industries; for adhesives, lubricants and consumer products (such as spot removers and rug cleaners).
Until recently, it was used to make hop extracts for beer, decaffeinated coffee and spice extracts.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
trichloroethylene	79-01-6	> 99

OSHA PEL
TWA: 100 ppm; STEL: 200 ppm; from Table Z-2. Other Values: 300 mg/m^3; 5 min peak 2hr ppm.

OSHA PEL Vacated 1989 Limits
TWA: 50 ppm; 270 mg/m^3; STEL: 200 ppm; 1080 mg/m^3.

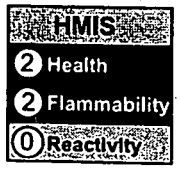
ACGIH TLV
No data found.

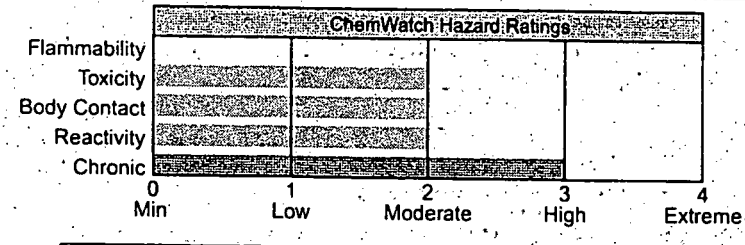
NIOSH REL
No data found.

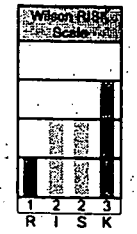
IDLH Level
1000 ppm.

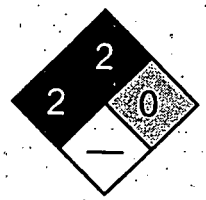
DFG (Germany) MAK
TWA: 50 ppm; 270 mg/m^3.

Section 3 - Hazards Identification









Fire Diamond

ANSI Signal Word
Warning!


Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Clear, colorless liquid; sweet odor. Irritating to eyes/skin/respiratory tract. Inhalation: irregular heart beat, drunkenness. Chronic: heart, liver and kidney damage, dermatitis. Birth defects and cancer may occur based on animal studies. Flammable.

Potential Health Effects

Primary Entry Routes: inhalation, skin contact, eye contact, ingestion (rarely)

Target Organs: respiratory system, central nervous system (CNS), peripheral nervous system, cardiovascular system, liver, kidneys, skin

Acute Effects

Inhalation: The vapor is mildly discomforting to the upper respiratory tract.
Inhalation hazard is increased at higher temperatures.
Anesthetics and narcotic effects (with dulling of senses and odor fatigue) are a consequence of exposure to chlorinated solvents.
Individual response varies widely; odor may not be considered objectionable at levels which quickly induce central nervous system effects.
High vapor concentrations may give a feeling of euphoria. This may result in reduced responses, followed by rapid onset of unconsciousness, possible respiratory arrest and death.
Acute effects from inhalation of high concentrations of vapor are pulmonary irritation, including coughing, with nausea; central nervous system depression - characterized by headache and dizziness, increased reaction time, fatigue and loss of coordination.
If exposure to highly concentrated solvent atmosphere is prolonged this may lead to narcosis, unconsciousness, even coma and possible death.
Evidence of acute human toxicity comes mainly from the use of TCE as an anesthetic, Tachypnea and ventricular arrhythmias are experienced at inhaled concentrations exceeding 15000 ppm. Systemic toxicity is low following anesthesia. Occasional hepatotoxicity (liver dysfunction) has been reported; this is probably due to the breakdown of TCE to dichloroacetylene and phosgene by soda-lime present in some anesthetic devices. The effects of TCE appear to be enhanced in some individuals by simultaneous exposure to caffeine, ethanol and other drugs. "Degreasers Flush" describes a reddening of facial, neck, and back skin and is seen after intake of substantial quantities of ethanol by certain individuals after exposures to TCE.

Eye: The liquid is highly discomforting to the eyes and is capable of causing pain and severe conjunctivitis.
Corneal injury may develop, with possible permanent impairment of vision, if not promptly and adequately treated.
The vapor is discomforting to the eyes.
The material may produce moderate eye irritation leading to inflammation.
Repeated or prolonged exposure to irritants may produce conjunctivitis.

Skin: The liquid is discomforting to the skin and may cause drying of the skin, which may lead to dermatitis.
Toxic effects may result from skin absorption.
Bare unprotected skin should not be exposed to this material. The material may accentuate any pre-existing skin condition.
The material may produce severe skin irritation after prolonged or repeated exposure, and may produce a contact dermatitis (nonallergic).
This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis.
Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.
Repeated exposures may produce severe ulceration.
Localized application may produce pustular eruptions, pruritus and erythema. A permeability coefficient of 1.6×10^{-2} cm/hr has been calculated by the US EPA. Percutaneous absorption is unlikely to contribute significantly to total body burdens unless dermatitis is present.

Ingestion: The liquid is highly discomforting and toxic if swallowed.
Ingestion may result in nausea, abdominal irritation, pain and vomiting.
Considered an unlikely route of entry in commercial/industrial environments.

Carcinogenicity: NTP - Not listed; IARC - Group 3, Not classifiable as to carcinogenicity to humans; OSHA - Not listed; NIOSH - Listed as carcinogen; ACGIH - Class A5, Not suspected as a human carcinogen; EPA - Not listed; MAK - Class B, Justifiably suspected of having carcinogenic potential.

Chronic Effects: Sensitive humans may experience anesthetic effects from short exposures.
Chronic effects of exposure include fatigue, headache, irritability, vomiting, skin flush and intolerance to alcohol.
Liver, kidney, heart and neurological damage may also result from chronic overexposure.
Alcohol intake may increase the toxic effects of the material.
A variety of disturbances have been seen among workers exposed at concentrations ranging from 1 to 335 ppm. These disturbances increased with the length of exposure (to 5 years or more) and where more prominent when exposures exceeded 40 ppm. Increased complaints of alcohol intolerance, tremors, giddiness and anxiety were amongst symptoms recorded. Variation in effects in different occupational settings may be due to different physical workloads.

There appeared to be no increase in the expected rates of congenital defects in children born to women exposed to TCE over a 13 year period.
Epidemiological studies consistently fail to show a link between cancers and TCE exposure. This is significant because of the tens of thousands of exposed workers monitored.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If available, administer medical oxygen by trained personnel.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor, without delay.
Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.
Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.
Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).
Wash affected areas thoroughly with water (and soap if available).
Seek medical attention in event of irritation.
Ingestion: Contact a Poison Control Center.
Do NOT induce vomiting. Give a glass of water.
Avoid giving milk or oils.
Avoid giving alcohol.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Treat symptomatically.
Do not administer sympathomimetic drugs as they may cause ventricular arrhythmias.
Following acute or short-term continued exposures to trichloroethylene:
1.Trichloroethylene concentration in expired air correlates with exposure. 8 hours exposure to 100 ppm produces levels of 25 ppm immediately and 1 ppm 16 hours after exposures.
2.Most mild exposure respond to removal from the source and supportive care.
Serious toxicity most often results from hypoxemia or cardiac dysrhythmias so that oxygen, intubation, intravenous lines and cardiac monitoring should be started initially as the clinical situation dictates.
3.Ipecac syrup should be give to alert patients who ingest more than a minor amount and present within 2 hours.
4.The efficacy of activated charcoal and cathartics is unclear.
5.The metabolites, trichloracetic acid, trichlorethanol and to a lesser degree, chloral hydrate, may be detected in the urine up to 16 days postexposure.

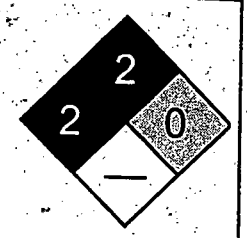
BIOLOGICAL EXPOSURE INDEX - BEI
These represent the determinants observed in specimens collected from a healthy worker exposed at the Exposure Standard (ES or TLV):

Determinant	Index	Sampling Time	Comments
Trichloroacetic acid in urine	10 mg/gm creatinine	End of work-week	NS
Trichloroacetic acid AND Trichloroethanol in urine	300 mg/mg creatinine	End of shift at end of work-week	NS
Free Trichloroethanol in blood	4 mg/L	End of shift at end of work-week	NS
Trichloroethylene in end-exhaled air			SQ
Trichloroethylene in blood			SQ

NS: Non-specific determinant; also seen after exposure to other materials
SQ: Semi-quantitative determinant - Interpretation may be ambiguous; should be used as a screening test or confirmatory test.

Section 5 - Fire-Fighting Measures

Flash Point: 32.222 °C Closed Cup
Autoignition Temperature: 420 °C
LEL: 8% v/v
UEL: 10.5% v/v
Extinguishing Media: Water spray or fog; foam, dry chemical powder, or BCF (where regulations permit).
Carbon dioxide.
General Fire Hazards/Hazardous Combustion Products: Vapor will burn when in contact with high temperature flame.
May form a flammable/explosive mixture in an oxygen enriched atmosphere. Heating may cause expansion/vaporization with violent rupture of containers. Decomposes on heating and produces corrosive fumes of hydrochloric acid, carbon monoxide and small amounts of toxic phosgene.
Fire Incompatibility: Avoid reaction with strong oxidizing agents (particularly oxygen in gas or liquid form and nitrogen dioxide), strong bases, sodium and sodium-potassium alloys. Powdered metals; magnesium, zinc and aluminum.
Contact with water may result in the slow formation of hydrochloric acid.
Attacks natural rubber.
Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
Use water delivered as a fine spray to control fire and cool adjacent area.
Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protected location.
If safe to do so, remove containers from path of fire.



Fire Diamond

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb spill with sand, earth, inert material or vermiculite.
Wipe up. Place in a suitable labeled container for waste disposal.
Large Spills: Clear area of personnel and move upwind.
Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
Increase ventilation.
No smoking or bare lights within area.
Stop leak if safe to do so.
Contain and absorb spill with sand, earth, inert material or vermiculite.
Collect and seal in labeled drums for disposal.
If contamination of drains or waterways occurs, advise emergency services.
After clean-up operations, decontaminate and launder all protective clothing and equipment before storing and reusing.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid all personal contact, including inhalation.
Wear protective clothing when risk of overexposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
DO NOT allow material to contact humans, exposed food or food utensils.
Avoid smoking, bare lights or ignition sources. When handling, DO NOT eat, drink or smoke. Avoid contact with incompatible materials.
Keep containers securely sealed when not in used. Avoid physical damage to containers. Always wash hands with soap and water after handling. Working clothes should be laundered separately.
Launder contaminated clothing before reuse.
Observe manufacturer's storing/handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.
Recommended Storage Methods: Inhibited grades may be stored in metal drums.
DO NOT use aluminum or galvanized containers. Check that containers are clearly labeled and free from leaks.
Packaging as recommended by manufacturer.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Local exhaust ventilation usually required.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection. NIOSH-approved self contained breathing apparatus (SCBA) may be required in some situations.
Provide adequate ventilation in warehouse or closed storage area.

