FOCUSED FEASIBILITY STUDY
DELPHI HARRISON THERMAL SYSTEMS
WEST LOCKPORT COMPLEX
LOCKPORT, NEW YORK
NYSDEC REGISTRY SITE # 932113

PREPARED FOR:
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APPENDICES

1.00 INTRODUCTION

This report presents the results of the Focused Feasibility Study (FFS) of alternatives for the environmental remediation of a release of trichloroethylene (TCE) identified in November, 1994 at the Delphi Harrison Thermal Systems (Delphi Thermal) West Lockport Complex (Site) located in Lockport, New York (See Figure 1). The Site is listed as a Class 3 site on the New York State Department of Environmental Conservation (NYSDEC) Registry of Inactive Hazardous Waste Sites, Site No. 932113.

1.1 BACKGROUND

Delphi Thermal has been voluntarily assessing the release of TCE since it was identified in November 1994. GZA GeoEnvironmental of New York (GZA) was retained by Delphi Thermal in 1995 to investigate the extent of contamination. Then, in response to the identified groundwater contamination in bedrock at the Site, Delphi Thermal entered a Remedial Investigation/Feasibility Study Order on Consent with NYSDEC in July 2001. Under its Order on Consent, Delphi Thermal prepared a focused remedial investigation and focused feasibility study work plan. The Focused Remedial Investigation[1] (FRI) report was approved by NYSDEC in a letter dated August 12, 2002, which is included in Appendix A.

The objective of the FRI was to characterize the nature and extent of groundwater contamination associated with the TCE release and to provide data for use in the FFS. The scope of the work for the FRI is described in work plan documents approved by the NYSDEC (see Section 1.3). The FRI included a qualitative exposure assessment to identify potential risks to human health and the environment due to contaminants present at the Site.

This FFS report addresses contamination and remediation issues, related to groundwater, for the Delphi Thermal Site. The area of study includes the Delphi Thermal property east of Building 8 to Route 93.

As described in the project Work Plan, the FFS is focused in nature, in that the feasibility of a select group of remedial alternatives is assessed. There are a limited number of technologies available to remediate contaminated groundwater in fractured bedrock. Additionally, dense nonaqueous phase liquid (DNAPL) was found at the Site in monitoring well MW-5. It is recognized by engineers and regulatory agencies that groundwater restoration in the presence of DNAPL in bedrock is impractical because no remedial technologies are available for completely removing subsurface DNAPL in fractured bedrock.

A preliminary list of remedial alternatives was originally discussed in Section 6.3 of the February 1997 Supplemental Phase III Extent of Contamination Studies and Evaluation of Alternatives and again in Section 2.40 of the Work Plan. During a meeting between Delphi, GZA, and NYSDEC on June 25, 2002, a revised group of remedial alternatives was tentatively agreed upon, based on

[1] "Focused Remedial Investigation Report, Delphi Harrison Thermal Systems West Lockport Complex, Lockport, New York, NYSDEC Registry Site #932113" dated August 2002.

previous discussions and the results of the remedial investigation. A preliminary screening of alternatives is provided in Section 2.5.

This focused feasibility study includes considering four remedial alternatives for reducing the presence of DNAPL in bedrock (source reduction) and for reducing the presence of chlorinated volatile organic compounds (CVOCs) in groundwater (dissolved phase), as presented below.

DNAPL SOURCE REDUCTION

Alternative No. 1: No Further Action;

Alternative No. 2: Monitored Natural Attenuation with Groundwater Monitoring;

Alternative No. 3: DNAPL Extraction and Ex-Situ Treatment with Groundwater Monitoring;

Alternative No. 4: In-Situ Chemical Oxidation with Groundwater Monitoring.

GROUNDWATER

Alternative No. 1: No Further Action;

Alternative No. 2: Monitored Natural Attenuation with Groundwater Monitoring;

Alternative No. 3: Groundwater Extraction and Ex-Situ Treatment with Groundwater Monitoring;

Alternative No. 4: In-Situ Chemical Oxidation with Groundwater Monitoring.

Additional details regarding the criteria used and components of these potential remedial alternatives are presented in Sections 2.0 and 3.0, respectively.

1.2 PURPOSE AND ORGANIZATION OF REPORT

The purpose of the FFS is to identify and evaluate specific technologies that are available to remediate the portions of the Site identified in the FRI as requiring remedial action. The technologies most appropriate for the Site conditions are then developed into remedial alternatives that are evaluated based on their environmental benefits and cost. The information presented in the FFS will be used by Delphi Thermal and NYSDEC to select a remedial action for the Site. Selected remedial actions will be summarized by NYSDEC in a Proposed Remedial Action Plan (PRAP), which will be released for public comment. After receipt of public comments, the NYSDEC will issue a Record of Decision (ROD).

1.3 SCOPE OF WORK

The FFS study and report were conducted in general accordance with:

- The scope of work described in the "Focused Remedial Investigation and Focused Feasibility Study Work Plan, Delphi Harrison Thermal Systems, West Lockport Complex, Lockport, New York, NYSDEC Registry Site # 932113" dated April 2001 (with attachments including the Field Activities Plan (FAP), Sampling and Analysis Plan and Addenda, Health and Safety Plan (HASP), and Citizen Participation Plan (CCP));

- Procedures recommended in the NYSDEC Division of Hazardous Waste Remediation, TAGM 4025 Guidance, "Guidelines for Remedial Investigation/Feasibility Studies" dated March 1989;

- NYSDEC Division of Hazardous Waste Remediation TAGM 4030 Guidance, "Selection of Remedial Actions at Inactive Hazardous Waste Sites" as revised May 1990;

- USEPA Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA dated October 1988;

- Discussions/correspondence between NYSDEC and Delphi Thermal on December 17, 2002; January 9, 2003 (conference call); January 28, 2003; June 10, 2003 (phone conversation); July 22, 2003; and September 30, 2003 (email).

