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Field Investigation Work Plan

West Plume Area
Grafton, Wisconsin

Prepared for:

Village of Grafton
Grafton, Wisconsin

Prepared by:

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May 2008

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EXECUTIVE SUMMARY

Groundwater sampling of private wells was conducted in the Manchester subdivision and along Green Bay Road in the Village of Grafton, Wisconsin, to assess groundwater quality in 1995. A TCE plume (the "West Plume") was identified in groundwater through groundwater sampling that occurred between 1996 and 1998. The presence of TCE in groundwater exceeded Wisconsin Department of Natural Resources (WDNR) water quality standards. The Village of Grafton assumed responsibility for plume investigation in a 1998 agreement between the Village and potentially responsible parties.

On May 23, 2007, representatives from the WDNR and the Village of Grafton (including their consultants Earth Tech, Inc. and Buck Sweeney, Esq.) met to determine a course of action for the plume investigation. An agreement was reached at the meeting that Earth Tech would prepare a summary of the West Plume investigation history, and recommend further action for the West Plume investigation. Earth Tech negotiated the scope with the WDNR for completion of the West Plume remedial investigation.

This work plan is based upon the agreements reached between the WDNR, Village of Grafton, and Village representatives.

A significant portion of the West Plume field investigation was completed in 1998. Prior to the 1998 investigation, the source of contamination in area groundwater was not clear. During the investigation, it became clear that there were two sources of groundwater contamination; the Lime Kiln Landfill located within Lime Kiln Park, and the former Milwaukee Sign property on 1st Avenue.

After the two sources were identified, the previous investigation was focused on the Lime Kiln Landfill, as the other source was not at the time the responsibility of the Village. An investigation report for the Lime Kiln Landfill was submitted in 1999, and groundwater near the landfill continues to be monitored as the plume naturally attenuates. The investigation on the West Plume was not completed.

This work plan defines the detailed work required to complete the West Plume field investigation. The objective is to complete the investigation of groundwater quality impacts which are known to exist in the nearly defined plume. A second objective is to assess cleanup strategies to address the contaminant plume. These objectives will be achieved by utilizing the monitoring well network installed in 1998, the use of private wells for groundwater sampling, and new field efforts including the following:

1. Identify and characterize potential contamination sources at the former Milwaukee Sign property.

2. Characterize the plume's southern extent with installation of a groundwater well.

3. Characterize the nature and extent of impacts to groundwater with a round of groundwater sampling at existing private and monitoring wells.

This Work Plan was prepared to define the data needs and data acquisition procedures to implement a Site Investigation and Interim Action Evaluation for the West Plume area, as required by the Wisconsin Administrative Code NR 700. Following completion of work in this work plan, a Site Investigation report is required by NR 700.

1.0 INTRODUCTION

Groundwater sampling of private wells was conducted in the Manchester subdivision and along Green Bay Road in the Village of Grafton, Wisconsin, to assess groundwater quality in 1995. A TCE plume (the "West Plume") was identified in groundwater through groundwater sampling that occurred between 1996 and 1998. The presence of contaminants in groundwater in concentrations exceeded water quality standards set forth in Chapter NR 140 of the Wisconsin Administrative Code (WAC). Several possible sources were identified in a 1999 Remedial Investigation (RUST, 1999) that was submitted to the Wisconsin Department of Natural Resources (WDNR). The Village of Grafton assumed responsibility for plume investigation in a 1998 agreement between the Village and potentially responsible parties.

On May 23, 2007, representatives from the WDNR and the Village of Grafton (including their consultants Earth Tech, Inc. and Buck Sweeney, Esq.) met to determine a course of action for the plume investigation. The meeting minutes compiled by Pat Chung of the WDNR, correspondence from John Feeney (WDNR), and Earth Tech responses are included in Appendix A.

An agreement was reached at the meeting that Earth Tech would prepare a summary of the West Plume investigation history, and recommend further action for the West Plume investigation under Wisconsin Administrative Code NR 716.07, Site Investigation Scoping. The scope was submitted and negotiated as documented in further correspondence in Appendix A.

This work plan is based upon the agreements between the WDNR and Village of Grafton.

1.1 PROJECT PURPOSE

The project objective is to complete the investigation of groundwater quality impacts which are known to exist in the defined plume. A second objective is to assess mitigation strategies to address the contaminant plume. These objectives will be achieved by the following:

1. Identify and characterize potential on-site contaminant sources which may impact groundwater quality, including the nature, degree, and extent of potential contaminants which may emanate from the assumed source.

2. Supplement hydrogeologic characterization in the study area, particularly in relation to mechanisms of contaminant transport.

3. Characterize the nature and extent of impacts to groundwater.

4. Provide sufficient information to evaluate remedial action alternatives and the need for interim actions.

In turn, this investigation will provide information to further evaluate:

1. Potential for further contaminant releases from the assumed source area.

2. Potential pathways for migration.

3. Impacts of contamination on receptors.

4. Known or potential impacts on natural resources.

5. Definition of other potential source areas that impact the same area, in particular the Lime Kiln Landfill.

6. Identification of potential mitigation measures including natural attenuation.

This Work Plan was prepared to define the data needs and data acquisition procedures to implement a Site Investigation and Interim Action Evaluation for the West Plume area. The Work Plan presents the site history, physical and cultural setting, current conditions, data needs to further characterize the facility and to evaluate potential remedial options if needed, and specific procedures for data acquisition. The specific objectives of this Work Plan are to:

1. Provide a scope of work for the site investigation and preliminary remedial options evaluation consistent with the requirements of WAC NR 716 and 722.

2. Document and control the technical conduct of the work.

3. Provide a mechanism for assigning responsibilities and controlling the cost and schedule of the work.

4. Provide a mechanism for communicating to regulatory agencies the management of this effort.

1.2 PROJECT APPROACH

This investigation is the completion of a site investigation that was initiated in 1997. Much of the field work was completed during an investigation of the Lime Kiln Park Landfill. This project will evaluate two areas needed to complete the previous investigation. The evaluation of nature and extent of groundwater contamination, impacts to receptors and migration pathways was previously completed, with the following exceptions: 1) source material nature and extent and 2) extent of the West Plume along its southern edge.

Further evaluation of site investigation data is meaningful to both site characterization and the selection of appropriate remedial options. The continuation of this investigation will be conducted in the following sequence: 1) characterize the source material extent and contaminants; 2) determine if the assumed source area is still contributing to the groundwater plume; 3) complete the nature and extent of groundwater contamination; 4) re-confirm previously investigated migration pathways of contaminant releases; 5) re-confirm potential contaminant receptors; and 6) evaluate potential remedial options.

This work is most efficient if certain evaluations associated with the remedial options evaluation are completed during the investigation.

The project will be conducted in phases. The phased approach will provide opportunities to assess current conditions and to periodically re-assess data needs and overall project strategy. Currently, the project is planned to be completed in two phases.

1.2.1 Phase 1 - Source Characterization/Nature and Extent

The objective of Phase 1 is to identify and characterize potential sources and nature and extent of the contaminant plume, with the primary focus being the former Milwaukee Sign property, located at 2076 First Avenue. Phase 1 will involve the following activities:

1. Characterize the extent of the source (i.e., limits of contaminated soil):

    a. Review information from the previous investigation.
    b. Advance Geoprobe borings to determine;

        - extent of contaminated soil;
        - assess cover type and thickness;
        - determine groundwater presence/interaction/contamination.

2. Characterize the southern extent of contamination along Green Bay Road:

    a. Complete one additional groundwater well along the south edge of the plume.
    b. Conduct geophysical logging in the borehole prior to well installation to evaluate lithology and previously determined potential preferential migration pathways;

        - Racine Formation ("B" Monitoring Zone)
        - Racine Formation Romeo Beds ("C" Monitoring Zone)
        - Waukesha Formation ("D" Monitoring Zone)

3. Conduct water level measurements and groundwater sampling in monitoring wells and accessible private wells.

1.2.2 Phase 2 - Contamination Evaluation

Based on the Phase 1 findings, a sampling plan addendum will be developed for additional sampling of monitoring wells, if necessary, to evaluate the rate and extent of contaminant migration. This sampling will allow a comparison of groundwater quality in the area to the leachate quality. In addition, Phase II will include a preliminary review of remedial alternatives.

1.2.3 Preliminary Remedial Alternatives Review

If the findings of the investigation warrant, a preliminary remedial alternatives review will be completed for the site. Alternatives will be chosen to protect human health and the environment.

The preliminary remedial alternatives review will:

- Identify the existing and projected future contaminant migration pathways to be addressed by the remedial actions.

- Define remedial action objectives for the site.

- Develop a list of potentially feasible remedial technologies and screen the list to retain those which are feasible and applicable.

- Conduct an initial screening of alternative remedial actions eliminating those which do not meet remedial action objectives or are not practical for this site. Appropriate remedial actions are evaluated based on 1) technical criteria including long and short-term effectiveness, implementability and restoration timeframe, 2) economic feasibility, and 3) other considerations such as the practicality, minimization of harmful effects, and other applicable regulations.

- Complete rough-order-of-magnitude performance and reliability evaluations of each alternative.

- Recommend selection of remedial actions for engineering evaluation.

1.3 ORGANIZATION OF THE WORK PLAN

This Work Plan has five chapters. Chapter 1 is this introduction. Chapter 2 presents the facility background and setting. The information in Chapter 2 is from previous investigations in the area and discussions with the Village of Grafton, WDNR, and Wisconsin Department of Health (DOH). Chapter 3 summarizes the current conditions of the former Milwaukee Sign property. Chapter 4 presents the Work Plan approach and lists the number and location of samples to be obtained in the field program. Chapter 5 is the Field Sampling Plan and defines the specific sampling and analysis procedures to be followed.

Appendices include Correspondence (Appendix A), the Site-Specific Health and Safety Plan (Appendix B), Field Forms (Appendix C), and Analytical Parameters (Appendix D.)

2.0 FACILITY BACKGROUND AND SETTING

2.1 GENERAL FACILITY INFORMATION

2.1.1 Project Title

The title of this project is Village of Grafton West Plume Investigation.

2.1.2 Project Participants

Responsible Party:

Village of Grafton
1300 Hickory Street
P.O. Box 125
Grafton, WI 53024

Director of Public Works – David Murphy

Consultant:

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Sheboygan, WI 53083
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B.J. Le Roy, Project Manager
Joan Underwood, P.G., V.P., Senior Consultant

WDNR:

Southeast District:
John Feeney (920) 892-8756, ext. 3023

Current Site Owner:

Grafton Investments, LLC
35056 West Old Woods
Oconomowoc, WI

2.2 FACILITY DESCRIPTION

2.2.1 Location

The West Plume site area is within the Village of Grafton, Ozaukee County, shown on Figure 1. Specifically, it is in the SE 1/4 of the NW 1/4 of Section 25, Township 10 North, Range 21 East of the Cedarburg USGS 7.5-Minute Topographic Quadrangle.

Figure 2 shows a detailed site drawing of the Lime Kiln and West Plume area. The West Plume is bounded by First Avenue to the West, Lakefield Road to the South, Oak Street and Lime Kiln Park to the north, and the Lime Kiln Plume on the east. The former Milwaukee Sign property is located at 2076 First Avenue, which is the assumed source area northeast of the West Plume. Lime Kiln Park

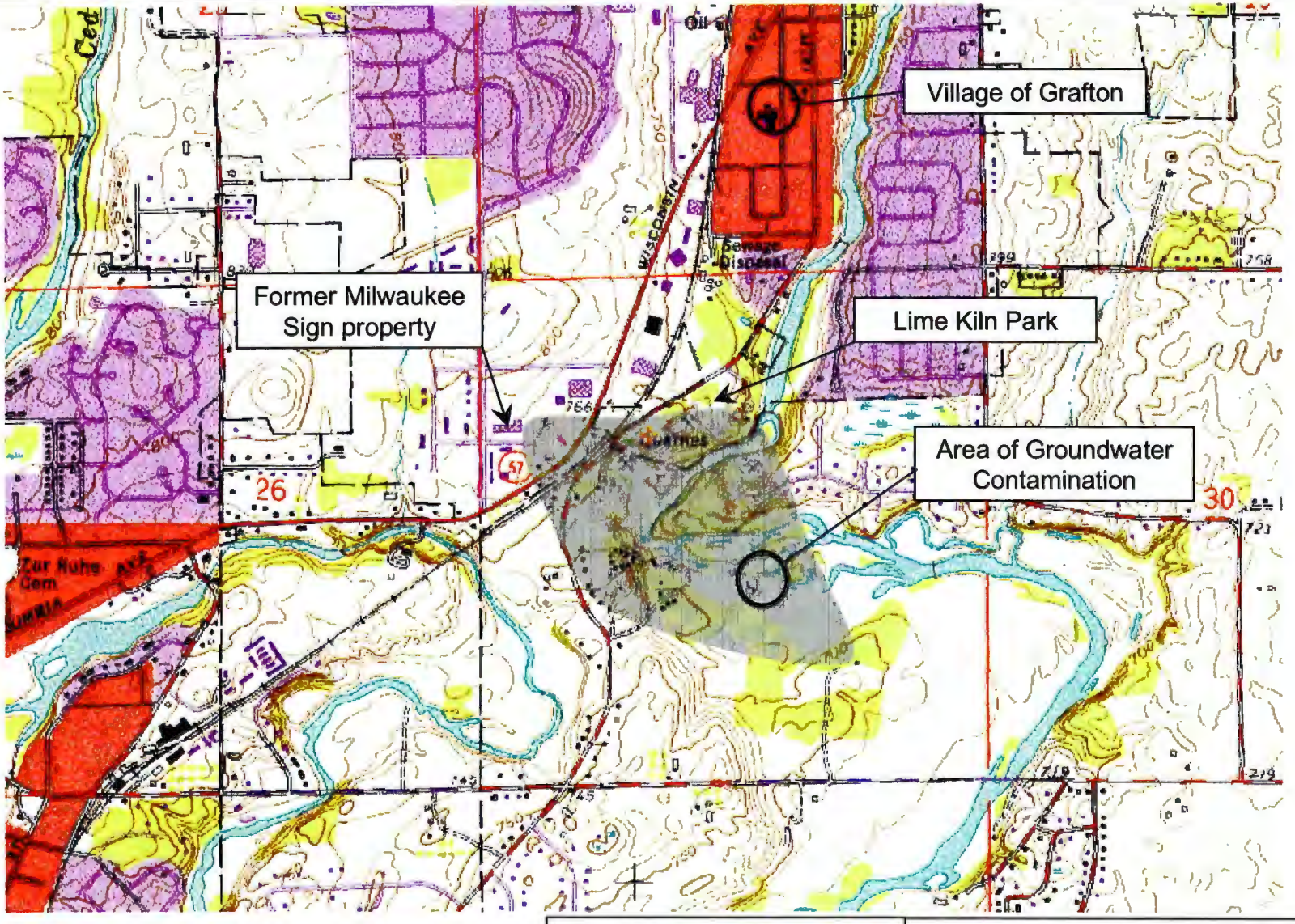

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FIGURE 1
SITE LOCATION MAP
SITE INVESTIGATION WORK PLAN
VILLAGE OF GRAFTON
GRAFTON, WISCONSIN

OCTOBER 2007

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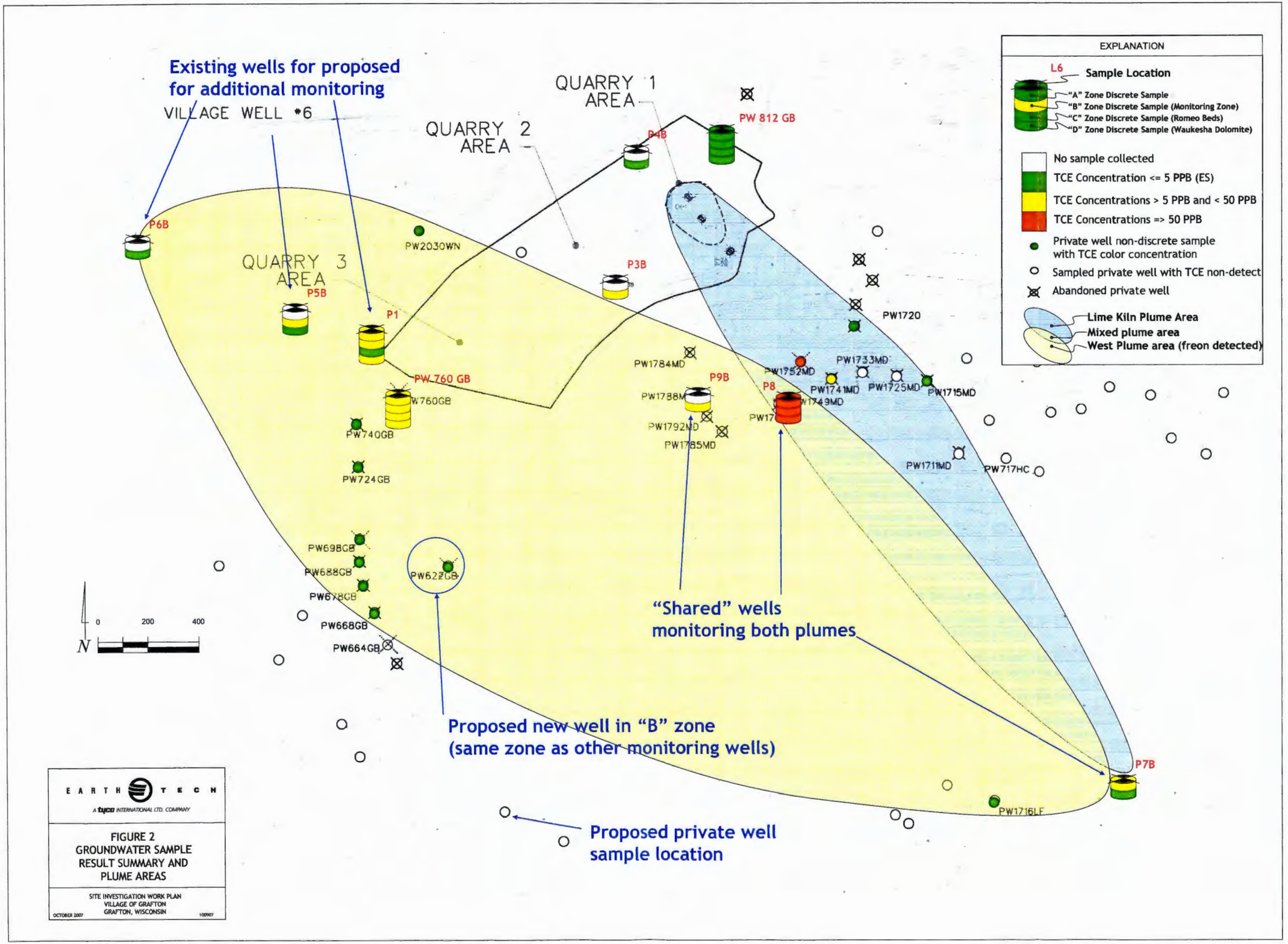

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FIGURE 2
GROUNDWATER SAMPLE RESULT SUMMARY AND PLUME AREAS

SITE INVESTIGATION WORK PLAN
VILLAGE OF GRAFTON
GRAFTON, WISCONSIN

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is located off of Green Bay Road, just south of the intersection of Falls Road and Green Bay Road. The landfill is inside the park, and the Lime Kiln Plume extends to the south as shown on Figure 2.

The Milwaukee River borders the south and east edges of the park, while residential areas border the northeast, west, and southwest sides of the plume area. Industries and businesses, including the former Milwaukee Sign property, are located west, north, and northwest of the plume area.

2.2.2 Site Area History

Preliminary investigations in the early 1980s by WDNR (IT, 1989) detected volatile organic compounds (VOCs) in municipal well Nos. 1, 2, 4, 5, and 6. As a result, the WDNR conducted a groundwater quality survey of public, private, and monitoring wells in the Village and Town of Grafton. Groundwater was tested for 45 VOC compounds. Eight compounds were detected throughout the area, including compounds that are detected in groundwater near Lime Kiln Park.

The Wisconsin Department of Health (WDH) and the WDNR initiated the sampling of approximately 95 residential wells in the site area during July 1996, because of VOCs detected by a private well owner in July 1996. Agency sampling continued through 1997. The United States Environmental Protection Agency (EPA) was notified about well contamination by residents who asked EPA to provide interim funding for alternative drinking water and guidance. The EPA also performed groundwater sampling during this period.

The WDNR and EPA sampled private wells in the area, mainly along Green Bay Road and within the Manchester Drive area, south (downgradient) of the site area. Based on groundwater sampling results the EPA issued a consent order that was signed and dated by Village representatives on July 7, 1997. The EPA delineated an advisory zone in which private wells were to be abandoned and homes were to receive Village water. Construction of the water mains commenced in 1997 and private residences were connected to the Village water system by 1998. The WDNR targeted the Lime Kiln Landfill as the source of contamination, and required the Village of Grafton, the landfill owner, to investigate the landfill under NR 700.

Groundwater contamination was detected upgradient and sidegradient of Lime Kiln Park, to the west and northwest along Green Bay Road and Wisconsin Avenue. Several compounds detected in groundwater are not detected in samples collected within the Lime Kiln Landfill or associated groundwater plume. In particular, Freon 113 has been detected upgradient of the Lime Kiln Park, and TCE has been detected at several wells along Green Bay Road. The upgradient groundwater contamination originates between Wisconsin Avenue and First Avenue, near the area formerly occupied by Milwaukee Sign.

Wells in the Green Bay Road area showed detects of Freon 113, which is not detected in the Lime Kiln Landfill. Based on the Freon compound, two plumes were delineated as shown on Figure 2. The Village and the Lime Kiln PRP Group addressed the Lime Kiln Landfill, and the PRPs eventually paid the Village to be removed from liability for the landfill. The Village did not address the West Plume (Green Bay Road) at the time because it is a result of a source other than Lime Kiln Landfill.

2.2.3 Types and Generators of Waste

Several categories of industries are in the area and types of wastes that could be expected to have been generated by those industries and potentially disposed at the site include:

1.	Metal stamping	TCE (trichloroethylene), toluene, xylene, lacquer thinner
2.	Tool and die	PERC or PCE (tetrachloroethylene), TCE
3.	Porcelanized, enamel finisher	Unknown

4.	Printed circuits	Acetone, plastic resins, TCE, silver screen process wastes, toluene
5.	Unknown	MEK (methyl ethyl ketone), hydraulic fluids, dry cleaners solvents
6.	Silk screening (paint)	Toluene, acetone, MIBK (methylisobutyl-ketone or 4-methyl 2-pentonone), methyl amyl ketone, n-propyl acetate, Dowanol® PM glycol ether, Dowanol® EB consolve 100, xylene
7.	Vinyl coated products	MEK
8.	WDNR records	Solvents, volatile solvents (lithograph industry), oils, dieldrin, possible medical wastes (autoclaved serums)

2.3 ENVIRONMENTAL IMPACTS

2.3.1 Groundwater

The Wisconsin DOH and DNR sampled about 95 residential wells in the vicinity of the site during July 1996 and May 1997. The United States Environmental Protection Agency (EPA) also performed groundwater sampling during this period. Earth Tech has continued sampling at several site wells through the Lime Kiln Landfill monitoring program through 2007.

Monitoring and private wells in the West Plume area are shown on Figure 2. Well logs on record with the State of Wisconsin for wells with addresses located within the area are available in the project file. Qualitative sampling results are shown on Figure 2. Most private wells in the plume area have been abandoned, and homes have been supplied with Village water.

Below is a summary of the analytes detected at monitoring wells within the plume, along with their Preventive Action Limit (PAL) and Enforcement Standard (ES).

Analytes	Maximum Results (ug/l)	PAL (ug/l)	ES (ug/l)
Vinyl chloride	1.0	0.02	0.2
Trichloroethylene (TCE)	53	0.5	5.0
Cis-1,2-dichloroethylene (DCE)	4.9	7.0	70.0
Trans-1,2-dichloroethylene (DCE)	7.6	20.0	100.0
1,1,1-trichloroethane (TCA)	5.0	40.0	200.0
1,1-dichloroethane (DCA)	16	85.0	850.0
1,1-dichloroethene (DCE)	2.0	0.7	7.0
Freon 113	380	--	--

2.3.2 Gas Migration

The possibility of lateral gas migration beyond the limits of waste is extremely low, although it exists and would most likely occur in surficial soils or fractured rock located above the groundwater. Gas generation may be limited because of the age of the waste and the expected relatively small size of the source area. The horizontal extent of gas migration will vary through the year, depending on the state of surficial soils, for example:

If the surficial soils are very wet, due to frequent rain or freezing, as typically occurs in the spring and winter, the horizontal extent of gas migration could be quite far. If the surficial soils are very dry, due to lack of rain, or have many cracks, lateral gas migration may not occur because gas can vent through the surficial soil.

It is important to note that no lateral gas migration problems have been reported at this site.

2.3.3 Other Potential Contaminant Sources

Several other potential contaminant sources are located in the vicinity of the site including industries, properties with USTs or LUSTs, and another quarry located east of the Milwaukee River. In addition, Village Well No. 6 is located sidegradient of the former Milwaukee Sign property and has periodic detections of volatile organic compounds (VOCs). These results suggest there are other potential sources for the VOCs detected in groundwater in the vicinity of Lime Kiln Park.

An existing municipal well (No. 6) is located in the parking lot of K-Mart west of the site and has had historical VOC detections. WDNR initially indicated that the Village could not pump this well, but then allowed minimal pumping. When the well is pumped too much, VOCs increase. During 1996, Well No. 6 was pumped too much and contaminant concentrations in this well were unacceptable. This well is sidegradient of the potential West Plume source and therefore, may indicate that there are other potential sources of contaminants to the groundwater system other than the former Milwaukee Sign property or Lime Kiln Landfill. Compounds which have been detected in Well No. 6 and their respective NR 140 PALs, ESs, and maximum concentrations based on data through March 1997 include:

Analyte	Concentration (ug/l)	PAL (ug/l)	ES (ug/l)
1,2-dichloroethane	2.0	0.5	5.0
1,1-dichloroethane	2.5	85.0	850.0
1,1-dichloroethylene	1.2	0.7	7.0
Tetratchloroethylene	4.2	0.5	5.0
1,1,1-trichloroethane	3.2	40.0	200.0
Trans-1,2-dichloroethylene	2.8	20.0	100.0
Trichloroethylene	27.3	0.5	5.0
Cis-1,2-dichloroethylene	2.2	7.0	70.0
Methylene chloride	1.9	0.5	5.0
2,2-dichloropropane	2.4	--	--
Bromodichloromethane	1.0	0.06	0.6
Bromoform	0.2	0.44	4.4
Dibromochloromethane	0.9	6.0	60.0
Chloroform	0.9	0.6	6.0

2.4 REGIONAL GEOTECHNICAL INFORMATION

The following section describes the regional geotechnical information as it pertains to the site. Site-specific location information as required under NR 716 will be collected during the site investigation.

2.4.1 Topography

The West Plume area is located in the Village of Grafton, Ozaukee County. Ozaukee County's topography is a product of the Wisconsin stage of Pleistocene glaciation. Ozaukee County consists primarily of ground moraines and end moraines which are mainly parallel to the Lake Michigan shore and mark various stages of the advancement or recession of glaciers from the Lake Michigan Basin. An end moraine runs north to south through most of Ozaukee County and the Village of Grafton. The Milwaukee River valley eroded through this end moraine immediately southeast of the site.

The former Milwaukee Sign property lies atop a flat terrace in an industrial/commercial area of Grafton. The ground surface topography to the south and east consists primarily of a sloping river valley. The topography slopes southeast towards the Milwaukee River, and varies from gentle to steep sloping. Dolomite bedrock outcrops along the valley to the south east, which parallels Green Bay Road near the western portion of Lime Kiln Park.

2.4.2 Surface Water

Surface water in the Lake Michigan Basin is abundant and of good quality, although hardness is a persistent problem. Conductivity generally ranges from 500 to 750 micromhos, and dissolved solids generally range from 310 to 465 milligrams per liter (USGS Hydrogeologic Investigations Atlas). The Milwaukee River flows southward, forming the eastern and southern boundaries of Lime Kiln Park.

Small ponds are located in Lime Kiln Park and further to the east and southeast.

2.4.3 Surficial Soils

The majority of the soils in the site are disturbed by industrial/commercial construction. Soils in the area are as follows, according to the Ozaukee County Soil Survey (USDA, 1970):

The Ritchey soil series (0 to 20 percent slope) and an area designated as "loamy land" are identified south and east of the site near the Milwaukee River. The Ritchey series consists of a well-drained silt loam soil found on nearly level to moderately steep positions in the landscape. This soil formed in a thin 10 to 20-inch layer of silt or glacial drift deposits overlying limestone bedrock. The subsoil ranges from silt loam to clay loam. The area designated as "loamy land" consists of areas on the landscape disturbed by cut and fill activities. The soil characteristics found in this area are dependent on the parent material source but typically consist of loamy glacial till with pockets of sand and gravel or clayey material.

The soil units identified on the surrounding land typify the soils likely present on the site prior to being disturbed. The Knowles soil series (0 to 6 percent slope), the Hochheim-Sisson-Casco complex (2 percent to 20 percent slope) and an area designated as "alluvial land" are identified on the surrounding land. The Knowles series consists of a well drained silt loam soil found on nearly level to gently sloping positions in the landscape. This soil formed in a 20 to 42-inch layer of silt or glacial drift deposits overlying limestone bedrock. The subsoil ranges from silt loam to clay loam.

The Hochheim-Sisson-Casco complex consists of a well-drained silt loam soil found on gently sloping and gently undulating positions in nearly circular upland areas. This complex formed in a thin mantle glacial till overlying limestone bedrock. The subsoil ranges from loam to clay loam intermixed with stratified layers of variable material which affect subsurface water flow.

The area designated as "alluvial land" consists of low-lying silt and sand deposits located near floodplains along major streams and drainageways. The soil material in these areas is dominated by silt loam, but ranges from sandy loam to sand.

2.5 GEOLOGY

Sections 2.5 and 2.6 summarize the information available concerning geology and hydrogeology. This information is used to evaluate expected groundwater flow patterns including geologic layers which may provide easier pathways for groundwater movement, directions of groundwater movement, and information about how contaminants have moved at other sites in the area. This information then provides a basis for evaluating what additional data needs to be collected to

evaluate where contaminant sources may be located, how they have moved previously, and what may be expected in the future.

2.5.1 Regional Geology

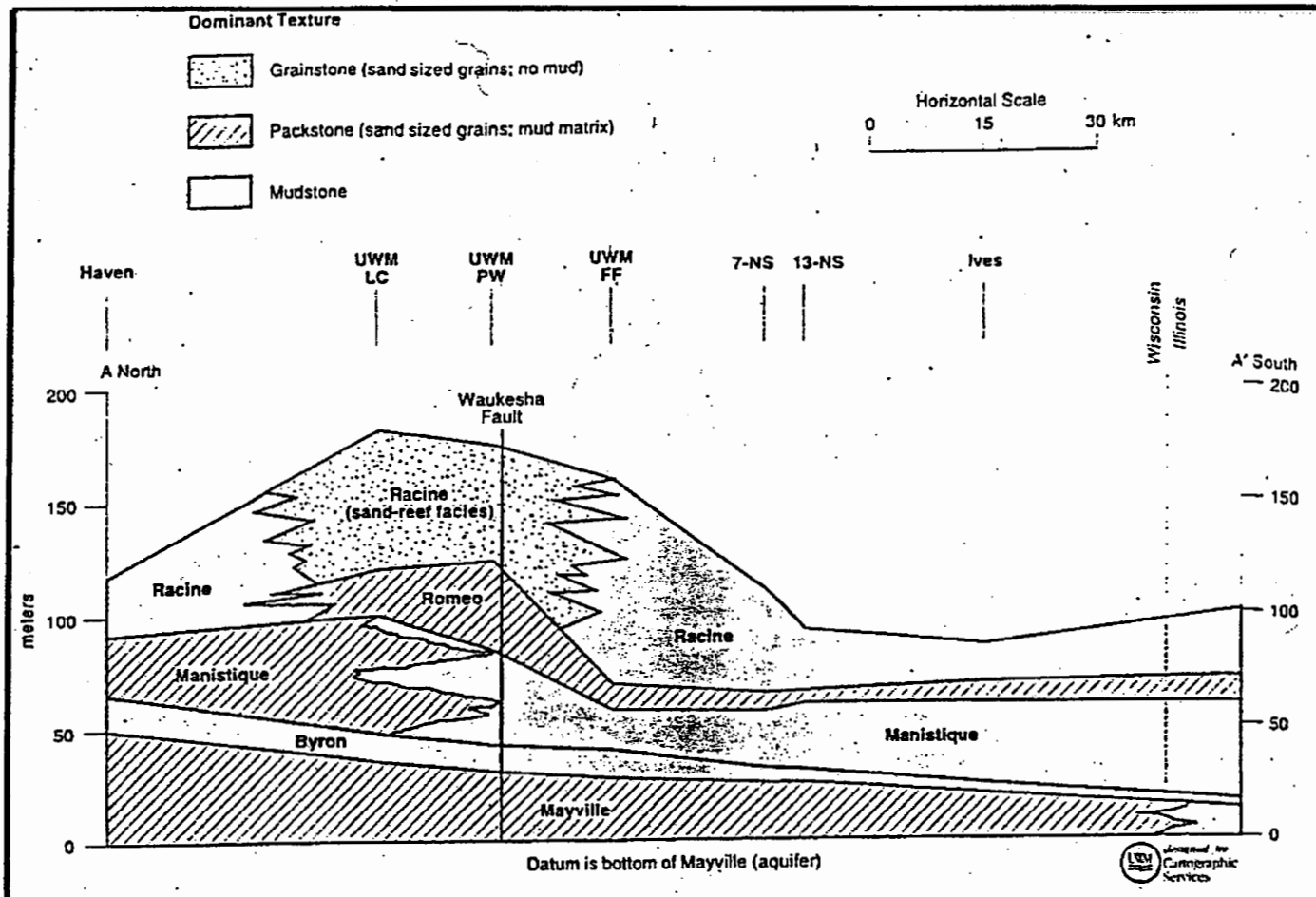
The site is contained within Wisconsin's Eastern Ridges and Lowlands Province, an area characterized by alternating resistant and nonresistant Paleozoic sedimentary rocks overlain by a series of Wisconsinan tills and interbedded outwash deposits (Paull and Paull, 1977).

Generally, unconsolidated glacial Quaternary deposits unconformably overlie bedrock in Ozaukee County. The glacial deposits (drift) are Pleistocene in age and consist of a heterogeneous mixture of gravel, sand, silt, and clay. The glacial sediment in this area was deposited as glacial end moraines and ground moraines. The end moraines in Ozaukee County are mainly parallel to the Lake Michigan shore and mark various stages of the advancement or recession of glaciers from the Lake Michigan Basin. The unconsolidated deposits, which consist of mostly till, range in thickness from 0 (on-site where bedrock outcrops) to more than 50 feet to the west of the site (Young and Batten, 1980).

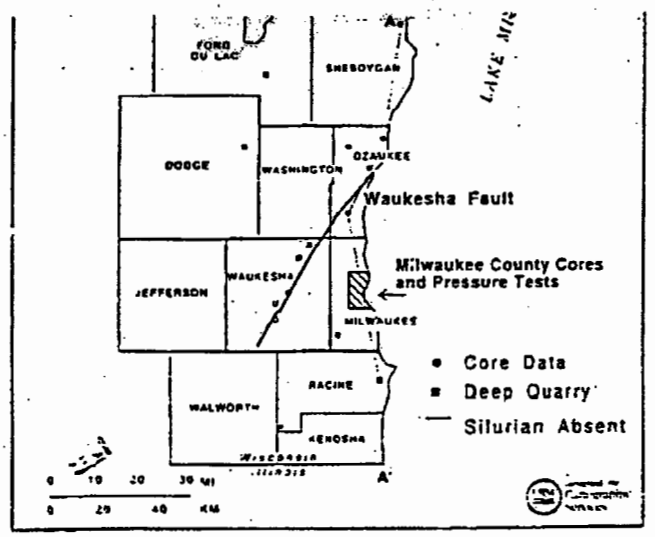
The unconsolidated glacial deposits are unconformably underlain by Paleozoic sedimentary rocks which dip gently to the east, toward the Lake Michigan Basin, at an approximately 0.5 percent slope. The Paleozoic bedrock throughout most of the Province is resistant Silurian dolomite. Devonian dolomite and shale are present along the eastern edge of Wisconsin, but do not extend to the study area. The sedimentary rocks consist of Silurian dolomite, which overlies Ordovician shales, dolomites, sandstones, and Cambrian sandstones. The Paleozoic sedimentary rock sequence unconformably overlies Precambrian crystalline rocks, which are present beneath the site at a depth of more than 1,200 feet below grade (Young and Batten, 1980).

The Silurian dolomite is the uppermost bedrock unit in the study area. The Silurian dolomite is generally fractured, massive to thinly bedded, with a total thickness of approximately 550 feet in the study area. The Silurian dolomite was originally divided into two formations, the Niagara and the Waubakee (Chamberlin, 1877; Foley and others, 1953). These formations have since been subdivided into several distinct lithostratigraphic units with characteristic hydraulic conductivity values, thicknesses, and lateral extents that are related to the depositional environments of the original sediments (Rovey, 1990; Rovey and Cherkauer, 1994a). From oldest to youngest, these included the Mayville, Byron, Manistique, Racine, and Waubakee. Overlying these units are the Devonian-age Thiensville and Milwaukee Formations.

A generalized north-south regional cross-section was constructed through southeast Wisconsin, as shown on Figure 3. This cross-section depicts the various bedrock units in the area of Grafton. The most significant feature identified in Figure 3 is a northeast to southwest-trending barrier reef complex that passed through the vicinity of Grafton. This reef structure may have substantially different groundwater flow properties because of the way it was formed as compared to the chemically precipitated dolomite. Isolated reefs are characteristic of the Racine dolomite throughout Milwaukee County. The contact between typical non-reef Racine dolomite and the overlying Waubakee dolomite is gradational, but the contact between the Racine dolomite reef facies and the overlying Waubakee dolomite may be locally unconformable (Mikulic and Kluessendorf, 1988). The most permeable portions of the Racine Formation and the thickest sequences of the highly permeable Romeo Member of the Racine Formation are associated with the reef structure. These various stratigraphic units anticipated to be encountered during the investigation are further described below, from oldest to youngest.



North-south cross section showing major hydrostratigraphic units, dominant textures and major facies changes. See Figure 3 for cross section location. The location of the facies change within the Mayville is highly generalized. Datum is the base of the aquifer; consequently, displacement along the Waukesha Fault is not shown. The apparent width of the Racine sand-reef facies is exaggerated, because the cross section is not perpendicular to strike. Units younger than the Racine are not shown, because of their restricted extent.



Major controls used to delineate facies changes in the dolomite aquifer, eastern Wisconsin.

SOURCE: ROVEY (1990), MIKULIC (1979), AND CHAMBERLIN (1877, 1883).

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FIGURE 3
REGIONAL CROSS SECTION
SITE INVESTIGATION WORK PLAN
VILLAGE OF GRAFTON
GRAFTON, WISCONSIN

OCT 2007 100907

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2.5.1.1 Thiensville Formation

The age of the Thiensville Formation is Middle Devonian based on fossil occurrences. The Thiensville Formation of Milwaukee County is a lithologically complex unit that grades upward from poorly lithified argillaceous sediments, to dense, less argillaceous carbonates near the top. A characteristic lithologic feature of the Thiensville Formation is solution-derived breccias, commonly present in the middle and upper portions of the unit.

2.5.1.2 Racine Formation

The late Silurian Racine dolomite consists of porous, light to dark gray, medium bedded, pure dolostone (Mikulic, 1977). Graziano (1993) describes the Racine dolomite in Milwaukee County as light to dark gray, thin to thick bedded, nonporous, slightly argillaceous, crystalline dolostone. Average thickness of the Racine dolomite in Milwaukee County is about 170 feet, but the formation thickness may increase to approximately 290 feet where reefs occur (Mikulic and Kluessendorf, 1988).

2.5.1.3 Waubakee Formation

The Waubakee dolomite is Late Silurian based on its stratigraphic position above the Racine dolomite and its lithologic similarity to Late Silurian carbonates in the Michigan Basin. The Waubakee dolomite of Milwaukee County is light to dark gray, dense, crystalline, laminated to thin bedded, slightly argillaceous dolostone. Localized dolomitic breccia zones have been identified at the top of the Waubakee dolomite. The Waubakee dolomite is generally 60 to 110 feet thick in Milwaukee County, but is absent in some locations where Racine dolomite reefs extend upward to the unconformable Silurian-Devonian boundary (Mikulic and Kluessendorf, 1988). The Waubakee dolomite is separated from the overlying Middle Devonian Thiensville Formation by an erosional unconformity.

2.5.1.4 Maquoketa Shale

The Silurian dolomite is underlain by the Upper Ordovician Maquoketa Shale, which is primarily a blue-gray dolomitic shale, with some thin beds of dolomite. The dolomite layers are most common in the upper portion of the unit. The Maquoketa Shale occurs at a depth of approximately 600 feet below grade in the study area and is approximately 200 feet thick. The Maquoketa Shale acts as a regional aquitard in the area, separating the Silurian aquifer from the underlying sandstone aquifer. Because of its low permeability, this unit yields little water and restricts the vertical movement of water (Young and Batten, 19890).

2.5.1.5 Sandstone Aquifer

The Maquoketa Shale is underlain by a thick sequence of Cambrian through Middle Ordovician rock units, which are collectively referred to as the "sandstone aquifer." From youngest to oldest, the sandstone aquifer consists of the Galena-Platteville unit, the St. Peter Sandstone, the Prairie du Chien Group, and the Cambrian sandstones. The sandstone aquifer lies on relatively impermeable Precambrian rocks.

2.5.2 Local Geology

Local geology was extensively studied during the 1999 Investigation.

Thick sequences of carbonate sediments deposited in near-shore environments are the origin of bedrock in the West Plume area. Alternating sequences of biologic shell debris and carbonate mud

were deposited as Silurian-aged seas advanced and retreated across the landscape. Though not intersected in the study area, vast reefs grew when water became shallow enough to support reef life. The sediments that later became dolomite bedrock were deposited in slightly deeper water than the reef facies, as evidenced by the finer grained material and mostly incomplete fossils and shells. As seas retreated, calcium was replaced by magnesium in the sediment, forming the dolomite that presently exists beneath the site. Plate tectonics and orogenic land movement created fracture systems within the rock by moving and compressing the dolomite. As water continued to flow through the rock system, dissolution continued within the rock, dissolving and recrystalizing solution voids and small fractures. The later advance of glaciers eroded the dolomite rock surface, blanketed the rock with a layer of glacial sediments, and carved drainage systems into the rock.

In the West Plume area, glacial deposits ranging from organic soil to diamicton overly bedrock, which is encountered within 4 to 23 feet of the ground surface. The dolomite units in the West Plume vicinity are relatively flat lying, dipping slightly to the south/southeast. The geologic units described in publications are easily recognizable, and contain similar properties at boreholes throughout the area. The stratigraphic bedrock units encountered during the geologic investigation include, from top to bottom, Silurian Age undifferentiated Racine Dolomite, the Romeo beds of the Racine Formation, and the Waukesha Dolomite.