Personal Protective Clothing/Equipment

Eyes: Safety glasses with side shields; chemical goggles. Full face shield.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: PVA gloves. Polyethylene gloves.
Viton gloves.
PVC boots.

Respiratory Protection:
Exposure Range >100 to <1000 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range 1000 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Note: odor threshold unknown

Other: Overalls. Eyewash unit. Barrier cream. Skin cleansing cream.

Glove Selection Index:

PE/EVAL/PE	A
PVA	A
TEFLON	A
VITON	B
VITON/NEOPRENE	C
VITON/NITRILE	C
HYPALON	C
NEOPRENE	C
PVC	C
NITRILE	C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless liquid with a sweetish, chloroform-like odor, miscible with most organic solvents.

Physical State: Liquid
Vapor Pressure (kPa): 7.87 at 20 °C
Vapor Density (Air=1): 4.54
Formula Weight: 131.38
Specific Gravity (H_2O=1, at 4 °C): 1.47 at 15 °C
Water Solubility: < 1 mg/mL at 21 °C

pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: 87 °C (189 °F)
Freezing/Melting Point Range: -73 °C (-99.4 °F)
Volatile Component (% Vol): 100

Section 10 - Stability and Reactivity

Stability/Polymerization: Decomposes in the presence of moisture to produce corrosive acid.
Product is considered stable under normal handling conditions. Hazardous polymerization will not occur.

Storage Incompatibilities: Avoid storage with strong oxidizers (particularly oxygen in gas or liquid form and nitrogen dioxide), strong bases, acetone, sodium/sodium-potassium alloys, magnesium, zinc and aluminum.
Avoid contact with water as the slow formation of hydrochloric acid results.
Attacks natural rubber.
Haloalkenes are highly reactive. Some of the more lightly substituted lower members are highly flammable; many members of the group are peroxidizable and polymerizable.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (human) LD_{Lo}: 7000 mg/kg
Oral (man) TD_{Lo}: 2143 mg/kg
Oral (rat) LD_{50}: 5650 mg/kg
Inhalation (man) LC_{Lo}: 2900 ppm
Inhalation (human) TD_{Lo}: 812 mg/kg
Inhalation (human) TC_{Lo}: 6900 mg/m^3/10 m
Inhalation (man) TC_{Lo}: 2900 ppm
Inhalation (man) TC_{Lo}: 110 ppm/8h
Inhalation (man) TC_{Lo}: 160 ppm/83 m

IRRITATION
Skin (rabbit): 500 mg/24h - SEVERE
Eye (rabbit): 20 mg/24h - SEVERE

See NIOSH, *RTECS* KX 4550000, for additional data.

Section 12 - Ecological Information

Environmental Fate: No data found.
Ecotoxicity: LC_{50} Sheepshead minnow 20 mg/l/96 hr. /Conditions of bioassay not specified; LC_{50} Mexican axolotl (3-4 wk after hatching) 48 mg/l/48 hr /Conditions of bioassay not specified; LC_{50} Clawed toad (3-4 wk after hatching) 45 mg/l/48 hr /Conditions of bioassay not specified; LC_{50} Pimephales promelas (fathead minnow) 40.7 mg/l/96 hr (95% confidence limits 31.4-71.8 mg/l) /Flow-through test; EC_{10} Pimephales promelas (fathead minnow) 15.2 mg/l/24 hr; 16.9 mg/l/48 hr; 15.5 mg/l/72 hr; 13.7 mg/l/96 hr; Toxic effect for all concentrations specified: loss of equilibrium: /Flow-through bioassay; Toxicity Threshold (Cell Multiplication Inhibition Test) Scenedesmus quadricauda(green algae) >1000 mg/l /Time not specified, conditions of bioassay not specified; Toxicity Threshold (Cell Multiplication Inhibition Test) Pseudomonas putida (bacteria) 65 mg/l ; LC_{50} Grass shrimp 2 mg/l/96 hr. /Conditions of bioassay not specified
Henry's Law Constant: 1 x10^{-2}
BCF: bluegill 17 to 39
Biochemical Oxygen Demand (BOD): 0%, 20 days
Octanol/Water Partition Coefficient: log K_{ow} = 2.29
Soil Sorption Partition Coefficient: K_{oc} = 2.0

Section 13 - Disposal Considerations

Disposal: Recycle wherever possible. Consult manufacturer for recycling options.
Follow applicable federal, state, and local regulations.
Reclaim solvent at an approved site.
Evaporate or incinerate residue at an approved site.
Recycle containers if possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: TRICHLOROETHYLENE **Additional Shipping Information:**
Hazard Class: 6.1(b)
ID No.: 1710
Packing Group: III
Label: Harmful[6]

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U228 Toxic Waste
CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4); per RCRA Section 3001; per CWA Section 307(a) 100 lb (45.35 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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Material Safety Data Sheet Collection
Genium Publishing Corp.
1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

1,1,1-Trichloroethane
MSDS 311
MET2840

Section 1 - Chemical Product and Company Identification 54

Material Name: 1,1,1-Trichloroethane
CAS Number: 71-55-6
Chemical Formula: $C_2H_3Cl_3$
Structural Chemical Formula: CH_3CCl_3
Synonyms: AEROTHENE MM; AEROTHENE TT; ALGYLEN; ALPHA-T; BALTANA; CF 2; CHLOROETENE; CHLOROETHANE-NU; CHLOROETHENE; CHLOROETHENE NU; CHLOROFORM,METHYL-; CHLOROTENE; CHLOROTHANE NU; CHLOROTHENE; CHLOROTHENE (INHIBITED); CHLOROTHENE NU; CHLOROTHENE SM; CHLOROTHENE VG; CHLOROTHENE(INHIBITED); CHLORTEN; CHLORTHANE-NU; CHLORYLEN; DOWCLENE LS; ETHANA NU; ETHANE,1;1,1-TRICHLORO-; GEMALGENE; GENKLENE; ICI-CF 2; INHIBISOL; METHYL CHLOROFORM; METHYLCHLOROFORM; METHYLTRICHLOROMETHANE; SOLVENT 111; STROBANE; TAFCLEAN; 1,1,1-TCE; TCEA; 1,1,1-TRICHLOORETHAAN; 1,1,1-TRICHLORAETHAN; TRICHLORAN; 1,1,1-TRICHLOROETHANE; ALPHA-TRICHLOROETHANE; TRICHLORO-1,1,1-ETHANE; TRICHLOROETHANE; 1,1,1-TRICHLOROETHANE (STABILIZED); TRICHLOROMETHYLMETHANE; 1,1,1-TRICLOROETANO; TRIELENE; TRI-ETHANE
General Use: Used as a solvent for metal degreasing and vapor degreasing. Used in pesticides, some protective coatings, adhesives and cements, polishes, printing inks. Component of so called "safety" i.e. (nonflammable) solvents. Material is highly volatile and may quickly form concentrated atmosphere in confined or unventilated area. Vapor is heavier than air and may displace and replace air in breathing zone, acting as a simple asphyxiant. This may happen with little warning of overexposure.
The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
1,1,1-trichloroethane	71-55-6	>94

OSHA PEL
TWA: 350 ppm; 1900 mg/m^3.

OSHA PEL Vacated 1989 Limits
TWA: 350 ppm; 1900 mg/m^3;
STEL: 450 ppm; 2450 mg/m^3.

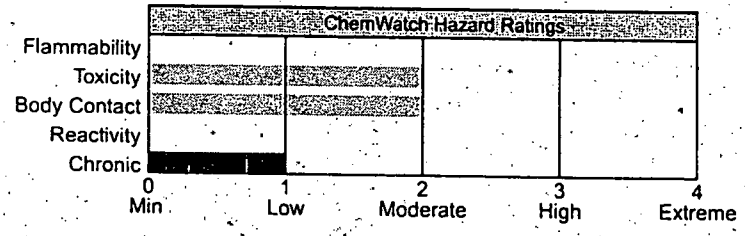
ACGIH TLV
No data found.

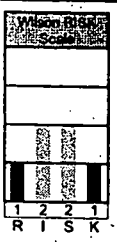
NIOSH REL
STEL: 350 ppm; 1900 mg/m^3; 15-minute.

IDLH Level
700 ppm.

DFG (Germany) MAK
TWA: 200 ppm; 1080 mg/m^3.

Section 3 - Hazards Identification





Fire Diamond

ANSI Signal Word
Caution

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless liquid with a sweet odor. Irritating to eyes/skin/respiratory tract. Also causes: headache, dizziness, incoordination; mild liver and kidney dysfunction may occur. Vapor will burn with a strong ignition source.

Potential Health Effects

Primary Entry Routes: inhalation, skin contact
Target Organs: skin, eyes, central nervous system (CNS), cardiovascular system
Acute Effects

Inhalation: The vapor is mildly discomforting to the upper respiratory tract.
Inhalation hazard is increased at higher temperatures.
Anesthetic and narcotic effects (with dulling of senses and odor fatigue) are a consequence of exposure to chlorinated solvents.
Individual response varies widely; odor may not be considered objectionable at levels which quickly induce central nervous system effects.
High vapor concentrations may give a feeling of euphoria. This may result in reduced responses, followed by rapid onset of unconsciousness, possible respiratory arrest and death.
Acute intoxication by halogenated aliphatic hydrocarbons appears to take place over two stages. Signs of a reversible narcosis are evident in the first stage and in the second stage signs of injury to organs may become evident. A single organ alone is (almost) never involved.
WARNING: Odor is not considered objectionable at levels likely to result in central nervous system effects (500-1000 ppm).
If the odor is strong, leave the area promptly; ventilate well before returning. Avoid becoming a casualty.
Perception of odor may decline after several hours of exposure (olfactory fatigue).
Sensitive humans may experience anesthetic effects from short exposures at 800-1000 ppm. These effects readily occur at concentrations of 2000 ppm or greater. Numerous deaths due to depression of the nervous system, control of respiration, and/or fatal cardiac arrhythmia have been reported following inhalation. Autopsy has revealed intracerebral hemorrhage and passive congestion of the brain. Use in clinical anaesthesiology confirms the cardiotoxicity of 1,1,1-trichloroethane. Volunteers exposed to 200 ppm or 400 ppm for 4 hours on two occasions (with six day separation between each) exhibited increases in reaction time and average body sway. In a further study male subjects repeatedly exposed at 350 ppm showed impaired reaction time, perceptual speed and manual dexterity.

Eye: The liquid is highly discomforting to the eyes and is capable of causing pain and severe conjunctivitis.
Corneal injury may develop, with possible permanent impairment of vision, if not promptly and adequately treated.
The vapor is discomforting to the eyes.
The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

Skin: The liquid is discomforting to the skin and may cause drying of the skin, which may lead to dermatitis.
Toxic effects may result from skin absorption.
Bare unprotected skin should not be exposed to this material. The material may accentuate any pre-existing skin condition.
The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.