Geophysical testing was used to investigate fractures in the bedrock, groundwater flow characteristics, and stratigraphic breaks for correlation with other boreholes. The geophysical survey results are listed in the 1999 Site Investigation Report. Borehole P-1 was initially logged so that the results could be correlated to the rock core. Five downhole geophysical probes were used to characterize the P-1 boring. Natural gamma and caliper were used to estimate geologic characteristics; and water temperature, heat pulse flow, and impeller flow were used to estimate hydrogeologic characteristics. Multiple methods were used to correlate and interpret the data. For example, temperature is an indicator of changes in groundwater flow, but it does not specifically indicate higher or lower flow rates. Large caliper readings may suggest fractures or voids in the rock, but may simply be indicating a zone which the drill bit went off center and created a larger borehole annulus.

Four private wells within the site vicinity were drilled into the Waukesha dolomite, which is easily recognizable because of high natural gamma counts associated with the argillaceous nature of this unit. P-1 and private wells PW760GB, PW812GB and PW1749MD are drilled as deep as the Waukesha Dolomite. The Romeo beds are also recognizable at each hole due to the low gamma counts and proximity to the Waukesha Dolomite.

Slight variations in the undifferentiated Racine Dolomite could not be correlated between borings. The undifferentiated Racine Dolomite does not have recognizable sub-units within the Lime Kiln Park vicinity. Fracture zones within the Racine Dolomite, though potentially recognized within individual private wells, could not be correlated between borings.

2.5.3 Site Stratigraphy

The site area stratigraphy is described in the following sections, from top (ground surface) to bottom. A rock core was completed at P-1 for the upper 250 feet of bedrock. Dr. Don Mikulic and Dr. JoAnne Klussendorf, from the Illinois State Geologic Survey, logged the rock core. Dr. Mikulic and Dr. Klussendorf are published experts in Midwest Silurian stratigraphy, and logged the core to provide geologic and hydrogeologic information about the rock.

2.5.3.1 Surficial Deposits

Glacial deposits blanketing the bedrock range from 4 to 23 feet thick. Glacial deposits were not specifically studied during the previous investigation because they occur in a thin sequence above the water table, which is in bedrock. General soil descriptions from boreholes describe the glacial material as medium dense, cohesive, medium plastic lean clay, with 10 to 20 percent sand and gravel. The diamicton is typically oxidized, free of fractures, and fairly consistent in lithology throughout its thickness.

2.5.3.2 Undifferentiated Racine Formation

The uppermost bedrock unit encountered is the undifferentiated dolomite, Racine Formation. The top of the Racine Formation lies below a thin sequence of glacial deposits. The 184-foot thick rock unit is undifferentiated, and contains several lithologies that re-occur throughout the section.

The most common lithology is a massive, finely crystalline pale yellow dolomite with varying beds of mudstone and grainstone. The rock is typically dense, medium to slightly weathered with thick nearly flat-lying beds. The unit's primary porosity is in fossil voids, which comprise 10 to 40 percent of the sample. Fossil voids in the Racine Formation typically range from less than 1 to 3 millimeters in diameter, with rare openings between 1 and 3 centimeters in diameter.

The other common lithology within the undifferentiated Racine Formation is a massive, finely porous and granular dolomite, consisting mostly of nearly flat-lying grainstone beds. The rock is typically fine to medium grained, dense and slightly weathered to unweathered. The porosity ranges from 5 to 25 percent, with voids typically between 1 and 2 millimeters in diameter. There are rare fossil voids between 1 and 3 centimeters in diameter.

Fractures occur throughout the undifferentiated Racine Formation. Most fractures observed into the core from borehole location P-1 are nearly vertical, and may be open as much as 1 millimeter, but are typically recemented and closed. Fractures range from unweathered to slightly weathered and are typically discolored to various colors of strong brown.

Within the Racine Formation, 10 zones of highly fractured dolomite are noted on the boring log for the P-1 core, ranging between 1 and 10 feet in thickness. Of these 10 zones, several are thin (1 to 2-foot) highly fractured zones which occur at the beginning of some core runs and are likely due to mechanical breaks caused by the drilling process. Significant fracture zones, located at 152 and 182 feet below ground surface, occur within brecciated dolomite. Fractures in these two zones are recemented and closed. Horizontal bedding planes within the unit are typically closed and indications of alterations along these planes are not typically observed.

Within the P-1 boring, the three major stratigraphic rock units, the undifferentiated Racine, the Romeo beds and the Waukesha Dolomite are recognizable from the geophysical analysis. The undifferentiated Racine is characterized by variable natural gamma counts, variations in caliper width related to voids and fractures in the rock, and somewhat higher temperature than the lower units. Flow in the unit is typically too high for the heat pulse system to operate properly, and no readings were obtained. Impeller flow readings are typically lower than the Romeo beds, and higher than the underlying Waukesha Dolomite.

2.5.3.3 Romeo Beds

The Romeo beds of the Racine Formation are first encountered at a depth of approximately 187 feet at P-1, or at 570 feet MSL. The unit is 24 feet thick at P-1 and is comprised of massive, finely crystalline, pale yellow dolomite with abundant fossil interclasts. The rock is moderately weathered

and discolored in bands of brownish yellow and olive gray. Pores in the rock comprise 30 percent of the sample and range from 1 to 3 millimeters. Vertical fractures observed in the core occur approximately once every 2 feet and are recemented and closed. The Romeo beds lie unconformably above the Waukesha dolomite. Though the Romeo beds encountered in the area correlate stratigraphicaly with reef facies in the area, and the porosity is slightly higher than the overlying Racine, the unit was not considered a reef by Dr. Mikulic and Dr. Klussendorf.

The Romeo beds have more consistent readings in both natural gamma and caliper, and slightly lower temperature than undifferentiated Racine Dolomite. Groundwater flow is slightly higher in the Romeo beds, according to impeller flow readings. Flow in the unit is too high for the heat pulse system, and the meter was typically unable to obtain readings.

2.5.3.4 Waukesha Formation

The Waukesha Formation thickness is unknown because drilling was terminated in the unit. The unit has one typical lithology, consisting of massive, very-fine crystalline light gray dolomite. Abundant stylolites occur throughout the unit as argillaceous partings, less than 1 millimeter thick. The unit is argillaceous and the porosity is estimated to be low because of the fine grained and recemented nature of the rock. Chert nodules up to 10 centimeters long make up 10 to 15 percent of the sample. Rare solution voids occur every 1 to 5 feet, and are as large as 8 centimeters long and 2 centimeters wide. The voids are not interconnected as they are sparsely found and the rock is nearly unfractured. The void walls are typically recrystallized with dolomite crystals or chert. The Waukesha Formation is unweathered.

The Waukesha Formation is characterized by much higher natural gamma readings, attributed to the argillaceous character of the unit. Groundwater temperature is lower, and groundwater flow decreases. Flow, caliper, and temperature are much more consistent through the unit as compared to the dolomite units above. The natural gamma count varies with higher and more frequent peaks than in the undifferentiated Racine Formation. Groundwater flow within the unit falls within the measurable range for the heat pulse apparatus. Flow within the unit is uniform, and downward. Flow within the unit is much smaller than flows through the overlying dolomite units.

2.6 HYDROGEOLOGY

2.6.1 Regional Hydrogeology

The primary sources of groundwater in the study area are the Silurian and the sandstone aquifers. The Maquoketa Shale acts as a regional confining unit, separating these two aquifers. Water in the Silurian aquifer is generally under water table conditions, and the deep sandstone aquifer is generally under artesian conditions. The Silurian aquifer is the primary aquifer for domestic, commercial, and municipal water supplies in the area. The sandstone aquifer is rarely used for domestic supplies because the overlying Silurian aquifer generally has adequate yields. The regional groundwater flows generally to the east/southeast toward Lake Michigan (Young and Batten, 1980).

Grafton Village wells receive water from both the Silurian and sandstone aquifers. Some wells are open to both formations. In addition, most private wells are constructed as an open borehole from near the top of rock to the total depth. The sampling results of local wells were previously discussed in Section 2.3.1. These wells are all within the Silurian dolomite.

Highly porous packstones and grainstones have an intrinsically high hydraulic conductivity above that which is potentially provided by fractures and secondary dissolution. Hydraulic conductivity

values for the Mayville Formation, Romeo Member of the Racine Formation, portions of the Racine Formation associated with reefs, and the Thiensville Formation may exceed 10^{-4} cm/s.

Abundant, but discontinuous, crevices and solution cavities are also present in the dolomite. The upper few feet of the rock generally has a higher hydraulic conductivity than the remainder of the aquifer because of interconnected fractures, joints, and solution openings formed during preglacial erosion.

Flow in the Silurian aquifer is generally under water table conditions. The water table usually occurs within the unconsolidated deposits, but may be within bedrock where bedrock is close to the surface. Groundwater flow is generally from west to east where Lake Michigan serves as a regional groundwater discharge area. Surface water bodies affect the local groundwater flow systems so that this general flow direction is affected. In the Grafton area, the water table slopes from west to east following the bedrock dip. Regional information depicts the Milwaukee River as a losing stream in the vicinity of Grafton, the result of the presence of several dams on the Milwaukee River. Just southeast of the site, the Milwaukee River changes from a losing to a gaining stream.

There is conflicting information concerning the influence the fractures and joints in the dolomite exert on the groundwater flow system. It appears that where the reef structure is present, primary porosity or bulk porosity will control flow more than the presence of jointing. Where pump tests have been conducted along fracture traces in the Milwaukee area, a strong anisotropy has been found in the direction of the fracture.

2.6.2 Local Hydrogeology

2.6.2.1 Formation Hydraulic Properties

Groundwater flow through the uppermost aquifer is controlled by bedrock structure and the hydraulic conductivity of the bedrock. In turn, the hydraulic conductivity of this unit is controlled by the primary and secondary porosity of the bedrock. The dolomite's primary porosity is in fossil voids and the amount and size of clastic material forming the rock. Fractures within the unit beneath the site area are typically recemented and closed at the scale of the P-1 core samples, and do not appear to greatly influence the hydraulic conductivity because of the higher hydraulic conductivity of the rock matrix. Regional information and the comparison of pumping and slug tests performed in the site vicinity indicate that larger scale fractures not observed in the core may influence the dolomite hydraulic conductivity in the site area. Relative changes in groundwater flow within the identifiable hydrostratigraphic units were characterized through the use of an impeller and heat-pulse flow meter. Based on these flowmeter readings, groundwater flow in the Romeo beds is slightly higher than in the undifferentiated Racine Formation. Conversely, the underlying Waukesha Formation is characterized by much lower flow. This is consistent with its characterization as an aquitard.

In-situ hydraulic conductivity tests (slug tests) were performed in wells and piezometers (2A, 2B, 3B, 4B, and 5B) screened within the undifferentiated Racine Formation dolomite. Slug tests evaluate a relatively small volume of aquifer and therefore most likely represent the permeability of the rock's matrix and not larger scale secondary porosity features. The K values reflect a relatively narrow range of values, between 9.9×10^{-4} and 3.6×10^{-3} cm/s, which suggests that aquifer hydraulic conductivity is relatively consistent throughout the site area. The geometric mean of these test data is 1.8×10^{-3} cm/s. These in-situ K values reflect the upper 139 feet of the undifferentiated Racine Formation.

Transmissivity values of the dolomite aquifer were preliminarily estimated by WDNR based on the analysis of time versus drawdown curves for pumping data from Grafton's municipal wells (Well Nos. 2, 4, 5, 6, and 7). Calculated transmissivity values range between 4,554 gpd/ft to

93,280 gpd/ft. However, these data are based on open boreholes extending through the uppermost aquifer into the Waukesha Formation. Utilizing these transmissivity data in conjunction with consideration of the portion of each borehole intersecting the uppermost aquifer, hydraulic conductivities were estimated. Thus derived, these hydraulic conductivity estimates range between $9.1x10^{-4}$ and $5.8x10^{-2}$ cm/sec. Because pumping wells affect a larger volume of aquifer (relative to slug tests), secondary porosity features such as fractures may be encountered during a pumping test. The higher range of hydraulic conductivity values derived from the pumping test may reflect secondary porosity features such as larger scale fractures.

2.6.2.2 Groundwater Flow

The water table represents the top of the groundwater flow system. The definition of this surface is based on a variety of quantitative data and qualitative observations. The water table surface has been measured in three monitoring wells: LH-1, LH-2, and P-2A. The observed water levels in some of the residential wells are found within the open boreholes of the wells. These residential well observations may only approximately reflect water table conditions because of the depth of the open boreholes and the presence of vertical gradients within the bedrock aquifer. Finally, the elevation of the water surface in the Milwaukee River provides a measure of the water table surface assuming that there are no areas of unsaturated soil or rock between the river and the water table.

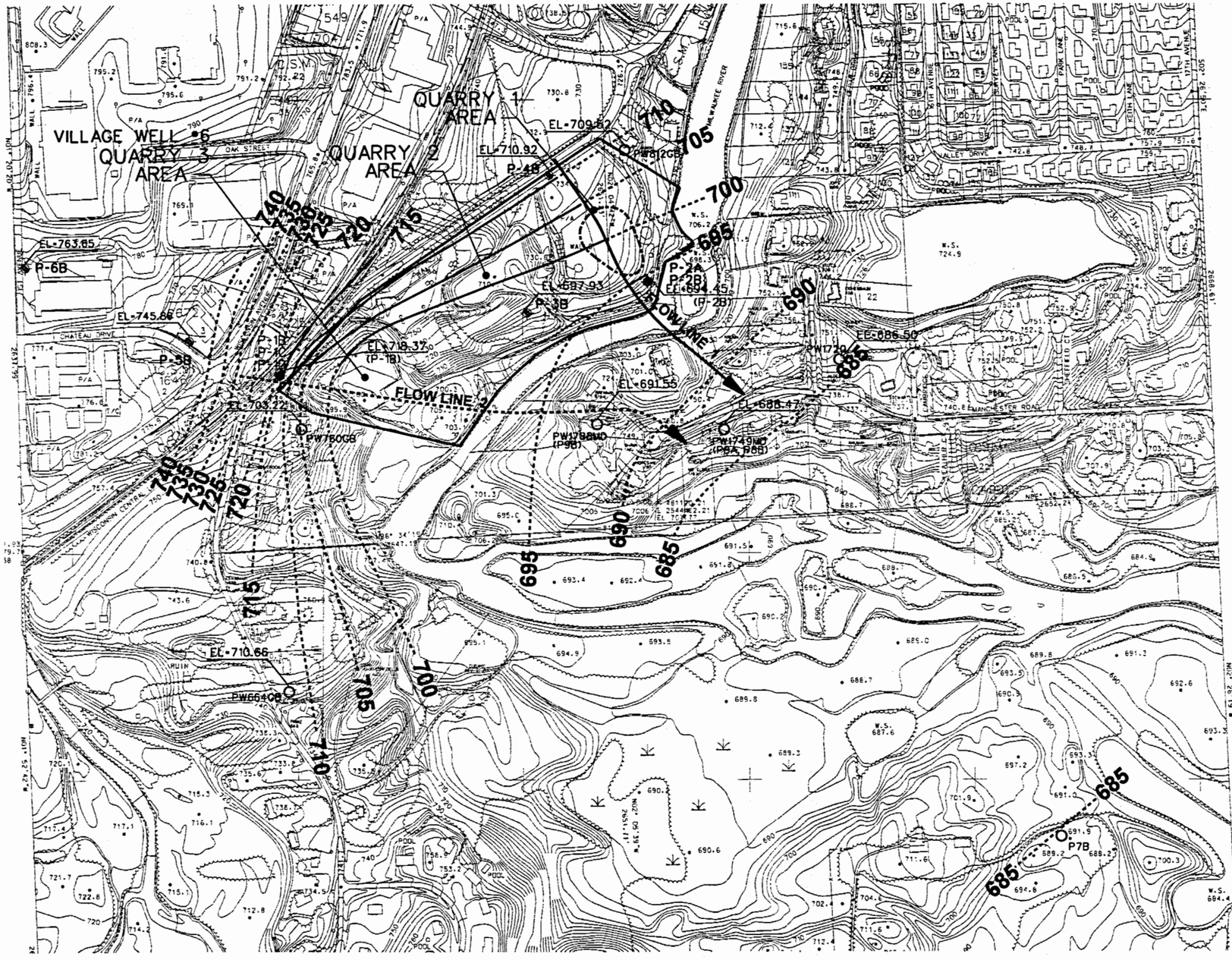
At the northern end of the Park, the water table is estimated to be at an elevation of about 715 feet MSL at location P-4 based on borehole observations of water occurrence. The water table surface drops to an elevation of about 700 feet MSL to the southeast in the area of the landfilled portion of the former quarry. The elevation of the Milwaukee River near monitoring well P-2A is about 0.5 feet higher than the water table at P-2A, indicating that the river is recharging the aquifer in this area.

Northwest of the former Milwaukee Sign area, the shallowest observation of water in a boring was at location P-6, where water was first noted at an elevation of about 765 feet MSL, while at P-1B it is at approximately 718 feet MSL. A small pond in Lime Kiln Park which is a result of groundwater discharging occurs in the northwest corner of Quarry 3, suggesting a water table elevation of approximately 700 feet MSL, although a pond with an approximate surface water elevation of 725 feet occurs north of Manchester Drive. The Milwaukee River elevation at the southeast corner of the Park is about 692 feet MSL. The presence of the quarry faces along with the topographically higher area west of the Park results in an expected steeper water table gradient west of the Park and towards the quarries.

Water level observations in residential wells PW1788MD and PW1749MD, to the east of the Milwaukee River, are within or near the top of rock within the open boreholes of these wells. This indicates that the water table may be within the bedrock aquifer to the east of the river. However, because the residential wells are constructed as long, open boreholes through a significant thickness of aquifer, their use to measure either the water table or a piezometric surface is uncertain.

Groundwater elevations for the piezometric surface within the Racine Formation, at an elevation between approximately 625 and 650 feet MSL, are depicted on Figure 4. As shown on Figure 4, the piezometric surface ranges in elevation from approximately 764 feet MSL at P-6B to 686 feet MSL southeast of the Milwaukee River (PW1720) and is lower than the water table where wells or observations allow this comparison (P-1 and P-2 locations). Based on these elevations, groundwater within the undifferentiated Racine Formation flows to the south-southeast near Lime Kiln Park, while west of the park groundwater flows east-southeast. The slight change in flow direction is depicted by the subtle bend in the piezometric surface contours shown on Figure 4.

VILLAGE WELL •2



EXPLANATION

- LIME KILN PARK PROPERTY BOUNDARY
- ESTIMATED LIMITS OF WASTE (GEOPHYSICS AND GEOPROBE)
- 690 — GROUNDWATER CONTOURS (5 FOOT INTERVAL)
- FLOW LINE 1 — GROUNDWATER FLOW DIRECTION
- EL-694.45 (P-2B) — LEACHATE WELL NEST WITH PIEZOMETRIC ELEVATON. DESIGNATED WELL IN PARENTHESES (P-2A, P-2B)
- EL-697.93 — PIEZOMETER WITH PIEZOMETRIC ELEVATON (P-3B)
- EL-688.47 — PRIVATE WELL WITH PIEZOMETRIC ELEVATON (PW1749MD)

NOTES:

1. TOPOGRAPHIC BASE MAP AND PRIVATE WELL LOCATIONS COMPILED FROM WISCONSIN DEPARTMENT OF NATURAL RESOURCES.
2. HORIZONTAL DATUM SYSTEM BASED ON THE STATE PLANE COORDINATE SYSTEM.
3. ELEVATIONS ARE USGS MEAN SEA LEVEL, DATUM BASED ON GROUNDWATER LEVELS MEASURED ON JUNE 3, 1998.
4. PRIVATE WELL PW760GB WAS NOT USED TO CALCULATE PIEZOMETRIC CONTOUR MAP.
5. P-6B WATER LEVEL WAS TAKEN ON AUGUST 5, 1998 AND THEREFORE NOT INCLUDED IN THE PIEZOMETRIC CONTOUR MAP.

N

SCALE 0' 125' 250' 500'

EarthTech
A Tyco International Ltd. Company

FIGURE 4
PIEZOMETRIC SURFACE
SITE INVESTIGATION WORK PLAN
VILLAGE OF GRAFTON
GRAFTON, WISCONSIN
OCT 2007 100907

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Horizontal hydraulic gradients were calculated along two flow lines as shown on Figure 4. The calculated horizontal gradients were 0.018 and 0.015 feet/foot for flow lines 1 and 2, respectively.

The horizontal gradients are affected by the landscape and regional hydrogeologic recharge and discharge areas. A slightly lower gradient (shown on Figure 4) is present in the Quarry 2 and 3 excavated areas of the park, where dewatering due to the existing quarry has taken place. Northwest of the existing quarry and Green Bay Road, the gradient becomes steeper reflecting this dewatering. Further northwest, between wells P-5B and P-6B, the steep gradient is attributed to a local groundwater divide and recharge area.

Vertical hydraulic gradients were calculated using June 3, 1998, water level data collected from piezometer nests.

The calculated vertical gradient within the undifferentiated Racine Formation at the P-2A/B piezometer nest is approximately 0.050 feet/foot downward. The vertical gradient between piezometers screened within the undifferentiated upper Racine Formation and the Romeo beds is also downward at approximately 0.017 feet/foot (P-1 location). This downward flow component is consistent with the site's location within a recharge area and the effect on groundwater flow of the quarries. The vertical hydraulic gradient between the Romeo beds and the underlying Waukesha Formation was calculated to be downward at approximately 0.382 feet/foot. This increase in the downward gradient is likely a result of the change in hydraulic conductivity. Downward gradients into the Waukesha Formation would increase because hydraulic conductivity decreases.

The average linear velocity of horizontal groundwater flow within the undifferentiated Racine Formation was calculated to range between between 0.4 and 0.8 ft/day (150 and 300 feet/year). The flow was calculated based on a modification of Darcy's Law:

$$V = \frac{Ki_h}{n_e}$$

Where: V = average linear velocity
K = horizontal hydraulic conductivity
i_h = horizontal hydraulic gradient
n_e = effective porosity

A horizontal hydraulic gradient of 0.015 feet/foot was used. The effective porosity of the bedrock was assumed to be between 0.1 and 0.2 based on visual observations of matrix porosity in the bedrock core.

2.6.3 Conceptual Site Hydrogeologic Model

The conceptual groundwater flow model for the West Plume area consists of thin unconsolidated glacial deposits and urban land/fill which overlie a nearly flat lying unconfined dolomite bedrock aquifer, the Racine Formation. The dolomite aquifer contains lithologic changes and individual hydrostratigraphic units classified as aquifers or aquitards. The vertical extent of the conceptual model is bounded by a lower permeability aquitard, the Waukesha Dolomite.

The Silurian-age dolomite aquifer is comprised of undifferentiated Racine Formation and the Romeo beds of the Racine Formation. The aquifer extends approximately 200 feet below the top of bedrock, coincident with the contact of the underlying Waukesha Formation. The Waukesha Formation is designated as an aquitard based on the visual observations of the rock core and low flow rates noted by borehole flowmeter testing.

The water table in the local groundwater flow system is found near or below the surface of the bedrock. The water table is approximately 15 to 20 feet below the ground surface.

The Milwaukee River lies south and east of the site area. The 500- to 700-foot reach of the River immediately downstream of the dam adjacent to Lime Kiln Park is higher than the water table. Water therefore flows from the river bottom to the aquifer. Groundwater may discharge to the River downstream of this reach.

Local groundwater flow components control groundwater flow in the site area, and are affected by larger, regional flow systems. Groundwater in the uppermost aquifer (Racine Formation including the Romeo beds) is considered part of the regional flow systems with a recharge area encompassing the site as well as topographically high areas west of the site area. Longer flow paths and discharge to Lake Michigan located about 2.5 miles to the east of the site also characterize the regional flow system.

Once water reaches the water table, flow is controlled by the hydraulic head in the units as shown by water levels in wells surrounding the site. The downward gradients are consistent with the site area's position within a recharge area as evidenced by vertical gradients observed at the several monitoring well locations.

Groundwater flow is controlled primarily by the bedrock structure and the regional discharge to Lake Michigan. In highly transmissive zones (higher hydraulic conductivity) such as the Racine Dolomite, groundwater flows predominantly by advection. Open borehole wells and vertical fractures interconnect the Racine Formation throughout its thickness.

The regional groundwater flow pattern may also be influenced by public and private water supply wells in the area. The Village of Grafton has seven water supply wells that pump groundwater. Two wells with limited usage are located near the site area. Private residence wells outside the Village limits also withdraw groundwater and may affect groundwater flow.

Four monitoring zones were determined through the field investigation; the water table "A" zone; the "B" Zone, a more porous limestone zone in the Racine formation; the Romeo Beds of the Racine Formation ("C" Zone), and the Waukesha Dolomite directly below the Romeo Beds (the "D" Zone.) The majority of wells were screened in the "B" Zone, where the highest levels of contamination were sampled. The B zone is the monitoring zone for the adjacent Lime Kiln Landfill monitoring program.

3.0 INITIAL SITE EVALUATION

3.1 PREVIOUS SITE INVESTIGATION

Earth Tech was contracted by the Village of Grafton to conduct the NR 700 investigation of the Lime Kiln Park and West Plume area in 1997. Implementation of the WDNR approved Work Plan began in February of 1998. An investigation report was submitted in January, 1999. Through the course of the investigation, the following items were completed:

- A literature search of the landfill and the Village of Grafton areas.
- Waste characterization that evaluated the size and type of source material at the Lime Kiln Landfill.
- A geologic, hydrogeologic, and surface water investigation of the West Plume and Lime Kiln Landfill area.
- Characterization of potential migration pathways.
- Preliminary Remedial Action Identification for the Lime Kiln Landfill.

Nine groundwater wells, 2 waste wells, 33 Geoprobe borings, and a geophysical investigation were implemented to evaluate the geology and hydrogeology, and investigate the sources, nature and extent of groundwater impacts in the West Plume and Lime Kiln Landfill site area. Multiple private wells were also used to characterize the subsurface and investigate the nature and extent of groundwater contamination. Figure 2 serves as an existing conditions map which shows the location of monitoring wells, sampled private wells, and the nature and extent of both plumes in the site area.

The conclusions of the Site Investigation were as follows:

- The Lime Kiln Landfill is a source of groundwater contamination.

- Groundwater is the only media through which contamination is expected to migrate from the landfill to receptors. Groundwater carries contamination from the landfill into the upper 100 to 200 feet of the Racine Dolomite.

- Receptors affected by groundwater contamination are private wells in Manchester Drive area. Potential receptors, currently not impacted, are wells along Lakefield Road, and the Milwaukee River and associated wetlands south of Manchester Subdivision.

- Low levels of contaminants were measured in Lime Kiln Landfill gas, which is not expected to be a significant pathway for contaminant migration because of the low methane levels encountered and the limited area in which landfill gas was detected.

- Two groundwater contaminant plumes were delineated during this investigation. Groundwater contamination from the landfill is limited to the area shown on Figure 2. Groundwater contamination from other sources contributes to the West Plume. The plumes are distinguished by compounds unique to each plume. NR 140 standards are exceeded for limited compounds in each plume.

- Transport of groundwater contamination occurs in both the pores of the rock matrix and fractures in the rock. The rock matrix is sufficiently permeable such that fractures are not the sole permeability controlling contaminant migration. However, the regional fracture set aids in keeping the plume narrow when groundwater flow is parallel to a fracture set.

- Treatment is occurring through natural attenuation of parent VOC products as evidenced by the presence of breakdown byproducts, and the levels of natural attenuation indicators in groundwater such dissolved oxygen, ethanes, and dissolved metals.

- The groundwater plume from the landfill is likely to be stable or receding, based on the length of time since the disposal of waste, the volume of the landfill, and natural attenuation processes.

At the time of the investigation report, data in the West Plume were not analyzed after the two plumes were identified, and the Village had taken responsibility of only the Lime Kiln Landfill area. Under this investigation, data from the West Plume area will be incorporated into further evaluation which will be included in the West Plume Investigation Report.

3.2 CHEMICAL CONSTITUENTS OF CONCERN

Groundwater sampling results are presented in Table 1, which lists sample results for wells in the West Plume. VOCs are the main constituents of concern, in particular TCE and its breakdown products. VOCs are relatively mobile in aqueous phases and are the constituents of highest interest in this evaluation. Detects above NR 141 groundwater standards are noted by "ES" and "PAL" in the "Exceedence" column.

3.3 POTENTIAL CONTAMINANT MIGRATION PATHWAYS AND IMPACTS

The site conceptual model consists of several potential primary sources including the former Milwaukee Sign property, other area industries, UST, and LUST sites. The primary contaminant source from the site is waste in the soil material. The quantity of waste material and concentrations of VOCs in the soil is unknown. The potentially contaminated soil and/or waste are potentially a continuing source of contaminants. Small pockets of product may exist, although it is more likely that contaminants are sorbed onto soil.

3.4 PRIMARY RELEASE MECHANISMS

As water infiltrates through the site soil, contaminants may be released from the soil and carried downward to the groundwater table. Thus, the main release will include advective and diffusive flow within the groundwater and the vadose zone. Accordingly, the primary pathway is groundwater and the corresponding primary concern is groundwater impacts as it affects water supply wells.

3.5 PATHWAYS

Pathways of exposure include surface water, groundwater, and air.

3.5.1 Surface Water

Surface water is not expected to be impacted, but if it is, it would be primarily impacted from groundwater seepage into the river. The river has previously been tested and was not impacted. Because the river loses water to the water table below the dam, it is unlikely that the West Plume contributes contaminants to the river.

Table 1

Village of Grafton - West Plume
Detected Volatile Organic Compounds
January 1997 to December 2006

Well	Date	Compound	Result	ES	PAL	Exceedence
P1B						
	5/13/1998	1,1,1-Trichloroethane	5	200	40	
	7/29/1998	1,1,1-Trichloroethane	5	200	40	
	5/13/1998	1,1,2-Trichlorotrifluoroethane	340			
	7/29/1998	1,1,2-Trichlorotrifluoroethane	230			
	7/29/1998	cis-1,2-Dichloroethene	1	70	7	
	5/13/1998	Trichloroethene	33	5	0.5	ES
	7/29/1998	Trichloroethene	30	5	0.5	ES
P1C						
	5/12/1998	1,1,1-Trichloroethane	5	200	40	
	7/28/1998	1,1,1-Trichloroethane	5	200	40	
	5/12/1998	1,1,2-Trichlorotrifluoroethane	380			
	7/28/1998	1,1,2-Trichlorotrifluoroethane	320			
	5/12/1998	1,1-Dichloroethene	2	7	0.7	PAL
	5/12/1998	cis-1,2-Dichloroethene	1	70	7	
	7/28/1998	cis-1,2-Dichloroethene	1	70	7	
	5/12/1998	Trichloroethene	30	5	0.5	ES
	7/28/1998	Trichloroethene	27	5	0.5	ES
P1D						
	7/28/1998	1,1,1-Trichloroethane	2	200	40	
	7/28/1998	1,1,2-Trichlorotrifluoroethane	23			
	5/14/1998	Trichloroethene	7	5	0.5	ES
	7/28/1998	Trichloroethene	13	5	0.5	ES
P3B						
	10/10/2006	1,1-Dichloroethane	16	850	85	
	5/11/1998	cis-1,2-Dichloroethene	2	70	7	
	3/23/2000	cis-1,2-Dichloroethene	0.48	70	7	
	10/10/2006	cis-1,2-Dichloroethene	450	70	7	ES
	10/10/2006	trans-1,2-Dichloroethene	7.4	100	20	
	5/11/1998	Trichloroethene	29	5	0.5	ES
	7/22/1998	Trichloroethene	20	5	0.5	ES
	1/25/2000	Trichloroethene	35	5	0.5	ES
	3/23/2000	Trichloroethene	32	5	0.5	ES
	6/19/2000	Trichloroethene	37	5	0.5	ES
	9/12/2000	Trichloroethene	36	5	0.5	ES
	12/13/2000	Trichloroethene	38	5	0.5	ES
	4/3/2001	Trichloroethene	42	5	0.5	ES
	6/13/2001	Trichloroethene	40	5	0.5	ES
	10/1/2001	Trichloroethene	36	5	0.5	ES
	3/19/2002	Trichloroethene	37	5	0.5	ES
	9/11/2002	Trichloroethene	48	5	0.5	ES
	3/19/2003	Trichloroethene	52	5	0.5	ES
	9/9/2003	Trichloroethene	53	5	0.5	ES

Table 1

Well	Date	Compound	Result	ES	PAL	Exceedence
	12/15/2003	Trichloroethene	46	5	0.5	ES
	3/23/2004	Trichloroethene	45	5	0.5	ES
	9/22/2004	Trichloroethene	46	5	0.5	ES
	3/24/2006	Trichloroethene	47	5	0.5	ES
	10/10/2006	Trichloroethene	120	5	0.5	ES
	5/11/1998	Vinyl chloride	1	0.2	0.02	ES
	10/10/2006	Vinyl Chloride	290	0.2	0.02	ES
P5B						
	5/7/1998	1,1,2-Trichlorotrifluoroethane	79			
	7/23/1998	1,1,2-Trichlorotrifluoroethane	99			
	5/7/1998	1,1-Dichloroethene	1	7	0.7	PAL
	5/7/1998	cis-1,2-Dichloroethene	1	70	7	
	7/23/1998	cis-1,2-Dichloroethene	1	70	7	
	5/7/1998	Trichloroethene	16	5	0.5	ES
	7/23/1998	Trichloroethene	19	5	0.5	ES
P7B						
	3/22/2006	1,1,2-Trichlorotrifluoroethane	0.58			
	9/14/2000	cis-1,2-Dichloroethene	0.58	70	7	
	12/13/2000	cis-1,2-Dichloroethene	0.53	70	7	
	4/5/2001	cis-1,2-Dichloroethene	0.61	70	7	
	6/14/2001	cis-1,2-Dichloroethene	0.88	70	7	
	10/4/2001	cis-1,2-Dichloroethene	2.3	70	7	
	12/13/2001	cis-1,2-Dichloroethene	1.6	70	7	
	3/20/2002	cis-1,2-Dichloroethene	2.2	70	7	
	6/12/2002	cis-1,2-Dichloroethene	2.5	70	7	
	3/24/2003	cis-1,2-Dichloroethene	0.99	70	7	
	12/17/2003	cis-1,2-Dichloroethene	2	70	7	
	6/29/2004	cis-1,2-Dichloroethene	3.5	70	7	
	9/23/2004	cis-1,2-Dichloroethene	1.6	70	7	
	12/9/2004	cis-1,2-Dichloroethene	1.3	70	7	
	3/22/2006	cis-1,2-Dichloroethene	1.3	70	7	
	3/23/2000	Trichloroethene	0.9	5	0.5	PAL
	6/22/2000	Trichloroethene	1	5	0.5	PAL
	9/14/2000	Trichloroethene	1.1	5	0.5	PAL
	12/13/2000	Trichloroethene	0.75	5	0.5	PAL
	4/5/2001	Trichloroethene	0.9	5	0.5	PAL
	6/14/2001	Trichloroethene	2.4	5	0.5	PAL
	10/4/2001	Trichloroethene	5.5	5	0.5	ES
	12/13/2001	Trichloroethene	4.3	5	0.5	PAL
	3/20/2002	Trichloroethene	5.6	5	0.5	ES
	6/12/2002	Trichloroethene	3.9	5	0.5	PAL
	9/12/2002	Trichloroethene	1.9	5	0.5	PAL
	3/24/2003	Trichloroethene	3.2	5	0.5	PAL
	6/11/2003	Trichloroethene	0.83	5	0.5	PAL
	9/10/2003	Trichloroethene	2.5	5	0.5	PAL
	12/17/2003	Trichloroethene	4.4	5	0.5	PAL
	6/29/2004	Trichloroethene	5.6	5	0.5	ES
	9/23/2004	Trichloroethene	3.6	5	0.5	PAL

Table 1

Well	Date	Compound	Result	ES	PAL	Exceedence
	12/9/2004	Trichlorocthene	1.2	5	0.5	PAL
	3/22/2006	Trichloroethene	2.9	5	0.5	PAL
	12/13/2000	Vinyl chloride	0.35	0.2	0.02	ES
	10/4/2001	Vinyl chloride	0.24	0.2	0.02	ES
	12/9/2004	Vinyl Chloride	0.33	0.2	0.02	ES
P9B						
	3/23/2000	1,1,1-Trichloroethane	0.86	200	40	
	12/15/2000	1,1,1-Trichloroethane	0.6	200	40	
	4/4/2001	1,1,1-Trichloroethane	0.51	200	40	
	3/25/1997	1,1,2-Trichlorotrifluoroethane	11			
	3/23/2000	1,1,2-Trichlorotrifluoroethane	8.7			
	6/21/2000	1,1,2-Trichlorotrifluoroethane	12			
	9/13/2000	1,1,2-Trichlorotrifluoroethane	15			
	12/15/2000	1,1,2-Trichlorotrifluoroethane	16			
	4/4/2001	1,1,2-Trichlorotrifluoroethane	13			
	10/2/2001	1,1,2-Trichlorotrifluoroethane	13			
	3/20/2002	1,1,2-Trichlorotrifluoroethane	16			
	3/22/2006	1,1,2-Trichlorotrifluoroethane	13			
	12/14/2006	1,1-Dichloroethane	15	850	85	
	9/13/2000	cis-1,2-Dichloroethene	0.41	70	7	
	12/15/2000	cis-1,2-Dichloroethene	0.44	70	7	
	4/4/2001	cis-1,2-Dichloroethene	0.55	70	7	
	10/2/2001	cis-1,2-Dichloroethene	0.92	70	7	
	3/22/2006	cis-1,2-Dichloroethene	4.9	70	7	
	12/14/2006	cis-1,2-Dichloroethene	420	70	7	ES
	12/14/2006	trans-1,2-Dichloroethene	7.6	100	20	
	3/23/2000	Trichloroethene	1.2	5	0.5	PAL
	6/21/2000	Trichloroethene	2	5	0.5	PAL
	9/13/2000	Trichloroethene	2.8	5	0.5	PAL
	12/15/2000	Trichloroethene	3.4	5	0.5	PAL
	4/4/2001	Trichloroethene	3.2	5	0.5	PAL
	10/2/2001	Trichloroethene	3.2	5	0.5	PAL
	3/20/2002	Trichloroethene	3.5	5	0.5	PAL
	3/22/2006	Trichloroethene	9.8	5	0.5	ES
	12/14/2006	Trichloroethene	110	5	0.5	ES
	12/15/2000	Vinyl chloride	0.22	0.2	0.02	ES
	4/4/2001	Vinyl chloride	0.19	0.2	0.02	PAL
	10/2/2001	Vinyl chloride	0.43	0.2	0.02	ES
	3/20/2002	Vinyl chloride	0.21	0.2	0.02	ES
	3/22/2006	Vinyl Chloride	0.32	0.2	0.02	ES
	12/14/2006	Vinyl Chloride	240	0.2	0.02	ES
PW724GB						
	3/7/1997	1,1,2-Trichlorotrifluoroethane	23			
PW740GB						
	3/11/1997	1,1 Dichloroethane	1	850	85	
	3/11/1997	1,1,1-Trichloroethane	0.5	200	40	
	3/11/1997	1,1,2-Trichlorotrifluoroethane	18			
	3/11/1997	1,1-Dichloroethane	0.7	850	85	

Table 1

Well	Date	Compound	Result	ES	PAL	Exceedence
	3/11/1997	Trichloroethene	2.2	5	0.5	PAL
PW-760 GB-100						
	3/19/1998	1,1,1-Trichloroethane	1	200	40	
	3/19/1998	1,1,2-Trichlorotrifluoroethane	140			
	3/19/1998	cis-1,2-Dichloroethene	1	70	7	
	3/19/1998	Trichloroethene	12	5	0.5	ES
PW-760 GB-140						
	3/19/1998	1,1,1-Trichloroethane	1	200	40	
	3/19/1998	1,1,2-Trichlorotrifluoroethane	88			
	3/19/1998	cis-1,2-Dichloroethene	1	70	7	
	3/19/1998	Trichloroethene	8	5	0.5	ES
PW-760 GB-195						
	3/19/1998	1,1,2-Trichlorotrifluoroethane	26			
	3/19/1998	Trichloroethene	2	5	0.5	PAL
PW-760 GB-235						
	3/19/1998	1,1,2-Trichlorotrifluoroethane	63			
	3/19/1998	Trichloroethene	6	5	0.5	ES
PW760GB						
	10/8/1997	1,1,1-Trichloroethane	2.5	200	40	
	10/8/1997	1,1,2-Trichlorotrifluoroethane	140			
	10/8/1997	1,1-Dichloroethene	0.7	7	0.7	
	10/8/1997	cis-1,2-Dichloroethene	1.6	70	7	
	10/8/1997	Trichloroethene	12	5	0.5	ES

The Exceedence column indicates the standard, either ES or PAL, if the result is above the standard.

Well Name Convention:
PW - Private Well
"-100" - Depth of discrete sample.

3.5.2 Groundwater

Groundwater is the most important pathway of concern because it can be impacted by all the primary sources. There may be preferential pathways for groundwater flow in a bedrock reef structure known to occur in the area. The numerous existing private wells in the area also serve to provide preferential pathways within the groundwater flow system because all the wells are constructed with long (up to about 100 feet) open boreholes within the rock. This allows constituents that enter the groundwater system to be mixed throughout the aquifer to at least the depth of the wells because groundwater flow can move freely both up and down the boreholes. Downward migration of constituents would be limited by an aquitard (Waukesha Dolomite) found at a depth of approximately 250 feet.

Fractures in the bedrock may also play a role in contaminant transport, however: 1) Tecumseh, a nearby investigation, found no strong correlation between fracture occurrence and contaminant concentrations, and 2) there are two scientific opinions on the importance of fracture flow in the area. One opinion believes it has a very strong influence, and the other opinion is that other factors, especially bulk permeability, will be a much more dominant influence on flow.

3.5.3 Air

Because the site is old, it has been years since product was added to the soil, the site is covered with nearly impermeable blacktop and cement, and concentrations by contaminants are not high in groundwater, it is not likely that there is an air pathway risk.

3.6 EXPOSURE ROUTES

The potential exposure route for surface water is dermal contact and incidental ingestion. Potential exposure routes for groundwater include ingestion, dermal contact, and inhalation (shower scenario). The potential exposure route for gas is inhalation. To evaluate risk, constituents in the groundwater, and soil will be characterized.

4.0 INVESTIGATION APPROACH AND PROCEDURES

4.1 DATA NEEDS

This chapter lists the specific data needs for characterizing the site and evaluating remedial actions, and lists the location and number of specific samples for each medium. Laboratory deliverables will include sample results and QA/QC summaries for blanks, duplicates, spikes, surrogates, and laboratory control samples. Deliverables will also provide the date of sample receipt, extraction date, analysis date, and analyst's name.

Analytical data generated from groundwater and soil sampling will also be added to the existing site database organized to facilitate data review and evaluation. The data set will include the data qualifiers provided by the performing laboratory.

The laboratory-provided qualifiers will include such items as:

- Nondetects.
- Concentration below required detection and reporting limits.
- Estimated concentration due to poor QC data.
- Concentration of chemical also found in the laboratory blank.

Analytical laboratory data will be reviewed to ensure project QC requirements were met. Data validation will be performed by conducting a systematic review of the data for compliance of the summary QA/QC packages to the established QC criteria based on the QC limits provided by the laboratory. An evaluation of data accuracy, precision, sensitivity, and completeness will be performed.