Ingestion: The liquid is highly discomforting and toxic if swallowed.
Ingestion may result in nausea, pain, vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis.
Considered an unlikely route of entry in commercial/industrial environments.

Carcinogenicity: NTP - Not listed; IARC - Group 3, Not classifiable as to carcinogenicity to humans; OSHA - Not listed; NIOSH - Not listed; ACGIH - Class A4, Not classifiable as a human carcinogen; EPA - Class D, Not classifiable as to human carcinogenicity; MAK - Not listed.

Chronic Effects: Prolonged or continuous skin contact with the liquid may cause defatting with drying, cracking, irritation and dermatitis following.
Toxic effects are increased by consumption of alcohol.
In a study conducted on workers exposed to 1,1,1-trichloroethane for periods ranging from several months to 6 years no adverse effects was noted when compared with a matched control group. Exposures for some workers exceeded 200 ppm during the study period.
Chronic exposure may result in liver and kidney damage.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.
Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).

Wash affected areas thoroughly with water (and soap if available).
Seek medical attention in event of irritation.

Ingestion: Contact a Poison Control Center.
Do NOT induce vomiting. Give a glass of water.
Avoid giving milk or oils.
Avoid giving alcohol.

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

Note to Physicians: For acute or short-term repeated exposure to 1,1,1-trichloroethane:
1.Do not administer sympathomimetic drugs as they may cause ventricular arrhythmias.
2. Institute prompt supportive measures to combat CNS depression.
3.An adequate title volume of 10-15 mL/kg body weight should be maintained.
4.For ingestion consider gastric lavage. A cuffed endotracheal tube, to protect airway, should be used if lavage given.
5. Consider activated charcoal approx 30 -50 gram in water slurry to follow lavage. Material is a GI tract irritant and a cathartic. Consider standard cathartic to hasten elimination.

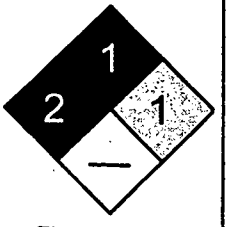
BIOLOGICAL EXPOSURE INDEX - BEI
These represent the determinants observed in specimens collected from a healthy worker exposed at Exposure Standard (ES or TLV):

Determinant	Index	Sampling Time	Comments
Trichloroethane in end-exhaled air	40 ppm	Prior to last shift of work-week	
Trichloroacetic acid in urine	10 mg/L	End of work-week	NS,SQ
Total trichloroethanol in urine	30 mg/L	End of shift at end of work-week	NS,SQ
Total trichloroethanol in blood	1 mg/m	End of shift at end of work-week	NS

NS: Non-specific determinant; also seen after exposure to other materials
SQ: Semi-quantitative determinant - Interpretation may be ambiguous; should be used as a screening test or confirmatory test.

Section 5 - Fire-Fighting Measures

Flash Point: > 93.3 °C
Autoignition Temperature: 500 °C
LEL: 7.5% v/v
UEL: 12.5% v/v
Extinguishing Media: Water spray or fog; foam, dry chemical powder, or BCF (where regulations permit).
Carbon dioxide.



Fire Diamond

General Fire Hazards/Hazardous Combustion Products: Nonflammable liquid. However vapor will burn when in contact with high temperature flame. Ignition ceases on removal of flame.
May form a flammable/explosive mixture in an oxygen enriched atmosphere. Heating may cause expansion/vaporization with violent rupture of containers. Decomposes on heating and produces corrosive fumes of hydrochloric acid, carbon monoxide and small amounts of toxic phosgene.

Fire Incompatibility: Avoid reaction with strong oxidizing agents (particularly oxygen in gas or liquid form and nitrogen dioxide), strong bases, sodium and sodium-potassium alloys. Powdered metals; magnesium, zinc and aluminum.
Contact with water may result in the slow formation of hydrochloric acid.
Attacks natural rubber.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
Use water delivered as a fine spray to control fire and cool adjacent area.
Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.

Cool fire-exposed containers with water spray from a protected location.
If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb spill with sand, earth, inert material or vermiculite.
Wipe up. Place in a suitable labeled container for waste disposal.
Large Spills: Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
No smoking, bare lights or ignition sources. Increase ventilation.
Stop leak if safe to do so.
Water spray or fog may be used to disperse/absorb vapor.
Contain or absorb spill with sand, earth or vermiculite.
Collect recoverable product into labeled containers for recycling.
Collect solid residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains.
After clean-up operations, decontaminate and launder all protective clothing and equipment before storing and reusing.
If contamination of drains or waterways occurs, advise emergency services.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid all personal contact, including inhalation.
Wear protective clothing when risk of overexposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
DO NOT allow material to contact humans, exposed food or food utensils.
Avoid smoking, bare lights or ignition sources. When handling, DO NOT eat, drink or smoke. Avoid contact with incompatible materials.
Keep containers securely sealed when not in used. Avoid physical damage to containers. Always wash hands with soap and water after handling. Working clothes should be laundered separately.
Launder contaminated clothing before reuse.
Use good occupational work practices. Observe manufacturer's storing/handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.
Recommended Storage Methods: Glass bottle. Inhibited grades may be stored in metal drums.
DO NOT use aluminum or galvanized containers.
Check that containers are clearly labeled.
Packaging as recommended by manufacturer.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area.
General exhaust is adequate under normal operating conditions.
Local exhaust ventilation may be required in specific circumstances.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection.
Provide adequate ventilation in warehouse or closed storage areas.
Personal Protective Clothing/Equipment
Eyes: Safety glasses with side shields; chemical goggles. Full face shield.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.
Hands/Feet: Butyl rubber gloves; Neoprene gloves.
Safety footwear.
Respiratory Protection:
Exposure Range >350 to <700 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range 700 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Note: poor warning properties
Other: Overalls. Eyewash unit. Barrier cream. Skin cleansing cream.

Glove Selection Index:

PE/EVAL/PE	A
PVA	A
VITON	A
TEFLON	A
NITRILE+PVC	C
PVDC/PE/PVDC	C
BUTYL	C
HYPALON	C
NITRILE	C
PVC	C
NEOPRENE	C
NATURAL RUBBER	C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless, highly volatile liquid. Miscible in most organic solvents. Mild chloroform-like odor.

Physical State: Liquid
Vapor Pressure (kPa): 14 at 20 °C
Vapor Density (Air=1): 4.6
Formula Weight: 133.42
Specific Gravity (H_2O=1, at 4 °C): 1.34 at 20 °C
Water Solubility: 0.4% by weight
Evaporation Rate: 12.8 (n-(BuAc=1)

pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: 74 °C (165 °F) at 760 mm Hg
Freezing/Melting Point Range: -30.4 °C (-22.72 °F)
Volatile Component (% Vol): 100
Decomposition Temperature (°C): 260

Section 10 - Stability and Reactivity

Stability/Polymerization: Product is considered stable. Hazardous polymerization will not occur.
Storage Incompatibilities: Avoid storage with strong oxidizers (particularly oxygen in gas or liquid form and nitrogen dioxide), strong bases, acetone, sodium and sodium-potassium alloys, magnesium, zinc and aluminum.
Avoid contact with water as the slow formation of hydrochloric acid results.
Attacks natural rubber.
Aerosols containing this material must not be packed in aluminum

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (human) TD_{Lo}: 670 mg/kg
Oral (rat) LD_{50}: 10300 mg/kg
Inhalation (human) TC_{Lo}: 920 ppm/70 min
Inhalation (man) LC_{Lo}: 27000 mg/m^3/10m
Inhalation (man) TC_{Lo}: 200 ppm/4 hr
Inhalation (man) TC_{Lo}: 350 ppm
Inhalation (rat) LC_{50}: 18000 ppm/4h
Dermal (rabbit) LD_{Lo}: 1000 mg/kg

IRRITATION
Skin (rabbit): 20 mg/24 hr moderate
Skin (rabbit): 5000 mg/12 d-I mild
Eye (man): 450 ppm/8 hr
Eye (rabbit): 2 mg/24 hr SEVERE
Eye (rabbit): 100 mg mild

See NIOSH, *RTECS* KJ 2975000, for additional data.

Section 12 - Ecological Information

Environmental Fate: Releases to surface water will decrease in concentration almost entirely due to evaporation. Spills on land will decrease in concentration almost entirely due to volatilization and leaching. Releases to air may be transported long distances and partially return to earth in rain. In the troposphere, it will degrade very slowly by photooxidation and also slowly diffuse to the stratosphere where photodegradation will be rapid.
Ecotoxicity: LC_{50} Poecilia reticulata (guppy) 133 ppm/7 day /Conditions of bioassay not specified; EC_{50} Pimephales promelas (fathead minnow) 28.8 mg/l/96 hr (confidence limit 23.0 -36.2 mg/l), flow-through bioassay with measured concentrations, 25.6 °C, dissolved oxygen 6.5 mg/l, hardness 46.4 mg/l $CaCO_3$, alkalinity 42.6 mg/l $CaCO_3$, and pH 7.99
Henry's Law Constant: 8×10^{-3}
BCF: bluegills 28
Octanol/Water Partition Coefficient: log K_{ow} = 2.49
Soil Sorption Partition Coefficient: K_{oc} = 183

Section 13 - Disposal Considerations

Disposal: Recycle wherever possible. Consult manufacturer for recycling options.
Follow applicable federal, state, and local regulations.
Reclaim solvent at an approved site.
Evaporate or incinerate residue at an approved site.
Recycle containers if possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: 1,1,1-TRICHLOROETHANE
Hazard Class: 6.1(b)
ID No.: 2831
Packing Group: III
Label: Harmful[6]

Additional Shipping Information: METHYLCHLOROFORM

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U226 Toxic Waste
CERCLA 40 CFR 302.4: Listed per RCRA Section 3001; per CWA Section 307(a) 1000 lb (453.5 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

Disclaimer: Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Material Safety Data Sheet Collection
Genium Publishing Corp.
1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

Vinyl Chloride
MSDS 382
VIN2980

Section 1 - Chemical Product and Company Identification 54

Material Name: Vinyl Chloride
CAS Number: 75-01-4
Chemical Formula: C_2H_3Cl
Structural Chemical Formula: CH_2=CHCl
Synonyms: CHLORETHENE; CHLOROETHYLENE; CHLOROETHYLENE; CHLORURE DE VINYLE; CLORURO DI VINILE; ETHENE,CHLORO-; ETHYLENE MONOCHLORIDE; ETHYLENE,CHLORO-; MONOCHLOROETHENE; MONOCHLOROETHYLENE; MONOCHOROETHENE; MONOVINYL CHLORIDE (MVC); TROVIDUR; VC; VCM; VINILE (CLORURO DI); VINYL C MONOMER; VINYL CHLORIDE; VINYL CHLORIDE MONOMER; VINYL CHLORIDE MONOMER (VCM); VINYL CHLORIDE,INHIBITED; VINYLCHLORID; VINYLE(CHLORURE DE); WINYLU CHLOREK
General Use: Used in the plastics industry; as a refrigerant; in organic syntheses

Section 2 - Composition / Information on Ingredients

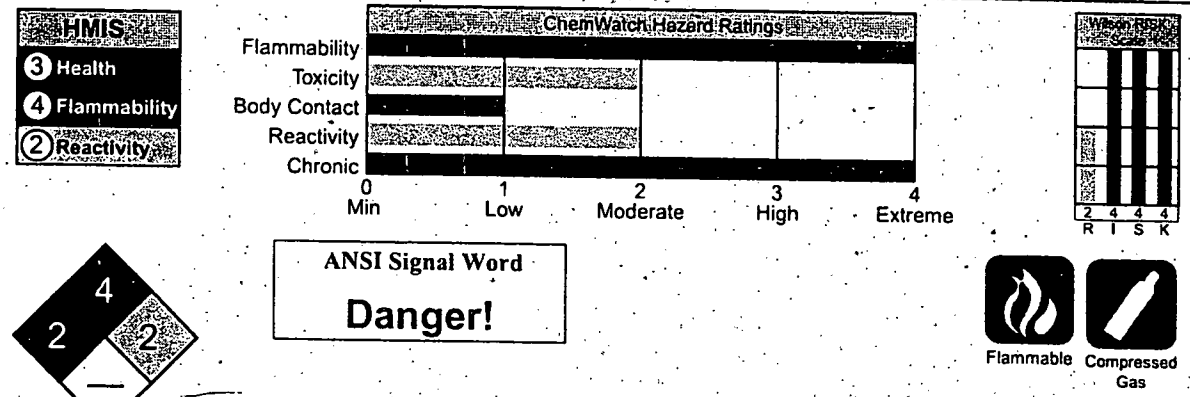
Name	CAS	%
vinyl chloride	75-01-4	>98

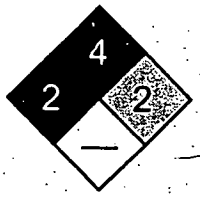
OSHA PEL
No data found.

NIOSH REL
No data found.

ACGIH TLV
No data found.

Section 3 - Hazards Identification





Fire Diamond

ANSI Signal Word
Danger!

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless gas; pleasant ethereal odor. Compressed gas can cause frostbite. Toxic. Also causes: CNS depression. Chronic: reproductive effects, skin/blood changes, arthralgias, bone effects (hand), vascular disorder (fingers/toes). Cancer hazard. Flammable

Potential Health Effects

Primary Entry Routes: inhalation, skin contact, eye contact
Target Organs: liver, central nervous system (CNS), respiratory system, lymphatic system, bone, connective tissue of the skin

Acute Effects

Inhalation: The gas is highly discomforting and may be fatal if inhaled.
Acute intoxication by halogenated aliphatic hydrocarbons appears to take place over two stages. Signs of a reversible narcosis are evident in the first stage and in the second stage signs of injury to organs may become evident. A single organ alone is (almost) never involved.

Depression of the central nervous system is the most outstanding effect of most halogenated aliphatic hydrocarbons. Inebriation and excitation, passing into narcosis, is a typical reaction. In severe acute exposures there is always a danger of death from respiratory failure or cardiac arrest due to a tendency to make the heart more susceptible to catecholamines (adrenalin).

A single 5 minute inhalation exposure of 8000-25000 ppm caused nausea, headache and dizziness among volunteers. After cessation of exposure only 3-5% of the parent compound was exhaled unchanged. Metabolism by microsomal cytochrome P-450 results in the production of chloroethylene oxide and 2-chloroacetaldehyde and subsequent urinary elimination as thiodiglycolic acid. Half-life is 4-5 hours.

Vinyl chloride and related vinyl monomers possess narcotic action and produce depending upon concentration, characteristic neurological effects, a state of euphoria, followed by a state of inebriation, similar to ethanol intoxication.

Exposure of mice, rats and guinea pigs at 100,000-300,000 ppm caused concentration-dependent mortality. Pulmonary edema, inflammation, hyperemia, congestion and engorgement were recorded - liver and kidney involvement was surprisingly low. Deaths were due to central arrest in narcosis.

Eye: The vapor is discomforting to the eyes and is capable of causing a mild, temporary redness of the conjunctiva (similar to wind-burn), temporary impairment of vision and/or other transient eye damage/ulceration.

Skin: The vapor is mildly discomforting to the skin.

Toxic effects may result from skin absorption.

Vinyl chloride acts upon the skin and produces a sensation of heat.

Vaporizing liquid causes rapid cooling and contact may cause cold burns, frostbite.

Ingestion: Not normally a hazard due to physical form of product.

Carcinogenicity: NTP - Class 1, Known to be a carcinogen; IARC - Group 1, Carcinogenic to humans; OSHA - Listed as a carcinogen; NIOSH - Listed as carcinogen; ACGIH - Class A3, Animal carcinogen; EPA - Listed; MAK - Class A1, Capable of inducing malignant tumors as shown by experience with humans.

Chronic Effects: Repeated exposure of laboratory animals to vinyl chloride produced little liver or kidney damage. Repeated exposures produce neurological effects in man with somnolence prominent. Dyspeptic disturbances include epigastric pain, swelling, discomfort, heaviness in the right hypochondrium and anorexia. Congestive hepatomegaly may mimic toxic hepatitis without jaundice. Some case become chronic. Allergic dermatitis and schleroderma and Raynaud's syndrome have been observed. Repeated exposure of workers has caused increased liver enzyme concentrations, restricted blood flow, bone degeneration in the fingers, liver and spleen enlargement, nervous system disturbance, CNS depression, decreased respiratory function and emphysema.

A dose-dependent relationship between exposure and the incidence of several tumor types has been established. Exposures to high concentrations have little additional effect because the action of metabolites is responsible for the carcinogenicity rather than the action of the parent molecule. Formation rates of the metabolites are limited and dose-dependent and once the enzyme systems responsible for vinyl chloride activation are saturated, greater doses do not produce a corresponding increase in tumor incidence. Reports of hepatic angiosarcoma and respiratory cancers in vinyl chloride workers have appeared over many years. Cancers of the respiratory system (primarily angiosarcoma), brain as well as lymphomas occur more often than might be expected among men occupationally exposed to vinyl chloride for at least one year.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.

Lay patient down. Keep warm and rested.

If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.

Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.

Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately flush body and clothes with large amounts of water, using safety shower if available.

Quickly remove all contaminated clothing, including footwear.

Wash affected areas with water (and soap if available) for at least 15 minutes. Transport to hospital or doctor.

In case of cold burns (frostbite): Bathe the affected area immediately in cold water for 10 to 15 minutes, immersing if possible and without rubbing.

Do not apply hot water or radiant heat. Apply a clean, dry dressing.

Transport to hospital or doctor.

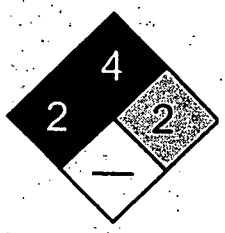
Ingestion: Not normally a hazard due to physical form of product. DO NOT delay. Immediately transport to hospital or doctor.

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

Note to Physicians: Treat symptomatically. Do not give adrenalin (epinephrine) or related drugs.

Section 5 - Fire-Fighting Measures

Flash Point: -78 °C Open Cup
Autoignition Temperature: 472 °C
LEL: 3.6% v/v
UEL: 33% v/v



Fire Diamond

Extinguishing Media: Dry chemical powder. DANGER: Deliver media remotely.
For minor fires: Flooding quantities only.
For large fires: Do not attempt to extinguish.
General Fire Hazards/Hazardous Combustion Products: WARNING: Long standing in contact with air and light may result in the formation of potentially explosive peroxides.
Liquid and vapor are highly flammable.
Dangerous hazard when exposed to heat or flame.
Severe vapor explosion hazard, when exposed to flame or spark.
Heating may cause expansion or decomposition leading to violent rupture of containers.
Decomposition may produce toxic fumes of hydrogen chloride.
Fire Incompatibility: Avoid reaction with copper, aluminum, oxidizing agents and certain catalytic impurities.
Explosion hazard may follow contact with incompatible materials. Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.
Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
Fight fire from a safe distance, with adequate cover.
May be violently or explosively reactive. Wear full body protective clothing with breathing apparatus. Consider evacuation.
If safe to do so, switch off electrical equipment until vapor fire hazard is removed.
If safe to do so, stop flow of gas.
Do not approach cylinders suspected to be hot.
Cool fire-exposed containers with water spray from a protected location.
Use water delivered as a fine spray to control the fire and cool adjacent area.
Given its high vapor density spilled vinyl chloride is slow to disperse and will collect in low lying areas.

Section 6 - Accidental Release Measures

Small Spills: Erect warning notices and seal off area.
1. Avoid breathing vapor and any contact with liquid or gas. Protective equipment including respirator should be used.
2. Do NOT enter confined spaces were gas may have accumulated.
3. Shut of all sources of possible ignition and increase ventilation.
4. Clear area of personnel.
5. Stop leak only if safe to so do.
6. Remove leaking cylinders to safe place. Release pressure under safe controlled conditions by opening valve.
7. Keep area clear of personnel until gas has dispersed.

Large Spills: Supply maximum air ventilation (explosion proof equipment) to keep concentration well below lower flammability limit.
1. Clear area of all unprotected personnel and move upwind.
2. Contact fire department and advise them of the location and nature of hazard.
3. May be violently or explosively reactive.
4. Wear full body clothing with breathing apparatus.
5. Consider evacuation.
6. Shut off all possible sources of ignition and increase ventilation.
7. No smoking or bare lights within area.
8. Use extreme caution to prevent violent reaction.
9. Stop leak only if safe to so do.
10. Water spray or fog may be used to disperse vapor.
11. Do NOT enter confined space where gas may have collected.
12. Keep area clear until gas has dispersed.

When leaking containers have been removed or leak has been stopped, hose spill area down with copious quantities of water. Allow any liquid to evaporate prior to wash down.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Used in closed pressurized systems, fitted with safety relief valve.
Vented gas is flammable, denser than air and will spread. Vent path must not contain ignition sources, pilot lights, bare flames.
Atmospheres must be tested and O.K. before work resumes after leakage.

Obtain a work permit before attempting any repairs.
Do not attempt repair work on lines, vessels under pressure.
Handle and open container with care.
Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
Avoid smoking, bare lights, heat or ignition sources.
When handling, DO NOT eat, drink or smoke.
Vapor may ignite on pumping or pouring due to static electricity.
DO NOT use plastic buckets. Ground and secure metal containers when dispensing or pouring product. Use spark-free tools when handling.
Avoid contact with incompatible materials.
Keep containers securely sealed. Avoid physical damage to containers.
Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.
DO NOT transfer gas from one cylinder to another.