Data validation will be performed using the "National Functional Guidelines for Organic Data Review," February 1994, and "Functional Guidelines for Inorganic Data Review," February 1994. Qualifiers used during the validation process will indicate that the data are: 1) usable as a quantitative concentration; 2) usable with caution as an estimated concentration (coded J); or 3) unusable due to out-of-control QC results (coded R).

Project-specific analytical methods and method detection limits will be presented in a Quality Assurance Project Plan when a project-specific laboratory is chosen. The selected laboratory will be a Wisconsin-certified laboratory.

4.1.1 Groundwater

Existing private wells, monitoring wells, and one newly installed groundwater monitoring well will be sampled to provide additional information of the impacts to groundwater quality and to develop a better understanding of the hydrogeology of the area.

One monitoring well will be installed to supplement the nine wells currently monitoring the West Plume. Private wells along Green Bay Road will be evaluated for use in a groundwater monitoring program. Groundwater sample analysis will be based on the special VOC list currently used for the area that incorporates all VOCs that have been previously detected. One set of groundwater analyses will be collected to determine the current conditions within the plume.

One set of groundwater levels will be obtained from monitoring wells to evaluate the effects of fluctuations in groundwater levels on groundwater flow.

4.1.2 Soil Gas

During the soil investigation performed at the former Milwaukee Sign property, headspace readings will be collected to determine the potential for soil gas to be a potential migration pathway for contaminants.

4.1.3 Soil Contamination Extent

The limits of potential soil contamination areas will be assessed by conducting a soil boring investigation. The investigation will be completed over the former Milwaukee Sign property with uniformly spaced borings throughout the site. Samples will be collected to determine if site soils are contaminated with VOCs that have been detected in groundwater. In addition, groundwater will be sampled at up to three borehole locations if it is encountered.

4.2 SAMPLE LOCATIONS, NUMBERS, AND ANALYTES

The sections below describe the number of samples to be collected for each medium and specifies the analyte samples to be collected. The sample and well locations are shown on Figure 2.

4.2.1 Groundwater

One groundwater well will be installed along Green Bay Road, near the edge of the West Plume as defined in 1998. The proposed location for the well is on the Grafton Dells property, shown in Figure 2.

The borehole will be installed using sonic drilling techniques. Sonic drilling provides a straight, clean borehole with an intact, 6-inch diameter sample. The rig is capable of drilling in rock and soil. Drilling can be performed efficiently with minimal cuttings and high quality samples. The borehole will be drilled to approximately 250 feet, and logged by an Earth Tech geologist. Downhole geophysical measurements will be collected to aide in selecting the monitoring zone. Groundwater in the borehole will be sampled using a packer apparatus to collect discrete samples from the "B", "C" (Romeo Beds of the Racine Formation) and "D" (Waukesha Dolomite) monitoring zones.

The groundwater well will be set in the "B" monitoring zone, at the depth of the highest concentration and consistent with other site wells. That depth is at approximately 130 feet, and will be determined more closely by field geology, natural gamma readings, and groundwater packer sampling. The well will be constructed of 2-inch diameter PVC according to NR 140 requirements. The well will be named P-10B using the naming convention consistent with previously installed wells.

The monitoring well will be constructed in conformance with Chapter NR 141 of the WAC. The new monitoring well will be developed in accordance with Chapter NR 141. Slug testing will be performed to determine hydraulic conductivity.

Subsequent to development of new monitoring wells, water levels in the wells will be measured. One round of water levels shall be collected during the Phase I field effort.

Monitoring wells will be sampled once in Phase I to determine groundwater quality in the site area. A groundwater sampling event will be completed on 10 wells to monitor the West Plume and determine the hydrogeologic setting and chemical concentrations in groundwater. Groundwater samples will be analyzed for the special list of VOCs listed in Appendix D. The proposed sample event includes the following wells, as shown on Figure 2:

- P-1B – Middle of the plume
- P-1C – Middle of the plume
- P-1D – Middle of the plume
- P-5B – Middle of the plume
- P-6B – Upgradient
- P-7B – Downgradient edge of plume
- P-9B – Sidegradient
- P-10B (Proposed) – Sidegradient
- One private well on Green Bay Road – Sidegradient

4.2.2 Soil

A soil investigation will be completed at the former Milwaukee Sign property. Approximately 12 borings, or as many borings as can be completed in 1 field day, will be advanced at the property to bedrock or to 20 feet maximum depth, using direct push technology. A field geologist will oversee the drilling operation. The geologist will log the boreholes, identify obvious contamination, monitor soil with a photoionization detector (PID), and collect 2 soil samples from every borehole for laboratory analysis. Samples will be selected based upon field observation and PID readings collected in the field. The soil samples will be analyzed for VOCs from the special list contained in Appendix D. The list was used during the Lime Kiln Investigation, and it encompasses the compounds of concern that have been detected in the site area during previous investigations.

4.3 ACCESS

Access to several sites in the West Plume area must be secured to complete this work plan. The locations requiring access agreements are as follows;

- Former Milwaukee Sign property – The direct push soil investigation will be completed on this property. The current owners have been contacted and they are willing to allow the Village access to the property for minimally intrusive subsurface investigation. Access will be secured after the work plan is approved.
- Grafton Dells – Well P-10B is proposed on the Grafton Dells property. Grafton Dells has been contacted, and the organization is willing to allow an easement to complete the well on the property. Grafton Dells will be contacted after the work plan is submitted.
- Private wells along Green Bay Road will be surveyed to determine which wells are suitable and available to sample. Many wells have been abandoned. After the work plan is approved, a well survey will be completed on Green Bay Road, and the property owners will be asked to allow the Village access for well sampling.

4.4 SCHEDULE

Project schedule is dependant upon WDNR approval of this work plan. If the work plan is approved within 30 days of submittal, the tentative schedule for field work and reporting is as follows:

Field Work – June 2008
Sampling Event – June 2008
Investigation Report Submitted to WDNR – November, 2008
Beginning of Groundwater Sampling Program – November, 2008

5.0 MEDIA-SPECIFIC SAMPLING PLANS

5.1 GROUNDWATER SAMPLING AND MONITORING PLAN

The groundwater sampling and monitoring plan will include borehole drilling, downhole geophysical logging, packer testing, monitoring well installation, and groundwater sampling from boreholes, monitoring wells, and private wells.

5.1.1 Borehole Drilling

5.1.1.1 Introduction

One deep (approximately 250 feet) boring will be completed to evaluate the stratigraphy and to facilitate monitoring well installation and groundwater sampling. Subsequent to completing the deep boring, packer sampling and geophysical logging will be completed as described in Sections 5.2.3 and 5.1.2, respectively. After completion of the geophysical logging and packer sampling in the deep boring, a single deep monitoring well will be installed to monitor the "B" monitoring zone.

5.1.1.2 Equipment

1. Indelible markers (blue and red).
2. Geologist hammer.
3. Acid bottle.
4. Tape measure.
5. Earth Tech core logging standards.
6. Rock color chart.
7. Camera and film.
8. Field notebook and field documentation forms.
9. Sonic drill rig capable of drilling through unconsolidated deposits rock to a depth of 250 feet.

5.1.1.3 Procedures

The borings will be drilled using 6-inch sonic drilling technology, which is capable of drilling through soil and/or rock. The sample core from each hole will be placed in core boxes. Each core run will be clearly marked and numbered. Parallel blue and red lines will be drawn down the length of the core to assure that the core is maintained in its proper orientation. The core run number, recovery, length, and rock quality designation (RQD) will be recorded on each core box lid. The geologist's log will be recorded on field soil and rock log borehole forms with special attention to sample recovery, fractures and weathered rock, fracture orientation, and whether or not fracture surfaces are fresh, stained, pitted, encrusted, or weathered by solution. After the box and core are labeled, a photograph will be taken of the full core box.

5.1.1.4 Decontamination

The drill rig and downhole equipment will be decontaminated by steam cleaning upon arrival on site, and before leaving the site. The decontamination fluids will be discharged to the ground surface downslope to the respective borings.

5.1.1.5 Quality Control

Field documentation will undergo an internal QC after the completion of field activities. Original field forms will be reviewed by the project manager or senior technical staff for completeness, accuracy, and compliance with the work plan.

5.1.1.6 Documentation

Data collected and observations made during borehole drilling will be recorded on field forms included in Appendix C. Required field forms include:

1. Daily Time Log
2. Field Boring Log
3. Field Rock Borehole Log
4. Atmospheric Monitoring Log

5.1.2 Packer Test Sampling

5.1.2.1 Introduction

Sample zones will be packer sealed and sampled at various levels within the deep borehole to obtain discrete groundwater samples from these same intervals. Intervals will be selected based on visual inspection of the rock core and/or geophysical logs, and previously investigated zones. Samples will be collected from a maximum of three 10-foot long zones within the borehole.

5.1.2.2 Equipment

1. Drill rig capable of packer testing with a double packer assembly with three pressure transducers.
2. Tape measure.
3. Field documentation forms.

5.1.2.3 Packer Test Sample Procedures

The packer test samples will be completed using a double packer assembly with three pressure transducers to monitor head conditions above, below, and within each test section. The packer assembly consists of a pair of inflatable rubber cylinders separated by a section of perforated steel pipe. When the packers are inflated, a test zone within the borehole is isolated from the rest of the borehole. Water is then pumped out of the test zone via the perforated pipe, and under controlled conditions.

The general packer testing procedure is as follows:

1. Lower the packer assembly to the required depth;

2. Calibrate the pressure transducers;

3. Inflate the packers using compressed nitrogen;

4. Pump water through the drill rods to develop the sample area and prevent cross contamination;

5. Pump water from the sealed formation for a minimum of 30 minutes;

6. collect groundwater sample; and

7. Deflation/opening of all valves and packers.

Packer samples will be collected at depth intervals starting at the bottom of the completed borehole. The packers will then be inflated to prevent leakage. Successive intervals will be tested sequentially upward within the borehole.

5.1.2.4 Decontamination

The packer assembly, drop pipe, and submersible pump will be decontaminated by steam cleaning prior to being used downhole, and at the completion of testing. Decontamination liquids will be discharged to the ground surface.

5.1.2.5 Quality Control

Field documentation will undergo an internal QC review after the completion of field activities. Original field forms will be reviewed by the Field Manager who will review the field forms for completeness, accuracy, and compliance with the sampling plan.

5.1.2.6 Documentation

Data collected and observations made during the packer tests will be recorded on the appropriate field forms included in Appendix C. Recordable data from each packer test will include the test number, packer inflation pressure, depth interval tested, length of interval, flow meter, water loss, elapsed time, rate of loss, and gauge pressure. Documentation will include:

1. Daily Time Log
2. Purging and Sample Collection Form
3. Chain of Custody

5.1.3 Downhole Geophysical Logging

5.1.3.1 Introduction

Upon completion of the borehole, geophysical logging consisting of natural gamma and caliper will be completed. The results of this logging will be used to determine packer test intervals and the installation depth of monitoring wells installed in bedrock. Select private wells may also be logged.

5.1.3.2 Equipment

The following equipment will be required:

1. Caliper probe.
2. Natural gamma probe.
3. Digital logger.
4. Laptop computer.
5. Field documentation forms.

5.1.3.3 Logging Procedures

The logging procedure consists of lowering a probe to the bottom of the open borehole to continuously record the amount of natural gamma radiation present within bedrock or soil as the probe is brought to the surface at a rate of approximately 15 feet per minute. The gamma logs are scaled horizontally in gamma counts per seconds (cps). Caliper logging is performed to measure the diameter of the cased and uncased section of the hole is the size of the drill bit. Differences in hole diameter are related to the formation material type and can be used in conjunction with natural gamma logs to refine stratigraphic data and may also be indicative of zones of secondary porosity within the rock. Caliper logging will be performed using a three-arm caliper probe which measures the borehole diameter as the probe is withdrawn from the borehole at a rate of approximately 5 feet per minute. Digital data will be stored to hard disk for backup.

5.1.3.4 Decontamination

The respective probes will be cleaned prior to use and between each use by:

1. Soap and tap water wash.
2. Deionized water rinse.

The decontamination liquids will be discharged to the ground surface.

5.1.3.5 Quality Control

Field documentation will undergo an internal QC after the completion of field activities. Original field forms will be reviewed by the project manager or senior technical staff for completeness, accuracy, and compliance with the work plan.

5.1.3.6 Documentation

Data collected and observations made during geophysical logging will be recorded in a field notebook.

5.1.4 Monitoring Well Installation

5.1.4.1 Introduction

One groundwater monitoring well will be installed at Grafton Dells at the proposed location. Actual finished depth for each well will depend on the location of the water table and site stratigraphy and the presence of contaminants as determined in the field by the site geologist. The wells will be used to obtain groundwater samples for analysis, and to evaluate groundwater flow.

5.1.4.2 Equipment

Equipment to be used during monitoring well installation activities will include:

1. Drill rig with the capability of:

    a. Advancing borings with a minimum 6-inch diameter sonic technology per NR 141.
    b. Completing monitoring well installation.

2. Fiberglass tape of adequate length to measure the bottom of the well.
3. Electric water-level indicator of adequate length.

4. Field notebook and field documentation forms.
5. Tap and deionized water.
6. Liquinox® detergent.
7. Generator, steam cleaner, and related equipment.
8. Personal protective equipment, as needed.
9. Well construction materials.
10. Isopropanol (A.C.S.).
11. pH and conductivity meters.
12. Thermometer.
13. Submersible pump.
14. Hardhat, safety glasses, and steel-toed shoes.
15. Indelible marking pen and black ink pen.
16. PID (11.7 eV).

5.1.4.3 Well Installation Procedures

The monitoring well will be constructed of 2-inch (I.D.), 5-foot flush-threaded 0.010-inch slot PVC with Schedule 80 PVC riser.

Wells and piezometers will be constructed pursuant to NR 141 requirements as follows:

The annular space between the well screen and the borehole wall will be backfilled with No. 50 sand and will extend 2 feet above the well screen. Two feet of No. 10 sand will then be placed above the No. 50 sand. The well screen will be set so the water table is near the top of the screen. A 2-foot hydrated pellet bentonite seal will be placed above the filter pack. Above the bentonite seal, a PureGold® bentonite grout will be used to the ground surface. A 4-inch diameter locking steel protective casing will be placed around the PVC riser. Three guard posts will be placed around the well.

Wells will be developed after a minimum of 24 hours has elapsed following the completion of well construction. Well development will consist of pumping the well using a submersible pump. Intermittent surging will be performed, if appropriate, to aid in removal of fine-grained material. Well development will continue until at least ten well volumes have been removed and the water being removed from the well has the following characteristics:

1. Water is silt-free.
2. Water temperature is stabilized to $\pm$0.5 degrees Celsius.
3. pH is stabilized to $\pm$0.1 units.
4. Conductivity is stabilized to $\pm$10 percent.

Field instruments will be calibrated before use and the results recorded on Field Meter Instrument Calibration Logs.

5.1.4.4 Decontamination

Soil boring, monitoring well, and piezometer installation equipment will be decontaminated upon arrival on-site and between well locations to avoid the possibility of cross-contamination. Decontamination of drill rigs, vehicles, and other equipment will be accomplished with high-pressure hot-water steam cleaning. Additional scrubbing may be required to remove encrusted material.

Decontamination of the riser, well screens, and end caps will consist of high-pressure hot-water steam cleaning. Workers shall use clean cotton gloves when handling riser and well screen. Decontamination of well development equipment will consist of an external 1) soap and tap water

wash; 2) followed by a tap water rinse; 3) an isopropanol rinse; and 4) two rinses with deionized water. The pump will be equipped with a check valve to prevent purged water from flowing back into the well. Wastewater fluids generated during drilling and water removed from the wells during development will be disposed of on the surface at each well location with the exception of well P-2 which will have its water containerized for disposal off-site. Soil samples and rock core will be stored at Village of Grafton facilities. Should any landfill waste be encountered in these boreholes, the waste will be drummed for disposal at an acceptable permitted landfill.

5.1.4.5 Quality Control

Field documentation will undergo an internal QC review after the completion of field activities. Original field forms will be reviewed by the Field Manager or senior technical staff for completeness, accuracy, and compliance with the Work Plan.

5.1.4.6 Documentation

Data collected and observations made during the installation of the monitoring wells will be recorded on the appropriate field forms included in Appendix C. Documentation will include:

1. Daily Time Log.
2. Water Table Well Installation Diagram.
3. Piezometer Installation Diagram.
4. Well Development Form.
5. Field Meter Instrument Calibration Logs.
6. Atmospheric Monitoring Log.

5.1.5 Hydraulic Characterization

5.1.5.1 Introduction

Field hydraulic conductivity tests (slug tests) will be performed and water level measurements will be obtained to determine the hydraulic characteristics of the aquifer.

5.1.5.2 Equipment

Equipment includes the following:

1. Stainless steel slug.
2. Rope or cord.
3. Electric water-level indicator.
4. Water-level data logger with pressure transducer.
5. Field documentation forms.
6. Liquinox® detergent.
7. Deionized water.
8. Tap water.

5.1.5.3 Procedures

In-Field Hydraulic Conductivity Testing

The new well will be slug tested following development of the wells to determine the hydraulic conductivity of the formation materials near each well. Both falling and rising head tests will be recorded on an Infield Hydraulic Conductivity Test Form (Appendix C).

The pressure transducer will be lowered below the static water level to a depth which allows the slug to be lowered into the water without coming into contact with the transducer. The maximum transducer depth will be limited by the settings of the data logger and will be addressed when setting up the test. The rising or falling water level produced by dropping the slug into or pulling the slug out of the water will be recorded by a data logging device. A computer program using the KGS method of slug test analysis will be used to calculate the hydraulic conductivity values.

Water Level Measurements

Water level and well depth measurements will be taken immediately after installation of the new well, before and after well development, and during groundwater sampling. Water levels will be collected once during Phase I from monitoring wells for site characterization purposes. Well integrity will also be noted. Static water levels will be measured and recorded for estimating groundwater flow directions and gradients at the site. The water-level surface will be measured using an electric water-level indicator. Each well will have a reference point indicated on the top of the PVC well casing from which water-level measurements noted to the nearest 0.01 foot will be taken. A reference point elevation on the well will be established by survey with respect to mean sea level elevation with an accuracy of 0.01 feet.

5.1.5.4 Decontamination

Slugs, bailers, and water-level measurement equipment, with the exception of the pressure transducer, will be decontaminated prior to use and at each well location by:

1. Washing with soap and tap water solution.
2. Rinsing with tap water.
3. Rinsing twice with deionized water.

A distilled water rinse only (with no soap and water) will be used to decontaminate the pressure transducer. Decontamination liquids will be collected for proper disposal at a permitted facility.

5.1.5.5 Quality Control

Field documentation will undergo an internal QC review after the completion of field activities. Original field forms will be reviewed by the Field Manager or senior technical staff for completeness, accuracy, and compliance with the Work Plan.

5.1.5.6 Documentation

Data collected and observation made during in-field hydraulic conductivity tests and water level measurements will be recorded on the appropriate field documentation forms (Appendix C). Forms will consist of:

1. Daily Time Logs.
2. Infield Hydraulic Conductivity Test Form.
3. Water Elevation Form.

5.1.6 Groundwater Sampling

5.1.6.1 Introduction

New monitoring wells and selected private wells will be sampled for VOCs. Sampling of the monitoring wells and selected private wells will occur once during Phase I.

5.1.6.2 Equipment

The equipment to be used for groundwater sampling consists of:

- Two-inch diameter Grundfos® pump or equivalent.
- Electric water-level indicator, water-level popper, or steel tape.
- Field notebook.
- Conductivity meter.
- pH meter and pH 4 and 7 calibration buffer solutions.
- Tap water, deionized water, and ACS isopropanol.
- Liquinox® detergent.
- Sample containers and preservatives.
- Coolers.
- Ice.
- Plastic containers for transport of sampling equipment to the site.
- Thermometer.
- Teflon bailer and cord.
- PID.
- Disposable latex gloves.
- Outer nitrile gloves.
- Disposable outer boots.
- Tyvek® coveralls.

5.1.6.3 Sample Collection Procedures

Monitoring Wells

Prior to groundwater sampling, the static water levels in the monitoring wells will be measured and recorded. Once water levels are recorded, wells will be purged in order to collect samples for chemical analysis.

A minimum of five well volumes will be removed from the wells using a submersible pump or bailer. Purge water will be allowed to infiltrate the ground except at wells with ES exceedences, which will have their water containerized. If recharge rates are insufficient to conduct continuous pumping, the wells will be pumped or bailed dry, and a sample will be obtained after sufficient recharge has occurred to obtain enough volume to fill the sample containers.

Pumps used in the purging process will be fitted with a check valve to prevent purge water from flowing back into the well. During the purging process, selected chemical and physical characteristics of the purge water will be monitored and recorded. These characteristics include turbidity, color, odor, conductivity, pH, Eh, and temperature. Field meters will be calibrated daily according to manufacturer's instructions prior to sampling procedures.

Required purge volumes will be calculated as follows:

- To determine the volume of water to be purged from each well, measure the depth to the static water level, and depth to the bottom of the well from the reference measuring point.

- Based on the depth to water, the total depth of the well, and the diameter of the well, the volume of water standing (well volume) shall be calculated using the following formula:

  1 well volume (gallons) = 3.14 $d^2/4$ x h x 7.48 gallons/ft^3

  Where:

  d = diameter of well (ft)
  h (height of water) = depth to bottom (ft) - depth to water (ft)

Samples will be collected within 24 hours of purging, with the exception of those wells where recovery from the purging process exceeds 24 hours. Groundwater samples will be collected from the wells using a Teflon bottom-emptying bailer attached to a nylon cord or submersible pump.

Before pumping begins and after each of the five well volumes is removed, measurements of pH, conductivity, temperature, and turbidity will be recorded on the Well Purging and Sample Collection Form. Pumping should continue until the readings have stabilized to pH ±0.1 unit, conductivity ±10 percent, and temperature ±0.5 degrees Celsius. The total volume of water removed during the purging process will be recorded. The water level will be measured as soon as possible after the pump is removed from the well.

Chemical sampling equipment and bottles will be transported into the field in clean plastic pails. Samples, duplicates, and quality control samples will be collected. Equipment removed from the pails will be placed on clean plastic sheets in order to minimize contamination from the ground surface. New sheeting will be used for each sampling location. Samples for VOCs will be collected in three 40-mL glass vials with Teflon septa. The vials will be filled to the top, leaving no headspace or bubbles, then quickly capped to minimize losses of VOCs.

Samples for dissolved metals (if applicable) analysis will be field filtered using a 0.45 µm filter. Other analysis that requires filtration will also be done at the same time. Following field filtering, the samples will be preserved with the appropriate preservative. Samples will be stored in coolers containing ice in a secure area until custody is relinquished.

Private Wells

Private wells will be sampled for the same parameters and in the same manner as the previously described groundwater samples unless obstructions or access problems are encountered. Other procedures will be the same as for the well sampling.

5.1.6.4 Decontamination

Field equipment used for collection of groundwater samples will be decontaminated using the following method:

1. Wash with Liquinox®, Alconox®, or other suitable detergent and tap water.

2. A tap water rinse.

3. Isopropanol rinse.

4. Two rinses with deionized water.

Isopropanol rinses will be containerized for disposal off-site.

5.1.6.5 Quality Control

In order to verify the absence of contamination in field equipment, a rinsate blank (field blank) will be collected in the following manner after 10 groundwater samples are collected.

1. Field equipment used in groundwater sampling will be decontaminated.

2. Distilled water will be placed in the bailer.

3. Appropriate sample containers will be filled, preserved, and sent to the contract lab for analysis.

In order to assess the degree of accidental contamination by VOCs during the sample collection and shipment procedures, 40-mL volatile vials (trip blanks) will be filled by the field crew with the deionized water source to be used for field decontamination prior to mobilizing to the site. The filled vials will accompany the empty volatile vials that will be used for sample collection in the field. Two filled 40-ml vials will be packed with the site field samples and sent to the laboratory in each cooler containing groundwater samples for VOC analysis. The trip blanks will be analyzed for VOCs to be able to make a comparison to other VOC analyses in the same cooler. Field documentation will undergo an internal QC review after the completion of field activities. Original field forms will be reviewed by the Field Manager (FM) who will review the field forms for completeness, accuracy, and compliance with the sampling plan.

5.1.6.6 Documentation

Data collected and observations made during groundwater sample collection will be recorded on the field documentation forms, as shown in Appendix C. Documentation will consist of:

1. Daily Time Log.
2. Well Purging and Sample Collection Form.
3. Field Meter Instrument Calibration.
4. Air Monitoring Results.
5. Daily Quality Control Report.

5.2 GAS SAMPLING AND MONITORING PLAN

5.2.1 Introduction

Soil gas generation will be measured at direct push borings.

To establish the presence of gas migration at the site, the direct push boreholes will be monitored during drilling for both headspace and ambient air in the borehole.

5.2.2 Equipment

1. 4 Gas Detector (O_2, CH_4, CO, and H_2S).
2. Methane meter (% methane).
3. 11.7 eV PID

4. Liquid-level indicator.
5. Field documentation forms.
6. Plastic baggies.

5.2.3 Procedures

Soil samples will be extracted from each borehole for analysis. The monitoring technician will monitor the sample employing the following procedures.

Field monitoring will be performed with a natural gas indicator that measures concentration as percent by volume methane equivalents. An oxygen meter will measure concentrations as percent by volume. A 4 Gas Detector and an 11.7 PID will also be used to monitor for the presence of other gasses, and volatile organic gas.

The soil sample will be collected in a poly tube, which the driller will cut open when the technician is prepared to collect the headspace sample. The sample will be collected in a plastic bag and allowed to warm to 70 degrees Fahrenheit. The bag will be punctured with the tip of the methane and gas detectors, and the PID, to determine if gasses are present in the soil.

The monitoring devices will be placed in the direct push boreholes to determine the level of gas in the borehole at the ground surface. The reading will be collected after each sample is removed from the borehole.

The meters will be calibrated at the start and end of each monitoring day. The manufacturer's recommended calibration procedures shall be followed to obtain accurate measurements.

Each borehole will have a number or letter designation corresponding to site maps prepared for the site. This designation must be adhered to when completing the monitoring logs.

Water elevations will be measured in each borehole.

A field log will be completed for each monitoring event.

5.2.4 Decontamination

The water-level indicator will be decontaminated with deionized water between wells. The decontamination liquids will be discharged to the ground surface.

5.2.5 Quality Control

Meters will be calibrated before and after the start and completion of each day of monitoring. The calibration gas will be a certified standard. Field documentation will undergo an internal QC review after the completion of field activities. Original field forms will be reviewed by the Field Manager who will review the field forms for completeness, accuracy, and compliance with the Work Plan.

The laboratory performing the gas analyses will have a QA/QC program in place and will ensure all QA/QC procedures are followed for the analysis of organic compounds. Canisters will be decontaminated by the contract laboratory and evacuated to a known vacuum prior to shipment to the site for sampling. Trip blanks or duplicates will not be required, however the contract laboratory must have a program in place to conduct periodic testing of decontaminated canisters to ensure quality control and the integrity of the sample canisters.

5.2.6 Documentation

A log of daily monitoring activities will be maintained including liquid levels, pressure measurements, atmospheric conditions, and gas quality (Appendix C).

A log of calibrations will be maintained and a copy of the standard gas concentration certificate shall be incorporated into the records of the monitoring operations.

The appropriate copy of the chain of custody will be retained and placed in the records of site monitoring operations.

5.3 SOIL MATERIAL INVESTIGATION

5.3.1 Introduction

Soil materials will be investigated to determine the level of VOCs in soil at the former Milwaukee Sign property.

5.3.2 Soil/Waste Borings

5.3.2.1 Equipment

Equipment and materials used during soil/waste boring activities will include:

1. Direct push rig capable of:
    a. Advancing borings to an approximate 20-foot depth.
    b. Performing continuous sampling using appropriate continuous sampling system.
2. Fiberglass tape of adequate length to measure depth of soil boring.
3. Generator, steam cleaner, and related equipment (to be supplied by the driller).
4. Tap water.
5. Munsell Soil Color Chart.
6. Hardhat, safety glasses, and steel-toed boots.

5.3.2.2 Procedures

Direct push borings will be performed by a qualified subcontractor under the direction/supervision of a geologist or hydrogeologist who will field screen, visually inspect, classify soils according to USCS, log, and containerize soil samples. The drilling log will be used to evaluate the physical characteristics of the subsurface material. Field screening results will provide information on the presence of VOCs in the subsurface. Laboratory samples will be collected, containerized and shipped to the laboratory under chain of custody. Excess soil from the borings will be left on-site. Waste material encountered will be containerized for disposal/storage.

5.3.2.3 Decontamination

Upon mobilization to the site, prior to leaving the site and between boreholes, the drill rig, and sampling equipment will be decontaminated by steam cleaning to minimize the potential for cross-contamination. Decontamination liquids will be containerized for disposal off-site.

5.3.2.4 Quality Control

Field documentation will undergo an internal QC review after the completion of field activities. Original field forms will be reviewed by the project manager or senior personnel for completeness, accuracy, and compliance with the Work Plan.

5.3.2.5 Documentation

Soil boring information and other observations made by the on-site geologist or hydrogeologist during geoprobe activities will be recorded on the appropriate field forms shown in Appendix C. This will include:

1. Daily Time Logs.
2. Field Log - Soil Borehole.
3. Atmospheric Monitoring Logs.
4. Photographs and Descriptions.

5.4 SAMPLE IDENTIFICATION NUMBERS AND DOCUMENTATION

Each sample will be identified using the identification systems described below. These numbers will be used to complete sample documentation required for sample labels, and Chain of Custody Forms.

5.4.1 Sample Location Identifier

Sample location identifiers will be used on sample labels and Chain of Custody Forms. Sample Location Identifiers consist of the following components.

5.4.2 Project Identification Code

A two-letter designation will be used to identify the site where the sample was collected. The two-letter designation for the West Plume area will be WP.

5.4.3 Sample Matrix and Location Codes

Each sample will be identified by an alpha code corresponding to the sample medium (or sample type), followed by a sample location code. The alpha codes are as follows:

FB - Field Blank Sample
GS - Gas Sample
P - Monitoring Well Sample
PW - Private Well
TB - Trip Blank Sample
SS - soil VOC Sample
DG - Direct push groundwater sample

Field blank samples will have an identification code of FB followed by the appropriate alpha code for the type of sample (for example, a sediment water field blank will be identified as "FBSD"). Field duplicates will have the appropriate alpha code for the type of sample and a number which will be designated as a field duplicate number in field notes and the sample logbook.

Examples:

Private Well

WP-PW1300 Groundwater sample from private Well at street address 1300.

Monitoring Well

WP-P10B Groundwater sample from monitoring Well P10B.

Soil Sample

WP-SS01-10 Soil sample from boring 1, depth of 10 feet.

Grab Groundwater Sample (Direct Push Borehole)

WP-DG1 Groundwater sample from direct push boring 1.

NOTE: It is very important for database management purposes that the sample numbers be formatted exactly as shown in the examples.

5.4.4 Sample Labels

Every sample container that is to be transported to a laboratory for analysis of field samples must have a sample label attached to it. If an error is made in completing the sample label, destroy it, and complete a new one. Refer to Appendix C and complete the sample label as follows:

1. Sample Labels

    a. Fill in the Project Name and Project Number for the sampling event.
    b. Fill in the date the sample was collected.
    c. Fill in the Sample Location. Sample location corresponds to the Sample Number.
    d. Initial the label in the "Collected By" space.
    e. Write in the analysis (or analyses) that the sample in this container will be used for.

5.5 SAMPLE CUSTODY

The EPA sample custody and chain of custody protocols will be followed as described in "NEIC Policies and Procedures," EPA-330/9-78-001-R, revised June 1985. This custody is in three parts: sample collection, laboratory analysis, and final evidence files. Final evidence files, including all originals of laboratory reports and purge files, are maintained under document control in a secure area.

A sample or evidence file is under custody if it:

- Is in the possession of the sampler/analyst.
- Is in the view, after being in the possession of the sampler/analyst.
- Is in the possession of and then placed in a secured location.
- Is in a designated secure area.

5.5.1 Field-Specific Custody Procedures - Chemical Samples

The sample packaging and shipment procedures summarized below should ensure that samples will arrive at the laboratory with the chain of custody intact.

Field procedures are as follows:

1. The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. As few people as possible should handle the samples.

2. All sample containers will be labeled with sample numbers and locations.

3. Sample labels are to be completed for each sample using waterproof ink, unless prohibited by weather conditions. For example, a logbook notation will explain that an ink marker was used to complete the sample tag because the ballpoint pen would not function in freezing weather.

Transfer of custody and shipment procedures are as follows:

1. Samples are accompanied by a properly completed Chain of Custody Form. The sample numbers and locations will be listed on the Chain of Custody Form (Appendix C). When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to the laboratory, or to/from a secure storage area.

2. Samples will be properly packaged for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in each sample box or cooler. Shipping containers will be locked and secured with strapping tape and custody seals for shipment to the laboratory. The preferred procedure includes use of a custody seal attached to the front right and back left of the cooler. The person sealing the cooler should date and sign each custody seal. The custody seals are then covered with clear plastic tape. The cooler is strapped shut with strapping tape in at least two locations.

3. All shipments will be accompanied by the Chain of Custody Form identifying the contents. The original and yellow copies will accompany the shipment and the pink copy will be retained by the sampler for inclusion in the project file.

4. Air bills will be used with samples sent by commercial overnight carriers. The air bill number will be recorded on the custody form. Air bills will be retained as part of the permanent custody documentation. Commercial carriers are not required to sign off on the custody forms as long as the custody forms are sealed inside the sample cooler and the custody seals remain intact. If sent by mail, the package will be registered with return receipt requested.

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APPENDIX A

CORRESPONDENCE

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

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Scott Hassett, Secretary
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May 29, 2007

Responded - June 29.

Darrell Hofland, Administrator
The Village of Grafton
1708 12th Avenue
Grafton, Wisconsin 53024

FID 246036780

Dear Mr. Hofland:

Thank you for meeting with representatives of the Department of Natural Resources on May 23, 2007, to discuss the notice of violation issued to the Village on April 23rd. If you are not in agreement with this summary, please send your comments to my attention at your earliest convenience.

In attendance: Darrell Hofland and David Murphy (Village of Grafton), Buck Sweeney (Axley Brynelson, LLP, representing the Village), B.J. LeRoy (Earth Tech, consultant for the Village), John Feeney, Walt Ebersohl, Judy Ohm and Pat Chung (DNR)

Conference Agreement

- Earth Tech will submit a 2006 remedial action status report for the Lime Kiln Park Landfill to John Feeney by June 30, 2007. The submittal will include 2006 sampling data for the east plume and recommendations for additional sampling and/or remedial actions, including a recommendation for additional deeper piezometers to determine the vertical extent of contamination in groundwater at the P8 and P2 locations. B.J. LeRoy will also include a copy of the map used at the meeting.
- Earth Tech will prepare a sampling plan for investigation of the west plume, to include conducting geo-probes of the Ozaukee Real Estate ("ORE") site, and installation of a new monitoring well/s. Following approval of the plan by the Village of Grafton, Earth Tech will submit the plan to the DNR, no later than July 31st, 2007. The submittal will include a summary of the Village's historical investigation of the site, including information obtained in interviews conducted by Winter Hess.
- Buck Sweeney will contact the owners of the ORE property to secure access for sampling. If there are problems securing access, Judy Ohm will assist in obtaining access, and will, if necessary, prepare a letter to the company explaining the potential consequence of prohibiting access under state law.
- John Feeney will review DNR files for the names of ORE contacts for the site, and will provide the name(s) to Buck Sweeney.
- Buck Sweeney will provide Judy Ohm with copies of documents from the Village's negotiation and cost recovery process under s. 292.35. Stats, including PRP agreements, if the documents are not found in the files for the DNR's Bureau of Remediation and Redevelopment, Fiscal and Information Technology Section.
- Walt Ebersohl will discuss Grafton's plans for redevelopment of the ORE property with Brownfield staff and will notify Buck Sweeney if staff is aware of any additional funding sources for the project.
- B.J. LeRoy will provide John Feeney with documentation of whether Earth Tech submitted a review fee with the 2005 report.

Discussion

Pat Chung thanked representatives of the Village and their agents for attending the meeting. She said that the Department was concerned about conditions at Lime Kiln, because it appeared that no actions had been taken to address conditions in the east plume for the past two years, and that no action had been taken to investigate and remediate the west plume. She said that the Department had authority to refer violations of S. 292.11, Wis. Stats., to the Department of Justice.

Buck Sweeney said that the April 23rd Notice of Violation had falsely stated that the Village did not respond to the Department's requests to investigate the West Plume. He said that Earth Tech had responded to requests for further investigation via e-mail and letter, indicating that the Village did not believe it was responsible for investigating contamination located on the Ozaukee Real Estate ("ORE") Association site.

Sweeney said that there was TCE in the west plume, but there was no evidence that TCE was used at the ORE site. He said that the owners of Milwaukee Sign (who leased the site from ORE) were convinced that the property was not the source of the plume containing TCE.

Sweeney said that the Village was interested in redeveloping the property as a Brownfield, and had asked Earth Tech to develop a plan that would meet the DNR's expectations and allow the Village to proceed with redevelopment.

B.J. LeRoy and Sweeney said that the Village had provided municipal water to home owners whose drinking water wells were contaminated by the west plume. LeRoy said that the potable wells had been helpful in determining the southern edge of the plume. He said that the wells were abandoned, and that Earth Tech was proposing to install a new monitoring well/s to further define the southern boundary of the west plume.

John Feeney said that Earth Tech should collect soil borings directly from the ORE property. Sweeney said that the Village was proposing to raze the building on the property, and redevelop the property using SAG grants and other money available for Brownfield's development. Sweeney said they were going to talk with the Department of Commerce to find out if they qualified for additional money; Walt Ebersohl said he would let Sweeney know if DNR Brownfield's staff were aware of other funding sources. Feeney said that if the building's concrete slab was destroyed, additional contamination might be released. Sweeney said it might be feasible to retain the cap. He said that Earth Tech could conduct geo-probes on the ORE property, but that they would need to work with ORE to secure access. Feeney said he would review DNR files for the names of any ORE contacts for the site. He said that if he found any, he would provide the name(s) to Sweeney. Judy Ohm said that if ORE denied access, she would assist Sweeney in securing access. Sweeney said that the Village would need a chance to review and approve a sampling plan for the ORE site before it could be sent to the DNR. David Murphy said that the Village could complete the review in time to allow submittal by the end of July. LeRoy said he would submit a new sampling plan for the west plume to the DNR, along with a brief summary of the historical investigation of the site, by July 31st.

Ohm said that the Department would like to review the documents from the negotiation and recovery process, under s. 292.35, Stats., including the agreements that the Village signed with all of the PRPs that entered into the municipal negotiation/cost recovery process. She said that she would check with Marie Stewart of the Bureau for Remediation and Redevelopment Fiscal and Information Technology Section to see if the Department had any of the documents. Sweeney said he would provide the documents to Ohm if she was unable to locate them.

Feeney said he had not received any data for samples collected in 2005 or 2006. LeRoy said that he had not done any sampling in 2005, because he had made an argument for natural attenuation in the report he submitted to the DNR in 2005. LeRoy said that he stopped sampling, waiting to hear from the Department, but since he did not hear back, he resumed sampling in 2006. He is currently only sampling for VOCs. The Department requested additional monitoring wells to define the vertical extent of

contamination in the east plume, due to increasing concentrations of trichloroethylene at PW8B. LeRoy said that Sigma can't find suitable locations for additional wells. He said that increasing concentrations of vinyl chloride demonstrate that natural attention is working and that trichloroethylene at PW8B is breaking down. LeRoy said that the 2006 report and data for the east plume is currently under review by the Village, and will be submitted to Feeney by June 30, 2007. LeRoy will also include recommendations for additional sampling of the east plume with the submittal.

Ebersohl said that it would be very unusual for the Department to not respond to a request for review, if it was submitted along with a review fee. (*Under NR 749.04 (1), Wis. Adm. Code, when a person requests the department to review a document listed in Table 1, the person requesting this assistance shall pay to the department the applicable fees....Appropriate fees shall accompany all requests for specific department assistance. Department assistance will not be provided unless the applicable fee accompanies the request for assistance....)* LeRoy said he would check his records and see whether the company had submitted a review fee with the report, and would submit the information to Feeney. He will also send Feeney a copy of the map he brought to the meeting.

Sincerely,

Pat Chung

Pat Chung
Environmental Enforcement
Southeast Region

cc: John Feeney – SER
Judy Ohm – LS/5
Walt Ebersohl - SER
Earth Tech
Buck Sweeney

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June 28, 2007

Ms. Pat Chung
Wisconsin Department of Natural Resources
Southeast Region Headquarters
2300 North Dr. Martin Luther King Jr. Drive
Milwaukee, WI 53212-3128

Subject: **ORE West Plume Correspondence**
Village of Grafton
Lime Kiln Landfill
Earth Tech Project No. 30250

Dear Ms. Chung:

Earth Tech, on behalf of the Village of Grafton, is submitting this letter is in response to your May 29, 2007, correspondence to the Village, regarding the ORE West Plume and the Lime Kiln Landfill projects in the Village. This letter clarifies several statements in the May 29 letter.

The WDNR references the FID number used for the Lime Kiln Landfill for both the ORE West Plume and Lime Kiln sites. While we understand the two sites share some data, we consider the two sites separate. We request the use of separate FID numbers for each site because they are two separate projects. We also request that FID 246036780 stay with the Lime Kiln site because that site has received grants under that FID and it has much more work under that FID than the ORE West Plume project.

We did not expect to discuss the Lime Kiln Landfill regarding the notice of violation for the ORE West Plume. We have responded to every WDNR request for the Lime Kiln project and have actively worked toward closure. As mentioned at the meeting, it was good to talk about the Lime Kiln project, and certainly the projects are related to the degree that the plumes are in the same area of the Village and may share a few monitoring wells. However, the Lime Kiln project status should not be in question and discussion of its status at the notice of violation meeting might have been misplaced.

Specific comments are as follows:

Conference Agreement Bullet 1: Earth Tech will make recommendations for future sampling of the existing wells monitoring the Lime Kiln plume. Earth Tech did not agree to recommend additional piezometers. At the May 23, 2007 meeting, John Feeney wondered aloud if additional piezometers would be beneficial. When John has asked this question before, Earth Tech has always responded the same way. We realize that monitoring for downgradient protection is warranted until levels are stable or decreasing. In the 1999 RI, we made the argument, and the WDNR agreed that the plume's nature and extent were adequately defined. The monitoring wells used in the RI are still sampled quarterly in the current monitoring plan. Earth Tech had also sampled at depth during the RI in several private wells that were later abandoned. There is

a significant confining layer below the site in the Waukesha Dolomite that has extremely low porosity and hydraulic conductivity. We also have no reasonable place to put additional piezometers in alternate locations because the river and associated wetlands are inaccessible. The current system adequately monitors the plume as it attenuates.

Conference Agreement Bullet 2: Earth Tech is preparing a sampling plan for submittal to the WDNR for the ORE West Plume investigation. At the meeting, we discussed and agreed upon one additional well to compliment the 10 wells that are already in place to monitor the plume. This well will be placed to monitor the south edge of the plume along Green Bay Road. We are not considering adding more than one well at this time, per our discussion and agreement on May 23.

Discussion Paragraph 5: Private wells were helpful in 1999 for determining the southern extent of the ORE West Plume. Not all private wells are abandoned along Green Bay Road, and these wells will be used again to evaluate the plume extent. One new discrete monitoring well will be proposed at a location along Green Bay Road that is dependent upon property access.

Discussion Paragraph 8: We have shown that natural attenuation is occurring through several processes. After 2004, we submitted our updated monitoring plan to the WDNR recommending that sampling be reduced to VOCs only, because natural attenuation was clearly documented as occurring. We did not submit the review fee at that time because it was our understanding that it was not necessary. We did make John aware of the plan to sample only VOCs. Earth Tech will continue to monitor the VOC trends within the plume, and to ensure downgradient users that their drinking water was suitable for use. Our intent was not to request closure, it was simply to reduce the monitoring plan after 5 years, as we had previously outlined in 1999. The site does require continued monitoring because one well shows an increasing trend of TCE breakdown products.

Discussion Paragraph 8: The WDNR did not request additional wells. John Feeney has forwarded only one correspondence to the Village since 2005 that is specific to the Lime Kiln Plume. His August 10, 2005, letter was received and we responded to that letter via phone call and e-mail, and submittal of the 2004 Annual Report. There was no specific request for additional piezometers in that letter. I spoke with John after receiving the letter. According to my phone log, he mentioned that he was working on a more specific letter regarding the Lime Kiln Plume. I explained that deep piezometers were not feasible or necessary for several reasons, which are detailed in the annual report and the RI. We agreed to wait until John's letter to have a further discussion. To my knowledge, the Village had not received a letter specifically requiring additional piezometers. We have heard nothing further from the WDNR regarding the Lime Kiln Plume until the ORE West Plume notice of violation meeting.

Discussion Paragraph 8: Please note that Sigma is not involved in this project.

Discussion Paragraph 8: The Village has a draft of the 2006 Lime Kiln Annual Report. Earth Tech will submit the Annual Report before June 30, 2007.

If you have any questions or comments, please let me know. It was good to speak with you and we look forward to working with the WDNR to close the ORE West Plume in a timely manner.

Sincerely,

Earth Tech, Inc.

B.J. Le Roy
Project Manager

c: John Feeney, WDNR
Judy Ohm, WDNR
Walt Ebersohl, WDNR
Darrell Hofland, Village of Grafton
David Murphy, Village of Grafton
Buck Sweeney, Axley Brynelson, LLP
Joan Underwood, Earth Tech

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July 31, 2007

Mr. John Feeney
Wisconsin Department of Natural Resources
1155 Pilgrim Road
Plymouth WI 53073-429

Subject: **Village of Grafton West Plume**
Earth Tech Project No. 100907.01

Dear John:

A TCE plume (the "West Plume") was identified in groundwater in the Village of Grafton through groundwater sampling that occurred between 1996 and 1998. The plume was further defined in a 1999 Site Investigation Report submitted to the Wisconsin Department of Natural Resources (WDNR). The Village of Grafton assumed responsibility for plume investigation in a 1998 agreement between the Village and potentially responsible parties.

On May 23, 2007, representatives from the WDNR and the Village of Grafton (including their consultants Earth Tech, Inc. and Buck Sweeney, Esq.) met to discuss the groundwater plume and determine a course of action for the plume investigation. The meeting minutes compiled by Pat Chung of the WDNR and an Earth Tech response to those minutes are included in Attachment A.

An agreement was reached at the meeting that Earth Tech would prepare a summary of the West Plume investigation history, and recommend further action for the West Plume investigation under Wisconsin Administrative Code NR 716.07, Site Investigation Scoping. This document includes the required summary and Earth Tech recommendations.

SITE SETTING

The West Plume and Lime Kiln Landfill site area is within the Village of Grafton, Ozaukee County. Specifically, it is in the SE 1/4 of the NW 1/4 of Section 25, Township 10 North, Range 21 East of the Cedarburg 7.5-minute quadrangle. The West Plume is bounded by First Avenue to the West, Lakefield Road to the South, Oak Street and Lime Kiln Park to the north, and the Lime Kiln Plume on the east. Lime Kiln Park is located off of Green Bay Road, just south of the intersection of Falls Road and Green Bay Road (Figure 1). The landfill is inside the park.

The Milwaukee River borders the south and east edges of the park, while residential areas border the northeast, west, and southwest sides of the plume area. Industries and businesses, including Milwaukee Sign/ORE, are located west, north, and northwest of the plume area.

SITE AREA HISTORY

Preliminary investigations in the early 1980s by WDNR (IT, 1989) detected volatile organic compounds (VOCs) in municipal well Nos. 1, 2, 4, 5, and 6. As a result, the WDNR conducted a groundwater quality survey of public, private, and monitoring wells in the Village and Town of Grafton. Groundwater was tested for 45 VOC compounds. Eight compounds were detected throughout the area, including compounds that are detected in groundwater near Lime Kiln Park.

The Wisconsin Department of Health (WDH) and the WDNR initiated the sampling of approximately 95 residential wells in the site area during July 1996, because of VOCs detected by a private well owner in July 1996. Agency sampling continued through 1997. The United States Environmental Protection Agency (EPA) was notified about well contamination by residents who asked EPA to provide interim funding for alternative drinking water and guidance. The EPA also performed groundwater sampling during this period.

The WDNR and EPA sampled private wells in the area, mainly along Green Bay Road and within the Manchester Drive area, south (downgradient) of the site area. Based on groundwater sampling results the EPA issued a consent order that was signed and dated by Village representatives on July 7, 1997. The EPA delineated an advisory zone in which private wells were to be abandoned and homes were to receive Village water. Construction of the water mains commenced in 1997 and private residences were connected to the Village water system by 1998. The WDNR targeted the Lime Kiln Landfill as the source of contamination, and required the Village of Grafton, the landfill owner, to investigate the landfill under NR 700.

Groundwater contamination was detected upgradient and sidegradient of Lime Kiln Park, to the west and northwest along Green Bay Road and Wisconsin Avenue. Several compounds detected in groundwater are not detected in samples collected within the Lime Kiln Landfill or associated groundwater plume. In particular, Freon 113 has been detected upgradient of the Lime Kiln Park, and TCE has been detected at several wells along Green Bay Road. The upgradient groundwater contamination originates between Wisconsin Avenue and First Avenue, near the area formerly occupied by Milwaukee Sign.

Wells in the Green Bay Road area showed detects of Freon 113, which is not detected in the Lime Kiln Landfill. Based on the Freon compound, two plumes were delineated as shown on Figure 1. The Village and the Lime Kiln PRP Group addressed the Lime Kiln Landfill, and the PRP's eventually paid the Village to be removed from liability for the landfill. The Village did not address the West Plume (Green Bay Road) because it is a result of a source other than Lime Kiln Landfill.

On May 23, 2007, representatives from the WDNR, the Village of Grafton and Earth Tech met to determine a course of action for the West Plume. After agreement was reached at the meeting, Earth Tech was tasked with proposing a scope of work to investigate the West Plume under NR 716.

SITE AREA CONCEPTUAL MODEL

The conceptual groundwater flow model for the site area consists of thin unconsolidated glacial deposits and urban land/fill which overlie a nearly flat lying unconfined dolomite bedrock aquifer, the Racine Formation. The dolomite aquifer contains lithologic changes and individual hydrostratigraphic units classified as aquifers or aquitards. The vertical extent of the conceptual model is bounded by a lower permeability aquitard, the Waukesha Dolomite.

The Silurian-age dolomite aquifer is comprised of undifferentiated Racine Formation and the Romeo beds of the Racine Formation. The aquifer extends approximately 200 feet below the top of bedrock, coincident with the contact of the underlying Waukesha Formation. The Waukesha Formation is designated as an aquitard based on the visual observations of the rock core and low flow rates noted by borehole flowmeter testing.

The water table in the local groundwater flow system is found near or below the surface of the bedrock. The water table is approximately 15 to 20 feet below the ground surface.

The Milwaukee River lies south and east of the site area. The 500- to 700-foot reach of the River immediately downstream of the dam adjacent to Lime Kiln Park is higher than the water table. Water therefore flows from the river bottom to the aquifer. Groundwater may discharge to the River downstream of this reach.

Local groundwater flow components control groundwater flow in the site area, and are affected by larger, regional flow systems. Groundwater in the uppermost aquifer (Racine Formation including the Romeo beds) is considered part of the regional flow systems with a recharge area encompassing the site as well as topographically high areas west of the site area. Longer flow paths and discharge to Lake Michigan located about 2.5 miles to the east of the site also characterize the regional flow system.

Once water reaches the water table, flow is controlled by the hydraulic head in the units as shown by water levels in wells surrounding the site. The downward gradients are consistent with the site area's position within a recharge area as evidenced by vertical gradients observed at the several monitoring well locations.

Groundwater flow is controlled primarily by the bedrock structure and the regional discharge to Lake Michigan. In highly transmissive zones (higher hydraulic conductivity) such as the Racine Dolomite, groundwater flows predominantly by advection. Open borehole wells and vertical fractures interconnect the Racine Formation throughout its thickness.

The regional groundwater flow pattern may also be influenced by public and private water supply wells in the area. The Village of Grafton has seven water supply wells that pump groundwater. Two wells with limited usage are located near the site area. Private residence wells outside the Village limits also withdraw groundwater and may affect groundwater flow.

Four monitoring zones were determined through the field investigation; the water table zone; the "B" Zone, a more porous limestone zone in the Racine formation; the Romeo Beds of the Racine Formation ("C" Zone), and the Waukesha Dolomite directly below the Romeo Beds (the "D" Zone.) The majority of wells were screened in the "B" Zone, where the highest levels of contamination were sampled. The B zone is the monitoring zone for the adjacent Lime Kiln Landfill monitoring program.

PREVIOUS SITE INVESTIGATION

Earth Tech was contracted by the Village of Grafton to conduct the NR 700 investigation of the Lime Kiln Park area in 1997. Implementation of the WDNR approved Work Plan began in February of 1998. An investigation report was submitted in January, 1999. Through the course of the investigation, the following items were completed:

- A literature search of the landfill and the Village of Grafton areas.
- Waste characterization that evaluated the size and type of source material at the Lime Kiln Landfill.
- A geologic, hydrogeologic, and surface water investigation of the surrounding area.
- Characterization of potential migration pathways.
- Preliminary Remedial Action Identification for the Lime Kiln Landfill.

Nine groundwater wells, 2 waste wells, 33 Geoprobe borings, and a geophysical investigation were implemented to evaluate the geology and hydrogeology, and investigate the sources, nature and extent of groundwater impacts in the site area. Multiple private wells were also used to characterize the subsurface and investigate the nature and extent of groundwater contamination. Figure 1 serves as an existing conditions map which shows the location of monitoring wells, sampled private wells, and the nature and extent of both plumes in the site area.

The conclusions of the Site Investigation were as follows:

- The Lime Kiln Landfill is a source of groundwater contamination.

- Groundwater is the only media through which contamination is expected to migrate from the landfill to receptors. Groundwater carries contamination from the landfill into the upper 100 to 200 feet of the Racine Dolomite.

- Receptors affected by groundwater contamination are private wells in Manchester Drive area. Potential receptors, currently not impacted, are wells along Lakefield Road, and the Milwaukee River and associated wetlands south of Manchester Subdivision.

- Low levels of contaminants were measured in Lime Kiln Landfill gas, which is not expected to be a significant pathway for contaminant migration because of the low methane levels encountered and the limited area in which landfill gas was detected.

- Two groundwater contaminant plumes were delineated during this investigation. Groundwater contamination from the landfill is limited to the area shown on Figure 1. Groundwater contamination from other sources contributes to the West Plume. The plumes are distinguished by compounds unique to each plume. NR 140 standards are exceeded for limited compounds in each plume.

- Transport of groundwater contamination occurs in both the pores of the rock matrix and fractures in the rock. The rock matrix is sufficiently permeable such that fractures are not the sole permeability controlling contaminant migration. However, the regional fracture set aids in keeping the plume narrow when groundwater flow is parallel to a fracture set.

- Treatment is occurring through natural attenuation of parent VOC products as evidenced by the presence of breakdown byproducts, and the levels of natural attenuation indicators in groundwater such dissolved oxygen, ethanes, and dissolved metals.

- The groundwater plume from the landfill is likely to be stable or receding, based on the length of time since the disposal of waste, the volume of the landfill, and natural attenuation processes.

EXISTING CONDITIONS

Seven of the nine previously mentioned monitoring well locations, including a three level multi-port well, are installed in such a way as to monitor the West Plume. Three private wells in the West Plume (PW760GB, PW1788MR/P9B, PW1749MD/P8B) were tested using a packer apparatus to sample discrete areas. Based upon groundwater samples from private and monitoring wells, the nature and extent definition of the West Plume was nearly complete at the time of the 1998 field investigation. Sample locations and generalized concentrations of TCE are shown on Figure 1.

Two data gaps exist in the definition of nature and extent for the West Plume. The southern plume boundary is not clearly defined, as there is no existing discrete well located along Green Bay Road. Private wells may be used for general plume location, but do not define the level of contamination in the area due to long, non-discrete screened intervals. Also, the West Plume source area has not been characterized to determine if soil contamination remains at the site from which impacts originated.

RECOMMENDATIONS

In order to complete the field investigation and determine the nature and extent for the West Plume, the following items are recommended:

- Source Characterization - A Geoprobe investigation is recommended at the Milwaukee Sign/ORE property. Approximately 12 borings will be advanced at the ORE property to bedrock, using direct push technology. A field geologist will oversee the drilling operation. The geologist will log the boreholes, identify obvious contamination, monitor soil with a photoionization detector, and collect two soil samples from every borehole for

laboratory analysis. Samples will be selected based upon field observation and PID readings collected in the field. The soil samples will be analyzed for VOCs from the special list contained in Attachment B. The list was used during the Lime Kiln Investigation, and it encompasses the compounds of concern that have been detected in the site area during previous investigations.

- Groundwater well installation - One groundwater well will be installed along Green Bay Road, near the edge of the West Plume as defined in 1998. The proposed location for the well is on the Grafton Dells property, shown in Figure 1. Access has not yet been contractually agreed upon. However, Grafton Dells has been contacted and is willing to work with the Village to find a suitable well location on their property.

  The borehole will be installed using sonic drilling techniques. Sonic drilling provides a straight, clean borehole with an intact, six-inch diameter sample. The rig is capable of drilling in rock and soil. Drilling can be performed efficiently with minimal cuttings and high quality samples. The borehole will be drilled to approximately 150 feet, and logged by an Earth Tech geologist. Downhole geophysical measurements will be collected to aide in selecting the monitoring zone. Groundwater in the borehole will be sampled using a packer apparatus to collect discrete samples from two specific intervals.

  The groundwater well will be set in the "B" monitoring zone, at the depth of the highest concentration and consistent with other site wells. That depth is at approximately 130 feet, and will be determined more closely by field geology, natural gamma readings, and groundwater packer sampling. The well will be constructed of 2-inch diameter PVC according to NR 140 requirements. The well will be named P-10B using the naming convention consistent with Lime Kiln Landfill wells.

- A groundwater sampling event will be completed on ten wells to monitor the West Plume and determine the hydrogeologic setting. The proposed sample event includes the following wells, as shown on Figure 1:

  P-1B – Middle of the plume
  P-1C – Middle of the plume
  P-1D – Middle of the plume
  P-5B – Middle of the plume
  P-6B – Upgradient
  P-7B – Downgradient edge of plume
  P-9B – Sidegradient
  P-10B (Proposed) – Sidegradient
  2 private wells on Green Bay Road – Sidegradient

  The wells will be sampled for VOCs from the special list that is used for the plume area. Field indicators including DO, ORP, temperature, conductivity and turbidity will also be collected. The samples will be used to evaluate the nature and extent of groundwater contamination in the West Plume area and to begin to assess if natural attenuation is a viable remedial option for the site.

- After the field investigation is completed, an NR 700 investigation report will be completed for the West Plume. The report will detail the site background, investigation procedures, site characterization including geology and hydrogeology, the nature and extent of contamination, a preliminary remedial alternatives identification, and site recommendations.

After the field investigation and NR 700 report are complete, Earth Tech will determine a technically and economically feasible remedial alternative for the West Plume in accordance with NR 700.

INVESTIGATION SCHEDULE

The Village of Grafton needs approval of this scope prior to August 26 in order to place the item on the September Village Board meeting agenda. If approval is received by that time, the Village will begin preparation for the field investigation upon their Board's approval. The investigation will begin with preparation of a brief work plan and a health and safety plan. Both will be submitted to the WDNR for approval. The field investigation can be completed in the fall of 2007 if WDNR approval is granted in a timely manner. The field investigation results would be analyzed in the fall/winter of 2007, with an investigation report submitted to the WDNR in the spring of 2008. The remedial option evaluation would begin immediately following submittal of the investigation report.

As the recommendations in this letter match the recommendations we agreed to at the May 23rd meeting, I anticipate that approval of this approach will be received by August 26. Please contact me at 920-451-2589 or bj.leroy@earthtech.com if you have any questions about the approach we have outlined.

Thank you,

Sincerely,

Earth Tech, Inc.

BJ.LeRoy Digitally signed by BJ.LeRoy
DN: cn=BJ.LeRoy
Reason: I am the author of this document
Date: 2007.07.31 11:25:00 -05'00'

B.J. Le Roy
Project Manager

c: Pat Chung, WDNR
David Murphy, Village of Grafton
Darrell Hofland, Village of Grafton

Enclosure: As Noted

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State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Jim Doyle, Governor
Matthew J. Frank, Secretary
Gloria L. McCutcheon, Regional Director

Plymouth Service Center
1155 Pilgrim Rd.
P.O. Box 408
Plymouth, Wisconsin 53073-0408
Telephone 920-892-8756
FAX 920-892-6638

September 18, 2007

Darrell Hofland
Village of Grafton
1971 Washington Street
Grafton, WI 53024

Dear Mr. Hofland:

Subject: Scope of Work for Village of Grafton West Plume, BRRTS #0246549906.

Thank you for submitting your scope of work for investigation and additional sampling having to do with the West Plume. I approve the work scope with the following caveats.

(1) Sample groundwater (if present before the bedrock) from at least three of the 12 borings at Milwaukee Sign (ORE). This can be done as temporary water-table wells or permanent wells at your discretion. If no groundwater is present above bedrock, complete and sample at least one water table well into the bedrock on the presumed downgradient side of this property.

(2) Please complete your proposed well, P10, to also sample the "C" level (Romeo Beds). (It may be helpful to also sample into Waukesha Dolomite):

- From your 1999 site investigation report, West Plume well P1C in the Romeo Beds had the highest concentration of Freon 113. TCE concentration was almost as high at the C depth as the B depth.

- At West Plume well PW760GB, the concentration of Freon 113 and TCE increased from near the base of the Racine Dolomite above the Romeo Beds, to where the sample was taken in the Waukesha Dolomite, which may indicate that a higher concentration was in the Romeo beds (C level) (no sample was taken at that interval).

(3) The department can ask for additional investigation based on the results of this work.

I understand that you will submit a review fee with your actual workplan. If you have any questions about this letter, please call me at 920-892-8756 extension 3023.

Sincerely,

John Feeney
Wisconsin Department of Natural Resources

Cc: SER File, Earth Tech

Le Roy, B. J.

From: Le Roy, B. J.
Sent: Tuesday, September 25, 2007 2:41 PM
To: 'Feeney, John M - DNR'
Cc: 'David Murphy'; 'dhofland@village.grafton.wi.us'
Subject: RE: Grafton West Plume Scope Approval

Hi John,

I received your letter regarding the Grafton West Plume area. I have a few comments listed below, following the numbering in your letter.

1a) We agree that sampling groundwater makes sense at the Geoprobe holes. We will attempt to recover groundwater samples in the soil materials.

1b) An additional permanent well at the former Milwaukee Sign property was not in the agreement we came to at the May 23, 2007 meeting.

We do not see the need for an additional water table well for these reasons;

- Existing groundwater wells measure a strong southeasterly flow direction. With the measured strong horizontal gradient, and a slight downward gradient, well P-5B is directly in line to monitor groundwater concentrations that are near the downgradient edge of the former Milwaukee Sign property.
- An additional well at the property edge would tell us the level of contamination at the water table, but nothing else. Even if there were a relatively high reading at the water table well, that would not change the direction of the investigation.
- Soil concentrations at the property will tell us if there is a significant source at the former Milwaukee Sign property.
- We do not expect high readings, because the overall plume concentrations are much lower than those in the Lime Kiln Park investigation.
- Monitoring well P-2A, the water table well directly downgradient of the waste material at the Lime Kiln property, is serving no practical purpose other than measuring the gradient with the river. That information is not needed at the Milwaukee Sign location.
- The concentrations at P-2A are lower than those at P-2B, which is deeper at the same location, so it is likely that well P-5B is a better monitoring well than a water table well at that location.

2) We agree that sampling the deeper aquifer zones would be helpful. At our May 23 meeting, we had agreed to one well in this location. Our scope proposed to construct a P-10B in the same monitoring zone as the rest of the wells. Prior to construction, we will drill to the Waukesha Dolomite, packer seal a discrete interval, and collect a groundwater sample. We will sample the Romeo beds in the same manner. We will then abandon the open borehole up to the "B" monitoring zone and set the proposed well in the "B" zone. It is likely that concentrations below the "B" zone will be low, if present at all, because they were low in 1998, it is at the edge of the 1998 plume area and the plume should be either stable or decreasing.

I need to submit the work plan to the Village by Friday meet the deadline for their next Public Works meeting. It would be helpful if we had your response to these items by that time.

I will submit the work plan to you along with the review fee after the plan has been approved by the Village.

Thank you,
BJ

B.J. Le Roy

APPENDIX B

SITE SPECIFIC HEALTH AND SAFETY PLAN

HEALTH AND SAFETY PLAN

Village of Grafton
Health and Safety Plan
Grafton, Wisconsin

Prepared for:

Village of Grafton
Grafton, Wisconsin

Prepared by:

EarthTech
Earth Tech, Inc.
4135 Technology Parkway
Sheboygan, WI 53083

May 2008

SAFETY NOW

HEALTH AND SAFETY PLAN

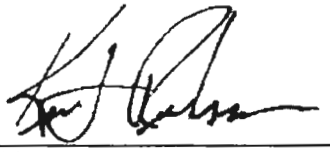
Environmental Services
Lime Kiln Landfill
West Plume Area
Village of Grafton
Grafton, Wisconsin

Prepared by:

BJ LeRoy
Project Manager

Date

Reviewed by:



Kurt Rubsam
Section Health and Safety Coordinator

May 6, 2008
Date

DISCLAIMER

This Health and Safety Plan (HASP) was prepared for employees performing a specific, limited scope of work. It was prepared based on the best available information regarding the physical and chemical hazards known or suspected to be present on the project site. Of course, it is not possible to discover, evaluate, and protect in advance against all possible hazards, which may be encountered during the completion of this project. However, adherence to the requirements of the HASP will significantly reduce the potential for occupational injury.

RECORD OF AMENDMENTS

Amendment Number	Inserted By (please print & sign)	Date
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LIST OF ACRONYMS

ACGIH	American Conference of Governmental Industrial Hygienists
ANSI	American National Standards Institute
AST	Aboveground storage tank
atm	Atmosphere
bgs	Below Ground Surface
Btu/lb	British thermal unit per pound
BWL	Body water loss
C	Ceiling Limit (Not to be exceeded)
°C	Degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CNS	Central nervous system
COO	Chief Operating Officer
CPR	Cardiopulmonary resuscitation
CRZ	Contamination reduction zone
CSP	Certified Safety Professional
DOT	Department of Transportation
EHS	Environmental, Health and Safety
eV	Electron Volts
EXC	30-Minute Excursion Limit
EZ	Exclusion zone
°F	Degrees Fahrenheit
HASP	Health and Safety Plan
HAZCOM	Hazard Communication
HAZWOPER	Hazardous Waste Operations and Emergency Response
HMIS	Hazardous Materials Information System
HR	Heart rate
HSM	Health and Safety Manager
IARC	International Agency for Research on Cancer
IAW	In Accordance With
IDEM	Indiana Department of Environmental Management
IDLH	Immediately Dangerous to Life or Health
IDW	Investigative Derived Waste
LEL	Lower explosive limit
mg/m^3	Milligrams per cubic meter
mg/kg	Milligrams per kilogram
mg/L	Milligrams per liter
MSDS	Material Safety Data Sheet
NIOSH	National Institute for Occupational Safety and Health

N	NIOSH
NA	Not Applicable
ND	Not Determined
NK	Not Known
NPL	National Priorities List
OHST	Occupational Health and Safety Technologist
OSHA	Occupational Safety and Health Administration
OT	Oral temperature
Pb	Lead
PCB	Polychlorinated biphenyl
PEL	Permissible Exposure Limit
PID	Photoionization Detector
PM	Project Manager
PPE	Personal protective equipment
PPM	Parts per million
PVC	Polyvinyl chloride
RISC	Risk Interated System of Closure
RGASD	Relative Density of Gas (air = 1)
RCRA	Resource Conservation and Recovery Act
R_x	Optical correction
SARA	Superfund Amendments and Reauthorization Act
SCBA	Self-Contained Breathing Apparatus
SKIN	Danger of Skin Absorption
SOP	Standard Operating Procedure
SSHO	Site Safety and Health Officer
STEL	Short Term Exposure Limit
SVOC	Semi-Volatile Organic Compound
SZ	Support zone
TBD	To Be Determined
TCLP	Toxicity Characteristic Leaching Procedure
THA	Task hazard analysis
TLV	ACGIH Threshold Limit Value
µg/L	Micrograms per Liter
UEL	Upper explosive limit
USCG	United States Coast Guard
U.S. EPA	United States Environmental Protection Agency
UST	Underground Storage Tank
VOC	Volatile organic compound

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1.0 INTRODUCTION

This Health and Safety Plan (HASP) (including Appendices A through D) provides a general description of the levels of personal protection and safe operating guidelines expected of each employee or subcontractor associated with the environmental services being conducted at environmental investigation sites in the Village of Grafton, Wisconsin. Site-specific Health and Safety Supplements will be generated as necessary to address any additional delivery/task orders associated with this program, and will require acknowledgment in writing on their respective signature pages. Once generated, each Supplement will be inserted in Appendix C, documented on the HASP Record of Amendments, and reviewed by field personnel prior to the start of applicable work activities.

1.1 GENERAL

The provisions of this HASP are mandatory for all Earth Tech personnel engaged in fieldwork associated with the environmental services being conducted at the subject site. A copy of this HASP, any applicable HASP Supplements and the Earth Tech Corporate Health and Safety Manual (SOPs) shall be maintained on site and available for review at all times. Record keeping will be maintained in accordance with this HASP and the applicable SOPs. In the event of a conflict between this HASP, SOPs and federal, state, and local regulations, workers shall follow the more stringent, more protective requirements.

1.2 POLICY STATEMENT

It is the policy of Earth Tech to provide a safe and healthy work environment for all of its employees. Earth Tech considers no phase of operations or administration is of greater importance than injury and illness prevention. Safety takes precedence over expediency or shortcuts. Every accident and every injury is avoidable. We will take every reasonable step to reduce the possibility of injury, illness, or accident.

This HASP and its appendices present procedures for the site. The practices and procedures presented in this HASP and any supplemental documents associated with this HASP are binding on all Earth Tech employees while engaged in the subject work. In addition, all site visitors shall abide by these procedures as a minimum. Operational changes to this HASP and supplements that could affect the health or safety of personnel, the community, or the environment will not be made without prior approval of the client, the Earth Tech Project Manager (PM) and the Earth Tech Health and Safety Manager (HSM). This HASP is based on federal, state and/or local safety and health regulations.

1.3 SITE INFORMATION

This section provides a general description and historical information associated with the site.

1.3.1 General Description

Lime Kiln Park and the West Plume Area are located in the Village of Grafton, Ozaukee County. The Milwaukee River borders the south and east edges of the park, while residential areas

border the northeast, west, and southwest sides of the Park, as well as the east side of the Milwaukee River. Industries and businesses are located west, north, and northwest of the park along Wisconsin Avenue. The quarry area actually filled is approximately 1.4 acres based upon previous field investigation results. The landfill location is shown on Figure 1 at the end of this section.

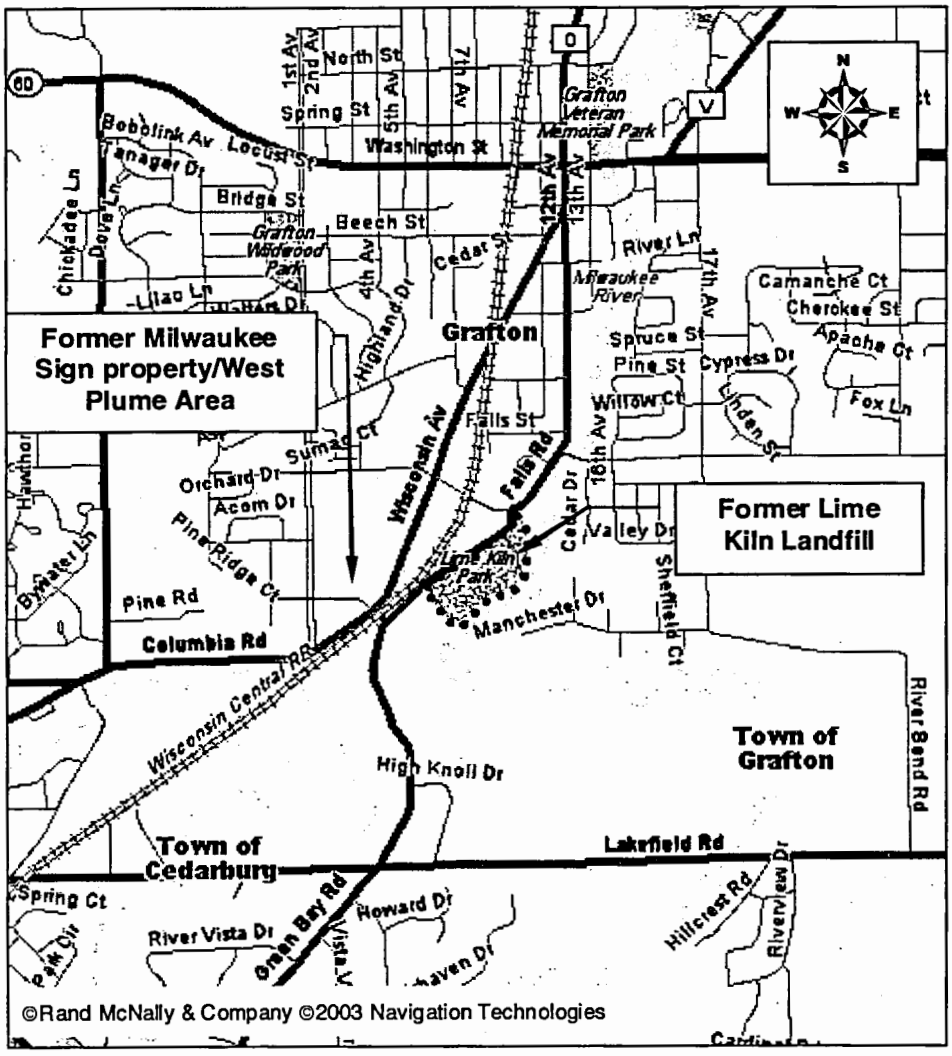
Earth Tech completed several investigations at the site including soil sampling, groundwater monitoring well installation and sampling, leachate/gas well installation and monitoring, surface water sampling, geophysical survey, pump tests, and private well sampling.

1.4 REFERENCES

This HASP conforms to the following guidelines established by the regulatory agencies in the following documents:

- U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), Code of Federal Regulations, Title 29 (29 CFR), Part 1910.120.
- U.S. Department of Labor, OSHA, 29 CFR, Part 1910.1200.
- U.S. Department of Labor, OSHA, 29 CFR, Part 1910 and Part 1926.
- National Institute for Occupational Safety and Health (NIOSH)/OSHA/U.S. Coast Guard (USCG)/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, Publication No. 85-115, 1985.

FIGURE 1 - SITE MAP



Note: Not to Scale
• • • • Approximate Site Boundary

Reference: http://www.randmcnally.com

2.0 SCOPE OF WORK

Earth Tech will conduct environmental services at Lime Kiln Park and the West Plume Area, in the Village of Grafton. Work will be performed in accordance with the applicable Statement of Work (SOW) and associated Work Plans developed for the West Plume Area and Lime Kiln Landfill site.

Environmental services being performed at the site include, but are not limited to:

- Mobilization
- Drilling to include Geoprobe and Roto Sonic drilling methods
- Groundwater Sampling and Private Well Sampling
- Decontamination
- Demobilization

3.0 PROJECT HEALTH AND SAFETY ORGANIZATION

3.1

3.2 ORGANIZATIONAL STRUCTURE

The organizational structure of the Health and Safety management for the site.

Name/Firm	Title/Function	Work Phone	Home Phone
Gary Beswick, CIH Earth Tech	Corporate Environmental Health and Safety Director	724-695-9353 412-897-9180 (Cell)	
Chad Ross Earth Tech	Midwest Health and Safety Manager	859-441-2300 859-512-7774 (Cell)	858-781-1159
BJ LeRoy Earth Tech	Project Manager	920-451-2589 920-912-0191 (Cell)	
Kurt Rubsam Earth Tech	1285 Section Health & Safety Representative	920-451-2558 920-918-0021 (Cell)	920-564-5355
Tory Schultz	Site Safety Officer	920-451-2489 920-698-6654 (Cell)	

3.3 ALL PERSONNEL

All personnel are responsible for their own health and safety, for completing tasks in a safe manner, and for reporting any unsafe acts or conditions to their supervisor and/or the Site Safety Officer (SSO). All Earth Tech personnel are responsible for continuous adherence to these health and safety procedures during the performance of their work. No person may work in a manner that conflicts with the letter or intent of safety and environmental precautions expressed in these procedures. Earth Tech employees are subject to progressive discipline and may be terminated for blatant or continued violations. Subcontractor employees who violate health and safety regulations will be warned via the subcontractor's supervisor; then, after due warning, will be denied access to the site.

3.4 PROJECT MANAGEMENT

An individual PM will lead each project and is ultimately responsible for ensuring that all project activities are completed in accordance with requirements set forth in this HASP. The site PM will confer with the HSM on all matters affecting health and safety. If an SSO is appointed, the PM will communicate with the SSO as necessary, but at least daily, regarding site-specific safety and health issues and any problems encountered.

3.4.1 Project Management Responsibilities

The PM health and safety responsibilities relating to the site include, but are not limited to:

- Ensuring that the project is performed in a manner consistent with this HASP.
- Ensuring that this HASP, where required, is approved and properly implemented.
- Providing the HSM with sufficient information, reasonably in advance of projects, to allow a proper evaluation of the operational or procedural hazards.
- Ensuring sufficient funds are allocated in projects to fully implement the safety procedures required.
- Ensuring that the training/medical surveillance requirements within the HASP are enforced for all Earth Tech field personnel and applicable contractors.
- Investigating and reporting accidents/incidents, and determining if modifications in work practices are required due to an accidental exposure or injury.
- Ensuring personnel are properly trained and informed about assigned tasks.

3.4.2 Project Management Authority

The authority of the PM associated with health and safety programs of the project includes, but is not limited to:

- Assigning an approved alternate SSO when the PM cannot adequately perform the SSO responsibilities as detailed in this HASP.
- Temporarily suspending field activities if the health and safety of personnel or bystanders is endangered, pending evaluation by the HSM.

3.5 HEALTH AND SAFETY MANAGER

The HSM is responsible for establishing, implementing, monitoring, and administering the corporate Health and Safety Program; ensuring that the program is in compliance with all federal, state, and/or local requirements; monitoring the effectiveness of the company's program, and making recommendations to improve it; and overseeing and coordinating all communications with federal, state, and local safety and health agencies. This includes keeping the project HASP current with new regulations and techniques, and in accordance with contract-specific health and safety requirements.

3.5.1 Health and Safety Manager Responsibilities

The HSM health and safety responsibilities relating to the project include, but are not limited to:

- Providing technical advice to the PM.
- Monitoring and interpreting changes in relevant regulations, technology, and work practices.
- Developing and/or providing input on all health and safety-related policies and procedures.
- Routinely evaluating the HASP, and reporting the status and recommended changes for activities associated with the program.
- Providing the PM with guidance relative to the requirements, effectiveness, and needs of the HASP.
- Ensuring that the medical surveillance requirements within the HASP are identified.
- Ensuring that the training requirements within the HASP are identified.

- Evaluating health and safety equipment needs for this project and reporting these needs to the PM.
- Reviewing accident investigation reports to ensure that corrective actions identified are appropriate.

3.5.2 Health and Safety Manager Authority

The authority of the HSM includes, but is not limited to:

- Approving employee qualifications to work in selected activities based on health and safety considerations.
- Approving or disapproving the HASP and supplemental documents.
- Establishing employee training and medical surveillance procedures.
- Suspending work on any project or activity that jeopardizes personnel health and safety.
- Authorizing or restricting personnel for work on hazardous waste sites based on medical and/or training status.
- Directing changes in work practices to improve health and safety.
- Acting as the official representative for safety matters within the division.
- Determining whether a change in an individual's work assignments is required due to injury, accidental exposure, or pregnancy.
- Determining the need for a HASP for specific projects or operations, or the appropriateness of specific SOPs.
- As required, meeting with clients to discuss the details of safety and health planning documents.
- Auditing facilities and field activities to evaluate performance/compliance with the Health and Safety Program on a periodic and as-needed basis.
- Directing changes in work practices to improve health and safety, and removing individuals from operations when their conduct jeopardizes the health and safety of themselves or others.
- Suspending work on any project or activity that jeopardizes the safety of anyone in the area.
- Suspending work on a project or activity if the HASP and/or protocols used appear to be inappropriate or inadequate.

3.6 SITE SAFETY OFFICER

Mr. Tory Schultz is the Site Safety Officer (SSO) for this portion of the environmental investigation. If the SSO must leave the site during field activities, an alternate SSO will be selected by name and informed of his/her duties (see below).

3.6.1 Site Safety Officer Responsibilities

The SSO is responsible to:

- Maintain data on regulatory information (e.g., OSHA, Superfund Amendments and Reauthorization Act (SARA) Title III, Right-to-Know) and be sure that timely reports are filed to appropriate agencies.
- Provide information to keep project current with new regulations, new techniques, and new topics for safety meetings.
- Provide leadership and support for the health and safety program.

- Assign sufficient personnel and allocate enough resources to implement the program at all levels.
- Monitor the lost time incidence rate for this project and work toward improving it.
- Monitor regulatory compliance and work toward zero citations and violations.
- Encourage site personnel to make safety their number one priority.
- Inspect the site at least monthly (per HSM) for regulatory violations and possible hazards in accordance with SOPs.
- Train and educate workers in methods and techniques that are most hazard-free.
- Ensure that employees understand the properties and hazards of materials to be used.
- Ensure that employees have had training in the following areas as necessary:

    1. Hazard Communication (chemical safety);
    2. Confined spaces, locations, and confined space entry procedures;
    3. Emergency operations procedures;
    4. Use and care of personal protective equipment (PPE);
    5. Electrical safety including lockout and tagout procedures;
    6. Respiratory protection and equipment; and
    7. Other appropriate topics based on the hazards at the site.

- Conduct daily safety meetings with on-site Earth Tech personnel.
- Ensure employees understand that they are responsible for their own safety and that they develop the right attitude toward safety practices.
- Ensure that employees have and use the proper tools, training, and equipment.
- Discipline employees who ignore safety rules and practices after attempts at training have failed.
- Monitor areas of responsibility to ensure that changing conditions do not result in human, situational, or environmental factors capable of causing accidents. Develop and implement corrective action plans to eliminate or mitigate hazards.
- Ensure that housekeeping in all areas under their control is up to the desired level.
- Ensure all injuries/illnesses/accidents and near misses are investigated in accordance with the HASP.
- Implement any monitoring programs established according to directives outlined in the HASP and its supplements.
- Forward any employee exposure monitoring information to the HSM to allow for exposure evaluation and employee notification.

3.6.2 Site Safety Officer Authority

The SSO has authority to:

- Temporarily suspend field activities if the health and safety of personnel are endangered, pending further consideration by the HSM.
- Temporarily suspend individuals from field activities for infractions against the HASP pending consideration by the HSM and the PM.

3.7 EMPLOYEES

Personnel working on the site are required to read and acknowledge their understanding of this HASP and its supplements. Personnel are expected to abide by the requirements of this HASP and cooperate with supervisory personnel to ensure a safe and healthful work site.

It is each employee's responsibility to be familiar and in compliance with all health and safety practices and to use PPE, air monitoring equipment, and other safety devices, as required. In addition, employees shall:

- Notify the PM, in writing, of unsafe conditions and acts.
- Report all injuries, illnesses, accidents, and near misses immediately.
- Perform all work in a safe and efficient manner.
- Seek training in any area where there are questions as to the safest and most effective way to work or use equipment.

3.7.1 Employee Responsibilities

It is each employee's responsibility to be familiar and comply with all health and safety practices and to use required PPE, air monitoring equipment, and other safety devices, as required. Responsibilities of employees associated with this project include, but are not limited to:

- Complying with the provisions of and following the procedures defined in the HASP.
- Providing feedback to health and safety management relating to omissions and modifications in the Health and Safety Program.
- Notifying the PM, in writing, of unsafe conditions and acts.
- Reporting all injuries, illnesses, accidents, and near misses immediately.
- Performing all work in a safe and efficient manner.
- Seeking training in any area where questions exist as to the safest and most effective way to work or use equipment.
- Understanding the policies and procedures specified in the Health and Safety Program, and clarifying those areas where understanding is incomplete.

3.7.2 Employee Authority

The health and safety authority of each employee assigned to the site consists of the following:

- Refusing to work in any operation that the employee feels is unsafe, or where specified safety precautions are not adequate or understood.
- Refusing to work on any site or operation where the safety procedures specified in this HASP are not being followed.
- Contacting the HSM at any time to discuss potential concerns.

3.8 SUBCONTRACTORS

Subcontractors are expected to be utilized during this phase of the project. Upon entering a subcontractor agreement for work performance at the site, the subcontractor will review this HASP prior to the start of work performance, and develop and submit a HASP that is in compliance with this HASP as a minimum, as well as federal and state requirements. Subcontractors are responsible for the safety and health of their employees and the submittal of the HASP for review is not for the purpose of procedure approval, but rather to ensure compliance with the contract provisions.

3.8.1 Subcontractor Responsibilities

Responsibilities of any subcontractors associated with the project, with respect to the health and safety aspects of the program, include the following:

- Complying with the appropriate provisions of their HASP and SOPs for work performed by their employees.
- Ensuring that subcontractor employees comply with all federal and state health and safety regulations.
- Ensuring that subcontractor employees comply with any specific safety and health provisions required by the client.

3.8.2 Subcontractor Authority

The health and safety authority of subcontractors assigned to the project consists of the following:

Refusing to work in any operation that the employee feels is unsafe, or where specified safety precautions are not adequate or understood.

3.9 CLIENT RESPONSIBILITIES

Designated agency employees or contract personnel, assigned to perform specific duties on the project, take responsibility for their compliance with applicable federal, state, and local statutes, ordinances, and regulations regarding health and safety requirements specified in the HASP.

3.10 VISITORS

Unauthorized visitors will not be permitted within established work site control zones. Authorized visitors (e.g., U.S. EPA, etc.) to any work location on the site will be briefed by the PM on the hazards present at that location. Visitors will be escorted at all times at the work location and will be responsible for compliance with their employer's health and safety policies.

3.11 SITE ACCESS DOCUMENTATION

If implemented by the PM, all personnel entering the site shall complete the "Site Entry/Exit Log" located at the site trailer or primary site support vehicle. In addition, if requested by the PM, all personnel required to enter established site control zones shall complete the Exclusion Zone Log located at the decontamination area.