Recommended Storage Methods: Check that containers are clearly labeled.
Cylinder fitted with valve protector cap.
Ensure the use of equipment rated for cylinder pressure.
Ensure the use of compatible materials of construction.
Cylinder valve must be closed when not in use or when empty.
Cylinder must be properly secured either in use or in storage.
WARNING: Suckback into cylinder may result in rupture.
Use back-flow preventive device in piping.
Aerosol pack.
Vacuum insulated container.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Fans and electrical equipment must be explosion-proof to meet TLV requirements. Approved respirators must be available for non-routine and emergency situations.
Areas where gas cylinders are stored/used require discrete, controlled exhaust ventilation.
Local exhaust ventilation usually required.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection. NIOSH-approved self contained breathing apparatus (SCBA) may be required in some situations.
Provide adequate ventilation in warehouse or closed storage area.

Personal Protective Clothing/Equipment

Eyes: Close fitting gas tight goggles and DO NOT wear contact lenses.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Neoprene rubber gloves.

Respiratory Protection:
Exposure Range >1 to 50 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range >50 to 1000 ppm: Supplied Air, Constant Flow/Pressure Demand, Full Face
Exposure Range >1000 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Note: poor warning properties

Other: Protective overalls, closely fitted at neck and wrist. Eye-wash unit.
IN CONFINED SPACES:
1: Non-sparking protective boots
2. Static-free clothing.

Glove Selection Index:
VITON.....A
NITRILE.....B

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: A colorless poisonous gas at ambient temperature, with a mild sweet odor in high concentrations. It liquefies readily under increased pressure or at reduced temperatures. Soluble in alcohol, ether, carbon tetrachloride and benzene.

Physical State: Liquefied gas
Vapor Pressure (kPa): 343.5 at 20 °C
Vapor Density (Air=1): 2.2
Formula Weight: 62.5
Specific Gravity (H_2O=1, at 4 °C): 0.912 at 20 °C
Water Solubility: Slightly soluble
Evaporation Rate: Not applicable
pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: -13.37 °C (8 °F)
Freezing/Melting Point Range: -153.8 °C (-244.84 °F)
Volatile Component (% Vol): 100

Section 10 - Stability and Reactivity

Stability/Polymerization: Presence of heat source and direct sunlight (ultra-violet radiation).
Presence of elevated temperatures.
Presence of an ignition source.
Storage in unsealed containers.
Stable under normal storage conditions. Polymerization may occur at elevated temperatures and in the presence of ignition sources.

Storage Incompatibilities: Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.
Avoid peroxides, copper and copper alloys and plastics.
Haloalkenes are highly reactive. Some of the more lightly substituted lower members are highly flammable; many members of the group are peroxidizable and polymerizable.
If peroxidation occurs, vinyl chloride tends to self-polymerize violently and this has resulted in several industrial accidents.
Accidental exposure of the recovered monomer to atmospheric oxygen for a long period resulted in the formation of an unstable polyperoxide which initiated explosion. A 20-30% aqueous solution has been used to destroy the peroxide.
An explosion in a valve in a liquid monomer line appears to have been caused by traces of nitrogen oxides remaining after passivation of the line by nitric acid.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (rat) LD_{50}: 500mg/kg
Oral (rat) TD_{Lo}: 3463mg/kg/52w
Inhalation (rat) TC_{Lo}: 1ppm/4h/52w
Inhalation (man) TC_{Lo}: 200ppm/14y
Tumors of the sense organs, vascular system, respiratory system, gastrointestinal system, skin and liver, lymphoma, paternal effects, effects on fertility, fetotoxicity, specific developmental abnormalities involving the musculoskeletal system recorded.

IRRITATION
Nil reported

See NIOSH, *RTECS* YZ 3200000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released to soil, it will be subject to rapid volatilization with reported half-lives of 0.2 and 0.5 days for evaporation from soil at 1 and 10 cm incorporation, respectively. Any which does not evaporate will be expected to be highly to very highly mobile in soil and it may leach to the groundwater. It may be subject to biodegradation under anaerobic conditions such as exists in flooded soil and groundwater. If released to water, it will not be expected to hydrolyze, to bioconcentrate in aquatic organisms or to adsorb to sediments. It will be subject to rapid volatilization with an estimated half-life of 0.805 hr for evaporation from a river 1 m deep with a current of 3 m/sec and a wind velocity of 3 m/sec. In waters containing photosensitizers such as humic acid, photodegradation will occur fairly rapidly. Limited existing data indicate that it is resistant to biodegradation in aerobic systems and therefore, it may not be subject to biodegradation in aerobic soils and natural waters. It will not be expected to hydrolyze in soils or natural waters under normal environmental conditions. If released to the atmosphere, it can be expected to exist mainly in the vapor-phase in the ambient atmosphere and to degrade rapidly in air by gas-phase reaction with photochemically produced hydroxyl radicals with an estimated half-life of 1.5 days.
Ecotoxicity: No data found.
Henry's Law Constant: 0.0560
BCF: estimated at 7
Biochemical Oxygen Demand (BOD): none
Octanol/Water Partition Coefficient: log K_{ow} = calculated at 0.6
Soil Sorption Partition Coefficient: K_{oc} = estimated at 56

Section 13 - Disposal Considerations

Disposal: The gas should be burned in a high temperature furnace equipped with an afterburner and scrubber to remove HCl formed.
Follow applicable federal, state, and local regulations.
Return all damaged and empty cylinders and containers to the supplier.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: VINYL CHLORIDE, INHIBITED OR STABILISED
Hazard Class: 2.1
ID No.: 1086
Packing Group: None
Label: Flammable Gas[2]

Additional Shipping Information:

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U043 Toxic Waste
CERCLA 40 CFR 302.4: Listed per RCRA Section 3001; per CWA Section 307(a); per CAA Section 112 1 lb (0.454 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date: .....1999-11 **Review Date:** 2000-07

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ATTACHMENT B
SAFETY MEETING FORM

BBL DAILY SAFETY MEETING LOG

PROJECT: _____ LOCATION: _____

DATE/TIME: _____ ACTIVITY: _____

1. Work Summary

2. Physical Chemical Hazards

3. Protective Equipment/Procedures

4. Emergency Procedures

5. Signatures of Attendees	

ATTACHMENT C
INCIDENT PREVENTION OBSERVATION

ATTACHMENT D
INCIDENT NEAR MISS INVESTIGATION OBSERVATION

BBL Incident Prevention Observation

Observer Name	Observer Title	Contractor Company Name

Date _____ Time ____ ☐ AM ☐ PM	Project Type / Task Observed

Background Information and Miscellaneous Comments

Observer's Positive Comments

Feedback Conducted By		Date		Time	☐ AM ☐ PM

Conclusion (Describe in Detail Why the Questionable Item Occurred). Add Any Employee Comments

Root Cause(s) Analysis (RCA):

1. Lack of skill or knowledge
2. Lack of or inadequate operational procedures or work standards
3. Inadequate communication of expectations regarding procedures or work standards
4. Inadequate tools or equipment
5. Correct way takes more time and/or requires more effort
6. Short-cutting standard procedures is positively reinforced or tolerated
7. Person thinks there is no personal benefit to always doing the job according to standards
8. Uncontrollable.

Questionable Item #	RCA #	Solution(s): How to Prevent Questionable Behavior From Reoccurring	Person Responsible	Due Date	Closure Date

Results of Solution Verification and Validation

Reviewed by	Date	Reviewed by	Date

Environmental Operations

	PRE-TASK PREPARATION	Correct	Questionable	Comments
1.	Health and Safety Plan / MSDSs on site			
2.	Employee familiar / trained on task			
3.	OSHA-required training/medical surveillance			
4.	Utility mark out / check performed			
5.	Traffic hazard addressed / work area marked			
6.	Walking / working surfaces free of hazards			
7.	Tailgate safety meeting performed			
8.	SPSA performed prior to beginning work			
9.	Communicates intentions to other personnel			
10.	Knowledge of emergency procedures			
11.	Distance between equipment and power lines			
12.	Personal protective equipment			
13.	Air monitoring equipment on site, calibrated			
14.	First aid kit / fire extinguisher on site			
15.	One person trained in first aid / CPR			
16.	Work zones established and marked			
	PERFORMING TASK			
17.	SPSA before beginning new task			
18.	Correct body positioning			
19.	Proper lifting / pushing / pulling techniques			
20.	Keep hands / body away from pinch points			
21.	Walking / working surfaces kept clear of debris			
22.	Faces traffic as appropriate			
23.	Vehicles/ barricades to protect against traffic			
24.	Drill rig located properly, blocked / chocked			
25.	Drill rig moved only with derrick lowered			
26.	Excavator located on stable ground			
27.	Eye contact made with equipment operator			
28.	Spoil at least 2 feet back from edge of excavation			
29.	Excavation shored/sloped/benched			
30.	Excavation entry controlled			
31.	Equipment/tools used properly			
32.	Electrical equipment connected through GFCI			
33.	Power tools handled properly			
34.	Electrical cords inspected / in good condition			
35.	Follows lockout / tagout procedures			
36.	Air monitoring conducted/action levels understood			
37.	Equipment decontaminated properly			
38.	Personnel decon prior to eating/drinking/smoking			
39.	Decontamination effective			
	POST – TASK			
40.	Procedures / JSA adequate			
41.	Equipment / tools stored properly			
42.	Proper storage of soil / water / waste material			
43.	Work area secured			
44.	Other			
	Total #			**% Safe:** [(Total Correct/(Total Correct + Total Questionable)) * 100]

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

Incident/Near-Miss Investigation Report

☐ OSHA Recordable	☐ First Aid Injury	☐ Fire	Date of Incident:
☐ Lost Workday Injury	☐ Vehicle Accident	☐ Spill/Leak	
☐ Restricted Duty Injury	☐ Equipment Damage	☐ Near Miss	Incident Number:

Every employee injury, accident, and near miss must be reported within twenty-four hours of the injury. If the incident results in hospitalization, an immediate report must be made by telephone to the Project Manager and the Health and Safety Officer.

Project Information

Project Name:	Project #
Location of Incident:	

EMPLOYEE

Name:	Employee Number:
Employment Status: ☐ Regular ☐ Part Time	How long in present job?

INJURY OR ILLNESS INFO

Where did incident / near miss occur? (number, street, city, state, zip):

Employee's specific activity at the time of the incident / near miss:

Equipment, materials, or chemicals the employee was using when the incident / near miss occurred (e.g., the equipment employee struck against or which struck employee; the vapor inhaled or material swallowed; what the employee was lifting, pulling, etc.):

Describe the specific injury or illness (e.g., cut, strain, fracture, etc.):

Body part(s) affected (e.g., back, left wrist, right eye, etc.):

Name and address of treatment provider (e.g., physician or clinic):	Phone No.:
If hospitalized, name and address of hospital:	Phone No.:

Date of injury or onset of illness / /	Time of event or exposure: ☐ AM ☐ PM

Did employee miss at least one full shift's work? ☐ No ☐ Yes, 1st date absent (MM/DD/YYYY) / /

Has employee returned to work? ☐ Regular work ☐ Restricted work ☐ No

☐ Yes, date returned (MM/DD/YYYY) / /

To whom reported:	Other workers injured/made ill in this event? ☐ Yes ☐ No

Description of Incident / Near Miss: (Describe what happened and how it happened.)