4.0 HEALTH AND SAFETY PROGRAMS

4.1

4.2 MEDICAL SURVEILLANCE AND SUPPORT PROGRAM

All personnel performing field activities at the site will be medically monitored in accordance with Earth Tech SOP 108, *Medical Monitoring & Surveillance.* As stated in the SOP, additional medical testing may be required for personnel performing tasks involving project-specific stressors (see applicable chemical table in Section 6). For this project, additional site-specific testing includes:

a) HAZWOPER (per CFR 1910.120),
b) Respiratory Protection (per 29 CFR 1910.134), and
c) Noise (per 29 CFR 1910.95).

In addition, any time an actual exposure above the OSHA permissible exposure limit (PEL) occurs, the employee may be tested for that material to document effect(s) of the exposure.

4.2.1 Contractor Medical Surveillance

Subcontractors, upon award of specific work, must provide appropriate documentation of medical surveillance (e.g., IAW 29 CFR 1910.120(f)), signed by an occupational physician, for all personnel that will be assigned to the project. This documentation must state the ability to perform the subject work and, if applicable, the ability to wear respiratory protection. This documentation must be provided at least 7 days prior to work start-up. Medical certification for newly assigned employees must be provided before they begin field activities at the site.

Medical certificates must be made available upon request. Any subcontractor employee whose medical certification expires must be prevented, by the subcontractor, from performing work until the medical re-certification is attained.

4.3 ACCIDENT AND INCIDENT REPORTING

The investigation and reporting requirements specified in the SOP 100 series shall be used for reporting and documenting accidents, injuries, and work-related illnesses involving Earth Tech employees promptly after personnel become aware of the situation.

All accidents and incidents during field activities that involve any employee or subcontractor personnel associated with this project will be promptly reported to the PM/SSO and the appropriate supervisor. The PM/SSO will provide notification to the HSM as required by company policy. The supervisor of the injured employee or work crew where the accident occurred will initiate a written report that details the events surrounding the accident/incident in accordance with OSHA requirements.

For accidents and injuries involving Earth Tech personnel, the "Supervisor's Report of Incident" form (located in Appendix C) will be used to ensure all relevant information is recorded. Refer to SOP EH&S 101 *Injury, Illness, and Near-Miss Reporting* for reporting requirements.

OSHA and most states' occupational health and safety programs require verbal notification within 8 hours, and preferably during the same work shift, in the event of a fatality or severe injury requiring hospitalization of three or more employees. The HSM or PM will make such notifications to OSHA for Earth Tech and, therefore, must receive the information in time to make the notification without penalty. The subcontractor shall comply with applicable notification requirements for the subcontractor employees, and must inform the SSO after notification is made.

4.3.1 Subcontractor Accident and Incident Reporting

Accidents, incidents, or near misses involving subcontractor personnel will require the completion of the subcontractor-specific accident/incident report by a representative of the subcontractor, in accordance with federal, state and/or local requirements. The subcontractor will promptly provide the SSO with a copy of the documentation detailing the events surrounding the accident/incident. In addition, corrective actions undertaken by the subcontractor to prevent reoccurrence or modifications to the subcontractor's health and safety policies and procedures developed to inform their personnel of the hazard will be described. Copies of all documentation shall be submitted to the HSM and shall be maintained in the appropriate project files.

4.3.2 Additional Notifications

In the event of an accident or injury during the project, the PM will inform the HSM and the SSO (if appointed) of the incident and provide him/her with the appropriate information and documentation in order to initiate any additional notifications that may be required.

4.4 HEALTH AND SAFETY TRAINING PROGRAMS

All Earth Tech personnel performing work activities inside any controlled work area (see Section 9.0) will meet the requirements for training specified in the SOP 200 series and SOP 300 series. All subcontractor personnel will be required to demonstrate participation in equivalent training as specified by the standards applicable to site activities being performed (i.e., HAZWOPER, etc.). If training requirements needed to perform a specific task/operation are unknown or questionable, contact the SSO prior to performing the work to ensure that adequate training has been received or needs to be performed.

Employees handling materials as defined by the Department of Transportation (DOT) as hazardous, will also be required to complete the DOT training requirements for HazMat employees (see 49 CFR 172, Subpart H, *Training*).

All HAZWOPER 40-hour/24-hour, current refresher (8-hour) and Supervisor (8-hour if applicable) training certificates shall be maintained on site at all times and available for review. These documents will be kept on-site in a project file maintained by the SSO during site activities.

4.4.1 Site-Specific Training

As stated in the SOP, safety training may be conducted at the site by the SSO prior to work activities addressing site-specific safety concerns. Specific training may be required prior to

working with certain hazardous materials, such as asbestos, lead, or other known carcinogen. Attendance of these sessions will be formally documented using the form attached to the SOP.

In addition to the general health and safety training programs, personnel will be:

- Instructed on the contents of applicable portions of this plan and any supplemental health and safety information developed for the tasks to be performed.
- Informed about the potential routes of exposure, protective clothing, precautionary measures, and symptoms or signs of chemical exposure and heat/cold stress.
- Made aware of task-specific physical hazards and other hazards that may be encountered during site work. This includes any client-specific required training for health and safety.
- Made aware of fire prevention measures, fire extinguishing methods, and evacuation procedures.

For this project, the training required for workers to perform work might include (depending on task):

a) HAZWOPER 40-hour/24-hour.
b) Current 8-hour HAZWOPER refresher,
c) 8-hour HAZWOPER Supervisor (at least one person on site, each multi-person shift),
d) Hearing Conservation,
e) Respiratory Protection,
f) Site-Specific training (e.g., Site Orientation, Basic Gas Hazard Awareness Training, HazCom, etc.),
g) First Aid and CPR (at least one person on-site, each multi-person shift).

The site-specific training will be performed prior to the worker performing the subject task or handling the impacted materials and on an as-needed basis thereafter. Training will be conducted by the SSO (or his/her designee) and will be documented on the form attached to the SOP.

4.4.2 HAZWOPER Training Exceptions

OSHA regulations mandate specific training requirements for personnel involved in remediation processes and spill response. However, incidental personnel do not require HAZWOPER certification if the site characterization indicates that the potential for health and safety concerns is low, or entry is only allowed into non-hazardous perimeter areas. In addition, surveyors conducting work prior to excavation activities will not be required to have HAZWOPER certification. Personnel who only visit or deliver to the work site perimeters (e.g., vendors, personnel working in the support zone, etc.) are exempt from the HAZWOPER standard, and do not require certification. Visitors (including regulators, inspectors, etc.) would not require HAZWOPER certification to observe work in progress from perimeter areas.

4.5 HAZARD COMMUNICATION

The SSO/employees shall ensure compliance with the SOP 207 *Hazard Communication Program* found in the SOP Manual and/or company specific hazard communication requirements.

4.6 STOP WORK AUTHORITY

All employees have the right and duty to stop work when conditions are unsafe, and to assist in correcting these conditions. Whenever the SSO determines that workplace conditions present an uncontrolled risk of injury or illness to employees, immediate resolution with the appropriate supervisor shall be sought. Should the supervisor be unable or unwilling to correct the unsafe conditions, the SSO is authorized and required to stop work, which shall be immediately binding on all affected Earth Tech employees and subcontractors.

Upon issuing the stop work order, the SSO shall implement corrective actions so that operations may be safely resumed. Resumption of safe operations is the primary objective; however, operations shall not resume until the HSM has concurred that workplace conditions meet acceptable safety standards.

5.0 HAZARD ASSESSMENT

5.1

5.2 GENERAL HAZARDS

During operations at the Site, personnel may be exposed to a number of occupational and environmental hazards. In general, the following hazards can be expected:

- ***Chemical Exposures:*** Applicable health hazard information in the form of Material Safety Data Sheets (MSDSs) is included in Appendix A.
- ***Hazardous Noise:*** Produced during heavy equipment operations, material handling and container handling/staging activities that may be ongoing around the work site.
- ***Walking/Working Surfaces:*** Unsafe and/or elevated walking surfaces.
- ***Vehicle Operation Hazards:*** Associated with the operation of heavy equipment, support/sampling equipment and vehicles.
- ***Electrical and Other Powered Machine Hazards:*** Present during both the operation and maintenance of site support equipment.
- ***Heat and Cold Stress Environments:*** Associated with site-specific work activities, PPE usage and geographical project locations.
- ***Biological Hazards:*** Associated with exposures to plant/animal vectors and bloodborne pathogens.

It is unlikely that this HASP could anticipate all of the hazards associated with the project. Therefore, this HASP has been developed as a programmatic document outlining the protective measures for hazards most likely to be present at each project location. Site-specific Task Hazard Analysis (THA) forms, listing the significant hazards, applicable PPE (in addition to required Level D ensemble), operational programs and safety considerations of each major task, have been developed and are included at the end of Section 5. Additional tasks may become necessary during work at the site and appropriate THAs will be developed by the HSM and forwarded as a supplement to this HASP (Appendix D).

Supplements associated with this HASP will not be developed as stand-alone documents. Each of the supplements generated for the project will be accompanied by this document at all times.

5.3 STANDARD OPERATING PROCEDURES

Standard operating procedures (SOPs) have been developed as guidance documents for specific work tasks. The following is a list of SOPs found in the Earth Tech Corporate Health and Safety Manual. In the table below, SOPs containing specific information regarding tasks anticipated for this project have been identified.

TABLE 1 - APPLICABLE STANDARD OPERATING PROCEDURES

(SOPs anticipated to be at the project are checked in the boxes below)

	SOP #	TOPIC
		SH&E 000 Series
☒	001	SH&E Policy Statement
☒	002	SH&E Dept. Structure & Responsibilities
☒	003	Operational SH&E Structure & Responsibilities
☒	004	SH&E Administration Support
☒	005	Review of Safety Manual
		SH&E 100 Series
☒	101	Injury, Illness, & Near Miss Reporting
☒	102	Incident Investigation and Review
☐	103	Regulatory Agency Inspections
☒	104	SH&E Audits, Inspections, and Corrective Actions
☒	105	SH&E Procedure Variance
☒	106	Drug-Free Workplace Program
☐	107	Modified Duty Program
☒	108	Medical Monitoring & Surveillance
☒	109	Hearing Conservation Program
☐	110	Fetal Protection Program
☒	111	Employee Exposure Monitoring Program
☒	112	Respiratory Protection Program
☒	113	Personal Protective Equipment (PPE)
☒	114	Safety Training Programs
☒	115	Hazard Communication Program
☒	116	Driver and Vehicle Safety
☐	117	Commercial Vehicle Program
☐	118	Confined Space Entry Program
☐	119	Lock-Out / Tag-Out Program
☐	120	Fall Protection Program
☐	121	Electrical Safety Program
☐	122	Environmental Compliance Program
☐	123	Ergonomics Program
☒	124	Heat Stress Prevention Program
☒	125	Cold Stress Prevention Program
☐	126	Radiation Safety Program
☐	127	Radiation Protection Plans
☐	128	Radiological Exposure Assessment
☐	129	ALARA
☐	130	Non-Ionizing Radiation
☐	131	Safety Assessment Program
☐	132	Competent Persons

	SOP #	TOPIC
		SH&E 200 Series
☒	201	General Safety Rules
☒	202	Safety Meetings
☒	203	Accident Prevention Program – Requirements for SH&E Documentation
☒	204	Task Hazard Analysis
☒	205	Emergency Action Planning & Prevention
☒	206	Stop Work Authority
☒	207	Contractor & Subcontractor SH&E Requirements
☒	208	General Housekeeping, Hygiene, and Sanitation
☒	209	Disciplinary Actions/Accountability
☒	210	Walking-Working Surfaces Protection
		SH&E 300 Series
☒	301	Hazardous Waste Operations (HAZWOPER)
☐	302	Office Safety
☐	303	OE and UXO Operations
☐	304	Landfill Quality Assurance and Operations
☐	305	Demolition Operations
☐	306	Structural Steel Operations
☐	307	Underground Construction & Tunneling
☐	308	Rail Operations
☐	309	Marine Operations - Working On/Near Water
☐	310	Overhead Electrical Lines
☐	311	Blasting and Use of Explosives
		SH&E 400 Series
☐	401	Clearing & Grubbing
☐	402	Excavation & Trenching
☒	403	Drilling
☒	404	Manual Lifting
☒	405	Handling Drums & Large Containers
☐	406	Drum Sampling
☐	407	Tank & Large Container Sampling
☐	408	Unknown Hazardous Waste Drum Handling
☐	409	Tank Cleaning
☐	410	Tank Removal & Demolition
☐	411	Welding, Cutting, & other Hot Work
☐	412	Line Entry
☐	413	Cylinder Disposition & Decommissioning
☐	414	Pile Driving
☐	415	Abrasive Blasting

TABLE 1 - APPLICABLE STANDARD OPERATING PROCEDURES (continued)

	SOP #	TOPIC		SOP #	TOPIC
		SH&E 500 Series			**SH&E 400 Series (continued)**
☐	501	Ladders	☐	416	Concrete & Masonry Work
☐	502	Scaffolding	☐	417	Automotive Service Operations
☐	503	Machine Guarding	☐	418	Spray Finishing & Dip Tanks
☐	504	Woodworking and Metalworking Machines	☐	419	Cleanup of Bird Excrement/Amplified Fungal Growth
☐	505	Powered Hand Tools			**SH&E 600 Series**
☒	506	Manual Hand Tools	☒	601	Hazardous Materials Shipping
☐	507	Powder-Actuated Tools	☐	602	Process Safety Management
☒	508	Fire Extinguishers	☐	603	Chemical Hygiene Plan
☐	509	Refuse Packer Units	☒	604	Decontamination
☒	510	High Pressure Washers	☐	605	Protection from Solvents
☐	511	All Terrain Vehicles	☒	606	Flammable & Combustible Materials
☐	512	Forklifts	☒	607	Chemical and Biological
☒	513	Heavy Equipment	☒	608	Blood-Borne Pathogens
☐	514	Manlifts	☐	609	Asbestos
☐	515	Cranes, Lifting Devices & Rigging Requirements	☐	610	Lead
☐	516	Equipment Safety Cards	☐	611	Cadmium
☒	517	Traffic Safety	☐	612	Compressed Gases

5.4 TASK HAZARD ANALYSIS

Task Hazard Analysis (THA) is required by OSHA to determine the potential dangers involved with work practices engaged in by employees. THAs for tasks anticipated at this Site can be found at the end of Section 5. If additional tasks are identified, contact the HSM to develop additional THAs.

5.5 ADDITIONAL SAFETY INFORMATION

The following information is included in this HASP to address specific activities on the site.

5.5.1 Utilities

There are no utility lines or pipes that may be encountered during the groundwater sampling process for this phase of the project. However, if additional work is to be performed on-site, then utility clearance must be obtained.

Various forms of underground/overhead utility lines or pipes may be encountered during additional site activities. Prior to the start of intrusive operations, utility clearance is mandated, as well as obtaining authorization from all concerned public utility department offices. Should intrusive operations cause equipment to come into contact with utility lines, the SSO and the HSM will be notified immediately. Work will be suspended until the applicable utility agency is contacted and the appropriate actions for the particular situations can be taken. For this site,

the applicable agency is Diggers Hotline (800-242-8511). The phone number is also provided in the Emergency Contacts list found in Section 8.

5.5.2 Biological Hazards

Contact with animals, insects, and plants can cause injury and illness to personnel. Care must be taken to ensure that these types of injuries are avoided. Some examples of biological hazards include:

- Wild animals, such as snakes, raccoons, squirrels, and rats. These animals not only can bite and scratch, but can carry transmittable diseases (e.g., rabies). Avoid the animals whenever possible. If bitten, go to the nearest medical facility.
- Insects such as ticks, bees, and wasps. Ticks can transmit Lyme disease or Rocky Mountain Spotted Fever. Bees and wasps can sting by injecting venom, which causes some individuals to experience anaphylactic shock (extreme allergic reaction). Whenever you will enter areas that provide a habitat for insects (e.g., grass areas, woods), wear light-colored clothing, long pants and shirt, and spray exposed skin areas with a DEET-containing repellent. Keep away from high grass wherever possible. Keep your eyes and ears open for bee and wasp nests. If bitten by insects, see a doctor if there is any question of an allergic reaction.
- Plants such as poison ivy and poison oak can cause severe rashes on exposed skin. Be careful where you walk, wear long pants, and minimize touching exposed skin with your hands after walking through thickly vegetated areas until after you have thoroughly washed your hands with soap and water.

5.5.3 Buddy System

All personnel shall use the buddy system during the site activities. The personnel involved with the site activities shall be teamed with at least one additional worker or "buddy." Team members shall routinely maintain visual contact with each other and be alert for signs of illness or toxic exposure, such as:

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

Anyone exhibiting symptoms should be taken immediately to the nearest medical facility or stabilized for transport by qualified medical personnel. If imminent danger exists, call the applicable emergency contact number listed in Table 5 of Section 8.0.

The groundwater monitoring and the private well sampling will be completed using one person. Previous investigations have shown that there are no readings (ppm readings using a PID) in the breathing zone or perimeter monitoring during groundwater sampling. However, prior to starting a groundwater monitoring event at Lime Kiln Park or the West Plume Area, the groundwater monitoring person shall inform the Village of Grafton contact and the Earth Tech Project Manager that he or she is at Lime Kiln Park or the West Plume Area completing the groundwater monitoring. After the monitoring is complete, the field person shall inform the Village of Grafton contact and the Earth Tech Project Manager that the work is complete and

they are leaving the site. If imminent danger exists, personnel will call the applicable emergency contact number listed in Table 7 of Section 8.0.

5.6 MANUAL LIFTING

Most materials associated with the groundwater monitoring are moved by hand. The human body is subject to severe damage in the forms of back injury, muscle strains, and hernia if caution is not observed in the handling process. Whenever possible, use at least two people to lift, or roll/lift with your arms as close to the body as possible. Under no circumstances should any one person lift more than 49 pounds unassisted. It is anticipated that no heavy lifting (>49 lbs.) will be required during the groundwater sampling phase of this project.

5.7 HAZARDOUS, SOLID, OR MUNICIPAL WASTE

If hazardous, solid and/or municipal wastes are generated during any phase of the project, the waste shall be accumulated, labeled, and disposed of in accordance with applicable Federal, State, and/or local regulations.

It is anticipated that all IDW (including but is not limited to PPE, soil cuttings, and sample tubing) produced during the investigation will be drummed. Each drum will be properly labeled with contact information, contents, and date of generation.

5.8 SPILL CONTAINMENT PROCEDURE

Work activities may involve the use of hazardous materials (i.e. fuels, solvents) or work involving drums or other containers. The following procedures will be used to prevent or contain spills:

- All hazardous material will be stored in appropriate containers
- Tops/lids will be placed back on containers after use.
- Containers of hazardous materials will be stored appropriately away from moving equipment.
- At least one spill response kit, to include an appropriate empty container, materials to allow for booming or diking the area to minimize the size of the spill, and appropriate clean-up material (i.e. speedy dri) shall be available at each work site (more as needed).
- All hazardous material in use (i.e. fuels) shall be properly labeled.
- Containers shall only be lifted using equipment specifically manufactured for that purpose.
- For drums/containers, follow the procedures in SOP 405, *Handling of Drums and Large Containers*, to minimize spillage.

Groundwater purged from the monitoring wells during the sampling process is containerized (drummed). Drums (55-gallon) are staged at each monitoring well by the Village of Grafton. The Village of Grafton is responsible to move the drums to the Wastewater Treatment Plant for disposal of the groundwater. Earth Tech employees do not handle or move the drums other than to open for access for the purged groundwater and closure of the lid when finished.

5.9 CLIENT SPECIFIC SAFETY REQUIREMENTS

The client has specified no additional health and safety requirements.

TABLE 2 - TASK HAZARD ANALYSIS TABLE

TASK	HAZARDS	MINIMUM PPE	HAZARD CONTROLS
Mobilization/ Demobilization: Mobilization/demobilization activities typically present limited hazards as compared to the majority of site tasks. However, the potential still exists for exposures to a variety of hazards, typically physical in nature.	Physical: • Slips, trips, falls, and protruding objects • Heavy lifting • Vehicle/equipment traffic • Hazardous noise • Heat/cold stress • Severe weather • Pinch points • Insect, plants, and animals Chemical: • None anticipated.	Level D: • ANSI approved hardhat. • ANSI approved safety glasses. • ANSI approved steel toe safety shoes/boots. • High visibility reflective safety vest when working near heavy equipment and other vehicle traffic • Hearing protection (as necessary). • Work clothing (coveralls or work uniform appropriate for weather conditions). • Leather gloves while handling sharp edges. • Safety harness (fall protection).	• Evaluate surrounding work area for additional hazards that may be present and modify work activities accordingly. • Keep area surrounding work areas free of obstructions during mobilization and demobilization activities.
Equipment Decontamination: This task includes performing equipment decontamination of the groundwater sampling equipment.	Physical: • Slips, trips, falls, and protruding objects • Heavy lifting • Vehicle/equipment traffic • Hazardous noise • Heat/cold stress • Severe weather • Pinch points • Insect, plants, and animals Chemical: • See Table in Section 6 of the HASP for specific chemical hazards. • Decon solutions and/or detergents	Modified Level D: • ANSI approved hardhat. • ANSI approved safety glasses. • ANSI approved steel toe safety shoes/boots. • High visibility reflective safety vest when working near heavy equipment and other vehicle traffic • Hearing protection (as necessary). • Work clothing (coveralls or work uniform appropriate for weather conditions). • Impervious gloves when handling impacted materials. • Face shield (if splash or high impact hazards exist) • Leather gloves while handling sharp edges • Protective coveralls (as needed) • Rain suit or Apron (as needed)	• Evaluate surrounding work area for additional hazards that may be present and modify work activities accordingly. • Keep area surrounding work areas free of obstructions. • Always keep in view of drivers of heavy equipment or vehicles. • Routinely use hand signals to communicate with the equipment operators.

TABLE 2 - TASK HAZARD ANALYSIS TABLE (continued)

TASK	HAZARDS	MINIMUM PPE	HAZARD CONTROLS
Project Oversight: This includes any Earth Tech supervision located on site overseeing site work. This task encompasses all SOPs and HASP requirements. The person performing this task will have responsibilities to include assessment and management of providing a safe and healthy work environment	Physical: • Slip, trip, falls, and protruding objects • Heat/cold Stress • Heavy equipment Chemical: • See Table 2 in Section 6 of the HASP for specific chemical hazards	Modified Level D: • ANSI approved hardhat • ANSI approved safety glasses • Work clothing (coveralls or work uniform) • Safety toe boots (metatarsal protection may be required) • Hearing protection (as necessary while working near noise producing equipment) • High visibility reflective safety vest while working near equipment/traffic • Leather gloves while handling sharp edges Additional Safety Equipment: • Cell phone (or equivalent) • First aid kit • Fire extinguisher • Portable Eyewash Solution • Monitoring Equipment	• Evaluate surrounding work area for additional hazards that may be present. • Coordination with site management is required prior to start of sampling activities. • If historic sampling (minimum of 3 consecutive sample rounds) indicates low concentrations less than 50% of airborne PEL of the site contaminants at the sampling location, this task may be preformed as a non-HAZWOPER Task using one person (historical data must be present at sampling location). • Provide awareness to dangerous plants, animals, insects that may be present at the location
Drilling/Direct Push Borings: Drilling activities are performed with various types of rigs (e.g., hollow stem, air rotary, Geoprobe®, Roto Sonic, etc) and for a variety of construction/environmental activities. Drilling can be performed to help characterize soils, set pilings, well installation/abandonment, etc.	Physical: • Slips trips falls and protruding objects • Heavy lifting • Vehicle/equipment traffic • Hazardous noise • Insects, plants and/or animals • Severe weather • Heat/cold stress • Sunburn Chemical: • See Table 2 in Section 6 of the HASP for specific chemical hazards	Modified Level D: • Work clothing (coveralls or work uniform appropriate for the weather conditions) • ANSI approved hardhat • ANSI approved safety glasses • ANSI approved safety shoes/boots • Hearing protection (as necessary while working near noise producing equipment) • High visibility reflective safety vest while working near equipment/traffic • Impervious gloves (Nitrile) • Protective coveralls (Tyvek) • Respiratory Protection (full face respirator) as needed • Leather gloves while handling sharp edges Additional Safety Equipment: • Multi-gas meter (as needed during sampling activities) • PID meter (as needed during sampling activities)	• Evaluate surrounding work area for additional hazards that may be present and modify work activities accordingly. • Keep area surrounding work areas free of obstructions. • Use Deet® containing product in areas of possible exposure to ticks, mosquitoes, etc. • Clear utilities (underground and overhead) in the immediate work area or travel route prior to positioning equipment or starting sampling activities. • Keep all guards in place while operating or near rotating or moving equipment.

Air Monitoring: Provide direct read air monitoring for PPE upgrades or downgrades and off-site migration. If necessary, conduct ambient air monitoring at the site perimeter or at down wind locations. Perform personal air sampling.	Physical: • Vehicle/heavy equipment traffic • Insects, plants, and animals • Hazardous noise • Severe weather • Heat/cold stress • Slips, trips, and falls • Water • Confined space • Sunburn Chemical: • See Table 2 in Section 6 of the HASP for specific chemical hazards	Level D: • ANSI approved hardhat • ANSI approved safety glasses • Work clothing (coveralls or work uniform appropriate for the weather conditions). • ANSI approved safety shoes/boots • Hearing protection (as necessary while working near noise producing equipment). • High visibility reflective safety vest while working near equipment/traffic • Protective coveralls when applicable (Tyvek). Additional Safety Equipment: • Multi-gas meter (as needed during sampling activities) • PID meter (as needed during sampling activities)	• Evaluate surrounding work area for additional hazards that may be present and modify work activities accordingly. • Keep area surrounding work areas free of obstructions during mobilization/demobilization activities. • Use Deet® containing product in areas of possible exposure to ticks, mosquitoes, etc. • Use sunscreen lotion 15 SPF or higher on exposed skin as necessary. • Use Coast Guard approved life vests while working on or near water.
Sampling and Testing: Sampling involves collecting known or unknown materials for characterizing purposes. These materials may include water, groundwater, sediments, soil, soil gas, leachate, sludge, or other unspecified material.	Physical: • Slips, trips, falls, and protruding objects • Heavy lifting • Vehicle/equipment traffic • Hazardous noise • Heat/cold stress • Severe weather • Pinch points • Insect, plants, and animals Chemical: • See Table in Section 6 of the HASP for specific chemical hazards	Modified Level D: • ANSI approved hardhat. • ANSI approved safety glasses. • ANSI approved steel toe safety shoes/boots. • High visibility reflective safety vest when working near heavy equipment and other vehicle traffic • Hearing protection (as necessary). • Work clothing (coveralls or work uniform appropriate for weather conditions). • Impervious gloves when handling impacted materials. • Protective coveralls when handling impacted materials. • Respiratory Protection (full face respirator) as needed • Leather gloves while handling sharp edges	• Evaluate surrounding work area for additional hazards that may be present and modify work activities accordingly. • Keep area surrounding work areas free of obstructions. • If required, clear utilities (underground and overhead) in the immediate work area or travel route prior to positioning equipment or starting sampling activities. • Purge water from the groundwater sampling is stored in drums at the monitoring well locations. The Client is responsible for removal of the drums and disposal of the purge water.

6.0 CHEMICAL AND MONITORING INFORMATION

6.1 CHEMICAL INFORMATION

6.1.1 Chemical Exposures

Preventing exposure to toxic chemicals is a primary concern during any activity that may present an exposure potential to site personnel. Exposure to toxic chemicals on-site are minimal due to the lower contaminant levels in the groundwater. However, personnel must be aware of the potential to encounter chemical contaminants while performing environmental services at the site.

Substances can enter the body by inhalation, skin absorption, ingestion, or through a puncture wound (injection). A contaminant can cause damage at the point of contact or it can act systemically, causing a toxic effect at a part of the body distant from the point of initial contact.

Chronic exposure refers to relatively low levels of exposure over a long period of time. Acute exposure refers to high levels of exposure for short periods. The differing toxicity of the chemicals anticipated must be taken into account. Chronic toxins may show no adverse health effects at the time of exposure, but could appear years later. Acute toxins may be capable of extreme health effects during or immediately after excessively high exposures, and may show no residual effects after that. Many chemicals cause both chronic and acute conditions that may vary greatly.

Inhalation, ingestion, and skin contact are possible routes of exposure during project activities. The primary chemicals of concern are listed below in Table 3 along with a brief outline of their applicable exposure limits and physical properties. These compounds have the potential to create an unhealthful ambient environment for site workers. The following information has been compiled from the September 2005 *NIOSH Pocket Guide to Chemical Hazards,* and the 2007 American Conference of Governmental Industrial Hygienists (ACGIH) *Guide to Occupational Exposure Values.*

TABLE 3 - CHEMICAL, PHYSICAL AND EXPOSURE INFORMATION

CHEMICAL**	EXPOSURE LIMITS (UNITS AS DESIGNATED)			VAPOR PRESSURE (MM/HG OR AS DESIGNATED)	IONIZATION POTENTIAL (eV)	LEL/UEL (PERCENT)	SPECIFIC GRAVITY	POTENTIAL CARCINOGEN
	PEL (OR AS DESIGNATED)	STEL/ CEILING (C)	IDLH (NIOSH)					
1,2-Dichloroethane	50 ppm	100 ppm (C)	50 ppm	64	11.05	6.2 / 16	1.24	Yes
1,1-Dichloroethylene	5 ppm (ACGIH)	NA	ND	500	10.00	6.5 / 15.5	1.21	Yes
Tetrachloroethylene	100 ppm	200 ppm (C)	150 ppm	14	9.32	NA	1.62	Yes
Trichloroethylene	100 ppm	200 ppm (C)	1,000 ppm	58	9.45	8 / 10.5	1.46	Yes
Chloromethane	100 ppm	200 ppm (C)	2,000 ppm	5.0 atm	11.28	8.1 / 17.4	NA	Yes
Vinyl Chloride	1 ppm	5 ppm	ND	3.3 atm	9.99	3.6 / 33	NA	Yes
Freon 113 (TTE)	1000 ppm	NA	2,000 ppm	285	11.99	ND	1.56	No
MEK (2-butanone)	200 ppm	300 ppm (ACGIH)	3,000 ppm	176.2	ND	ND	1.12	No
1,1-Dichloroethane	100 ppm	NA	3,000 ppm	182	11.06	5.4 / 11.4	1.18	No
1,1,1-Trichloroethane (Methyl Chloroform)	350 ppm	NA	700 ppm	100	11.00	7.5 / 12.5	1.34	No
Chloroform	10 ppm (ACGIH)	50 ppm	500 ppm	160	11.42	NA	1.48	Yes
Acetone	1000 ppm	NA	2,500 ppm	180	9.69	2.5 / 12.8	0.79	No

*See the front of this document for a complete *List of Acronyms*
**The above chemicals are found in concentrations above the Drinking Water Enforcement Standard (ES).

6.1.2 Symptom/First Aid Information

Exposure symptoms and applicable first aid information for each material listed above can be referenced from the MSDSs in Appendix B of this HASP.

6.2 MONITORING INFORMATION

6.2.1 Work Zone Air Monitoring

Monitoring shall be performed within the work zones on site in order to detect the presence and relative levels of toxic substances. The data collected throughout monitoring shall be used to determine the appropriate levels of PPE. Monitoring shall be conducted in order to determine baseline data on potential hazards prior to entry in the work area, and periodically while conducting site work to evaluate any changes in conditions of the specific work area.

Periodic monitoring on the site will consist of initial monitoring, during changes in site conditions (e.g., excavating in a new location, opening a drum/container or well, wind direction change), and at regular intervals throughout the day, during intrusive, handling, sampling, transportation, and decontamination activities, or as deemed necessary by the SSO. Tables 4 and 5 provide the monitoring equipment and action level requirements for this project.

TABLE 4 - MONITORING EQUIPMENT

Instrument:	PID/FID 11.7 eV lamp
Frequency:	Continuously during intrusive activities or confined space entry
Monitoring Location:	Breathing zone in work zone or confined space.

TABLE 5 - ACTION LEVELS DURING ENVIRONMENTAL SERVICES

PARAMETER	LOCATION AND INTERVAL	RESPONSE LEVEL (Meter units/ppm above background)	RESPONSE
Hydrocarbons (Total by PID/FID)*	Site perimeter at least every 30 minutes during intrusive activities involving impacted materials.	< 1	Continue work and continue monitoring.
		≥ 1 (Sustained for more than 2 minutes)	Implement mitigation measures and contact the SSO. If no detector tubes are drawn, upgrade to Level C PPE (minimum GMA/P100 cartridges or equivalent chemical cartridge combined with P100)

* = or equivalent method approved by HSM.

6.2.2 Environmental Sampling

Previous investigations have shown that there were no readings (ppm readings using a PID) in the breathing zone (BZ) during groundwater sampling. No atmospheric monitoring will be completed during the groundwater and private well sampling.

During drilling operations, the BZ of the drillers and the geologist shall be monitored using a PID with a 10.2 eV bulb.

6.2.3 Personal Sampling

Should site activities warrant performing personal sampling of Earth Tech employees, the SSO, under the direction of the HSM, will be responsible for specifying the monitoring required. Within 5 working days after the receipt of monitoring results, the HSM will notify each employee, in writing, of the results that represent that employee's exposure. Copies of air sampling results will be maintained in the project files. In addition, copies shall be provided to the HSM for inclusion in medical records as necessary.

Should the site activities warrant, the subcontractor will ensure its employees' exposures are quantified via the use of appropriate sampling techniques. The subcontractor shall notify the employees sampled in accordance with health and safety regulations, and provide the results to the SSO for use in determining the potential for other employees' exposure.

6.2.4 Monitoring Equipment Calibration

All instruments used will be calibrated in accordance with the manufacturer's recommendations. If the owner's manual is not available, the personnel operating the equipment will contact the applicable office representative, rental agency or manufacturer for technical guidance for proper calibration. If equipment cannot be pre-calibrated to specifications, site operations requiring monitoring for worker exposure or off-site migration of contaminants will be postponed or temporarily ceased until this requirement complete.

6.2.5 Health and Safety Action Levels

The groundwater sampling and private well sampling will be completed in Modified Level D PPE due to low level concentrations (although they are above the Drinking Water Enforcement Standard) that exist in the groundwater. The sampler shall wear appropriate PPE to prevent contact with the groundwater (nitrile gloves, disposable rubber boots, tyvek coveralls where a splash hazard exists, and safety glasses).

Personnel should also be able to upgrade or downgrade their level of protection with the concurrence of HSM/SSO. Prior to upgrading levels of protection, the HSM, SSO, or the Health and Safety contact must be informed of the reasons for the upgrade and the steps taken to minimize the need for the upgrade (i.e., engineering controls, venting the area, changing the work zone, etc.).

Reasons to upgrade:

- Known or suspected presence of dermal hazards.
- Occurrence or likely occurrence of gas, vapor, or dust emission.
- Change in work task that will increase the exposure or potential exposure to hazardous materials.

Reasons to downgrade:

- New information indicating that the situation is less hazardous than was originally suspected.
- Change in site conditions that decrease the potential hazard.
- Change in work task that will reduce exposure to hazardous materials.

7.0 PERSONAL PROTECTIVE EQUIPMENT

The harmful effects that chemical substances may have on the human body often necessitate the use of personal protective clothing/equipment (PPE). The purpose of PPE is to provide a barrier, which will shield or isolate individuals from the chemical and/or physical hazards that may be encountered during work activities.

The level of protection (LOP) required must correspond to the level of hazards known, or suspected, in the specific work area. Protection against different types of chemicals and differing concentrations of those substances can be quite varied. Level A provides the highest level of protection and Level D provides the lowest. A protective clothing ensemble can range from safety glasses, hard hats, and safety shoes/boots to fully encapsulating suits with a supplied source of breathing air. See SOP 301 for an outline of the general PPE ensembles available.

Site-specific tasks being performed, the probability of exposure to the hazards, and the environmental conditions must all be considered when specifying PPE. Once the specific hazards have been identified, the appropriate equipment can be selected (see THAs in Section 5 for the initial LOP and the Action Level Table in Section 6). To assist project personnel with the PPE selection and procurement process, an inventory list has been attached to summarize the equipment required by this HASP (Table 6). The PPE listed has been selected consistent with the hazards associated with the expected field activities, and is available in various sizes to provide a good fit for all personnel during the subject tasks. Site workers are responsible for the proper maintenance and clean storage of PPE and associated support equipment at the site.

The LOP required for the excavation of the lead contaminated soil on-site will be Level D/Modified Level D based on the work being completed by the site personnel. Personnel who will be in physical contact and/or will be sampling lead contaminated soil will be in Modified Level D. LOP protection is described below:

Level D personal protective clothing and equipment includes:

- Work uniform (to include layered clothing in cold weather).
- Hardhat - Required during field activities.
- ANSI approved safety glasses with sideshields or safety goggles.
- ANSI approved safety shoes/boots.
- Reflective Safety Vest.
- Noise protection (muffs or plugs)- as warranted.

Modified Level D protective clothing and equipment includes (in addition to the Level D clothing/equipment):

- Tyvek® disposable coveralls. Note: polyethylene coated Tyvek® shall be worn in sampling areas when splashing with contaminated water is possible.
- Disposable vinyl gloves.
- Outer Nitrile/Neoprene gloves.
- Disposable outer boots. Rubber ANSI approved steel toed boots can be worn but must be decontaminated between locations and prior to leaving the site.

7.1 HEAD PROTECTION

Earth Tech employees will wear a hard hat during field activities (see SOP 205). Ear protection and face shields may be attached to hard hats. Hard hats purchased after July 5, 1994, shall comply with ANSI Z89.1, 1986. Head protection purchased prior to July 5, 1994, shall comply with ANSI Z89.1, 1969.

7.2 EYE PROTECTION

Eye protection will be worn at all times within work areas. Sunglasses may be permitted during activities performed outside as long as they meet the requirements of safety glasses. Wire-framed sunglasses used for eye protection will not be permitted at any time. Subcontractor employees who do not have suitable eye protection will have an appropriate type of eye protection provided to them by their respective employers prior to performing work at the site.

Eye protection will meet the following minimum requirements:

- Provide adequate protection against the particular hazards for which they are designed.
- Is reasonably comfortable when worn under the designated conditions.
- Fit snugly and not unduly interfere with the wearer's movements.
- Be durable.
- Be easily cleaned and disinfected.
- Comply with ANSI Z87.1, 1989 (if purchased prior to July 5, 1994, comply with ANSI Z87.1, 1968).

TABLE 6 - SITE-SPECIFIC PERSONAL PROTECTIVE EQUIPMENT LIST

TYPE	MATERIAL	ADDITIONAL INFORMATION
Safety Vest	High-visibility	Must be worn near traffic areas. Must have reflective tape and visible from all sides.
Boots	Leather	ANSI approved safety toe.
Gloves	Nitrile, PVC, Neoprene	Leather if working with sharp objects or powered/hand tools.
Suits	Tyvek (poly or saran-coated if splash hazard exists).	If handling impacted material.
Respirator (Negative Pressure)	MSA (Full Face or equivalent) equipped with GMA/P100	Training as required.
Respirator (SCBA)	Grade "D" Certified Air (Certificate Required)	Obtain certificate of analysis from compressed gas vendor. Training as required.
Hard Hat		ANSI Approved, worn during site activities.
Tape	Duct (or equivalent)	Joints on the suit/gloves, etc...
Decontamination Supplies	Bleach, Alconox (or equivalent)	
Hearing Protection	Ear plugs and/ or muffs	In hazardous/elevated noise areas (e.g., near Geoprobe, Roto Sonic, or drill rig, etc.).
Safety Glasses/Face shield if pressure washer is to be used in decontamination.	Side Shields	ANSI Approved.
Boot Covers	Latex, Rubber	

7.3 HEARING PROTECTION

Appropriate hearing protection, including ear plugs, canal caps, and ear muffs, will be provided when noise may be a problem, such as around heavy machinery, power support equipment, and impact tools. When employees may be exposed to hazardous noise, a hearing conservation program will be implemented in accordance with 29 CFR 1910.95.

7.4 FOOT PROTECTION

Employees will wear appropriate foot protection while working on site, which will consist of leather or water and chemical-resistant boots with safety toes. Footwear (including leather work boots and chemical-resistant boots) must meet the specifications of ANSI Z41.1-1969 (if purchased after July 5, 1994, ANSI Z41, 1991), which is the standard for industrial footwear with safety toes. Protection against liquid hazardous chemicals requires boots of neoprene, polyvinyl chloride (PVC), butyl rubber, or other material selected for resistance to the specific chemical. For tasks where contact with contaminated materials is expected to be slight or nonexistent, leather work boots with safety toes are appropriate.

7.5 HAND PROTECTION

Employees will use appropriate hand protection when exposed to hazards that could cause injury to the hands. Gloves must resist puncturing and tearing as well as provide any necessary chemical resistance.

Protective clothing will be worn over glove cuffs to prevent any liquid from spilling into the gloves. A pair of inner gloves adds an extra layer of protection for the hands during the removal of outer gloves and other chemical protective items and will be worn at all times when outer protective gloves are required. Where necessary, heavy leather gloves may be worn over chemical-protective gloves when doing heavy work. If they become contaminated, they will be discarded because leather is difficult to decontaminate.

7.6 RESPIRATORY PROTECTION

Respiratory protection is not expected to be needed for this phase of the investigation. However if site conditions change, respiratory protection could be implemented. The THAs will be modified for respiratory protection. If respiratory protection is selected and used for worker comfort, or is worn as specified by the THAs, the requirements outlined in SOP 206 will be met. Respiratory protection upgrade criteria are specified in Section 6 of this HASP. In accordance with 29 CFR 1910.134 (d)(iii), a respirator cartridge change-out schedule is required to minimize worker exposure during respirator use. If monitoring levels are below Level B upgrade criteria contained in Section 6 and Level C is selected and worn, respirator cartridges will be replaced at the end of every daily shift, in accordance with the *cartridge life expectancy/change-out schedules* obtained from the manufacturer's web site in lieu of other objective data. For this project the cartridges shall be properly disposed of after each change-out.

7.7 BODY PROTECTION

Protective clothing and body protection are selected on the basis of the tasks to be performed and the hazards, both chemical and physical, to which the worker may be exposed. For all work areas, including the support and administrative areas, appropriate work clothing will be worn that, at a minimum, covers from the skin from the boots to the shoulders. Tank and halter-tops are not appropriate. Shorts and cut-off pants are not appropriate.

In more hazardous work areas, substantial pants and long sleeves are appropriate. Chemical-protective body protection may be selected using predicted chemical exposures and the clothing manufacturer's chemical-specific permeation and degradation information to provide optimum protection.

7.8 DECONTAMINATION

Refer to SOP 535 for decontamination procedures.

7.8.1 PPE Doffing and Donning Information

The following information is to provide field personnel with helpful hints that, when applied, make donning and doffing of PPE a more safe and manageable task:

- Never cut disposable booties from your feet with basic utility knives. This has resulted in workers cutting through the booty and the underlying sturdy leather work boot, resulting in significant cuts to the legs/ankles. Recommend using a pair of scissors or a package/letter opener (cut above and parallel with the work boot) to start a cut in the edge of the booty, then proceed by manually tearing the material down to the sole of the boot for easy removal.
- When applying duct tape to PPE interfaces (wrist, lower leg, around respirator, etc.) and zippers, leave approximately one inch at the end of the tape to fold over onto itself. This will make it much easier to remove the tape by providing a small handle to grab while still wearing gloves. Without this fold, trying to pull up the tape end with multiple gloves on may be difficult and result in premature tearing of the PPE.
- Have a "buddy" check your ensemble to ensure proper donning before entering controlled work areas. Without mirrors, the most obvious discrepancies can go unnoticed and may result in a potential exposure situation.

8.0 EMERGENCY RESPONSE INFORMATION

8.1 INTRODUCTION

For Earth Tech emergency response procedures, refer to SOP 102, *General EH&S Plan Requirements*. A site-specific emergency response plan may be developed to ensure a safe and reliable response in the event of an emergency.

8.1.1 Emergency Response Coordinator

The site SSO shall also service as the site Emergency Response Coordinator (EC). The duties of the EC and the alternate EC have been specified in SOP 102.

8.1.2 Site-Specific Emergency Procedures

Prior to the start of site operations, the SSO/EC shall fill in the following with any site-specific information regarding evacuations, muster points, spill response, communication, and other site-specific emergency procedures:

TABLE 7 - EMERGENCY CONTACTS

Emergency Coordinators / Key Personnel

Name	Title	Telephone Number	Cell
BJ LeRoy	Project Manager	920-451-2589	920-912-0191
Tory Schultz	SSO/EC	920-451-2489	920-698-6654
Gary Beswick	Health & Safety Director	724-695-9353	412-897-9180
Chad Ross	Health & Safety Manager	859-441-2300 858-781-1159 (Home)	859-512-7774
Kurt Rubsam	Section Health & Safety Coordinator	920-451-2558 920-564-5355 (Home)	920-918-0021
Travis Westra	Health & Safety Professional	616-975-4620	616-485-0243

Organization / Agency	**Telephone Number**
Police Department (Grafton Police Dept.)	911 or 262-375-5320
Fire Department (Grafton Fire Dept.)	911 or 262-375-5314
Ambulance Service ***(EMT will determine appropriate hospital for treatment)***	911
Hospital (Use by site personnel is only for non-emergency cases)	
St. Mary's Hospital Ozaukee 13111 N. Port Washington Rd. Mequon, WI 53097	262-243-7300

Hospital Route:
(See Hospital Route Map on following page)

Poison Control Center	800-222-1222
Pollution Emergency	800-292-4706
National Response Center	800-424-8802
Chem-Trec	800-424-9300
Title 3 Hotline	800-535-0202

Public Utilities

Diggers Hotline	800-242-8511

FIGURE 2 - HOSPITAL ROUTE/DETAIL MAP

Hospital Route Directions:

1. Left (south) on Falls Road (Green Bay Road) to County Highway T (Lakefield Road).
2. Left (east) on CTH T to CTH W (Port Washington Road).
3. Right (south) on CTH W to St Mary's Hospital. Hospital will be on the right side of the road, look for emergency entrance.

Total Distance: approximately = 5 miles.

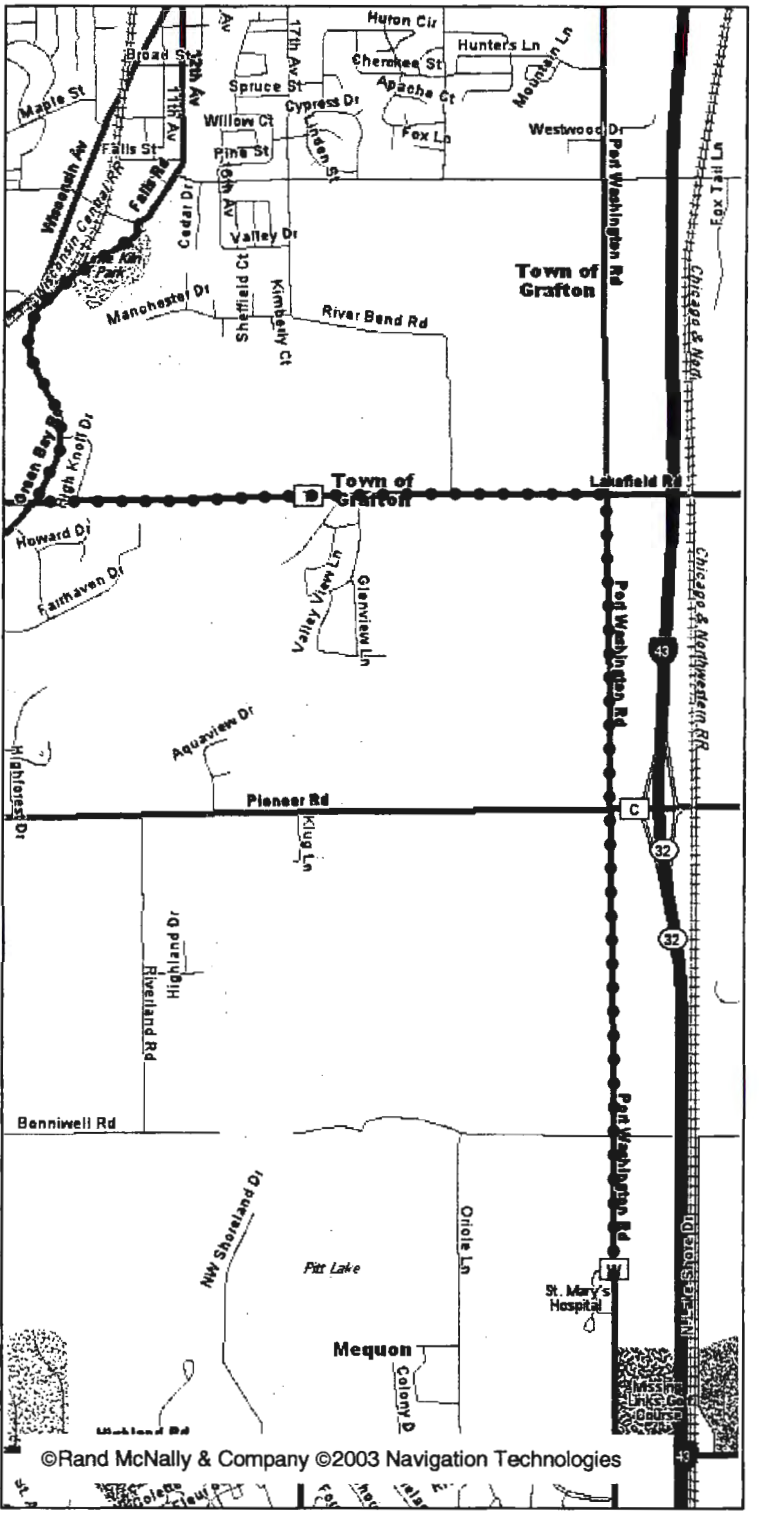
Before the field activities start up, the SSO shall drive the route to the hospital to confirm the directions and post directions/map to the hospital (map and directions in each vehicle on-site), set up the first aid station, and setup any other emergency equipment.

Hospital Address:
St. Mary's Hospital Ozaukee
13111 N. Port Washington Rd.
Mequon, WI 53097
Phone: 262-243-7300

Note: Map not to Scale

• • • • Hospital Route

Reference: http://www.randmcnally.com



9.0 SITE CONTROL

9.1 GENERAL

The purpose of site control is to minimize potential contamination of workers, protect the public from site hazards, and prevent vandalism. The degree of site control necessary depends on the site characteristics, site size, and the surrounding community.

Site-specific work zones will be established at each work area, and if required, will be established directly prior to the work being conducted. The work zones will be drawn on site maps, posted in the support vehicle or trailer and discussed during the daily safety meetings. If the site layout changes, the new zones and their potential hazards will be discussed immediately after the changes are made or prior to the next work shift. General examples of zone layouts have been developed for drilling and earth moving activities (e.g., excavating, trenching, etc.) and are attached to this section.

Each work area will establish three zones:

- ***Exclusion Zone:*** Contaminated work area.
- ***Contamination Reduction Zone:*** Decontamination area.
- ***Support Zone***: Uncontaminated or "clean area" where personnel should not be exposed to hazardous conditions.

Each zone will be periodically monitored in accordance with the air monitoring requirements established in this HASP. The Exclusion Zone and the Contamination Reduction Zone are considered work areas. The Support Zone is accessible to the public (e.g., vendors, inspectors).

9.2 EXCLUSION ZONE

The Exclusion Zone is the area where primary activities occur, such as sampling, remediation operations, installation of wells, cleanup work, etc. This area must be clearly marked with hazard tape, barricades or cones, or enclosed by fences or ropes. Only personnel involved in work activities will be allowed in the Exclusion Zone.

9.3 CONTAMINATION REDUCTION ZONE

The Contamination Reduction Zone is the transition area between the contaminated area and the clean area. Decontamination is the main focus in this area. The decontamination of workers and equipment limits the physical transfer of hazardous substances into the clean area. This area must also be clearly marked with hazard tape and access limited to personnel involved in decontamination. Decontamination is explained in SOP 604.

9.4 SUPPORT ZONE

The Support Zone is an uncontaminated zone where administrative and other support functions, such as first aid, equipment supply, emergency information, etc., are located. The Support

Zone shall have minimal potential for exposure to contaminants and is equivalent to that of background.

Employees will establish a decontamination area and Support Zone (if necessary) at the site before the commencement of site activities. The Support Zone would also serve as the entry point for controlling site access. All personnel leaving the Support Zone, in addition to the associated PPE required, will be required to wear (at a minimum) chemical-resistant outer boots when traversing the site.

9.5 SITE SECURITY

Site security is necessary to:

- Prevent the exposure of unauthorized, unprotected people to site hazards.
- Avoid the increased hazards from vandals or persons seeking to abandon other wastes on the site.
- Prevent theft.
- Avoid interference with safe working procedures.

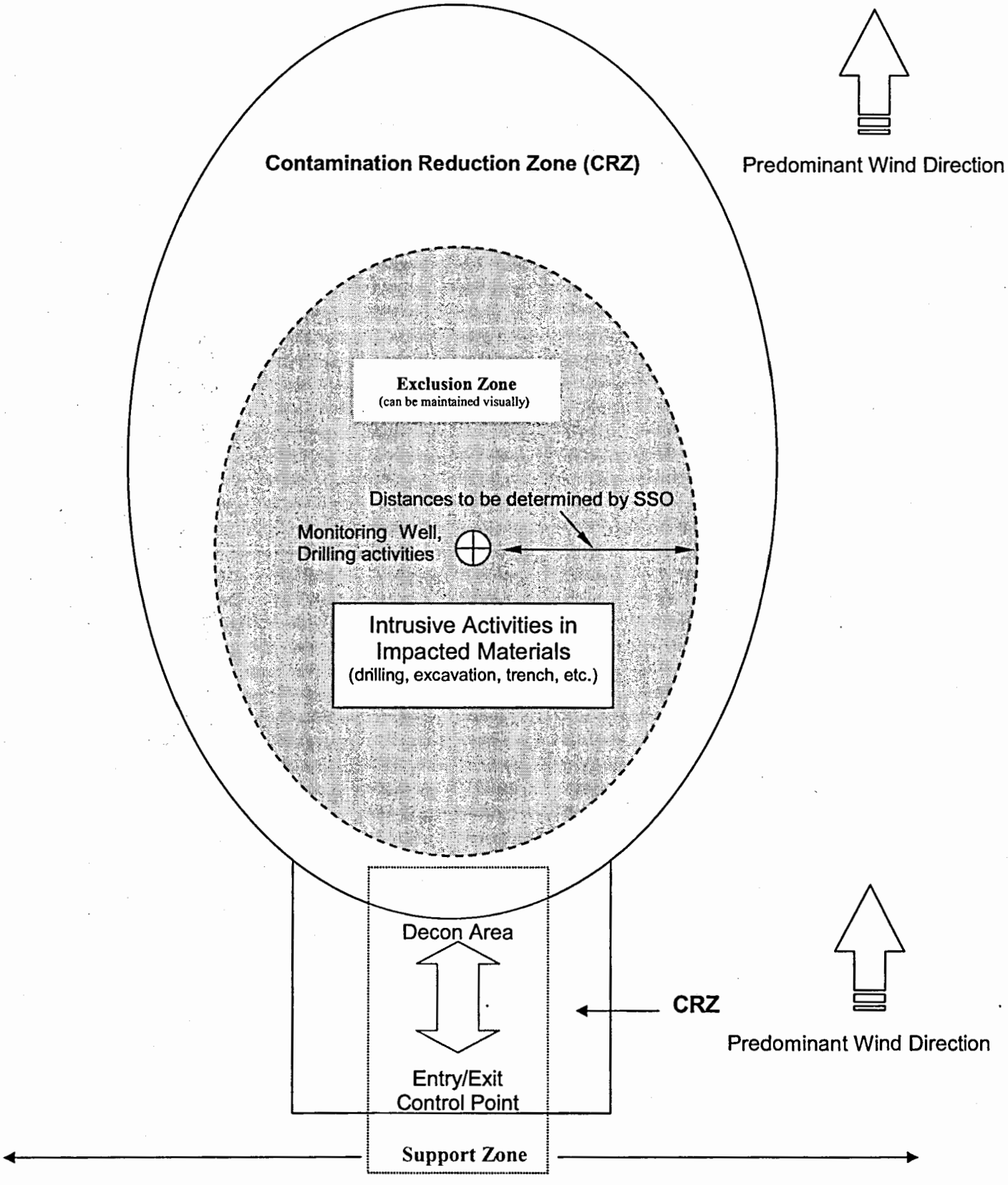
To maintain site security during working hours:

- Maintain security in the Support Zone and at access control points.
- Establish an identification system to identify authorized persons and limitations to their approved activities.
- Assign responsibility for enforcing authority for entry and exit requirements.
- When feasible, install fencing or other physical barrier around the site.
- If the site is not fenced, post signs around the perimeter and whenever possible, use guards to patrol the perimeter. Guards must be fully apprised of the hazards involved and trained in emergency procedures.
- Have the PM approve all visitors to the site. Make sure they have valid purpose for entering the site. Have trained site personnel accompany visitors at all times and provide them with the appropriate protective equipment.

To maintain site security during off-duty hours:

- If possible, assign trained, in-house technicians for site surveillance. They will be familiar with the site, the nature of the work, the site's hazards, and respiratory protection techniques.
- If necessary, use security guards to patrol the site boundary. Such personnel may be less expensive than trained technicians, but will be more difficult to train in safety procedures and will be less confident in reacting to problems around hazardous substances.
- Enlist public enforcement agencies, such as the local police department, if the site presents a significant risk to local health and safety.
- Secure the equipment.

FIGURE 3 - EXAMPLE SAMPLING SITE CONTROL LAYOUT



10.0 PERSONNEL ACKNOWLEDGEMENT

All employees, subcontractors, and visitors must sign the Health and Safety Acknowledgement form, in this section, before conducting field activities at this site and/or entering the Exclusion or Contamination Reduction Zones (including decontamination and restricted staging/delivery areas).

By signing this form, Earth Tech employees agree that:

1. I have read this Health and Safety Plan and I understand the requirements of the Plan.

2. I will conduct work at this site in accordance with the requirements of the HASP.

By signing this form, subcontractors and visitors agree that:

1. I have read and understood the potential hazards associated with the site.

2. I will ensure compliance with my company's policies on health and safety in regards to site entry at remediation locations.

Print Name & Company	Date	Signature
Print Name & Company	Date	Signature
Print Name & Company	Date	Signature
Print Name & Company	Date	Signature
Print Name & Company	Date	Signature
Print Name & Company	Date	Signature

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Print Name & Company	Date	Signature

APPENDIX A

MATERIAL SAFETY DATA SHEETS

International Chemical Safety Cards

1,1,1-TRICHLOROETHANE

ICSC: 0079

Methyl chloroform
Methyltrichloromethane
alpha-Trichloroethane
$C_2H_3Cl_3$ / CCl_3CH_3
Molecular mass: 133.4

ICSC # 0079
CAS # 71-55-6
RTECS # KJ2975000
UN # 2831
EC # 602-013-00-2

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Combustible under specific conditions. Heating will cause rise in pressure with risk of bursting. See Notes. Gives off irritating or toxic fumes (or gases) in a fire.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION			In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		PREVENT GENERATION OF MISTS!	
•**INHALATION**	Headache. Dizziness. Drowsiness. Nausea. Ataxia. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
•**SKIN**	Dry skin. Redness.	Protective gloves.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
•**EYES**	Redness.	Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•**INGESTION**	Diarrhoea. Nausea. Vomiting. (Further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Give a slurry of activated charcoal in water to drink. Do NOT induce vomiting. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Ventilation. Collect leaking and spilled liquid in sealable, suitable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe	Provision to contain effluent from fire extinguishing. Separated from food and feedstuffs and incompatible materials (see Chemical Dangers). Cool. Dry.	Do not transport with food and feedstuffs. Marine pollutant. Note: F Xn symbol

place. Do NOT let this chemical enter the environment. (Extra personal protection: self-contained breathing apparatus).	Ventilation along the floor.	N symbol R: 20-59 S: 2-24/25-59-61 UN Hazard Class: 6.1 UN Packing Group: III

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0079

Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 2002. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

1,1,1-TRICHLOROETHANE

ICSC: 0079

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
The vapour is heavier than air.

CHEMICAL DANGERS:
The substance decomposes on heating or on burning producing toxic and corrosive fumes including phosgene and hydrogen chloride. Reacts violently with aluminium, manganese and their alloys, alkalis, strong oxidants, acetone and zinc. Attacks natural rubber. Mixtures of 1,1,1-trichloroethane with potassium or its alloys are shock sensitive. Reacts slowly with water releasing corrosive hydrochloric acid.

OCCUPATIONAL EXPOSURE LIMITS:
TLV: 350 ppm; 1910 mg/m^3 (as TWA); RET450 ppm; 2460 mg/m^3 (as STEL) (ACGIH 1994-1995).
OSHA PEL: TWA 350 ppm (1900 mg/m^3)
NIOSH REL: C 350 ppm (1900 mg/m^3) 15-minute See Appendix C (Chloroethanes)
NIOSH IDLH: 700 ppm

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation of its vapour and by ingestion.

INHALATION RISK:
A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20°C.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance irritates the eyes, the skin and the respiratory tract. The substance may cause effects on the heart and central nervous system, kidneys and liver , resulting in cardiac disorders and respiratory failure. Exposure at high level may result in death. Medical observation is indicated.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
The liquid defats the skin. The substance may have effects on the liver.

PHYSICAL PROPERTIES

Boiling point: 74°C
Melting point: -30°C
Relative density (water = 1): 1.34
Solubility in water: none
Vapour pressure, kPa at 20°C: 13.3
Relative vapour density (air = 1): 4.6
Flash point: see Notes
Auto-ignition temperature: 537°C
Explosive limits, vol% in air: 8-16
Octanol/water partition coefficient as log Pow: 2.49

ENVIRONMENTAL DATA

The substance is harmful to aquatic organisms. This substance may be hazardous to the environment; special attention should be given to air and ground water.

NOTES

Combustible vapour/air mixtures difficult to ignite, may be developed under certain conditions. The substance burns only in excess oxygen or if a strong source of ignition is present. Use of alcoholic beverages enhances the harmful effect. Depending on the degree of exposure, periodic medical examination is indicated. An added stabilizer or inhibitor can influence the toxicological

properties of this substance, consult an expert. Do NOT use in the vicinity of a fire or a hot surface, or during welding. Aerothene, Algylen, Trichloran, Chlorylen, Genklene, Chlorothene NU, Chlorothene VG, and Solvent 111 are trade names.

Transport Emergency Card: TEC (R)-721
NFPA Code: H2; F1; R0

ADDITIONAL INFORMATION	

ICSC: 0079 **1,1,1-TRICHLOROETHANE**

International Chemical Safety Cards

1,1-DICHLOROETHANE

ICSC: 0249

Ethane, 1,1-dichloro-
Ethylidene chloride
CH_3CHCl_2
Molecular mass: 99.0

ICSC # 0249
CAS # 75-34-3
RTECS # KI0175000
UN # 2362
EC # 602-011-00-1

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Highly flammable. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames, NO sparks, and NO smoking.	Powder, water spray, foam, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Do NOT use compressed air for filling, discharging, or handling.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		PREVENT GENERATION OF MISTS!	
•INHALATION	Dizziness. Drowsiness. Dullness. Nausea. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Refer for medical attention.
•SKIN	Dry skin. Roughness.	Protective gloves.	Remove contaminated clothes. Rinse skin with plenty of water or shower.
•EYES	Redness. Pain.	Safety spectacles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Burning sensation (further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Collect leaking liquid in sealable containers. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT wash away into sewer (extra personal protection: self-contained breathing apparatus).	Fireproof. Separated from: see Chemical Dangers. Cool.	Marine pollutant. F symbol Xn symbol R: 11-22-36/37 S: 16-23 UN Hazard Class: 3

		UN Packing Group: II

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0249	Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 1998. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

1,1-DICHLOROETHANE

ICSC: 0249

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** The vapour is heavier than air and may travel along the ground; distant ignition possible. **CHEMICAL DANGERS:** The substance decomposes on heating and on burning producing toxic and corrosive fumes including phosgene (see ICSC 0007) and hydrogen chloride (see ICSC 0162). Reacts violently with strong oxidants, alkali metals and earth-alkali metals, powdered metals, causing fire and explosion hazard. Attacks aluminium, iron and polyethylene. Contact with strong caustic will cause formation of flammable and toxic acetaldehyde gas. **OCCUPATIONAL EXPOSURE LIMITS:** TLV: 100 ppm; 405 mg/m^3 (ACGIH 1992-1993). OSHA PEL: TWA 100 ppm (400 mg/m^3) NIOSH REL: TWA 100 ppm (400 mg/m^3) See Appendix C (Chloroethanes) NIOSH IDLH: 3000 ppm	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation and by ingestion. **INHALATION RISK:** A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20°C. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance may cause effects on the central nervous system. Exposure at high levels may result in unconsciousness. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** The liquid defats the skin. The substance may have effects on the kidneys and liver.
PHYSICAL PROPERTIES	Boiling point: 57°C Melting point: -98°C Relative density (water = 1): 1.2 Solubility in water, g/100 ml at 20°C: 0.6 Vapour pressure, kPa at 20°C: 24	Relative vapour density (air = 1): 3.4 Flash point: -6°C c.c. Auto-ignition temperature: 458°C Explosive limits, vol% in air: 5.6-11.4 Octanol/water partition coefficient as log Pow: 1.8
ENVIRONMENTAL DATA		

NOTES

Do NOT use in the vicinity of a fire or a hot surface, or during welding.

Transport Emergency Card: TEC (R)-30G34
NFPA Code: H 2; F 3; R 0;

ADDITIONAL INFORMATION

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

VINYLIDENE CHLORIDE

ICSC: 0083

1,1-Dichloroethene
1,1-Dichloroethylene
VDC
$C_2H_2Cl_2$ / $H_2C=CCl_2$
Molecular mass: 97

ICSC # 0083
CAS # 75-35-4
RTECS # KV9275000
UN # 1303 (stabilized)
EC # 602-025-00-8

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Extremely flammable. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames, NO sparks, and NO smoking.	Powder, water spray, foam, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Use non-sparking handtools.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		PREVENT GENERATION OF MISTS!	
•INHALATION	Dizziness. Drowsiness. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
•SKIN	Redness. Pain.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
•EYES	Redness. Pain.	Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Abdominal pain. Sore throat (further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Do NOT induce vomiting. Give plenty of water to drink. Rest.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area! Consult an expert! Remove all ignition sources. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent	Fireproof. Provision to contain effluent from fire extinguishing. Separated from incompatible materials (see Chemical Dangers). Cool. Keep in the dark. Store only if stabilized.	Airtight. Unbreakable packaging; put breakable packaging into closed unbreakable container. Marine pollutant. Note: D

and remove to safe place. Do NOT wash away into sewer. Do NOT let this chemical enter the environment. (Extra personal protection: complete protective clothing including self-contained breathing apparatus).		F+ symbol Xn symbol R: 12-20-40 S: (2-)7-16-29 UN Hazard Class: 3 UN Packing Group: I

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0083

Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 2000. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

VINYLIDENE CHLORIDE

ICSC: 0083

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
VOLATILE COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
The vapour is heavier than air and may travel along the ground; distant ignition possible. Vinylidine chloride monomer vapours are uninhibited and may form polymers in vents or flame arresters of storage tanks, resulting in blockage of vents.

CHEMICAL DANGERS:
The substance can readily form explosive peroxides. The substance will polymerize readily due to heating or under the influence of oxygen, sunlight, copper or aluminium, with fire or explosion hazard. May explode on heating or on contact with flames. The substance decomposes on burning producing toxic and corrosive fumes (hydrogen chloride , phosgene). Reacts violently with oxidants.

OCCUPATIONAL EXPOSURE LIMITS:
TLV: 5 ppm; A4 (ACGIH 1999).
OSHA PEL: none
NIOSH REL: Ca See Appendix A
NIOSH IDLH: Potential occupational carcinogen
No data

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation and by ingestion.

INHALATION RISK:
A harmful contamination of the air can be reached very quickly on evaporation of this substance at 20° C.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance irritates the eyes, the skin and the respiratory tract. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. Exposure at high levels could cause lowering of consciousness.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the kidneys and liver .

PHYSICAL PROPERTIES

Boiling point: 32°C
Melting point: -122°C
Relative density (water = 1): 1.2
Solubility in water, g/100 ml at 25°C: 0.25
Vapour pressure, kPa at 20°C: 66.5
Relative vapour density (air = 1): 3.3
Relative density of the vapour/air-mixture at 20°C (air = 1): 2.5
Flash point:
-25°C c.c.
Auto-ignition temperature: 570°C
Explosive limits, vol% in air: 5.6-16
Octanol/water partition coefficient as log Pow: 1.32

ENVIRONMENTAL DATA

The substance is harmful to aquatic organisms.

NOTES

Depending on the degree of exposure, periodic medical examination is indicated. An added stabilizer or inhibitor can influence the toxicological properties of this substance, consult an expert. The odour warning when the exposure limit value is exceeded is insufficient. Do NOT use in the vicinity of a fire or a hot surface, or during welding.

Transport Emergency Card: TEC (R)-641
NFPA Code: H2; F4; R2;

ADDITIONAL INFORMATION

ICSC: 0083 **VINYLIDENE CHLORIDE**

International Chemical Safety Cards

1,2-DICHLOROETHANE

ICSC: 0250

Ethylene dichloride
1,2-Ethylene dichloride
Ethane dichloride
$ClCH_2CH_2Cl$ / $C_2H_4Cl_2$
Molecular mass: 98.96

ICSC # 0250
CAS # 107-06-2
RTECS # KI0525000
UN # 1184
EC # 602-012-00-7

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Highly flammable. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames, NO sparks, and NO smoking.	Powder, water spray, foam, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Prevent build-up of electrostatic charges (e.g., by grounding). Do NOT use compressed air for filling, discharging, or handling.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		AVOID ALL CONTACT!	IN ALL CASES CONSULT A DOCTOR!
•INHALATION	Abdominal pain. Cough. Dizziness. Drowsiness. Headache. Nausea. Sore throat. Unconsciousness. Vomiting. Symptoms may be delayed (see Notes).	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Half-upright position. Artificial respiration if indicated. Refer for medical attention.
•SKIN	Redness.	Protective gloves.	Remove contaminated clothes. Rinse and then wash skin with water and soap. Refer for medical attention.
•EYES	Redness. Pain. Blurred vision.	Safety goggles, face shield, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Abdominal cramps. Diarrhoea. (Further see Inhalation).	Do not eat, drink, or smoke during work. Wash hands before eating.	Give nothing to drink. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING

Evacuate danger area! Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT wash away into sewer. (Extra personal protection: self-contained breathing apparatus).	Fireproof. Separated from strong oxidants, food and feedstuffs and other incompatible substances (see Chemical Dangers). Cool. Dry.	Unbreakable packaging; put breakable packaging into closed unbreakable container. Do not transport with food and feedstuffs. Marine pollutant. Note: E F symbol T symbol R: 45-11-22-36/37/38 S: 53-45 UN Hazard Class: 3 UN Subsidiary Risks: 6.1 UN Packing Group: II

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0250

Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 2001. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

1,2-DICHLOROETHANE

ICSC: 0250

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
COLOURLESS, VISCOUS LIQUID , WITH CHARACTERISTIC ODOUR. TURNS DARK ON EXPOSURE TO AIR, MOISTURE AND LIGHT.

PHYSICAL DANGERS:
The vapour is heavier than air and may travel along the ground; distant ignition possible. As a result of flow, agitation, etc., electrostatic charges can be generated.

CHEMICAL DANGERS:
The substance decomposes on heating and on burning producing toxic and corrosive fumes including hydrogen chloride (ICSC 0163) and phosgene (ICSC 0007). Reacts violently with aluminium, alkali metals, alkali amides, ammonia, bases, strong oxidants. Attacks many metals in presence of water. Attacks plastic.

OCCUPATIONAL EXPOSURE LIMITS:
TLV: 10 ppm; 40 mg/m^3 (as TWA) (ACGIH 1994-1995).
OSHA PEL: TWA 50 ppm C 100 ppm 200 ppm 5-minute maximum peak in any 3 hours
NIOSH REL: Ca TWA 1 ppm (4 mg/m^3) ST 2 ppm (8 mg/m^3) See Appendix A See Appendix C (Chloroethanes)
NIOSH IDLH: Potential occupational carcinogen 50 ppm

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation of its vapour, through the skin and by ingestion.

INHALATION RISK:
A harmful contamination of the air can be reached very quickly on evaporation of this substance at 20° C.

EFFECTS OF SHORT-TERM EXPOSURE:
The vapour irritates the eyes, the skin and the respiratory tract. Inhalation of the vapour may cause lung oedema (see Notes). The substance may cause effects on the central nervous system, kidneys, liver , resulting in impaired functions.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
Repeated or prolonged contact with skin may cause dermatitis. This substance is probably carcinogenic to humans.

Boiling point: 83.5°C	Relative density of the vapour/air-mixture at 20°C

PHYSICAL PROPERTIES	Melting point: -35.7°C Relative density (water = 1): 1.235 Solubility in water, g/100 ml: 0.87 Vapour pressure, kPa at 20°C: 8.7 Relative vapour density (air = 1): 3.42	(air = 1): 1.2 Flash point: 13°C c.c. Auto-ignition temperature: 413°C Explosive limits, vol% in air: 6.2-16 Octanol/water partition coefficient as log Pow: 1.48
ENVIRONMENTAL DATA		

NOTES

Depending on the degree of exposure, periodic medical examination is indicated. The symptoms of lung oedema often do not become manifest until a few hours have passed and they are aggravated by physical effort. Rest and medical observation are therefore essential. Immediate administration of an appropriate spray, by a doctor or a person authorized by him/her, should be considered.

Transport Emergency Card: TEC (R)-605
NFPA Code: H 2; F 3; R 0;

ADDITIONAL INFORMATION

ICSC: 0250 **1,2-DICHLOROETHANE**

Material Safety Data Sheet
2,2-Dichloropropane, 98%

ACC# 98038

Section 1 - Chemical Product and Company Identification

MSDS Name: 2,2-Dichloropropane, 98%
Catalog Numbers: AC307040000, AC307040050
Synonyms:
Company Identification:

Acros Organics N.V.
One Reagent Lane
Fair Lawn, NJ 07410

For information in North America, call: 800-ACROS-01
For emergencies in the US, call CHEMTREC: 800-424-9300

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
594-20-7	2,2-Dichloropropane	98.0	209-832-0

Hazard Symbols: XN F
Risk Phrases: 11 20/22

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: Not available. Flash Point: -4 deg C. **Danger! Extremely flammable liquid.** May cause eye and skin irritation. May cause respiratory and digestive tract irritation. May cause liver and kidney damage. May cause cardiac disturbances.
Target Organs: None known.

Potential Health Effects
Eye: May cause eye irritation. Vapors may cause eye irritation.
Skin: May cause skin irritation.
Ingestion: May cause irritation of the digestive tract.
Inhalation: May cause respiratory tract irritation. May cause liver and kidney damage. May cause cardiac abnormalities. Inhalation of high concentrations may result in bronchospasm.
Chronic: No information found.

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 immediately.
Skin: Get medical aid. Flush skin with plenty of water for at least 15 minutes while removing

contaminated clothing and shoes.
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 immediately.
Inhalation: Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Treat symptomatically and supportively.

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. Vapors may form an explosive mixture with air. Vapors can travel to a source of ignition and flash back. Use water spray to keep fire-exposed containers cool. Extremely flammable liquid and vapor. Containers may explode in the heat of a fire. Vapors may be heavier than air. They can spread along the ground and collect in low or confined areas.
Extinguishing Media: Use water spray to cool fire-exposed containers. Do NOT use straight streams of water. For large fires, use water spray, fog or regular foam. For small fires, use dry chemical, carbon dioxide, water spray or regular foam. Cool containers with flooding quantities of water until well after fire is out.
Flash Point: -4 deg C (24.80 deg F)
Autoignition Temperature: Not available.
Explosion Limits, Lower: Not available.
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: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Remove all sources of ignition. A vapor suppressing foam may be used to reduce vapors.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Use with adequate ventilation. Ground and bond containers when transferring material. Avoid contact with eyes, skin, and clothing. Empty containers retain product residue, (liquid and/or vapor), and can be dangerous. Keep container tightly closed. Avoid contact with heat, sparks and flame. Avoid ingestion and inhalation. Do not pressurize, cut, weld, braze, solder, drill, grind, or expose empty containers to heat, sparks or open flames.
Storage: Keep away from heat, sparks, and flame. Keep away from sources of ignition. Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
2,2-Dichloropropane	none listed	none listed	none listed

OSHA Vacated PELs: 2,2-Dichloropropane: 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 protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: Follow the OSHA respirator regulations found in 29 CFR 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: Liquid
Appearance: Not available.
Odor: Not available.
pH: Not available.
Vapor Pressure: Not available.
Vapor Density: 3.9
Evaporation Rate: Not available.
Viscosity: Not available.
Boiling Point: 70.5 deg C
Freezing/Melting Point:-35 deg C
Decomposition Temperature: Not available.
Solubility: Not available.
Specific Gravity/Density:1.0820g/cm3
Molecular Formula:C3H6Cl2
Molecular Weight:112.99

Section 10 - Stability and Reactivity

Chemical Stability: Stability unknown.
Conditions to Avoid: Incompatible materials, ignition sources.
Incompatibilities with Other Materials: Strong oxidizing agents, dimethylzinc
Hazardous Decomposition Products: Hydrogen chloride, carbon monoxide, carbon dioxide.
Hazardous Polymerization: Has not been reported.

Section 11 - Toxicological Information

RTECS#:
CAS# 594-20-7: TX9662500
LD50/LC50:
Not available.

Carcinogenicity:
CAS# 594-20-7: Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology: No data available.

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

No information available.

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	IATA	RID/ADR	IMO	Canada TDG
Shipping Name:	DOT regulated - small quantity provisions apply (see 49CFR173.4)				No information available.
Hazard Class:					
UN Number:					
Packing Group:					

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 594-20-7 is listed on the TSCA inventory.
Health & Safety Reporting List
CAS# 594-20-7: Effective Date: 3/7/86; Sunset Date: 12/19/95
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

CERCLA Hazardous Substances and corresponding RQs

None of the chemicals in this material have an RQ.
SARA Section 302 Extremely Hazardous Substances
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
CAS# 594-20-7 can be found on the following state right to know lists: Massachusetts.
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:
XN F
Risk Phrases:
R 11 Highly flammable.
R 20/22 Harmful by inhalation and if swallowed.

Safety Phrases:
S 16 Keep away from sources of ignition - No smoking.
S 24 Avoid contact with skin.

WGK (Water Danger/Protection)
CAS# 594-20-7: No information available.
Canada - DSL/NDSL
CAS# 594-20-7 is listed on Canada's DSL List.
Canada - WHMIS
WHMIS: Not available.
Canadian Ingredient Disclosure List
Exposure Limits

Section 16 - Additional Information

MSDS Creation Date: 10/07/1997
Revision #2 Date: 3/18/2003

International Chemical Safety Cards

TETRACHLOROETHYLENE

ICSC: 0076

1,1,2,2-Tetrachloroethylene
Perchloroethylene
Tetrachloroethene
C_2Cl_4 / $Cl_2C{=}CCl_2$
Molecular mass: 165.8

ICSC # 0076
CAS # 127-18-4
RTECS # KX3850000
UN # 1897
EC # 602-028-00-4

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Not combustible. Gives off irritating or toxic fumes (or gases) in a fire.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION			
EXPOSURE		STRICT HYGIENE! PREVENT GENERATION OF MISTS!	
•INHALATION	Dizziness. Drowsiness. Headache. Nausea. Weakness. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
•SKIN	Dry skin. Redness.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
•EYES	Redness. Pain.	Safety goggles, face shield.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Abdominal pain (further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Do NOT induce vomiting. Give plenty of water to drink. Rest.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Ventilation. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT let this chemical enter the environment. (Extra personal protection: filter respirator for organic gases and vapours).	Separated from metals see Chemical Dangers food and feedstuffs Keep in the dark. Ventilation along the floor.	Do not transport with food and feedstuffs. Marine pollutant. Xn symbol N symbol R: 40-51/53 S: (2-)23-36/37-61 UN Hazard Class: 6.1 UN Packing Group: III

SEE IMPORTANT INFORMATION ON BACK	
ICSC: 0076	Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 2000. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

TETRACHLOROETHYLENE

ICSC: 0076

I M P O R T A N T D A T A

PHYSICAL STATE; APPEARANCE:
COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
The vapour is heavier than air.

CHEMICAL DANGERS:
On contact with hot surfaces or flames this substance decomposes forming toxic and corrosive fumes (hydrogen chloride, phosgene, chlorine). The substance decomposes slowly on contact with moisture producing trichloroacetic acid and hydrochloric acid. Reacts with metals such as aluminium, lithium, barium, beryllium.

OCCUPATIONAL EXPOSURE LIMITS:
TLV: 25 ppm; (STEL): 100 ppm; (ACGIH 1999).
OSHA PEL: TWA 100 ppm C 200 ppm 300 ppm (5-minute maximum peak in any 3-hours)
NIOSH REL: Ca Minimize workplace exposure concentrations. See Appendix A
NIOSH IDLH: Potential occupational carcinogen 150 ppm

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation and by ingestion.

INHALATION RISK:
A harmful contamination of the air will be reached rather slowly on evaporation of this substance at 20° C.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance irritates the eyes, the skin and the respiratory tract. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. The substance may cause effects on the central nervous system. Exposure at high levels may result in unconsciousness.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the liver and kidneys. This substance is probably carcinogenic to humans.

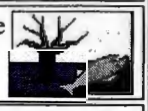
PHYSICAL PROPERTIES

Boiling point: 121°C
Melting point: -22°C
Relative density (water = 1): 1.6
Solubility in water, g/100 ml at 20°C: 0.015

Vapour pressure, kPa at 20°C: 1.9
Relative vapour density (air = 1): 5.8
Relative density of the vapour/air-mixture at 20°C (air = 1): 1.09
Octanol/water partition coefficient as log Pow: 2.9

ENVIRONMENTAL DATA

The substance is toxic to aquatic organisms. The substance may cause long-term effects in the aquatic environment.



NOTES

Depending on the degree of exposure, periodic medical examination is indicated. The odour warning when the exposure limit value is exceeded is insufficient. Do NOT use in the vicinity of a fire or a hot surface, or during welding. An added stabilizer or inhibitor can influence the toxicological properties of this substance, consult an expert.

Transport Emergency Card: TEC (R)-722
NFPA Code: H2; F0; R0;

ADDITIONAL INFORMATION

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

TRICHLOROETHYLENE

ICSC: 0081

1,1,2-Trichloroethylene
Trichloroethene
Ethylene trichloride
Acetylene trichloride
C_2HCl_3 / $ClCH=CCl_2$
Molecular mass: 131.4

ICSC # 0081
CAS # 79-01-6
RTECS # KX4550000
UN # 1710
EC # 602-027-00-9

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Combustible under specific conditions. See Notes.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION		Prevent build-up of electrostatic charges (e.g., by grounding).	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		PREVENT GENERATION OF MISTS! STRICT HYGIENE!	
•INHALATION	Dizziness. Drowsiness. Headache. Weakness. Nausea. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
•SKIN	Dry skin. Redness.	Protective gloves.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
•EYES	Redness. Pain.	Safety spectacles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Abdominal pain (further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Do NOT induce vomiting. Give plenty of water to drink. Rest.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Ventilation. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. (Extra personal protection: filter	Separated from metals see Chemical Dangers strong bases, food and feedstuffs Dry. Keep in the dark. Ventilation along the floor.	Do not transport with food and feedstuffs. Marine pollutant. Xn symbol R: 40-52/53 S: 2-23-36/37-61

respirator for organic gases and vapours). Do NOT let this chemical enter the environment.		UN Hazard Class: 6.1 UN Packing Group: III

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0081

International Chemical Safety Cards

TRICHLOROETHYLENE

ICSC: 0081

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
The vapour is heavier than air. As a result of flow, agitation, etc., electrostatic charges can be generated.

CHEMICAL DANGERS:
On contact with hot surfaces or flames this substance decomposes forming toxic and corrosive fumes phosgene hydrogen chloride The substance decomposes on contact with strong alkali producing dichloroacetylene , which increases fire hazard. Reacts violently with metal powders such as magnesium, aluminium, titanium, and barium. Slowly decomposed by light in presence of moisture, with formation of corrosive hydrochloric acid.

OCCUPATIONAL EXPOSURE LIMITS:
TLV: 50 A5 ppm;(STEL): 100 ppm; (ACGIH 2000).
OSHA PEL: TWA 100 ppm C 200 ppm 300 ppm (5-minute maximum peak in any 2 hours)
NIOSH REL: Ca See Appendix A See Appendix C
NIOSH IDLH: Potential occupational carcinogen 1000 ppm

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation and by ingestion.

INHALATION RISK:
A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20°C.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance irritates the eyes and the skin. Swallowing the liquid may cause aspiration into the lungs with the risk of chemical pneumonitis. The substance may cause effects on the central nervous system , resulting in respiratory failure Exposure could cause lowering of consciousness.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the central nervous system , resulting in loss of memory. The substance may have effects on the liver kidneys (see notes). This substance is probably carcinogenic to humans.

PHYSICAL PROPERTIES

Boiling point: 87°C
Melting point: -73°C
Relative density (water = 1): 1.5
Solubility in water, g/100 ml at 20°C: 0.1
Vapour pressure, kPa at 20°C: 7.8
Relative vapour density (air = 1): 4.5
Relative density of the vapour/air-mixture at 20°C (air = 1): 1.3
Auto-ignition temperature: 410°C
Explosive limits, vol% in air: 8-10.5
Octanol/water partition coefficient as log Pow: 2.42
Electrical conductivity (NOT on card): 800pS/m

ENVIRONMENTAL DATA

The substance is harmful to aquatic organisms. The substance may cause long-term effects in the aquatic environment.

NOTES

Combustible vapour/air mixtures difficult to ignite, may be developed under certain conditions. Use of alcoholic beverages

enhances the harmful effect. Depending on the degree of exposure, periodic medical examination is indicated. The odour warning when the exposure limit value is exceeded is insufficient. Do NOT use in the vicinity of a fire or a hot surface, or during welding. An added stabilizer or inhibitor can influence the toxicological properties of this substance, consult an expert.