Motor Vehicle Accident (MVA)

Company Vehicle? ☐ Yes ☐ No

Accident Location (street, city, state)									
Vehicle Towed?	☐ Yes ☐ No	Other Vehicle?	☐ Yes ☐ No	# Vehicles Towed		# of Injuries			

Spill

Material Spilled	Quantity	Source
Agency Notifications		

Cost of Incident $

Third Party Incidents

Name of Owner		Address	Telephone
Description of Damage:			
Witness Name		Address	Telephone
Witness Name		Address	Telephone

Root Cause and Contributing Factors: Conclusion (Describe in Detail Why Incident / Near Miss Occurred)

1	
2	
3	
4	
5	

Root Cause(s) Analysis (RCA):

1. Lack of skill or knowledge
2. Lack of or inadequate operational procedures or work standards
3. Inadequate communication of expectations regarding procedures or work standards
4. Inadequate tools or equipment
5. Correct way takes more time and/or requires more effort
6. Short-cutting standard procedures is positively reinforced or tolerated
7. Person thinks there is no personal benefit to always doing the job according to standards
8. Uncontrollable

#	RCA #	Solution(s): How to Prevent Incident / Near Miss From Reoccurring	Person Responsible	Due Date	Closure Date

Investigation Team Members

Name	Job Title	Date

Results of Solution Verification and Validation

Reviewed By

Name	Job Title	Date
	Project Manager	
	Health and Safety Reviewer	

ATTACHMENT E
AIR MONITORING FORM

DAILY AIR MONITORING LOG

Project: **Date:**

Monitoring Instruments:

Air Monitor: **Activity:**

Level of Protection:

Time	Location	Instrument Reading	Comments

ATTACHMENT F
DAILY PROJECT REPORT

BBL
BLASLAND, BOUCK & LEE, INC.
engineers & scientists

DAILY PROJECT REPORT

	DAY: DATE:
	NAME:
	SIGNATURE:
ACTIVITIES PERFORMED:	
	TOTAL:____HOURS
	CHECKED BY:

ATTACHMENT G
INCIDENT PREVENTION OBSERVATIONS FOR SELECT JOBS

Job Safety Analysis

JSA Type: ☒ SAR Operations ☐ Transport ☐ Office ☐ Construction	☒ New ☐ Revised	Date: 03/30/00
Co: Dept: Div: Org Unit: Loc:		
Work Type: Environmental	Work Activity: Soil Boring/Monitoring Well Installation	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, steel-toed and shank boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HSP). Also refer to the HSP for required traffic control, air monitoring, and emergency procedures.

Development Team	Position/Title	Reviewed By	Position/Title	Date

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each work day. Safe Performance Self Assessment (SPSA) procedures must be used during field activities. Also consider weather conditions (heat, cold, rain, lightning).

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
Clear drilling locations.	Traffic hazards, overhead and underground installations, product releases, property damage, dealer inconvenience	Reference Borehole Clearance Review form and coordinate with Station Manger (or designee) to minimize potential conflicts. Review proposed locations against available construction drawings and known utilities, tanks, product lines, etc. Mark out the proposed borehole locations. Call underground utility locating service for public line location clearance, and get list of utilities being contacted. If necessary, coordinate private line locator for private property.
Mobilize with proper equipment/supplies for drilling.	Vehicle accident. Lifting hazards. Delay or improper performance of work due to improper equipment onsite.	Follow safe driving procedures. Use proper lifting techniques. Verify that subcontractors are aware of their responsibilities for labor, equipment and supplies. Review HSP and permit conditions, and gather necessary PPE.
Visually clear proposed drilling locations.	Underground and overhead utilities/obstructions.	Complete Pre-Mobilization section of Borehole Clearance Review form and adjust drilling locations as necessary.
Set up necessary traffic control.	Struck by vehicle during placement. Vehicle accident as a result of improper traffic control equipment placement.	Use buddy system for placing traffic control. Reference traffic control plan section of HSP (may include specific requirements based on permits).
Assist with set up of drill rig.	Vehicle accident during rig movement. Damage caused by drill rig while accessing set-up location. Overhead utilities and structures. Soft terrain. Rig movement.	Verify clear pathway to drilling location and clearance for raising mast. Provide as-needed hand signals and guidance to driver to place rig. Visually inspect rig (fire extinguisher on board, no oil or other fluid leaks, cabling and associated equipment in good condition, pressurized hoses secured with whip-checks or adequate substitute, jacks in good condition?). If necessary, use wooden blocks under jacks to spread load. Chock wheels.
Set up exclusion zone(s) and work stations (drilling and logging/sample collection).	Struck by vehicle. Slip/fall hazards.	Implement exclusion zone set-up instructions of HSP. Set up work stations with clear walking paths to and from rig.
Clear upper five feet of borehole using post-hole digger or bucket auger.	Back strain, exposure to chemical hazards, hitting an underground utility, repetitive motion.	Don any additional PPE and initiate air quality monitoring in accordance with the HSP. Use proper lifting techniques and tools. Complete the Pre-Drilling section of the Borehole Clearance Review form.

Commence drilling borehole.	Cross-contamination from previous hole. back strain, heat or cold, eye injury, exposure to chemical hazards, hitting an underground utility, trip and fall, equipment failure, lifting hazards, overhead hazards.	Decontaminate sampling equipment after collecting a sample and decontaminate drilling auger/rods after drilling a borehole. Use proper lifting techniques. Use PPE and monitoring in accordance with HSP. Monitor drilling progress. Keep work area clear of tripping or slipping hazards. Perform periodic visual inspections of drill rig.
Collect samples in accordance with sampling plan.	Cross-contamination, improper labeling or storage, exposure to site contaminants.	Decontaminate sampling equipment between each sampling run. Label samples in accordance with sampling plan. Keep samples stored in proper containers, at correct temperature, and away from work area. Perform air monitoring and wear proper PPE.
Store cuttings properly in accordance with site-specific requirements.	Exposure to public. Traffic hazard or obstruction/inconvenience to station operation. Improper storage or disposal.	Have proper storage containment and labeling available onsite. Place materials in isolated location away from traffic and other site functions. Coordinate proper disposal offsite (where applicable).
Construct well.	Back strain, eye injury, trip hazard. Cross-contamination. Non-approved well construction.	Use proper lifting techniques and PPE. Keep pathways from well supplies to borehole clear of tripping hazards. Make sure casing and other materials are clean before going into borehole. Verify presence or other authorization by any required inspectors for well installation/grouting.
Cut pavement to set well vault.	Moving blade, eye hazards, exhaust from motor, noise, back strain. Traffic hazards.	Wear proper PPE. Employ proper lifting techniques or mechanical assistance. Keep work area clear of debris. Maintain traffic control and face oncoming traffic.
Install well vault and set in concrete.	Back strain, eye injury, skin exposure to concrete, particulate inhalation, trip hazard. Traffic hazards.	Use proper lifting technique and equipment to install well vault and in concrete preparation. Wear proper PPE . Complete well vault smooth to grade to eliminate trip hazard (if slightly elevated to prevent storm water intrusion, slope concrete skirt gradually). Maintain traffic control and face oncoming traffic.
Develop well	Physical injury from mechanical failure or drill rig or air compressor. Trip hazard. Exposure to contaminants. Cross-contamination. Electric shock.	Make sure equipment is in good working order and pressurized hoses are whip-checked. Wear PPE in accordance with HSP. Keep work area orderly. Decontaminate all equipment going into well. Generators must be equipped with GFCI circuit.
Dispose or store purge water (if any) onsite	Back strain. Exposure to contaminants. If disposing through onsite treatment system, damage or injury from improper use of equipment. Improper storage or disposal.	Use proper equipment to transport water (pumps, drum dollies, etc.). Wear PPE in accordance with HSP. Review any instructions for use of onsite treatment systems. Label storage containers properly and locate in isolated area away from traffic and other site functions. Coordinate offsite disposal (where applicable).
Clean site/demobilize	Traffic. Safety hazard left on site. Lifting hazard.	Use buddy system as necessary to remove traffic control. Leave site clean of refuse and debris. Clearly mark/barricade any well heads that need later work or concrete curing. Notify station personnel of departure, Map well locations, site structures, and location of drilling wastes. Use proper lifting techniques.
Package and deliver samples to lab.	Bottle breakage, back strain.	Handle and pack bottles carefully (bubble wrap bags are helpful). Use proper lifting techniques.

Job Safety Analysis

JSA Type: ☒ SAR Operations ☐ Transport ☐ Office ☐ Construction	☒ New ☐ Revised	Date: 03/30/00
Co: Dept: Div: Org Unit: Loc:		
Work Type: Environmental	Work Activity: Monitoring Well Sampling/Gauging	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, steel-toed and shank boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HSP). Also refer to the HSP for required traffic control, air monitoring, and emergency procedures.

Development Team	Position/Title	Reviewed By	Position/Title	Date

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). A tailgate safety meeting must be performed and documented at the beginning of each work day. Safe Performance Self Assessment (SPSA) procedures must be used throughout the project. Weather conditions (heat, cold, rain, lightning) must also be considered.

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
Mobilize with proper equipment/supplies for sampling.	Vehicle accident. Lifting hazards. Delay or improper/unsafe performance of work due to improper equipment onsite. Cross-contamination of wells.	Follow safe driving procedures. Use proper lifting techniques. Review work plan to determine equipment/supply needs. Make sure all sampling/gauging equipment is decontaminated. Bring ice for sample storage. Review HSP and gather necessary PPE.
Set up necessary traffic control.	Struck by vehicle during placement. Vehicle accident as a result of improper traffic control equipment placement.	Use buddy system for placing traffic control. Reference traffic control plan section of HSP (may include specific requirements based on encroachment permit).
Set up exclusion zone(s).	Struck by vehicle. Slip and fall hazards to workers.	Face incoming station traffic. Implement exclusion zone set-up instructions of HSP (barricades, caution tape, cones, etc.). Set up work area free of trip hazards.
Gauge water levels and product thickness (where applicable) in wells.	Back strain, inhalation or dermal exposure to chemical hazards, repetitive motion.	Don required PPE, and initiate air quality monitoring in accordance with the HSP. Maintain safe distance from well head. Bend at knees, not waist.
Purge well(s) and collect purge water.	Cross-contamination. Back strain, inhalation or dermal exposure to chemical hazards, slip and fall. Spilling contaminated water.	Decontaminate purging equipment between each sampling location. Use proper lifting techniques. Use PPE and monitoring in accordance with HSP. Keep work area clear of tripping or slipping hazards. Store purge water in appropriate containers.
Collect samples in accordance with sampling plan.	Cross-contamination. Back strain, inhalation or dermal exposure to chemical hazards, slip and fall. Improper labeling or storage, injury from broken sample bottle (cuts or acid burn).	Decontaminate sampling equipment between each well (unless disposable). Use proper lifting techniques. Use PPE in accordance with HSP. Label samples in accordance with sampling plan. Keep samples stored in proper containers, at correct temperature, and away from work area. Handle bottles carefully.

Dispose or store purge water onsite.	Back strain. Exposure to contaminants. If disposing through onsite treatment system, damage or injury from improper use of equipment. Improper storage or disposal.	Use proper equipment to transport water (pumps, drum dollies, etc.). Wear PPE in accordance with HSP. Review any necessary instructions for use of onsite treatment systems. Label storage containers properly and locate in isolated area away from traffic and other site functions. Coordinate offsite disposal (where applicable).
Clean site/demobilize.	Traffic. Safety hazard left on site. Lifting hazard.	Use buddy system as necessary to remove traffic control. Leave site clean of refuse and debris. Notify station personnel of departure, and any purge water left onsite. Use proper lifting technique.
Package and deliver samples to lab.	Bottle breakage, back strain.	Handle and pack bottles carefully (bubble wrap bags are helpful). Use proper lifting techniques.

Job Safety Analysis

DRAFT TEMPLATE

JSA Type: ☒ SAR Operations ☐ Transport ☐ Office ☐ Construction	☒ New ☐ Revised	Date: 03/30/00
Co: Dept: Div:	Org Unit:	Loc:
Work Type: Environmental	Work Activity: GWE and/or SVE Pilot Testing	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, steel-toed and shank boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HSP). Also refer to the HSP for required traffic control, air monitoring, and emergency procedures.

Development Team	Position/Title	Reviewed By	Position/Title	Date

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). A tailgate safety meeting must be performed and documented at the beginning of each work day. Self Performance Safety Analysis (SPSA) procedures must be used throughout the project. Weather conditions (heat, cold, rain, lightning) must also be considered.

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
Mobilize with proper equipment/supplies for testing.	Vehicle accident. Lifting hazards. Delay or improper performance of work due to improper equipment onsite.	Follow safe driving procedures. Employ safe lifting procedures. Make sure sub-contractors are aware of their responsibilities for labor, equipment and supplies. Review HSP and permit conditions and gather necessary PPE.
Set up necessary traffic control.	Struck by vehicle during placement. Vehicle accident as a result of improper traffic control equipment placement.	Use buddy system for placing traffic control. Reference traffic control plan section of HSP (may include specific requirements based on permits).
Unload and set up test equipment.	Struck by vehicle. Trip hazards. Accident when maneuvering equipment. Lifting hazard. Electrical hazard. Adverse impacts to station sales.	Place equipment away from pump islands or other high traffic areas. Store hoses, electrical cords neatly and protect with traffic control equipment (cones, barricades, etc). Provide as-needed hand signals and guidance to driver when placing testing equipment trailers or other large equipment. Visually inspect equipment (fire extinguisher on board/available on site, no damaged hoses or electrical lines, pressurized hoses secured with whip-checks or adequate substitute, all vapor and/or water hoses firmly connected, equipment grounded?). Use proper lifting techniques. Use GFIC on generators or other electrical equipment and inspect cords.
Set up exclusion zone(s) and work station.	Struck by vehicle during set up. Slip/fall hazards.	Implement exclusion zone set-up instructions of HSP. Set up work station with clear walking paths to all testing locations. Face oncoming traffic.
Gauge water levels and product thickness (where applicable).	Back strain, inhalation or dermal exposure to chemical hazards. Repetitive motion. Traffic hazards.	Don any additional PPE and initiate air quality monitoring in accordance with the HSP. Maintain safe distance from well heads. Bend at knees, not waist. Decontaminate equipment between each measurement. Face oncoming traffic.

Commence testing.	Explosion or fire. Trip hazards. Unauthorized release of contaminants. Exposure to contaminants (inhalation, dermal contact). Noise. Electrical hazards.	Follow equipment-specific operation instructions. Monitor influent vapor and oxygen concentrations if applicable. Keep work area tidy and free of loose equipment. Monitor treatment system and collect data to ensure discharge is within permit parameters and capacity of any storage containers (concentrations and flow rates). Wear PPE in accordance with HSP (including ear protection as necessary). Use GFIC and inspect cords.
Note regarding testing involving hydrogen peroxide (H_2O_2)	Burns to skin and eyes. Accelerating reaction with leather/metal can lead to explosion or fire. Unvented containers can build pressure and explode. Oxygen-enriched atmosphere.	Wear rubber gloves, boots, and coveralls, and eye shield (no leather!) in accordance with HSP. Use dilute concentration (≤8% when possible). Store and transport H_2O_2 in approved and labeled containers in accordance with DOT regulations. Refer to H_2O_2-specific safety procedures for all work with H_2O_2.
Collect samples in accordance with sampling plan.	Cross-contamination, improper sample labeling or storage, exposure to site contaminants. Repetitive motion. Body position.	Label samples in accordance with sampling plan. Keep samples stored in proper containers, at correct temperature, and away from work area. Perform air monitoring and wear proper PPE.
Store waste (water, carbon canisters, etc.) in accordance with site-specific requirements.	Back strain. Traffic hazard. Improper storage or disposal. If disposing through onsite treatment system, damage or injury from improper use of equipment	Use proper equipment to transport waste containers (pumps, drum dollies, etc.). Have proper storage containment and labeling available onsite. Place materials in isolated location away from traffic and other site functions. Label waste. Coordinate proper disposal offsite (where applicable). Review instructions for use of onsite treatment systems.
Clean site/demobilize	Traffic hazard. Lifting hazards. Safety hazard left on site.	Use buddy system as necessary to remove traffic control. Use proper lifting techniques. Leave site clean of refuse and debris. Notify station personnel of departure and location of any stored waste.
Package and deliver samples to lab.	Bottle breakage, back strain.	Handle and pack bottles carefully (bubble wrap bags are helpful). Use proper lifting techniques.

Job Safety Analysis

JSA Type: ☒ SAR Operations ☐ Transport ☐ Office ☐ Construction	☒ New ☐ Revised	Date: 03/30/00
Co: Dept: Div: Org Unit: Loc:		
Work Type: Environmental	Work Activity: Excavation Observation	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, steel-toed and shank boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HSP). Also refer to the HSP for required traffic control, air monitoring, and emergency procedures.

Development Team	Position/Title	Reviewed By	Position/Title	Date

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). A tailgate safety meeting must be performed and documented at the beginning of each work day. Safe Performance Self Assessment (SPSA) procedures must be used throughout the project. Weather conditions (heat, cold, rain, lightning) must also be considered.

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
Clear excavation locations.	Traffic hazards, overhead and underground installations, product releases, property damage, dealer inconvenience	Reference Overhead and Underground Utility Checklist, and coordinate with Station Manger (or designee) to minimize potential conflicts. Review proposed locations against available construction drawings and known utilities, tanks, product lines, etc. Mark out the proposed excavation locations. Call underground utility locating service for public line location clearance, and get list of utilities being contacted. If necessary, coordinate private line locator for private property.
Set up necessary traffic control.	Struck by vehicle during placement. Vehicle accident as a result of improper traffic control equipment placement.	Use buddy system for placing traffic control. Reference traffic control plan section of HSP (may include specific requirements based on permits).
Set up exclusion zone(s), stockpile area and establish work areas/heavy equipment pathways.	Injury or exposure to public or other onsite personnel. Slip/fall hazards. Onsite vehicular accident with heavy equipment.	Implement exclusion zone set-up instructions of HSP. Set up clear walking paths between work stations.
Hand digging/pot-holing where necessary to expose and protect underground installations as needed.	Damage to lines (and associated physical hazards or property damage). Back strain. Injury or vehicle damage from falling into holes.	Use hand tools whenever possible. Use proper lifting techniques. Barricade/cover holes until job is complete.
Assist with set up of heavy equipment.	Damage caused by heavy equipment while accessing set-up location. Struck by equipment.	Verify clear pathway to excavation and stockpiling locations. Provide as-needed hand signals and guidance to driver to place rig. Visually inspect equipment (fire extinguisher on board, no oil or other fluid leaks, cabling and associated equipment in good condition, pressurized hoses secured with whip-checks or adequate substitute, jacks in good condition?). Maintain eye contact with operator.

Commence excavation	Heat or cold exposure, exposure to chemical hazards, hitting an underground or overhead utility, flammable or oxygen-deficient atmosphere from accumulated vapors, trip and fall, side wall cave in, equipment failure, noise.	Monitor weather conditions and take breaks as needed for cold or hot weather. Use PPE and monitoring in accordance with HSP. Include Lower Explosive Limit (LEL) and oxygen monitoring. If >10% LEL or O_2 < 19.5%, discontinue work or ventilate area with explosion-proof equipment. Maintain required excavation set-backs for workers and equipment and monitor condition of side walls and surrounding ground conditions. Keep work area clear of tripping or slipping hazards. Perform periodic visual inspections of heavy equipment and keep it at least 5 ft from excavation edge. Perform necessary soil classification. Slope/bench walls or shore excavation to prevent cave in. Keep all spoils > 2 ft from excavation edge. Keep excavation entry controlled and equipped with required ladders and crosswalks.
Collect samples in accordance with sampling plan.	Cave in of side walls if entering excavation. Injury from heavy equipment. Exposure to site contaminants.	Stay out of excavation whenever possible (collect samples from backhoe bucket). If entry is required, excavation must: 1) be properly sloped, benched or shored, 2) be properly ventilated, 3) not have free-standing water or have water entering the hole, 4) have adequate entry/egress pathways (see OSHA and applicable state requirements). Use agreed-upon hand signals with heavy equipment operators. Monitor air in and around excavation.
Store excavated materials properly in accordance with site-specific requirements.	Exposure to public. Traffic hazard or obstruction/inconvenience to station operation. Improper storage or disposal.	Have proper storage containment and labeling available onsite. Place materials in isolated location away from traffic and other site functions. Cover and barricade access to waste in accordance with local regulations. Coordinate proper disposal offsite (where applicable).
Dewater excavation (if necessary).	Exposure to contaminants. Explosion from static electricity. Collapse of side walls. Electrical shock.	Wear PPE in accordance with HSP. Ground dewatering equipment (vacuum trucks are commonly used). Maintain safe setback from excavation walls. Use GFCI and inspect cords.
Backfill excavation	Struck by heavy equipment. Side wall collapse. Future damage or accidents resulting from subsidence.	Use agreed-upon hand signals with heavy equipment operators. Only enter excavation in compliance with OSHA and associated requirements. Compact soils to meet specifications. Maintain eye contact with equipment operators.
Clean site/demobilize	Traffic. Safety hazard left on site. Lifting hazards.	Use buddy system as necessary to remove traffic control. Leave site clean of refuse and debris. Notify station personnel of departure. Use proper lifting techniques or use mechanical assistance.
Package and deliver samples to lab.	Bottle breakage (if any), back strain.	Handle and pack bottles carefully (bubble wrap bags are helpful). Use proper lifting techniques.