Transport Emergency Card: TEC (R)-723
NFPA Code: H2; F1; R0;

ADDITIONAL INFORMATION

ICSC: 0081 **TRICHLOROETHYLENE**

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

TOLUENE

ICSC: 0078

TOLUENE
Methylbenzene
Toluol
$C_6H_5CH_3/C_7H_8$
Molecular mass: 92.1

CAS # 108-88-3
RTECS # XS5250000
ICSC # 0078
UN # 1294
EC # 601-021-00-3

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Highly flammable.	NO open flames, NO sparks, and NO smoking.	Powder, AFFF, foam, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Prevent build-up of electrostatic charges (e.g., by grounding). Do NOT use compressed air for filling, discharging, or handling.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		STRICT HYGIENE! AVOID EXPOSURE OF (PREGNANT) WOMEN!	
• **INHALATION**	Dizziness. Drowsiness. Headache. Nausea. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
• **SKIN**	Dry skin. Redness.	Protective gloves.	Remove contaminated clothes. Rinse and then wash skin with water and soap. Refer for medical attention.
• **EYES**	Redness. Pain.	Safety goggles or face shield.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**	Abdominal pain. Burning sensation (further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Give a slurry of activated charcoal in water to drink. Do NOT induce vomiting. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING

Collect leaking liquid in sealable containers. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT wash away into sewer (extra personal protection: self-contained breathing apparatus).	Fireproof. Separated from strong oxidants.	F symbol Xn symbol R: 11-20 S: (2-)16-25-29-33 UN Hazard Class: 3 UN Packing Group: II

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0078

International Chemical Safety Cards

TOLUENE

ICSC: 0078

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
The vapour is heavier than air and may travel along the ground; distant ignition possible. As a result of flow, agitation, etc., electrostatic charges can be generated.

CHEMICAL DANGERS:
Reacts violently with strong oxidants causing fire and explosion hazard.

OCCUPATIONAL EXPOSURE LIMITS (OELs):
TLV: 50 ppm; 188 mg/m^3 (as TWA) (skin) (ACGIH 1993-1994).
OSHA PEL: TWA 200 ppm C 300 ppm 500 ppm (10-minute maximum peak)
NIOSH REL: TWA 100 ppm (375 mg/m^3) ST 150 ppm (560 mg/m^3)
NIOSH IDLH: 500 ppm

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation, through the skin and by ingestion.

INHALATION RISK:
A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20°C.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance irritates the eyes and the respiratory tract. Exposure could cause central nervous system depression. Exposure at high levels may result in cardiac dysrhythmia, unconsciousness and death.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the central nervous system , resulting in decreased learning ability and psychological disorders. Animal tests show that this substance possibly causes toxic effects upon human reproduction.

PHYSICAL PROPERTIES

Boiling point: 111°C
Melting point: -95°C
Relative density (water = 1): 0.87
Solubility in water: none
Vapour pressure, kPa at 20°C: 2.9
Relative vapour density (air = 1): 3.2
Relative density of the vapour/air-mixture at 20°C (air = 1): 1.06
Flash point: 4°C c.c.°C
Auto-ignition temperature: 480°C
Explosive limits, vol% in air: 1.1-7.1
Octanol/water partition coefficient as log Pow: 2.69

ENVIRONMENTAL DATA

NOTES

Depending on the degree of exposure, periodic medical examination is indicated.

Transport Emergency Card: TEC (R)-31
NFPA Code: H 2; F 3; R 0;

ADDITIONAL INFORMATION

ICSC: 0078 **TOLUENE**

International Chemical Safety Cards

VINYL CHLORIDE

ICSC: 0082

Chloroethene
Chloroethylene
VCM
C_2H_3Cl / $H_2C=CHCl$
Molecular mass: 62.5
(cylinder)

ICSC # 0082
CAS # 75-01-4
RTECS # KU9625000
UN # 1086 (stabilized)
EC # 602-023-00-7

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Extremely flammable. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames, NO sparks, and NO smoking.	Shut off supply; if not possible and no risk to surroundings, let the fire burn itself out; in other cases extinguish with powder, carbon dioxide.
EXPLOSION	Gas/air mixtures are explosive.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Use non-sparking handtools.	In case of fire: keep cylinder cool by spraying with water. Combat fire from a sheltered position.
EXPOSURE		AVOID ALL CONTACT!	IN ALL CASES CONSULT A DOCTOR!
•INHALATION	Dizziness. Drowsiness. Headache. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Refer for medical attention.
•SKIN	ON CONTACT WITH LIQUID: FROSTBITE.	Protective gloves. Cold-insulating gloves. Protective clothing.	ON FROSTBITE: rinse with plenty of water, do NOT remove clothes.
•EYES	Redness. Pain.	Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION		Do not eat, drink, or smoke during work.	

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area! Consult an expert! Ventilation. Remove all ignition sources. (Extra personal protection: complete protective clothing including self-contained breathing apparatus).	Fireproof. Separated from incompatible materials (see Chemical Dangers). Cool. Store only if stabilized.	Note: D F+ symbol T symbol R: 45-12

		S: 53-45 UN Hazard Class: 2.1

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0082

International Chemical Safety Cards

VINYL CHLORIDE

ICSC: 0082

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
COLOURLESS COMPRESSED LIQUEFIED GAS , WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
The gas is heavier than air, and may travel along the ground; distant ignition possible. Vinyl chloride monomer vapours are uninhibited and may form polymers in vents or flame arresters of storage tanks, resulting in blockage of vents.

CHEMICAL DANGERS:
The substance can under specific circumstances form peroxides, initiating explosive polymerization. The substance will polymerize readily due to heating and under the influence of air, light, and on contact with a catalyst, strong oxidizing agents and metals such as copper and aluminium, with fire or explosion hazard. The substance decomposes on burning producing toxic and corrosive fumes (hydrogen chloride , phosgene). Attacks iron and steel in the presence of moisture.

OCCUPATIONAL EXPOSURE LIMITS:
TLV: 1 ppm; A1 (ACGIH 1999).
OSHA PEL: 1910.1017 TWA 1 ppm C 5 ppm 15-minute
NIOSH REL: Ca See Appendix A
NIOSH IDLH: Potential occupational carcinogen
No data

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation.

INHALATION RISK:
A harmful concentration of this gas in the air will be reached very quickly on loss of containment.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance irritates the eyes. The liquid may cause frostbite. The substance may cause effects on the central nervous system . Exposure could cause lowering of consciousness. Medical observation is indicated.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
The substance may have effects on the liver, spleen, blood andperipheral blood vessels, and tissue and bones of the fingers. This substance is carcinogenic to humans.

PHYSICAL PROPERTIES

Boiling point: -13°C
Melting point: -154°C
Relative density (water = 1): (liquid) 0.9
Density: (vapour) at 15°C 8
g/l
Solubility in water:
none

Relative vapour density (air = 1): 2.2
Flash point:
-78°C c.c.
Auto-ignition temperature: 472°C
Explosive limits, vol% in air: 3.6-33
Octanol/water partition coefficient as log Pow: 0.6

ENVIRONMENTAL DATA

This substance may be hazardous to the environment; special attention should be given to ground water .

NOTES

Depending on the degree of exposure, periodic medical examination is indicated. The odour warning when the exposure limit value is exceeded is insufficient. Do NOT use in the vicinity of a fire or a hot surface, or during welding. An added stabilizer or inhibitor can influence the toxicological properties of this substance, consult an expert.

Transport Emergency Card: TEC (R)-150
NFPA Code: H 2; F 4; R 2;

ADDITIONAL INFORMATION

ICSC: 0082 **VINYL CHLORIDE**

International Chemical Safety Cards

ACETONE

ICSC: 0087

2-Propanone
Dimethyl ketone
Methyl ketone
C_3H_6O / CH_3COCH_3
Molecular mass: 58.1

ICSC # 0087
CAS # 67-64-1
RTECS # AL3150000
UN # 1090
EC # 606-001-00-8

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Highly flammable.	NO open flames, NO sparks, and NO smoking.	Powder, alcohol-resistant foam, water in large amounts, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Do NOT use compressed air for filling, discharging, or handling.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE			
•INHALATION	Sore throat. Cough. Confusion. Headache. Dizziness. Drowsiness. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Refer for medical attention.
•SKIN	Dry skin.	Protective gloves.	Remove contaminated clothes. Rinse skin with plenty of water or shower.
•EYES	Redness. Pain. Blurred vision. Possible corneal damage.	Safety spectacles, or face shield. Contact lenses should not be worn.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Nausea. Vomiting. (Further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Ventilation. Collect leaking liquid in sealable containers. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT wash away into sewer. Then wash away with plenty of water. (Extra personal protection: self-	Fireproof. Separated from strong oxidants.	F symbol R: 11 S: 2-9-16-23-33 UN Hazard Class: 3 UN Packing Group: II

contained breathing apparatus).

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0087

International Chemical Safety Cards

ACETONE

ICSC: 0087

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
The vapour is heavier than air and may travel along the ground; distant ignition possible.

CHEMICAL DANGERS:
The substance can form explosive peroxides on contact with strong oxidants such as acetic acid, nitric acid, hydrogen peroxide. Reacts with chloroform and bromoform under basic conditions, causing fire and explosion hazard. Attacks plastic.

OCCUPATIONAL EXPOSURE LIMITS:
TLV: 750 ppm; 1780 mg/m^3 (ACGIH 1993-1993).
OSHA PEL: TWA 1000 ppm (2400 mg/m^3)
NIOSH REL: TWA 250 ppm (590 mg/m^3)
NIOSH IDLH: 2500 ppm LEL

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation and through the skin.

INHALATION RISK:
A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20°C on dispersing however much faster.

EFFECTS OF SHORT-TERM EXPOSURE:
The vapour irritates the eyes and the respiratory tract. The substance may cause effects on the central nervous system, liver, kidneys and gastrointestinal tract.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the blood and bone marrow.

PHYSICAL PROPERTIES

Boiling point: 56°C
Melting point: -95°C
Relative density (water = 1): 0.8
Solubility in water: miscible
Vapour pressure, kPa at 20°C: 24
Relative vapour density (air = 1): 2.0
Relative density of the vapour/air-mixture at 20°C (air = 1): 1.2
Flash point: -18°C c.c.
Auto-ignition temperature: 465°C
Explosive limits, vol% in air: 2.2-13
Octanol/water partition coefficient as log Pow: -0.24

ENVIRONMENTAL DATA

NOTES

Use of alcoholic beverages enhances the harmful effect.

Transport Emergency Card: TEC (R)-30
NFPA Code: H 1; F 3; R 0;.

ADDITIONAL INFORMATION

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

1,2-DICHLOROETHYLENE

ICSC: 0436

1,2-Dichloroethene
Acetylene dichloride
symmetrical Dichloroethylene
$C_2H_2Cl_2$ / ClCH=CHCl
Molecular mass: 96.95

ICSC # 0436
CAS # 540-59-0
RTECS # KV9360000
UN # 1150
EC # 602-026-00-3

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Highly flammable. Gives off irritating or toxic fumes (or gases) in a fire.	NO open flames, NO sparks, and NO smoking.	Powder, water spray, foam, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Do NOT use compressed air for filling, discharging, or handling.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		STRICT HYGIENE!	
•INHALATION	Cough. Sore throat. Dizziness. Nausea. Drowsiness. Weakness. Unconsciousness. Vomiting.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Refer for medical attention.
•SKIN	Dry skin.	Protective gloves.	Remove contaminated clothes. Rinse skin with plenty of water or shower.
•EYES	Redness. Pain.	Safety spectacles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Abdominal pain. (Further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Give plenty of water to drink. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Remove all ignition sources. Ventilation. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in dry sand or inert absorbent and remove to safe place.	Fireproof. Well closed. See Chemical Dangers.	Note: C F symbol Xn symbol R: 11-20-52/53

Do NOT wash away into sewer. (Extra personal protection: complete protective clothing including self-contained breathing apparatus.)		S: 2-7-16-29-61 UN Hazard Class: 3 UN Packing Group: II

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0436

Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 2003. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

1,2-DICHLOROETHYLENE

ICSC: 0436

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
The vapour is heavier than air and may travel along the ground; distant ignition possible.

CHEMICAL DANGERS:
The substance decomposes on heating or under the influence of air , light and moisture producing toxic and corrosive fumes including hydrogen chloride . Reacts with strong oxidants. Reacts with copper or copper alloys, and bases to produce toxic chloroacetylene which is spontaneously flammable in contact with air. Attacks plastic.

OCCUPATIONAL EXPOSURE LIMITS:
TLV: 200 ppm as TWA; (ACGIH 2003).
MAK: 200 ppm, 800 mg/m³;
Peak limitation category: II(2);
(DFG 2002).
OSHA PEL: TWA 200 ppm (790 mg/m^3)
NIOSH REL: TWA 200 ppm (790 mg/m^3)
NIOSH IDLH: 1000 ppm

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation of its vapour and by ingestion.

INHALATION RISK:
A harmful contamination of the air will be reached quickly on evaporation of this substance at 20°C; on spraying or dispersing, however, much faster.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance is irritating to the eyes and the respiratory tract . The substance may cause effects on the central nervous system at high levels , resulting in lowering of consciousness .

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
The liquid defats the skin. The substance may have effects on the liver .

PHYSICAL PROPERTIES

Boiling point: 55°C
Relative density (water = 1): 1.28
Solubility in water: poor
Relative vapour density (air = 1): 3.34
Flash point: 2°C c.c.
Auto-ignition temperature: 460°C
Explosive limits, vol% in air: 9.7-12.8
Octanol/water partition coefficient as log Pow: 2

ENVIRONMENTAL DATA

NOTES

This compound has two isomers, cis and trans.Data for the isomers: cis-isomer (CAS 156-59-2), trans isomer (CAS 156-60-5), other boiling point 60.3, melting point -81.5°C (cis), -49.4°C (trans); flash point c.c. 6°C (cis), 2-4°C (trans); relative density (water = 1) 1.28 (cis), 1.26 (trans); vapour pressure 24.0 kPa (cis), 35.3 kPa (trans) at 20°C; relative density of the vapour/air-mixture at 20°C (air = 1): 1.6 (cis), 1.8 (trans); octanol/water partition coefficient as log Pow: 1.86 (cis), 2.09 (trans). Depending on the degree of exposure, periodic medical examination is suggested.

Transport Emergency Card: TEC (R)-30GF1-I+II

NFPA Code: H2; F3; R2;

ADDITIONAL INFORMATION	

ICSC: 0436 **1,2-DICHLOROETHYLENE**

Material Safety Data Sheet

Bromodichloromethane, 98+%, stabilized with potassium carbonate

ACC# 77183

Section 1 - Chemical Product and Company Identification

MSDS Name: Bromodichloromethane, 98+%, stabilized with potassium carbonate
Catalog Numbers: AC160700000, AC160700100
Synonyms: Dichlorobromomethane.
Company Identification:

Acros Organics N.V.
One Reagent Lane
Fair Lawn, NJ 07410

For information in North America, call: 800-ACROS-01
For emergencies in the US, call CHEMTREC: 800-424-9300

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
75-27-4	Dichlorobromomethane	>98	200-856-7
584-08-7	Potassium carbonate	-	209-529-3

Hazard Symbols: XN
Risk Phrases: 22 40

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: clear, colorless liquid. **Warning!** Cancer suspect agent. Causes eye, skin, and respiratory tract irritation. Harmful if swallowed. May be harmful if absorbed through skin or if inhaled.
Target Organs: Respiratory system, eyes, skin.

Potential Health Effects
Eye: Causes eye irritation.
Skin: Causes skin irritation. May be harmful if absorbed through the skin.
Ingestion: Harmful if swallowed. May cause gastrointestinal irritation with nausea, vomiting and diarrhea.

Inhalation: Prolonged exposure may result in dizziness and general weakness. Causes severe irritation of upper respiratory tract with coughing, burns, breathing difficulty, and possible coma. May cause narcotic effects in high concentration. May be harmful if inhaled.
Chronic: May cause cancer according to animal studies.

Section 4 - First Aid Measures

Eyes: Immediately flush eyes with plenty of water for at least 15 minutes, occasionally lifting the upper

and lower eyelids. Get medical aid immediately.
Skin: Immediately flush skin with plenty of 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. Get medical aid immediately.
Inhalation: Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical aid.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Substance is noncombustible.
Extinguishing Media: Use extinguishing media most appropriate for the surrounding fire.
Flash Point: Not available.
Autoignition Temperature: Not available.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: (estimated) Health: 2; Flammability: ; Instability:

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Wash area with soap and water. Provide ventilation.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Avoid contact with eyes, skin, and clothing. Avoid ingestion and inhalation. Use only in a chemical fume hood.
Storage: Store in a cool, dry place. Store in a tightly closed container.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use only under a chemical fume hood.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Dichlorobromomethane	none listed	none listed	none listed
Potassium carbonate	none listed	none listed	none listed

OSHA Vacated PELs: Dichlorobromomethane: No OSHA Vacated PELs are listed for this chemical.
Potassium carbonate: No OSHA Vacated PELs are listed for this chemical.
Personal Protective Equipment

Eyes: Wear chemical goggles.
Skin: Wear appropriate protective gloves to prevent skin exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: Follow the OSHA respirator regulations found in 29 CFR 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: Liquid
Appearance: clear, colorless
Odor: chloroform-like
pH: Not available.
Vapor Pressure: 50 mm Hg @ 20 deg C
Vapor Density: Not available.
Evaporation Rate: Not available.
Viscosity: Not available.
Boiling Point: 87 deg C @ 760 mm Hg
Freezing/Melting Point:-55 deg C
Decomposition Temperature: Not available.
Solubility: in water: 4700 mg/l
Specific Gravity/Density:1.9800g/cm3
Molecular Formula:CHBrCl2
Molecular Weight:163.83

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: Excess heat, confined spaces.
Incompatibilities with Other Materials: Strong bases, strong oxidizing agents, magnesium.
Hazardous Decomposition Products: Hydrogen chloride, carbon monoxide, carbon dioxide, hydrogen bromide.
Hazardous Polymerization: Has not been reported.

Section 11 - Toxicological Information

RTECS#:
CAS# 75-27-4: PA5310000
CAS# 584-08-7: TS7750000
LD50/LC50:
CAS# 75-27-4:
Oral, mouse: LD50 = 450 mg/kg;
Oral, rat: LD50 = 430 mg/kg;
CAS# 584-08-7:
Oral, mouse: LD50 = 2570 mg/kg;
Oral, rat: LD50 = 1870 mg/kg;
Carcinogenicity:
CAS# 75-27-4:
California: carcinogen; initial date 1/1/90

NTP: Suspect carcinogen
OSHA: Possible Select carcinogen
IARC: Group 2B carcinogen CAS# 584-08-7: Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology: No data available.
Teratogenicity: No data available.
Reproductive Effects: See actual entry in RTECS for complete information.
Neurotoxicity: No data available.
Mutagenicity: See actual entry in RTECS for complete information.
Other Studies: No data available.

Section 12 - Ecological Information

Ecotoxicity: No data available. log Pow: 2.10
Environmental: Terrestrial Fate: In soils where exposure to the atmosphere can occur, volatilization is likely to be the dominant environmental fate process due to the high vapor pressure of bromodichloromethane. It's highly mobile in soil and can therefore leach into ground water and subsurface regions. Laboratory studie have indicated that significant biodegradation can occur under anaerobic conditions. Aquatic fate: Volatilization of bromodichlormoethane is the dominant removal mechanism from environmental surface waters.
Physical: No information available.
Other: No information available.

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	IATA	RID/ADR	IMO	Canada TDG
Shipping Name:	DOT regulated - small quantity provisions apply (see 49CFR173.4)				No information available.
Hazard Class:					
UN Number:					
Packing Group:					

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 75-27-4 is listed on the TSCA inventory.
CAS# 584-08-7 is listed on the TSCA inventory.
Health & Safety Reporting List
CAS# 75-27-4: Effective Date: 6/1/87; Sunset Date: 12/19/95
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

CERCLA Hazardous Substances and corresponding RQs
CAS# 75-27-4: 5000 lb final RQ; 2270 kg final RQ
SARA Section 302 Extremely Hazardous Substances
None of the chemicals in this product have a TPQ.
SARA Codes
CAS # 75-27-4: acute, chronic. CAS # 584-08-7: acute.
Section 313
This material contains Dichlorobromomethane (CAS# 75-27-4, 98%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.
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. CAS# 75-27-4 is listed as a Priority Pollutant under the Clean Water Act. CAS# 75-27-4 is listed as a Toxic Pollutant under the Clean Water Act.
OSHA:
None of the chemicals in this product are considered highly hazardous by OSHA.
STATE
CAS# 75-27-4 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Massachusetts.
CAS# 584-08-7 is not present on state lists from CA, PA, MN, MA, FL, or NJ.
The following statement(s) is(are) made in order to comply with the California Safe Drinking Water Act: WARNING: This product contains Dichlorobromomethane, a chemical known to the state of California to cause cancer. California No Significant Risk Level: CAS# 75-27-4: 5 ug/day NSRL

European/International Regulations

European Labeling in Accordance with EC Directives
Hazard Symbols:
XN
Risk Phrases:
R 22 Harmful if swallowed.
R 40 Limited evidence of a carcinogenic effect.

Safety Phrases:
S 36/37 Wear suitable protective clothing and gloves.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

WGK (Water Danger/Protection)
CAS# 75-27-4: No information available.
CAS# 584-08-7: 1
Canada - DSL/NDSL
CAS# 584-08-7 is listed on Canada's DSL List.
CAS# 75-27-4 is listed on Canada's NDSL List.
Canada - WHMIS
This product has a WHMIS classification of D1B, D2A.
Canadian Ingredient Disclosure List
CAS# 75-27-4 is listed on the Canadian Ingredient Disclosure List.
CAS# 584-08-7 is listed on the Canadian Ingredient Disclosure List.
Exposure Limits

Section 16 - Additional Information

MSDS Creation Date: 9/02/1997
Revision #3 Date: 3/18/2003

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 event shall Fisher 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 Fisher has been advised of the possibility of such damages.

International Chemical Safety Cards

CHLOROFORM

ICSC: 0027

Trichloromethane
Methane trichloride
Formyl trichloride
$CHCl_3$
Molecular mass: 119.4

ICSC # 0027
CAS # 67-66-3
RTECS # FS9100000
UN # 1888
EC # 602-006-00-4

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Not combustible. See Notes. Gives off irritating or toxic fumes (or gases) in a fire.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION			In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		STRICT HYGIENE! AVOID EXPOSURE OF ADOLESCENTS AND CHILDREN!	
•**INHALATION**	Cough. Dizziness. Drowsiness. Headache. Nausea. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
•**SKIN**	Redness. Pain. Dry skin.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse skin with plenty of water or shower. Refer for medical attention.
•**EYES**	Redness. Pain.	Face shield or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•**INGESTION**	Abdominal pain. Vomiting. (Further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Give plenty of water to drink. Rest. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area! Consult an expert! Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do	Separated from food and feedstuffs and incompatible materials (see Chemical Dangers). Ventilation along the floor.	Unbreakable packaging; put breakable packaging into closed unbreakable container. Do not transport with food and feedstuffs. Xn symbol

NOT let this chemical enter the environment. (Extra personal protection: complete protective clothing including self-contained breathing apparatus).		R: 22-38-40-48/20/22 S: 2-36/37 UN Hazard Class: 6.1 UN Packing Group: III

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0027

Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 2000. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

CHLOROFORM

ICSC: 0027

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
VOLATILE COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
The vapour is heavier than air.

CHEMICAL DANGERS:
On contact with hot surfaces or flames this substance decomposes forming toxic and corrosive fumes (hydrogen chloride ICSC0163, phosgene ICSC0007 and chlorine fumes ICSC0126). Reacts violently with strong bases, strong oxidants, some metals, such as aluminium, magnesium and zinc, causing fire and explosion hazard. Attacks plastic, rubber and coatings.

OCCUPATIONAL EXPOSURE LIMITS:
TLV (as TWA): 10 ppm; A3 (ACGIH 1999).
MAK: 10 ppm; 50 mg/m^3; (1999).
MAK: class 3 (1999).
OSHA PEL: C 50 ppm (240 mg/m^3)
NIOSH REL: Ca ST 2 ppm (9.78 mg/m^3) 60-minute
See Appendix A
NIOSH IDLH: Potential occupational carcinogen
500 ppm

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation, through the skin and by ingestion.

INHALATION RISK:
A harmful contamination of the air can be reached very quickly on evaporation of this substance at 20° C.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance irritates the eyes. The substance may cause effects on the central nervous system liver and kidneys . The effects may be delayed. Medical observation is indicated.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
The liquid defats the skin. The substance may have effects on the liver and kidneys . This substance is possibly carcinogenic to humans.

PHYSICAL PROPERTIES

Boiling point: 62°C
Melting point: -64°C
Relative density (water = 1): 1.48
Solubility in water, g/100 ml at 20°C: 0.8

Vapour pressure, kPa at 20°C: 21.2
Relative vapour density (air = 1): 4.12
Relative density of the vapour/air-mixture at 20°C (air = 1): 1.7
Octanol/water partition coefficient as log Pow: 1.97

ENVIRONMENTAL DATA

The substance is toxic to aquatic organisms.

NOTES

Turns combustible on addition of small amounts of a flammable substance or an increase in the oxygen content of the air. Use of alcoholic beverages enhances the harmful effect. Depending on the degree of exposure, periodic medical examination is indicated. The odour warning when the exposure limit value is exceeded is insufficient. Do NOT use in the vicinity of a fire or a hot surface, or during welding.

Transport Emergency Card: TEC (R)-61G61c
NFPA Code: H 2; F 0; R 0;

ADDITIONAL INFORMATION	

ICSC: 0027 **CHLOROFORM**

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

METHYL CHLORIDE

ICSC: 0419

Chloromethane
Monochloromethane
CH_3Cl

Molecular mass: 50.5

ICSC # 0419
CAS # 74-87-3
RTECS # PA6300000
UN # 1063
EC # 602-001-00-7

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Highly flammable. Heating will cause rise in pressure with risk of bursting.	NO open flames, NO sparks, and NO smoking.	Shut off supply; if not possible and no risk to surroundings, let the fire burn itself out; in other cases extinguish with water spray.
EXPLOSION	Gas/air mixtures are explosive.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Use non-sparking handtools.	In case of fire: keep cylinder cool by spraying with water. Combat fire from a sheltered position.
EXPOSURE		STRICT HYGIENE!	
•INHALATION	Staggering gait. Dizziness. Headache. Nausea. Vomiting. Convulsions. Unconsciousness. See Notes.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
•SKIN	MAY BE ABSORBED! ON CONTACT WITH LIQUID: FROSTBITE.	Cold-insulating gloves. Protective clothing.	ON FROSTBITE: rinse with plenty of water, do NOT remove clothes.
•EYES	(See Skin).	Safety goggles, face shield, or eye protection in combination with breathing protection.	
•INGESTION			

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Evacuate danger area! Consult an expert! Ventilation. NEVER direct water jet on liquid. (Extra personal protection: complete protective clothing including self-contained breathing apparatus).	Fireproof. Ventilation along the floor.	F+ symbol Xn symbol R: 12-40-48/20 S: 2-9-16-33 UN Hazard Class: 2.1

SEE IMPORTANT INFORMATION ON BACK

International Chemical Safety Cards

METHYL CHLORIDE

ICSC: 0419

I M P O R T A N T D A T A	**PHYSICAL STATE; APPEARANCE:** COLOURLESS LIQUEFIED GAS. **PHYSICAL DANGERS:** The gas is heavier than air and may travel along the ground; distant ignition possible, and may accumulate in low ceiling spaces causing deficiency of oxygen. See Notes. **CHEMICAL DANGERS:** The substance decomposes on burning producing toxic and corrosive fumes including hydrogen chloride and phosgene. Reacts violently with powdered aluminium, powdered zinc, aluminium trichloride and ethylene causing fire and explosion hazard. Attacks many metals in the presence of moisture. **OCCUPATIONAL EXPOSURE LIMITS:** TLV: 50 ppm; (skin) (ACGIH 1998). TLV (as (STEL)): 100 ppm; (skin) (ACGIH 1998). OSHA PEL: TWA 100 ppm C 200 ppm 300 ppm (5-minute maximum peak in any 3 hours) NIOSH REL: Ca See Appendix A NIOSH IDLH: Potential occupational carcinogen 2000 ppm	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation and through the skin. **INHALATION RISK:** A harmful concentration of this gas in the air will be reached very quickly on loss of containment. **EFFECTS OF SHORT-TERM EXPOSURE:** The liquid may cause frostbite. The substance may cause effects on the central nervous system. Exposure may result in unconsciousness. Exposure far above OEL may result in liver, cardiovascular system and kidney damage. Medical observation is indicated. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** The substance may have effects on the central nervous system , resulting in effects measured using behavioural tests. Animal tests show that this substance possibly causes toxic effects upon human reproduction.
PHYSICAL PROPERTIES	Boiling point: -24.2°C Melting point: -97.6°C Relative density (water = 1): 0.92 Solubility in water, g/100 ml at 25°C: 0.5 Vapour pressure, kPa at 21°C: 506	Relative vapour density (air = 1): 1.8 Flash point: Flammable Gas Auto-ignition temperature: 632°C Explosive limits, vol% in air: 8.1-17.4 Octanol/water partition coefficient as log Pow: 0.91
ENVIRONMENTAL DATA		

NOTES

Following intoxication patient should be observed carefully for 48 hours. Check oxygen content before entering area.

Transport Emergency Card: TEC (R)-41/20G41
NFPA Code: H2; F4; R0;

ADDITIONAL INFORMATION

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

DICHLOROMONOFLUOROMETHANE

ICSC: 1106

Fluorodichloromethane
HCFC 21
Fluorocarbon 21
$CHCl_2F$
Molecular mass: 102.9
(cylinder)

ICSC # 1106
CAS # 75-43-4
RTECS # PA8400000
UN # 1029

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Not combustible. Gives off irritating or toxic fumes (or gases) in a fire.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION			In case of fire: keep cylinder cool by spraying with water.
EXPOSURE			
•INHALATION	Confusion. Drowsiness. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
•SKIN	ON CONTACT WITH LIQUID: FROSTBITE.	Cold-insulating gloves. Protective clothing.	ON FROSTBITE: rinse with plenty of water, do NOT remove clothes. Refer for medical attention.
•EYES		Safety goggles, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION		Do not eat, drink, or smoke during work.	

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Ventilation. NEVER direct water jet on liquid. Do NOT let this chemical enter the environment. (Extra personal protection: self-contained breathing apparatus).	Fireproof if in building.	R: S: UN Hazard Class: 2.2

SEE IMPORTANT INFORMATION ON BACK

ICSC: 1106

International Chemical Safety Cards

DICHLOROMONOFLUOROMETHANE

ICSC: 1106

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** COLOURLESS GAS OR COMPRESSED LIQUEFIED GAS , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** The gas is heavier than air, and may accumulate in low ceiling spaces causing deficiency of oxygen. **CHEMICAL DANGERS:** The substance decomposes on heating producing corrosive and highly toxic fumes (hydrogen chloride - see ICSC 0163, hydrogen fluoride - see ICSC 0283, and phosgene - see ICSC 0007). Reacts with powdered aluminium, zinc and magnesium. Reacts with acids or acid fumes producing highly toxic fumes (chlorides, fluorides). Attacks some forms of plastics, rubber and coatings. **OCCUPATIONAL EXPOSURE LIMITS:** TLV: 10 ppm; mg/m^3 (as TWA) (ACGIH 1999). MAK: 10 ppm; 45 mg/m^3; (1995) OSHA PEL: TWA 1000 ppm (4200 mg/m^3) NIOSH REL: TWA 10 ppm (40 mg/m^3) NIOSH IDLH: 5000 ppm **ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation. **INHALATION RISK:** A harmful concentration of this gas in the air will be reached very quickly on loss of containment. **EFFECTS OF SHORT-TERM EXPOSURE:** The liquid may cause frostbite. The substance may cause effects on the central nervous system at high concentrations. Exposure far above OEL could cause cardiac dysrhythmia. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** The substance may have effects on the liver.
PHYSICAL PROPERTIES	Boiling point: 8.9°C Melting point: -135°C Solubility in water: poor (1 g/100 ml at 20°C) Vapour pressure, kPa at 21°C: 159 Relative vapour density (air = 1): 3.8 Auto-ignition temperature: 522°C Octanol/water partition coefficient as log Pow: 1.55
ENVIRONMENTAL DATA	This substance may be hazardous to the environment; special attention should be given to its impact on the ozone layer. 

NOTES

High concentrations in the air cause a deficiency of oxygen with the risk of unconsciousness or death. Check oxygen content before entering area. No odour warning if toxic concentrations are present. Do NOT use in the vicinity of a fire or a hot surface, or during welding. Turn leaking cylinder with the leak up to prevent escape of gas in liquid state. Freon21, Genetron 21, Arcton 7 and Algofrene type 5 are trade names.

Transport Emergency Card: TEC (R)-20G39

ADDITIONAL INFORMATION

LEGAL NOTICE:	IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in. national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

METHYL ETHYL KETONE

ICSC: 0179

Ethyl methyl ketone
2-Butanone
MEK
Methyl acetone
C_4H_8O / $CH_3COCH_2CH_3$
Molecular mass: 72.1

ICSC # 0179
CAS # 78-93-3
RTECS # EL6475000
UN # 1193
EC # 606-002-00-3

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Highly flammable.	NO open flames, NO sparks, and NO smoking.	Powder, AFFF, foam, carbon dioxide.
EXPLOSION	Vapour/air mixtures are explosive.	Closed system, ventilation, explosion-proof electrical equipment and lighting. Do NOT use compressed air for filling, discharging, or handling. Use non-sparking handtools.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE			
•INHALATION	Cough. Dizziness. Drowsiness. Headache. Nausea. Vomiting.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Refer for medical attention.
•SKIN		Protective gloves.	Remove contaminated clothes. Rinse skin with plenty of water or shower.
•EYES	Redness. Pain.	Safety goggles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Unconsciousness. (Further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Give plenty of water to drink. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do	Fireproof. Separated from strong oxidants, strong acids. Cool. Well closed.	F symbol Xi symbol R: 11-36/37

NOT wash away into sewer. (Extra personal protection: self-contained breathing apparatus).		S: 2-9-16-25-33 UN Hazard Class: 3 UN Packing Group: II

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0179

International Chemical Safety Cards

METHYL ETHYL KETONE

ICSC: 0179

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** The vapour is heavier than air and may travel along the ground; distant ignition possible. **CHEMICAL DANGERS:** Reacts violently with strong oxidants and inorganic acids, causing fire and explosion hazard. Attacks some plastics. **OCCUPATIONAL EXPOSURE LIMITS:** TLV (as TWA): 200 ppm; 590 mg/m^3; RETas STEL: 300 ppm; 885 mg/m^3 (ACGIH 1997). MAK: 200 ppm; 590 mg/m^3; D (1992) OSHA PEL: TWA 200 ppm (590 mg/m^3) NIOSH REL: TWA 200 ppm (590 mg/m^3) ST 300 ppm (885 mg/m^3) NIOSH IDLH: 3000 ppm	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation and by ingestion. **INHALATION RISK:** A harmful contamination of the air can be reached rather quickly on evaporation of this substance at 20°C. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance irritates the eyes and the respiratory tract. The substance may cause effects on the central nervous system. Exposure far above the OEL may result in unconsciousness. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** The liquid defats the skin. Animal tests show that this substance possibly causes toxic effects upon human reproduction.
PHYSICAL PROPERTIES	Boiling point: 80°C Melting point: -86°C Relative density (water = 1): 0.8 Solubility in water, g/100 ml at 20°C: 29 Vapour pressure, kPa at 20°C: 10.5 Relative vapour density (air = 1): 2.41	Relative density of the vapour/air-mixture at 20°C (air = 1): 1.1 Flash point: -9°C (c.c.) Auto-ignition temperature: 505°C Explosive limits, vol% in air: 1.8-11.5 Octanol/water partition coefficient as log Pow: 0.29
ENVIRONMENTAL DATA		

NOTES

The odour warning when the exposure limit value is exceeded is insufficient.

Transport Emergency Card: TEC (R)-88.
NFPA Code: H1; F3; R0.

ADDITIONAL INFORMATION

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International Chemical Safety Cards

DICHLOROMETHANE

ICSC: 0058

Methylene chloride
DCM
CH_2Cl_2
Molecular mass: 84.9

ICSC # 0058
CAS # 75-09-2
RTECS # PA8050000
UN # 1593
EC # 602-004-00-3

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Combustible under specific conditions. Gives off irritating or toxic fumes (or gases) in a fire.		In case of fire in the surroundings: all extinguishing agents allowed.
EXPLOSION	Risk of fire and explosion (see Chemical Dangers).	Prevent build-up of electrostatic charges (e.g., by grounding).	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		PREVENT GENERATION OF MISTS! STRICT HYGIENE!	
•INHALATION	Dizziness. Drowsiness. Headache. Nausea. Weakness. Unconsciousness. Death.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
•SKIN	Dry skin. Redness. Burning sensation.	Protective gloves. Protective clothing.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
•EYES	Redness. Pain. Severe deep burns.	Safety goggles, face shield, or eye protection in combination with breathing protection.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
•INGESTION	Abdominal pain (further see Inhalation).	Do not eat, drink, or smoke during work. Wash hands before eating.	Rinse mouth. Do NOT induce vomiting. Give plenty of water to drink. Rest.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Ventilation. Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. (Extra personal protection: filter respirator for organic gases and vapours.)	Separated from metals (see Chemical Dangers), food and feedstuffs . Cool. Ventilation along the floor.	Do not transport with food and feedstuffs. Xn symbol R: 40 S: (2-)23-24/25-36/37 UN Hazard Class: 6.1 UN Packing Group: III

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0058

Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities (C) IPCS CEC 2000. No modifications to the International version have been made except to add the OSHA PELs, NIOSH RELs and NIOSH IDLH values.

International Chemical Safety Cards

DICHLOROMETHANE

ICSC: 0058

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** The vapour is heavier than air. As a result of flow, agitation, etc., electrostatic charges can be generated. **CHEMICAL DANGERS:** On contact with hot surfaces or flames this substance decomposes forming toxic and corrosive fumes. Reacts violently with metals such as aluminium powder and magnesium powder, strong bases and strong oxidants causing fire and explosion hazard. Attacks some forms of plastics, rubber and coatings. **OCCUPATIONAL EXPOSURE LIMITS:** TLV: 50 ppm; A3 (ACGIH 1999). OSHA PEL: 1910.1052 TWA 25 ppm ST 125 ppm NIOSH REL: Ca See Appendix A NIOSH IDLH: Potential occupational carcinogen 2300 ppm	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation and by ingestion. **INHALATION RISK:** A harmful contamination of the air can be reached very quickly on evaporation of this substance at 20° C. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance irritates the eyes, the skin and the respiratory tract. Exposure could cause lowering of consciousness. Exposure could cause formation of carboxyhaemoglobin. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** Repeated or prolonged contact with skin may cause dermatitis. The substance may have effects on the central nervous system and liver . This substance is possibly carcinogenic to humans.
PHYSICAL PROPERTIES	Boiling point: 40°C Melting point: -95.1°C Relative density (water = 1): 1.3 Solubility in water, g/100 ml at 20°C: 1.3 Vapour pressure, kPa at 20°C: 47.4	Relative vapour density (air = 1): 2.9 Relative density of the vapour/air-mixture at 20°C (air = 1): 1.9 Auto-ignition temperature: 556°C Explosive limits, vol% in air: 12-25 Octanol/water partition coefficient as log Pow: 1.25
ENVIRONMENTAL DATA	This substance may be hazardous to the environment; special attention should be given to ground water .	

NOTES

Addition of small amounts of a flammable substance or an increase in the oxygen content of the air strongly enhances combustibility. Depending on the degree of exposure, periodic medical examination is indicated. The odour warning when the exposure limit value is exceeded is insufficient. Do NOT use in the vicinity of a fire or a hot surface, or during welding. R30 is a trade name.

Transport Emergency Card: TEC (R)-720
NFPA Code: H2; F1; R0;

ADDITIONAL INFORMATION

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International Chemical Safety Cards

m-XYLENE

ICSC: 0085

m-XYLENE
meta-Xylene
1,3-Dimethylbenzene
m-Xylol
$C_6H_4(CH_3)_2/C_8H_{10}$
Molecular mass: 106.2

CAS # 108-38-3
RTECS # ZE2275000
ICSC # 0085
UN # 1307
EC # 601-022-00-9

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Flammable.	NO open flames, NO sparks, and NO smoking.	Powder, AFFF, foam, carbon dioxide.
EXPLOSION	Above 27°C explosive vapour/air mixtures may be formed.	Above 27°C use a closed system, ventilation, and explosion-proof electrical equipment.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		STRICT HYGIENE!	
• **INHALATION**	Dizziness. Drowsiness. Headache. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
• **SKIN**	Dry skin. Redness.	Protective gloves.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
• **EYES**	Redness. Pain.	Safety spectacles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**	Abdominal pain. Burning sensation (further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Give a slurry of activated charcoal in water to drink. Do NOT induce vomiting. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do NOT let this chemical enter the environment.	Fireproof. Separated from strong oxidants.	Xn symbol R: 10-20/21-38 S: (2-)25 Note: C UN Hazard Class: 3

SEE IMPORTANT INFORMATION ON BACK	
ICSC: 0085	Prepared in the context of cooperation between the International Programme on Chemical Safety & the Commission of the European Communities © IPCS CEC 1993 No modifications to the International version have been made except to add the OSHA PELs. NIOSH RELs and IDLH values.

International Chemical Safety Cards

m-XYLENE

ICSC: 0085

IMPORTANT DATA	**PHYSICAL STATE; APPEARANCE:** COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR. **PHYSICAL DANGERS:** As a result of flow, agitation, etc., electrostatic charges can be generated. **CHEMICAL DANGERS:** Reacts violently with strong oxidants such as nitric acid. **OCCUPATIONAL EXPOSURE LIMITS (OELs):** TLV: 100 ppm; 434 mg/m^3 (as TWA) (ACGIH 1993-1994). TLV (as STEL): 150 ppm; 651 mg/m^3 (ACGIH 1993-1994). OSHA PEL: TWA 100 ppm (435 mg/m^3) NIOSH REL: TWA 100 ppm (435 mg/m^3) ST 150 ppm (655 mg/m^3) NIOSH IDLH: 900 ppm	**ROUTES OF EXPOSURE:** The substance can be absorbed into the body by inhalation, through the skin and by ingestion. **INHALATION RISK:** A harmful contamination of the air will be reached rather slowly on evaporation of this substance at 20° C. **EFFECTS OF SHORT-TERM EXPOSURE:** The substance irritates the eyes. Exposure far above the OEL may result in central nervous system depression, unconsciousness and death. **EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:** The liquid defats the skin. The substance may have effects on the central nervous system , resulting in decreased learning ability.
PHYSICAL PROPERTIES	Boiling point: 139°C Melting point: -48°C Relative density (water = 1): 0.86 Solubility in water: none Vapour pressure, kPa at 20°C: 0.8 Relative vapour density (air = 1): 3.7	Relative density of the vapour/air-mixture at 20°C (air = 1): 1.02 Flash point: 27°C c.c.°C Auto-ignition temperature: 527°C Explosive limits, vol% in air: 1.1-7.0 Octanol/water partition coefficient as log Pow: 3.20
ENVIRONMENTAL DATA	This substance may be hazardous to the environment; special attention should be given to fish and crustacea. 	