Job Safety Analysis

JSA Type: ☒ SAR Operations ☐ Transport ☐ Office ☐ Construction	☒ New ☐ Revised	Date: 03/30/00
Co: Dept: Div: Org Unit: Loc:		
Work Type: Environmental	Work Activity: GWE and/or SVE system installation	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, steel-toed and shank boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HSP). Also refer to the HSP for required traffic control, air monitoring, and emergency procedures.

Development Team	Position/Title	Reviewed By	Position/Title	Date

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). A tailgate safety meeting must be performed and documented at the beginning of each work day. Safe Performance Self Assessment (SPSA) procedures must be used throughout the project. Weather conditions (heat, cold, rain, lightning) must also be considered.

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
Mark out the proposed trenching and above-ground structure locations. Call utility service clearance. Coordinate private line locator for private property.	Traffic hazards, overhead and underground lines & installations, electrocution, explosion, product release, property damage, interruption of services.	Review proposed location map in advance of arriving on site. Reference Borehole Clearance Review form and coordinate with Station Manger (or designee) to minimize potential conflicts. Contact utility service at least two full working days before drilling/digging. Identify utilities that will be contacted. Review proposed locations against available construction drawings and known utilities, tanks, product lines, etc. Where possible, perform preliminary site visit.
Cut pavement.	Traffic hazard. Contact with utilities. Eye injury from flying debris. Back strain when moving equipment. Noise.	Identify and barricade work area. Avoid underground installations. Wear eye and hearing protection. Use proper lifting techniques and assistance when moving equipment (lift gate on truck may be necessary).
Excavate trench and equipment pad footprint as necessary.	Injury or accident from heavy equipment. Injury from damaging underground lines. Back strain. Collapse of trench on workers. Vehicle or foot traffic. Falling into open trench. Trip hazards. Struck by equipment. Noise.	Maintain sight lines with vehicle operator. Use agreed-upon hand signals and work paths with operators. Hand excavate and protect underground lines that are in immediate path of trench. Use proper lifting technique and back support when hand digging. Use shoring/benching/sloping of trench walls if workers will have head and shoulders below top of trench (always for >5 ft deep, but may be required for <5 feet as well). Maintain adequate access/egress locations for workers in trench. Keep trench covered in non-active work areas and between work shifts. Heed vehicle backup alarm and establish eye contact with operator. Keep work area tidy.
Install GWE and/or SVE hose and piping.	Collapse of trench on workers. Vehicle or foot traffic. Falling into open trench. Trip hazards. Lifting hazard.	Use shoring/benching/sloping of trench walls if workers will have head and shoulders below top of trench (always for >5 ft deep, but may be required for <5 feet as well). Maintain adequate access/egress locations for workers in trench. Keep trench covered in non-active work areas and between work shifts. Use proper lifting techniques. Keep work area tidy.
Pressure-test piping (primary and secondary conduit as required).	Eye injury.	Don't over pressurize piping (usually <10 psi). Verify security of end caps.

Install electrical line and conduit to well heads.	Collapse of trench on workers. Vehicle or foot traffic. Falling into open trench. Trip hazards. Lifting hazard.	Use shoring/benching/sloping of trench walls if workers will have head and shoulders below top of trench (always for >5 ft deep, but may be required for <5 feet as well). Maintain adequate access/egress locations for workers in trench. Keep trench covered in non-active work areas and between work shifts. Use proper lifting techniques. Keep work area tidy.
Backfill and pave trench.	Injury from heavy equipment. Leg or foot injury from compaction equipment. Future accidents or damage as a result of subsidence. Traffic hazards.	Maintain sight lines with equipment operators. Use agreed-upon hand signals. Wear proper PPE during compaction. Perform compaction of backfill in accordance with specifications.
Construct treatment equipment pad.	Damage from heavy equipment. Trip hazard on rebar. Body position / lifting hazard. Traffic hazards.	Use agreed-upon hand signals with truck operator. Keep work area free of debris and supplies orderly.
Place and attach major equipment components.	Injury from transport equipment. Back strain when moving equipment. Eye or hand injury when using power tools.	Keep clear of equipment when large components are being set in place. Use mechanical assistance as needed to arrange equipment into place. Wear proper PPE when bolting equipment to pad.
Connect GWE and/or SVE hose and piping and associated valves, sampling ports, and gauges.	Eye or other injury from use of hand tools. Body position / lifting hazard.	Wear standard PPE. Use proper lifting techniques.
Install electrical control panel, equipment wiring and conduit, and system controls.	Electrical shock/electrocution. Fire from faulty wiring. Back strain when lifting panel into place. Eye or other injury from hand tools.	Use lock-out/tag-out procedures to isolate main power supply. Do not perform electrical work in rain. Keep work surfaces dry, especially standing locations. Use proper lifting techniques. Wear standard PPE.
Install fencing or other system enclosure.	Back strain. Eye or other injury from power tools. Trip hazards.	Use proper lifting techniques and assistance. Wear standard PPE. Keep fencing and other materials neatly stacked until ready for installation.
Place required labeling and signage.	Emergencies from fire, or rupture of piping or other containment structures.	Indicate emergency contact and phone #. Clearly label emergency shut-off. Properly label any hazardous materials (e.g. H_2O_2, petroleum collection containers, etc.)
Clean site/demobilize	Traffic hazards. Nuisance or safety hazard left on site. Lifting hazards.	Leave site clean of refuse and debris. Notify station personnel of departure. Use proper lifting techniques.

Job Safety Analysis

JSA Type: ☒ SAR Operations ☐ Transport ☐ Office ☐ Construction	☒ New ☐ Revised	Date: 08/21/01
Co: Dept: Div: Org Unit: Loc:		
Work Type: Environmental	Work Activity: Well Repair/Abandonment	

Personal Protective Equipment (PPE):

Minimum PPE is Level D including: safety glasses or goggles, hard hat, steel-toed and shank boots, hearing protection, and gloves (type dependent on job-specific requirements)

Additional PPE may be required in the Health & Safety Plan (HSP). Also refer to the HSP for required traffic control, air monitoring, and emergency procedures.

Development Team	Position/Title	Reviewed By	Position/Title	Date

Field staff must review job-specific work plan and coordinate with project manager to verify that all up-front logistics are completed prior to starting work including, but not limited to, permitting, access agreements, and notification to required contacts (e.g. site managers, inspectors, clients, subcontractors, etc.). Additionally, a tailgate safety meeting must be performed and documented at the beginning of each work day. Safe Performance Self Assessment (SPSA) procedures must be used during field activities. Also consider weather conditions (heat, cold, rain, lightning).

❶ Job Steps	❷ Potential Hazard	❸ Critical Actions
Coordinate well repair / abandonment activities.	Traffic hazards, overhead utiltities, property damage, dealer inconvenience	Coordinate with Station Manger (or designee) to minimize potential conflicts. Review well construction specifications.
Mobilize with proper equipment/supplies for well repair / abandonment activities.	Vehicle accident. Lifting hazards. Delay or improper performance of work due to improper equipment onsite.	Follow safe driving procedures. Use proper lifting techniques. Verify that subcontractors are aware of their responsibilities for labor, equipment and supplies. Review HASP and permit conditions, and gather necessary PPE.
Set up necessary traffic control.	Struck by vehicle during placement. Vehicle accident as a result of improper traffic control equipment placement.	Use buddy system for placing traffic control. Reference traffic control plan section of HASP (may include specific requirements based on permits).
Set up grout mixing and pumping equipment.	Vehicle accident during equipment movement. Damage caused by equipment while accessing set-up location. Overhead utilities and structures. Soft terrain.	Verify clear pathway to work location and clearance for visible utilities. Provide as-needed hand signals and guidance to driver to place equipment. Visually inspect equipment (fire extinguisher on board, no oil or other fluid leaks, associated equipment in good condition, pressurized hoses secured with whip-checks or adequate substitute?). Chock wheels.
Set up exclusion zone(s)	Struck by vehicle. Slip/fall hazards.	Implement exclusion zone set-up instructions of HASP. Set up work area with clear walking paths to and from support area(s).
Mix grout	Back strain, eye injury, noise, trip hazard. Equipment failure.	Use proper lifting techniques and PPE. Make sure equipment is in good condition and free of obstructions. Keep pathways from supplies to grout mixer clear of tripping hazards.
Pressure pump grout into well from bottom.	Back strain, eye injury, trip hazard. Failure of pressure hose. Issues associated with non-approved well abandonment procedures.	Use proper lifting techniques and PPE. Make sure equipment and hoses are in good condition and free of kinks or other obstruction. Keep pathways from well supplies to well clear of tripping hazards. Verify authorization by required inspectors for well grouting.
Cut and jack hammer pavement to remove well vault and pavement.	Moving blade, percussion equipment, eye hazards, exhaust from motor, noise, back strain. Traffic hazards.	Wear proper PPE. Employ proper lifting techniques or mechanical assistance. Keep work area clear of debris. Maintain traffic control and face oncoming traffic.
Remove/Repair well vault and pour new concrete/asphalt.	Back strain, eye injury, skin exposure to concrete/asphalt, particulate inhalation, trip hazard. Traffic hazards.	Use proper lifting technique and equipment to install well vault and in concrete preparation. Wear proper PPE . Complete concrete smooth to grade to eliminate trip

		hazard (if slightly elevated to prevent storm water intrusion, slope concrete skirt gradually). Maintain traffic control and face oncoming traffic.
Store debris properly in accordance with site-specific requirements.	Exposure to public. Traffic hazard or obstruction/inconvenience to station operation. Issues related to improper storage or disposal.	Have proper storage containment and labeling available onsite. Place materials in isolated location away from traffic and other site functions. Coordinate proper disposal offsite (where applicable).
Dispose or store "purge" water (if any) onsite	Back strain. Exposure to contaminants. If disposing through onsite treatment system, damage or injury from improper use of equipment. Improper storage or disposal.	Use proper equipment to transport water (pumps, drum dollies, etc.). Wear PPE in accordance with HASP. Review any instructions for use of onsite treatment systems. Label storage containers properly and locate in isolated area away from traffic and other site functions. Coordinate offsite disposal (where applicable).
Clean site/demobilize	Traffic. Safety hazard left on site. Lifting hazard.	Use buddy system as necessary to remove traffic control. Leave site clean of refuse and debris. Use proper lifting techniques. Clearly mark/barricade any former well heads that need later work or concrete curing. Notify station personnel of departure. Map well repair/abandonment locations, site structures, and location of wastes.

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