NOTES

Depending on the degree of exposure, periodic medical examination is indicated. The recommendations on this Card also apply to technical xylene. Also consult ICSC # 0084 and 0086 on o- and p-xylene.

NFPA Code: H 2; F 3; R 0;

ADDITIONAL INFORMATION

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International Chemical Safety Cards

o-XYLENE

ICSC: 0084

o-XYLENE
ortho-Xylene
1,2-Dimethylbenzene
o-Xylol
$C_6H_4(CH_3)_2/C_8H_{10}$
Molecular mass: 106.2

CAS # 95-47-6
RTECS # ZE2450000
ICSC # 0084
UN # 1307
EC # 601-022-00-9

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Flammable.	NO open flames, NO sparks, and NO smoking.	Powder, AFFF, foam, carbon dioxide.
EXPLOSION	Above 32°C explosive vapour/air mixtures may be formed.	Above 32°C use a closed system, ventilation, and explosion-proof electrical equipment.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		STRICT HYGIENE! AVOID EXPOSURE OF (PREGNANT) WOMEN!	
• **INHALATION**	Dizziness. Drowsiness. Headache. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
• **SKIN**	Dry skin. Redness.	Protective gloves.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
• **EYES**	Redness. Pain.	Safety spectacles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**	Abdominal pain. Burning sensation (further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Give a slurry of activated charcoal in water to drink. Do NOT induce vomiting. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do	Fireproof. Separated from strong oxidants.	Xn symbol R: 10-20/21-38 S: (2-)25

NOT let this chemical enter the environment.		Note: C UN Hazard Class: 3

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0084

International Chemical Safety Cards

o-XYLENE

ICSC: 0084

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
As a result of flow, agitation, etc., electrostatic charges can be generated.

CHEMICAL DANGERS:
Reacts violently with strong oxidants causing fire and explosion hazard.

OCCUPATIONAL EXPOSURE LIMITS (OELs):
TLV: 100 ppm; 434 mg/m^3 (as TWA) (ACGIH 1993-1994).
TLV (as (STEL): 150 ppm; 651 mg/m^3 (ACGIH 1993-1994).
OSHA PEL: TWA 100 ppm (435 mg/m^3)
NIOSH REL: TWA 100 ppm (435 mg/m^3) ST 150 ppm (655 mg/m^3)
NIOSH IDLH: 900 ppm

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation, through the skin and by ingestion.

INHALATION RISK:
A harmful contamination of the air will be reached rather slowly on evaporation of this substance at 20° C.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance irritates the eyes. Exposure far above the OEL may result in central nervous system depression, unconsciousness and death.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
The liquid defats the skin. The substance may have effects on the central nervous system , resulting in decreased learning ability. Animal tests show that this substance possibly causes toxic effects upon human reproduction.

PHYSICAL PROPERTIES

Boiling point: 144°C
Melting point: -25°C
Relative density (water = 1): 0.88
Solubility in water: none
Vapour pressure, kPa at 20°C: 0.7
Relative vapour density (air = 1): 3.7
Relative density of the vapour/air-mixture at 20°C (air = 1): 1.02
Flash point: 32°C c.c.°C
Auto-ignition temperature: 463°C
Explosive limits, vol% in air: 0.9-7.0
Octanol/water partition coefficient as log Pow: 3.12

ENVIRONMENTAL DATA

This substance may be hazardous to the environment; special attention should be given to fish and crustacea.

NOTES

Depending on the degree of exposure, periodic medical examination is indicated. The recommendations on this Card also apply to technical xylene. Also consult ICSC # 0086 p-xylene and 0085 m-xylene.

Transport Emergency Card: TEC (R)-33
NFPA Code: H 2; F 3; R 0;

ADDITIONAL INFORMATION	

ICSC: 0084 **o-XYLENE**

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and IDLH values.

International Chemical Safety Cards

p-XYLENE

ICSC: 0086

p-XYLENE
para-Xylene
1,4-Dimethylbenzene
p-Xylol
$C_6H_4(CH_3)_2/C_8H_{10}$
Molecular mass: 106.2

CAS # 106-42-3
RTECS # ZE2625000
ICSC # 0086
UN # 1307
EC # 601-022-00-9

TYPES OF HAZARD/ EXPOSURE	ACUTE HAZARDS/ SYMPTOMS	PREVENTION	FIRST AID/ FIRE FIGHTING
FIRE	Flammable.	NO open flames, NO sparks, and NO smoking.	Powder, AFFF, foam, carbon dioxide.
EXPLOSION	Above 27°C explosive vapour/air mixtures may be formed.	Above 27°C use a closed system, ventilation, and explosion-proof electrical equipment.	In case of fire: keep drums, etc., cool by spraying with water.
EXPOSURE		STRICT HYGIENE! AVOID EXPOSURE OF (PREGNANT) WOMEN!	
• **INHALATION**	Dizziness. Drowsiness. Headache. Unconsciousness.	Ventilation, local exhaust, or breathing protection.	Fresh air, rest. Artificial respiration if indicated. Refer for medical attention.
• **SKIN**	Dry skin. Redness.	Protective gloves.	Remove contaminated clothes. Rinse and then wash skin with water and soap.
• **EYES**	Redness. Pain.	Safety spectacles.	First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor.
• **INGESTION**	Abdominal pain. Burning sensation (further see Inhalation).	Do not eat, drink, or smoke during work.	Rinse mouth. Give a slurry of activated charcoal in water to drink. Do NOT induce vomiting. Refer for medical attention.

SPILLAGE DISPOSAL	STORAGE	PACKAGING & LABELLING
Collect leaking and spilled liquid in sealable containers as far as possible. Absorb remaining liquid in sand or inert absorbent and remove to safe place. Do	Fireproof. Separated from strong oxidants.	Xn symbol R: 10-20/21-38 S: (2-)25

NOT let this chemical enter the environment.		UN Hazard Class: 3

SEE IMPORTANT INFORMATION ON BACK

ICSC: 0086

International Chemical Safety Cards

p-XYLENE

ICSC: 0086

IMPORTANT DATA

PHYSICAL STATE; APPEARANCE:
COLOURLESS LIQUID , WITH CHARACTERISTIC ODOUR.

PHYSICAL DANGERS:
As a result of flow, agitation, etc., electrostatic charges can be generated.

CHEMICAL DANGERS:
Reacts violently with strong oxidants such as nitric acid.

OCCUPATIONAL EXPOSURE LIMITS (OELs):
TLV: 100 ppm; 434 mg/m^3 (as TWA) (ACGIH 1993-1994).
TLV (as STEL): 150 ppm; 651 mg/m^3 (ACGIH 1993-1994).
OSHA PEL: TWA 100 ppm (435 mg/m^3)
NIOSH REL: TWA 100 ppm (435 mg/m^3) ST 150 ppm (655 mg/m^3)
NIOSH IDLH: 900 ppm

ROUTES OF EXPOSURE:
The substance can be absorbed into the body by inhalation, through the skin and by ingestion.

INHALATION RISK:
A harmful contamination of the air will be reached rather slowly on evaporation of this substance at 20° C.

EFFECTS OF SHORT-TERM EXPOSURE:
The substance irritates the eyes. Exposure far above the OEL may result in central nervous system depression, unconsciousness and death.

EFFECTS OF LONG-TERM OR REPEATED EXPOSURE:
The liquid defats the skin. The substance may have effects on the central nervous system , resulting in decreased learning ability. Animal tests show that this substance possibly causes toxic effects upon human reproduction.

PHYSICAL PROPERTIES

Boiling point: 138°C
Melting point: 13°C
Relative density (water = 1): 0.86
Solubility in water: none
Vapour pressure, kPa at 20°C: 0.9
Relative vapour density (air = 1): 3.7
Relative density of the vapour/air-mixture at 20°C (air = 1): 1.02
Flash point: 27°C c.c.°C
Auto-ignition temperature: 528°C
Explosive limits, vol% in air: 1.1-7.0
Octanol/water partition coefficient as log Pow: 3.15

ENVIRONMENTAL DATA

This substance may be hazardous to the environment; special attention should be given to fish and crustacea.

NOTES

Depending on the degree of exposure, periodic medical examination is indicated. The recommendations on this Card also apply to technical xylene. Also consult ICSC # 0084 o-xylene and 0085 m-xylene.

Transport Emergency Card: TEC (R)-3[illegible]
NFPA Code: H 2; F 3; R 0;

ADDITIONAL INFORMATION	

ICSC: 0086 **p-XYLENE**

IMPORTANT LEGAL NOTICE:	Neither NIOSH, the CEC or the IPCS nor any person acting on behalf of NIOSH, the CEC or the IPCS is responsible for the use which might be made of this information. This card contains the collective views of the IPCS Peer Review Committee and may not reflect in all cases all the detailed requirements included in national legislation on the subject. The user should verify compliance of the cards with the relevant legislation in the country of use. The only modifications made to produce the U.S. version is inclusion of the OSHA PELs, NIOSH RELs and IDLH values.

APPENDIX C

SUPERVISOR'S REPORT OF INCIDENT FORM

APPENDIX C

FIELD FORMS

- Daily Time Logs
- Daily Drilling Summary
- Atmospheric Monitoring Logs
- Soil Boring Log Information
- Field Log - Soil Borehole
- Field Rock Borehole Log
- Monitoring Well Construction
- Piezometer Installation Diagram
- Grout Batch Record
- Well Development Form
- Well Purging and Sample Collection Form
- Infield Hydraulic Conductivity Test Form
- Water Elevation Form
- Chain of Custody
- Field Meter Instrument Calibration Logs

EARTH TECH

A TYCO INTERNATIONAL LTD. COMPANY

Daily Time Log

Date: ___/___/___

Circle: Sun Mon Tue Wed Thu Fri Sat

Site: _____ Project No.: _____

Weather: _____

Task/Equipment: _____

Firm/Contractor's Personnel: _____ Hrs On-Site: _____

Earth Tech's Personnel: _____ Hrs On-Site: _____

Site Visitors: _____

Time Log indicating work in progress, remarks:

0600 – 0630 _____

0630 – 0700 _____

0700 – 0730 _____

0730 – 0800 _____

0800 – 0830 _____

0830 – 0900 _____

0900 – 0930 _____

0930 – 1000 _____

1000 – 1030 _____

1030 – 1100 _____

1100 – 1130 _____

1130 – 1200 _____

1200 – 1230 _____

1230 – 1300 _____

1300 – 1330 _____

1330 – 1400 _____

1400 – 1430 _____

1430 – 1500 _____

1500 – 1530 _____

1530 – 1600 _____

1600 – 1630 _____

1630 – 1700 _____

1700 – 1730 _____

1730 – 1800 _____

Items requiring follow-up: _____

EarthTech

A tyco International Ltd. Company

Daily Drilling Summary

CONTRACTOR _____ DATE _____ SHIFT _____

SITE NAME _____ LOCATION _____

BOREHOLE NUMBER(S) THIS DATE _____

DRILL TIME LOG: Explain all down and standby time—who authorized—unusual circumstances, etc.

CATEGORY	TOTAL HOURS	A.M. 6 7 8 9 10 11 12	P.M. 1 2 3 4 5 6 7 8 9 10 11 12	A.M. 1 2 3 4 5 6
MOB/DEMOB				
DRILLING				
WELL CONST.				
MOVE/DECON				
TESTING				
STANDBY				
DOWN TIME				
OTHER				

REMARKS

EXPENDABLES: Itemize quantity, size, etc.

ITEM	QUANTITY	PART NO.

BOREHOLE NO.	FROM FEET	TO FEET	FOOTAGE DRILLED FEET	PIPE & CASING IN HOLE SIZE	PIPE & CASING IN HOLE FEET	BITS/CASING SHOES, ETC. SIZE	NUMBER	ON	OFF	FEET

PERSONNEL TIME LOG:

POSITION	NAME	HOURS
GEOLOGIST	TORY SCHULTZ	
DRILLER		
HELPER		

COMMENTS

GEOLOGIST T. Schultz	CONSULTANT REPRESENTATIVE ET
DRILLER	CONTRACTOR REPRESENTATIVE

RUST **Rust Environment & Infrastructure**

Atmospheric Monitoring Log
Field Health and Safety

Page ____ of ____

Date ____/____/____

Circle: Sun Mon Tue Wed Thu Fri Sat

Site: _____ Project No.: _____

Site Safety Officer: _____

Action Levels: D ☐ → C ☐ → B ☐ → (stop work, call in for instructions on all upgrades)

(Check box and write in levels for upgrade)

Task/Equipment: _____

Weather: _____

Location	Time	O_2 %	LEL %	H_2S PPM	Circle one: HNu/OVA Readings (ppm)				Comments
					Back ground	Breathing Zone	Sample Location	Head Space	

Additional Comments: _____

_____

_____

Signature: _____

Checked by: _____ Date: ____/____/____

NOTE: Place in project files.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION

Form 4400-122 Rev. 7-98

Route To: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Revelopment ☐ Other ☐ _____

Page _____ of _____

Facility/Project Name	License/Permit/Monitoring Number	Boring Number

Boring Drilled By: Name of crew chief (first, last) and Firm First Name: Last Name: Firm:	Date Drilling Started m m / d d / y y y y	Date Drilling Completed m m / d d / y y y y	Drilling Method

WI Unique Well No.	DNR Well ID No.	Well Name	Final Static Water Level	Surface Elevation	Borehole Diameter
_ _ _ _ _ _ _	_ _ _ _		_____ Feet MSL	_____ Feet MSL	_____ inches

Local Grid Origin ☐ (estimated: ☐) or Boring Location ☐ State Plane _____ N, _____ E _____ 1/4 of _____ 1/4 of Section _____, T _____ N, R _____	Lat ° ' " Long ° ' "	Local Grid Location ☐ N ☐ E _____ Feet ☐ S _____ Feet ☐ W

Facility ID	County	County Code	Civil Town/City/ or Village

Sample Number and Type	Sample Length Att. & Recovered (in)	Blow Counts	Depth in Feet (Below ground surface)	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties: Compressive Strength	Moisture Content	Liquid Limit	Plasticity Index	P 200	RQD/ Comments

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm

This form is authorized by Chapters 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats. Completion of this form is mandatory. Failure to file this form may result in forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on this form is not intended to be used for any other purpose. NOTE: See instructions for more information, including where the completed form should be sent.

State of Wisconsin
Department of Natural Resources

SOIL BORING LOG INFORMATION SUPPLEMENT
Form 4400-122A 7-91

Boring Number _____ Use only as an attachment to Form 4400-122. Page ____ of ____

Sample		Blow Counts	Depth in Feet	Soil/Rock Description And Geologic Origin For Each Major Unit	USCS	Graphic Log	Well Diagram	PID/FID	Soil Properties					ROD/ Comments
No.	Length Recovered (in)								Standard Penetration	Moisture Content	Liquid Limit	Plastic Limit	P 200	

Sheet __ of ___

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

FIELD BORING LOG W/ATMOSPHERIC MONITORING

BORING NO. ________

SITE: ________________ PROJECT NO. ____________

DRILLING METHOD: ________________

LOG BY: ________________

FIRM/DRILLER: ________________

PHYSICAL SETTING: ________________

WATER LEVEL READINGS

DATE/TIME	WATER DEPTH	HOLE DEPTH	CASING DEPTH

ABANDONMENT DATE: ____________

ABANDONMENT METHOD: ____________

GROUND SURFACE ELEV.: ____________

COORDINATE TYPE: ____________

NORTH: ____________

EAST: ____________

DATE/TIME START: ____________

DATE/TIME COMPLETE: ____________

WELL INSTALLATION DATE: ____________

DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS	SAMPLING DATA						AIR MONITORING			
				B	N	A	R	SAMPLE TYPE	SAMPLE INTERVAL	TIME	PID	O_2/LEL	

Sheet ___ of ___

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

FIELD BORING LOG W/ATMOSPHERIC MONITORING

BORING NO. ______

SITE: ______________________ PROJECT NO. ______________

WATER LEVEL READINGS

DRILLING METHOD:	DATE/TIME	WATER DEPTH	HOLE DEPTH	CASING DEPTH
LOG BY:				

FIRM/DRILLER: ______________

PHYSICAL SETTING: ______________

ABANDONMENT DATE: ______________

ABANDONMENT METHOD: ______________

GROUND SURFACE ELEV.: ______________

COORDINATE TYPE: ______________

NORTH: ______________

EAST: ______________

DATE/TIME START: ______________

DATE/TIME COMPLETE: ______________

WELL INSTALLATION DATE: ______________

DEPTH IN FEET	GRAPHIC LOG	USCS	SOIL DESCRIPTION AND DRILLING COMMENTS	SAMPLING DATA						AIR MONITORING		
				B	N	A	R	SAMPLE TYPE	SAMPLE INTERVAL	TIME	PID	%LEL

EarthTech
A Tyco International Ltd. Company

FIELD ROCK CORE LOG

Sheet 1 of ____

BORING NO. ____________

SITE: ______________________ PROJECT NO. ______________

	WATER LEVEL READINGS				
	DATE	TIME	DEPTH	CASING	GROUND SURFACE ELEV: ________
DRILLING RIG: ________					COORDINATE/TYPE: ________
CORE BARREL / BIT: ________					NORTH: ________
CASING USED: ________					EAST: ________
LOGGED BY: ________					DATE/TIME START: ________
FIRM/DRILLER: ________	ABANDONMENT DATE: ________				DATE/TIME COMPLETE: ________
PHYSICAL SETTING: ________	ABANDONMENT METHOD: ________				WELL INSTALLATION DATE: ________

Depth in Feet	CORING DATA							FRAC./ FT	GRAPHICS	ROCK TYPE CODE	ROCK DESCRIPTION	COMMENTS
	METHOD	RUN NO	LENGTH	% RECOVERY	MPF	%WATER GAIN/LOSS (GAL.)	% RQD					

&cont&

Tracking Codes: &prj.id&, F_ROCKP1, 3/22/94

State of Wisconsin
Department of Natural Resources

Route to: Watershed/Wastewater ☐ Waste Management ☐
Remediation/Redevelopment ☐ Other ☐ _____

MONITORING WELL CONSTRUCTION

Form 4400-113A Rev. 7-98

Facility/Project Name	Local Grid Location of Well ☐N. ☐S. _____ ft. ☐E. ☐W. _____ ft.	Well Name
Facility License, Permit or Monitoring No.	Local Grid Origin ☐ (estimated: ☐) or Well Location ☐ Lat. ° ' " Long. ° ' " or	Wis. Unique Well No. / DNR Well ID No.
Facility ID	St. Plane _____ ft. N, _____ ft. E. S/C/N	Date Well Installed ___/___/_____ (m m d d y y y y)
Type of Well Well Code ____/____	Section Location of Waste/Source ____1/4 of ____ 1/4 of Sec. ____, T. ____ N, R. ____ ☐E ☐W	Well Installed By: Name (first, last) and Firm
Distance from Waste/Source _____ ft. / Enf. Stds. Apply ☐	Location of Well Relative to Waste/Source u ☐ Upgradient s ☐ Sidegradient d ☐ Downgradient n ☐ Not Known	Gov. Lot Number

A. Protective pipe, top elevation _____ ft. MSL

B. Well casing, top elevation _____ ft. MSL

C. Land surface elevation _____ ft. MSL

D. Surface seal, bottom _____ ft. MSL or _____ ft.

12. USCS classification of soil near screen:
GP ☐ GM ☐ GC ☐ GW ☐ SW ☐ SP ☐
SM ☐ SC ☐ ML ☐ MH ☐ CL ☐ CH ☐
Bedrock ☐

13. Sieve analysis performed? ☐ Yes ☐ No

14. Drilling method used: Rotary ☐ 50
Hollow Stem Auger ☐ 41
_____ Other ☐

15. Drilling fluid used: Water ☐ 02 Air ☐ 01
Drilling Mud ☐ 03 None ☐ 99

16. Drilling additives used? ☐ Yes ☐ No
Describe _____

17. Source of water (attach analysis, if required):
_____

E. Bentonite seal, top _____ ft. MSL or _____ ft.

F. Fine sand, top _____ ft. MSL or _____ ft.

G. Filter pack, top _____ ft. MSL or _____ ft.

H. Screen joint, top _____ ft. MSL or _____ ft.

I. Well bottom _____ ft. MSL or _____ ft.

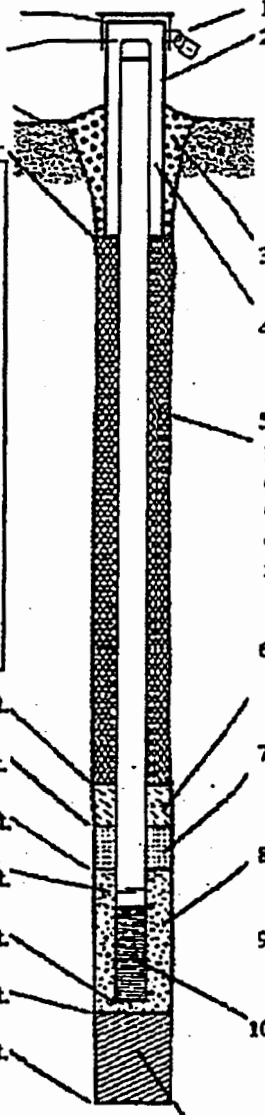
J. Filter pack, bottom _____ ft MSL or _____ ft.

K. Borehole, bottom _____ ft MSL or _____ ft.

L. Borehole, diameter ____ in.

M. O.D. well casing _____ in.

N. I.D. well casing _____ in.



1. Cap and lock? ☐ Yes ☐ No

2. Protective cover pipe:
a. Inside diameter: ____ in.
b. Length: ____ ft.
c. Material: Steel ☐ 04
_____ Other ☐
d. Additional protection? ☐ Yes ☐ No
If yes, describe: _____

3. Surface seal: Bentonite ☐ 30
Concrete ☐ 01
_____ Other ☐

4. Material between well casing and protective pipe:
Bentonite ☐ 30
_____ Other ☐

5. Annular space seal: a. Granular/Chipped Bentonite ☐ 33
b. _____ Lbs/gal mud weight ... Bentonite-sand slurry ☐ 35
c. _____ Lbs/gal mud weight ..... Bentonite slurry ☐ 31
d. _____ % Bentonite ..... Bentonite-cement grout ☐ 50
e. _____ Ft^3 volume added for any of the above
f. How installed: Tremie ☐ 01
Tremie pumped ☐ 02
Gravity ☐ 08

6. Bentonite seal: a. Bentonite granules ☐ 33
b. ☐1/4 in. ☐3/8 in. ☐1/2 in. Bentonite chips ☐ 32
c. _____ Other ☐

7. Fine sand material: Manufacturer, product name & mesh size
a. _____
b. Volume added _____ ft^3

8. Filter pack material: Manufacturer, product name & mesh size
a. _____
b. Volume added _____ ft^3

9. Well casing: Flush threaded PVC schedule 40 ☐ 23
Flush threaded PVC schedule 80 ☐ 24
_____ Other ☐

10. Screen material: _____
a. Screen type: Factory cut ☐ 11
Continuous slot ☐ 01
_____ Other ☐
b. Manufacturer _____
c. Slot size: 0.____ in.
d. Slotted length: ____ ft.

11. Backfill material (below filter pack): None ☐ 14
_____ Other ☐

I hereby certify that the information on this form is true and correct to the best of my knowledge.

Signature	Firm

Please complete both Forms 4400-113A and 4400-113B and return them to the appropriate DNR office and bureau. Completion of these reports is required by chs. 160, 281, 283, 289, 291, 292, 293, 295, and 299, Wis. Stats., and ch. NR 141, Wis. Adm. Code. In accordance with chs. 281, 289, 291, 292, 293, 295, and 299, Wis. Stats., failure to file these forms may result in a forfeiture of between $10 and $25,000, or imprisonment for up to one year, depending on the program and conduct involved. Personally identifiable information on these forms is not intended to be used for any other purpose. NOTE: See the instructions for more information, including where the completed forms should be sent.

EARTH TECH

PIEZOMETER INSTALLATION DIAGRAM

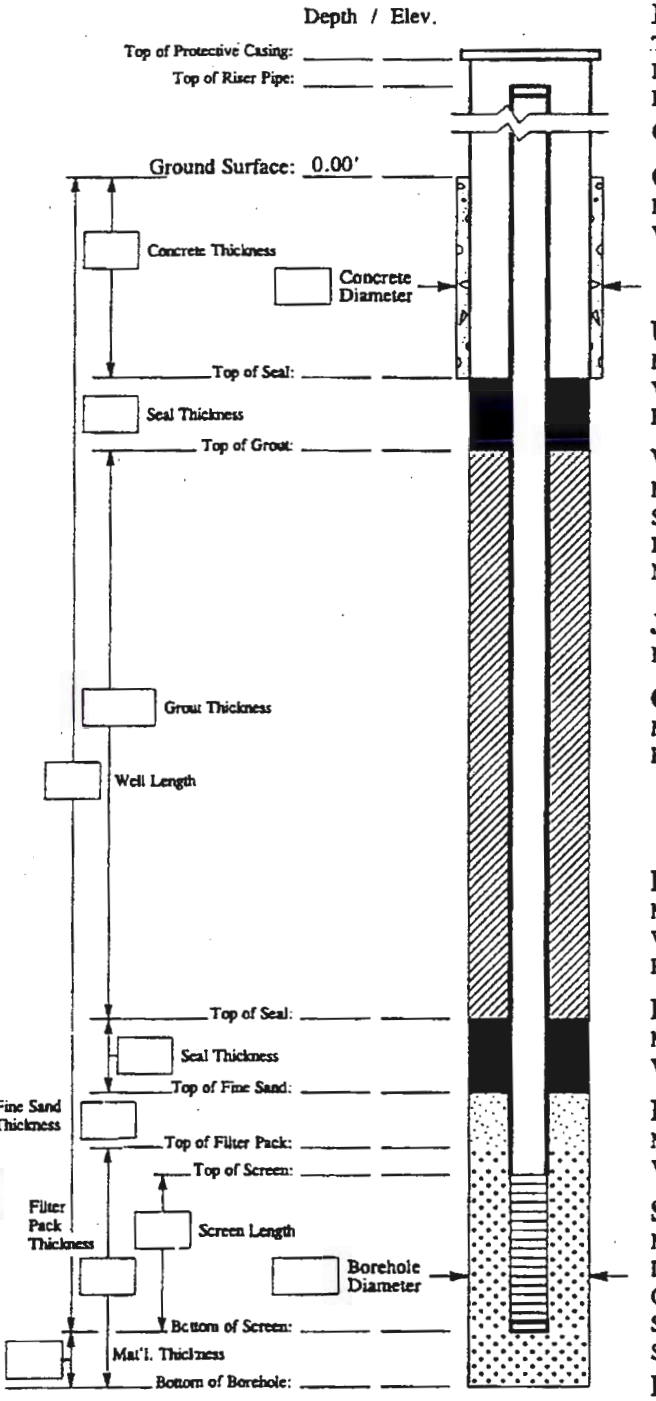
Site Name: _____ Project No. _____ Well No. _____

Northing: _____ Easting: _____ Surf.Elev. _____ Ref. Boring No. _____

Drilling Contractor: _____ Drilling Dates: _____

Driller: _____ Inspected By: _____ Well Completion Date: _____

Drilling Method: _____ Drilling Fluids (type): _____



Protective Casing

Type: _____ Vented (Y/N): _____

Dia.(in): _____ Locked (Y/N): _____

Length: _____ Key No.: _____

Cap or Plug Type: _____ Vented (Y/N): _____

Concrete Collar

Manufacturer: _____

Volumes: _____ Lbs. of Cement

\+ _____ Gal. of Water

= _____ Gal. total Volume

Upper Seal

Type: _____

Manufacturer: _____

Volume (Gal.) _____

Hydration: Volume Water: _____ Time: _____

Well Casing

Type: _____

Manufacturer: _____

Schedule: _____

Length per Section: _____ Casing O.D./I.D. _____

No. of Sections: _____ Total Length: _____

Joints Flush Threaded ☐ Taped ☐ Welded ☐ O-Ring ☐

Manufacturer: _____

Grout

Type: _____

Manufacturer: _____

Final Volumes: _____ Lbs. of _____

\+ _____ Lbs. of _____

\+ _____ Gal. of Water

= _____ Gal. total Volume

Lower Seal

Type: _____

Manufacturer: _____

Volume (Gal.) _____

Hydration: Volume Water _____ Time: _____

Fine Sand

Type: _____

Manufacturer: _____

Volume (Gal.) _____

Filter Pack

Type: _____

Manufacturer: _____

Volume (Gal.) _____

Screen

Type: _____ Sch: _____

Manufacturer: _____

Length/Sec. _____ No of Sec. _____

O.D. _____ I.D. _____

Slot Size: _____ No. Slots/ft. _____

Slotted Length: _____

Bottom Cap or Plug Type: _____ Length: _____

Water Source _____

NOTES: _____

Tracking Codes: &prj.id&, PIEZOFF, 12/15/97, 16:42

EarthTech

A tyco International Ltd. Company

Grout Batch Record

Site Name: _____ Project Number: _____ Date: _____

Boring/Well I.D.: _____ Type of Sealing (circle): Abandonment, Annular Space

Documented by: _____ Contractor: _____

Volume Calculations: Volume of borehole = $h \times \pi \times r^2_{\text{borehole}}$

Volume of Annular space = $(h \times \pi \times r^2_{\text{borehole}}) - (h \times \pi \times r^2_{\text{OD of well casing}})$

h = length of borehole of same diameter; for well casing this would be the length of the interval to be grouted in feet.

r = radius of borehole or well casing in feet if borehole has various diameters, volumes for each section should be calculated separately, then all sections should be added together to get a total volume of the borehole or annular space.

Calculations: (Note what volume calculation is for, i.e. PVC, borehole, annular space): _____

Equipment (grout mixer, pump, marsh funnel, mud scale, tremie, measuring devices for water, grout, bentonite, etc.): _____

Materials Manufacturers: _____

Mix ratio: _____

Notes: _____

Batch No.: _____ Installation date: _____ Time: _____

Mixture: _____ gallons/batch: _____

Cumulative volume (gallons): _____ Viscosity (seconds): _____

Mud weight (lbs/gal): _____ Depth of tremie pipe (ft): _____

Batch No.: _____ Installation date: _____ Time: _____

Mixture: _____ gallons/batch: _____

Cumulative volume (gallons): _____ Viscosity (seconds): _____

Mud weight (lbs/gal): _____ Depth of tremie pipe (ft): _____

Complete this section after sealing is completed:

Was boring/annular space pressure grouted: Yes No if No, describe method _____

Did sealing material rise to the surface: Yes No

Did sealing material settle after 24 hours: Yes No if Yes, how much (ft or in.)_____

Describe how topped off _____

For well abandonments:

Was the well overdrilled/drilled out: Yes No

Was all well casing and screen removed: Yes No

- If No, Explain _____

Comments: _____

EarthTech
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Grout Batch Record

Site Name: ____________ Boring/Well I.D.: ____________ Documented by: ____________ Page ___ of ___

Batch No.: ____________ Installation date: ____________ Time: ____________
Mixture: ____________ gallons/batch: ____________
Cumulative volume (gallons): ____________ Viscosity (seconds): ____________
Mud weight (lbs/gal): ____________ Depth of tremie pipe (ft): ____________

Batch No.: ____________ Installation date: ____________ Time: ____________
Mixture: ____________ gallons/batch: ____________
Cumulative volume (gallons): ____________ Viscosity (seconds): ____________
Mud weight (lbs/gal): ____________ Depth of tremie pipe (ft): ____________

Batch No.: ____________ Installation date: ____________ Time: ____________
Mixture: ____________ gallons/batch: ____________
Cumulative volume (gallons): ____________ Viscosity (seconds): ____________
Mud weight (lbs/gal): ____________ Depth of tremie pipe (ft): ____________

Batch No.: ____________ Installation date: ____________ Time: ____________
Mixture: ____________ gallons/batch: ____________
Cumulative volume (gallons): ____________ Viscosity (seconds): ____________
Mud weight (lbs/gal): ____________ Depth of tremie pipe (ft): ____________

Batch No.: ____________ Installation date: ____________ Time: ____________
Mixture: ____________ gallons/batch: ____________
Cumulative volume (gallons): ____________ Viscosity (seconds): ____________
Mud weight (lbs/gal): ____________ Depth of tremie pipe (ft): ____________

Batch No.: ____________ Installation date: ____________ Time: ____________
Mixture: ____________ gallons/batch: ____________
Cumulative volume (gallons): ____________ Viscosity (seconds): ____________
Mud weight (lbs/gal): ____________ Depth of tremie pipe (ft): ____________

Batch No.: ____________ Installation date: ____________ Time: ____________
Mixture: ____________ gallons/batch: ____________
Cumulative volume (gallons): ____________ Viscosity (seconds): ____________
Mud weight (lbs/gal): ____________ Depth of tremie pipe (ft): ____________

Batch No.: ____________ Installation date: ____________ Time: ____________
Mixture: ____________ gallons/batch: ____________
Cumulative volume (gallons): ____________ Viscosity (seconds): ____________
Mud weight (lbs/gal): ____________ Depth of tremie pipe (ft): ____________

Batch No.: ____________ Installation date: ____________ Time: ____________
Mixture: ____________ gallons/batch: ____________
Cumulative volume (gallons): ____________ Viscosity (seconds): ____________
Mud weight (lbs/gal): ____________ Depth of tremie pipe (ft): ____________

NOTES: ____________

EARTH TECH

Well Development
(Must Have Well Construction Diagrams)

Well No. ( )

Date: ___/___/___

Mon. Tues. Weds. Thurs. Fri.

Site: _____

Weather: _____ Project No.: _____

Development Method: Pumped ☐ Bailed ☐ Other: _____

Pump Type: _____ Bailer Type: _____

Volume Calculation: _____

(D.T.B. – D.T.W. x vol./ft. = PVC/well volume) + (N* x H* x Annulus vol./ft.) = Total Well Volume

* (Wells that cannot be purged dry, 10x's the Total Well Volume must be purged)
(Wells that can be purged dry, slowly removing water, without surging until dry)

Time	Depth to Water (D.T.W.)	Depth to Bottom (D.T.B.)	Volume Removed (gal.)	pH	Cond.	Temp.	Color	Odor Y/N	Turbidity

Comments: _____

_____

_____

*N = porosity of filter pack
*H = length of filter pack or length of saturated filter pack (water level within screen length)
* = A 30-minute surge and purge before the 10x's the Total Well Volume

Annulus	vol./ft.
4"	0.42
6"	1.24
8"	2.38
10"	3.85

Inside Diameter	vol./ft.
1"	0.04
1.25"	0.06
2"	0.16
4"	0.65

HNu/PPM	LEL/%	O_2/%	H_2S/PPM	CO/PPM	

Signature: _____

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Well Purging and Sample Collection

Project No.: _____ Well No.: _____ Site: _____

Purging Method: ☐ Pumped ☐ Bailed ☐ Other: _____

Pump Type: _____ Bailer Type: NA_____

Weather Conditions: _____

Volume Calculations: _____

(D.T.B. - D.T.W. x vol./ft. = Gals./well vol.)

(Gals./well vol. X 5 = Total Volume to be removed) Gals./well vol.: _____

Time	Depth to Water (D.T.W.)	Depth to Bottom (D.T.B.)	Volume Removed (gal.)	pH	Cond.	Temp.	Color	Odor Y/N	ORP	DO	Turbidity
		Sample Readings									

Inside Diameter	vol./ft.
1"	0.04
1.25"	0.06
2"	0.16
4"	0.65

Comments: _____

Field Blank Taken ☐ Time: _____

Well Duplicate ☐ No.: _____

Signature: _____

Date: ____/____/____

Hnu/PPM	LEL/%	0_2/%	H_2S/PPM	CO/PPM	

Rev. 10/98

F521/Earth.Scl

H:\data\Other Forms\Electronic Copies\GW Sampling\Well Purging_Sampling Form.doc

EARTH TECH

A TETRA TECH INTERNATIONAL LTD. COMPANY

Infield Hydraulic Conductivity Test (Data Logger Form)

Sheet _____ of _____

Project No.: _____ Well No.: _____

Site: _____ Station ID: _____

Date: _____ Test Performed By: _____

Diameter of Borehole (2R): _____ Total Depth of Well: _____

Diameter of Pipe (2r): _____ Static Water Level (ft.): _____

Screen Length: _____ Length of Water Column in Well(D): _____

Effective Screen Length (L): _____ Fall Rise

Observation Well/Piezometer (circle) Static Transducer Level: _____ _____

Confined/Unconfined (circle) Start Time: _____ _____

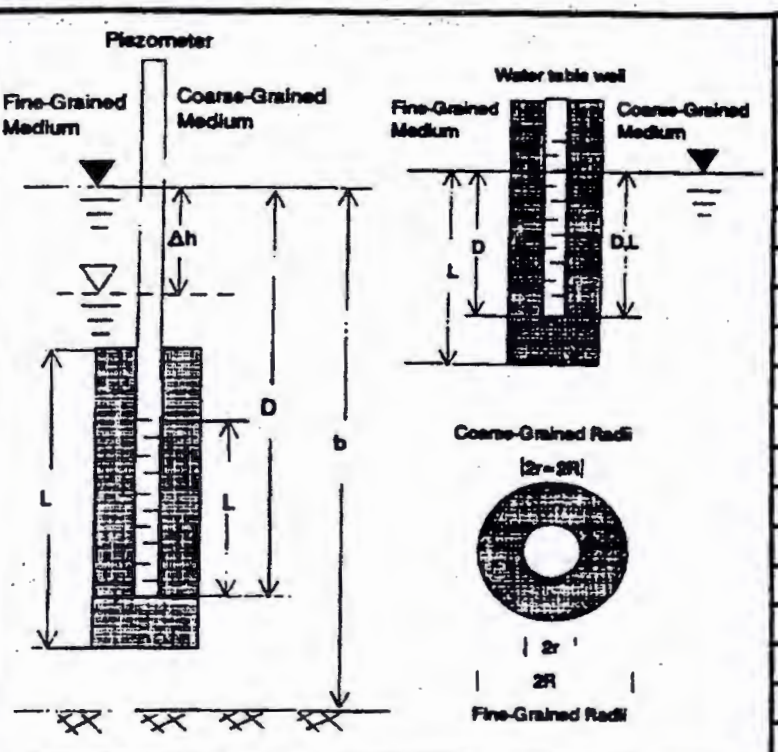
USCS Class of Screened Fmtn: _____ Pressure Transducer (PSI): _____

Aquifer Saturated Thickness in ft. (b): _____ Slug Length and Diameter: _____

Pump Test Information Only

Pumping Rate: _____ Time Pumping Started: _____

Distance from Pumping Well: _____ Time Pumping Stopped: _____



INFIELD TEST DATA

Segment Number	Number of Readings	Reading Interval (Seconds)	Segment Duration (Seconds)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			

Notes: _____

Logger Downloaded by: _____

Calculations by: _____ Date: _____

Computer File Name: _____ Date: _____

Location of Backup Files: _____

EARTH TECH

A TAISEI INTERNATIONAL LTD. COMPANY

Water Elevation

PROJECT NO. _____ SITE _____

Well Number	Elevation Of Top Of Pipe	Depth To Water	Water Elevation	Depth To Bottom	Well Integrity				Comments
					Locked	Capped	Cracked	Obstruct	

Description Of Site _____

Soil Conditions _____

Weather _____ Temperature _____

Entered On Computer _____ Signature _____ Date _____

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Chain of Custody

Client Information

Company _____
Address _____
City/State/Zip _____
Phone _____ Fax _____
Email _____

Project Information

Project Name _____
Project Nummber _____
Project Location _____ State _____
Report To _____
Invoice To _____

Requested Due Date/TAT:						Preservatives and # of Containers							Analyze For:								
Sample ID	Date Sampled	Time Sampled	G = Grab C = Composite	field filtered	Matrix Code see bottom of page for codes	HNO3	HCL	NaOH	H2SO4	Methanol	None	Other									Lab ID or Additional Comments

MATRIX (CODE)
Drinking Water (DW), Water (W), Waste Water (WW), Product (P), Soil/Solid (S), Sludge (SL), Oil (OL), Wipe (WP), Air (AR), Other (OT), Tissue (TS)

Special Instructions:

Relinquished By:		Date:		Time:		Received By:		Date:		Time:	
Relinquished By:		Date:		Time:		Received By:		Date:		Time:	
Relinquished By:		Date:		Time:		Received By:		Date:		Time:	

Sample Condition: Temp in C Received on ice Y N Custody Sealed Cooler Y N Sample Intact Y N

EARTH TECH
A tyco INTERNATIONAL LTD. COMPANY

Field Meter Instrument Calibration Log
Temperature, Conductivity, Dissolved Oxygen

	THERMOMETER				CONDUCTIVITY			D.O. METER			
Date Calibrated	NBS Reference °C	Field Thermo-meter °C	Correc-tion Factor °C	Cal. By	True Value umhos	Meter Readings umhos	Cal. By	Air Temp. °C	Calc. D.O. Air (mg/L)	Read D.O. Air (mg/L)	Cal. By

COMMENTS: _____

Thermometer No.: _____ EPA ID No.: _____

Conductivity Meter: MFG _____ Model: _____ EPA ID No.: _____

Conductivity Standard: MFG _____ Opened Date: _____

D.O. Meter: MFG _____ Model: _____ EPA ID No.: _____

APPENDIX D

ANALYTICAL PARAMETERS

Appendix D Special Volatile Organic Compound List Village of Grafton West Plume/Lime Kiln Landfill Plume Area
1,1,1,2-Tetrachloroethane
1,1,1-Trichloroethane
1,1,2,2-Tetrachloroethane
1,1,2-Trichloroethane
1,1,2-Trichlorotrifluoroethane
1,1-Dichloroethane
1,1-Dichloroethene
1,1-Dichloropropene
1,2,3-Trichlorobenzene
1,2,3-Trichloropropane
1,2,4-Trichlorobenzene
1,2,4-Trimethylbenzene
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
1,2-Dichlorobenzene
1,2-Dichloroethane
1,2-Dichloroethene, Total
1,2-Dichloropropane
1,3,5-Trimethylbenzene
1,3-Dichlorobenzene
1,3-Dichloropropane
1,4-Dichlorobenzene
2,2-Dichloropropane
2-Butanone
2-Chloroethylvinylether
2-Chlorotoluene
4-Chlorotoluene
4-Methyl-2-pentanone
Acetone
Benzene
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
Carbon Disulfide
Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
Chloromethane

Appendix D Special Volatile Organic Compound List Village of Grafton West Plume/Lime Kiln Landfill Plume Area
cis-1,2-Dichloroethene
cis-1,3-Dichloropropene
Dibromomethane
Dichlorodifluoromethane
Diisopropyl Ether
Ethylbenzene
Fluorotrichloromethane
Hexachlorobutadiene
Isopropylbenzene
Methylene Chloride
Methyl-tert-butyl-ether
Naphthalene
n-Butylbenzene
n-Propylbenzene
p-Isopropyltoluene
s-Butylbenzene
Styrene
t-Butylbenzene
Tetrachloroethene
Tetrahydrofuran
Toluene
trans-1,2-Dichloroethene
trans-1,3-Dichloropropene
Trichloroethene
Vinyl Chloride
Xylene, m + p
Xylene, o
Xylene, Total

NOTES:

Analysis Method 8260
Freon 113 synonym is 1,1,2-Trichlorotriflouroethane
List prepared and agreed upon during 1999 Site Investigation Report (Earth Tech, 1999)
Current VOC list for Lime Kiln Park Groundwater Monitoring Plan