GZA completed the following scope of work for the FFS.

- Identified Standards, Criteria and Guidelines (SCGs) that may apply to the specific conditions at the Site. These generally include State requirements that are used as a basis for establishing cleanup goals for the Site and other regulatory requirements that may apply to proposed remedial actions.

- Identified proposed cleanup goals (SCG goals) and remedial objectives for contaminants of concern at the Site.

- Completed preliminary screening of remedial technologies to develop a short list of technologies that appear implementable and effective based on the Site conditions and list of contaminants identified during the FRI.

- Developed remedial alternatives for detailed screening that are evaluated on the basis of:

  Short-term impacts and effectiveness;
  Long-term effectiveness and permanence;
  Reduction of toxicity, mobility and volume;
  Implementability;

Compliance with applicable or relevant and appropriate SCGs and Site remediation goals;
Overall protection of human health and the environment; and
Cost.

- Compared the alternatives based on the seven criteria identified above.
- Provided conclusions regarding the FFS and recommendations.
- Prepared this report summarizing the findings of the FFS.

1.4 SITE INFORMATION

This section summarizes the findings of the Focused Remedial Investigation. The FRI report and referenced correspondence should be consulted for additional details.

1.4.1 Site Description

Delphi Thermal owns and operates an automotive component manufacturing complex in Lockport, New York. The complex consists of three plants (see Figure 1). Building 8 is located in the north-central portion of the complex and has housed degreasing operations, which used TCE. An aboveground storage tank, which held TCE, was located at the southeast corner of Building 8 and is identified as the area of concern (AOC) (see Figure 2).

The AOC is defined as the area of the former secondary containment structure associated with the former TCE aboveground tank. This area is approximately 27 by 22 feet in size. The AOC is situated between Building 8 to the north and west and a concrete steam chase to the east. The concrete in-ground utility chamber (steam chase) is believed to extend to bedrock (approximately 7 to 8 feet below the ground surface (bgs). An equipment storage area is located to the south.

A water-cooling tower is located approximately 130 feet southeast of the AOC. The plant perimeter fence is located approximately 80 feet east of the AOC. Further to the east is an employee parking area, which slopes down to the east. The nearest public property is Route 93 located approximately 1200 feet to the east. The Delphi Thermal wastewater treatment plant is located east of Route 93.

The Niagara Escarpment, a significant regional feature that may affect groundwater flow at the Site, is located approximately one-half mile northeast of the AOC. It is an east-west trending rock ledge, which marks the boundary between two physiographic regions. The crest of the escarpment is approximately 200 feet higher than the Lake Ontario Plain located to the north. The Niagara Escarpment is notched by a northeast to southwest trending gorge, which is known locally as "The Gulf". The Gulf is located just east of the Delphi Thermal wastewater treatment plant. The difference in elevation between the crest and base of the Gulf is approximately 110 feet.

The nearest surface water body to the AOC is a drainage swale, which carries plant runoff

from a stormwater outfall. This swale is approximately 800 feet to the east and flows east, discharging to an onsite stream, which flows to the north. This onsite stream enters the Delphi Thermal Site from the southern property boundary and joins with the drainage swale, near MW-12. It then crosses beneath Route 93 and flows down over a 30 to 35 feet high waterfall into The Gulf at a location north of the wastewater treatment plant.

1.4.2 Site History

The aboveground TCE storage tank was closed in May 1994. This tank was situated within a concrete containment dike with a concrete bottom. Prior to the installation of this tank, a previous "old" TCE tank was located about 35 feet to the south of the former containment area. It is believed by Delphi Thermal that the aboveground TCE storage tank and the "old" tank were the same tank. The fill port for one or both tanks was located at the southeast corner of Building 8. TCE is no longer used at the Site.

Tetrachloroethylene (PCE) was also used as a degreasing solvent at the Delphi Thermal facility. Use of PCE as a manufacturing solvent was discontinued in 1992. In March 1994, PCE use was discontinued on the entire plant Site. PCE is sometimes found as an impurity within commercial TCE.

An underground gasoline storage tank was formerly located next to Building 8 near the former TCE tank. Delphi Thermal is not aware of any documented spills in the vicinity of the AOC. Research indicates that the gasoline underground storage tank was removed in June of 1980.

Four fire protection lines exist beneath the former TCE storage tank area at a depth of about 6 feet below ground surface (bgs). One of these pipes ruptured and flooded the area in October 1994. During excavation to repair the rupture, personnel working in the AOC noted a solvent odor. Subsequently, soils from an approximate 27 by 22-foot area were excavated to a depth of about 7.5 feet bgs and disposed by Delphi Thermal as a hazardous waste. Four soil samples were collected from the bottom of the excavation. TCE was measured at concentrations ranging between 0.38 mg/kg and 1800 mg/kg in the soil samples collected. The excavation was then backfilled with a manufactured crushed stone product. NYSDEC was notified of the release and assigned the incident Spill Number 9410972.

Written correspondence between the NYSDEC and Delphi Thermal (as General Motors Corporation, Harrison Division) regarding Spill Number 9410972 includes the following.

- Letter from NYSDEC to Harrison Division, General Motors Corporation dated December 2, 1994.
- Letter from Harrison Division, General Motors Corporation to NYSDEC dated December 22, 1994.
- Letter from Delphi Automotive Systems to NYSDEC dated April 13, 1995.

Copies of the noted correspondence are included in Appendix A.

1.4.2.1 Site Investigations

1.4.2.1.1 Summary of Investigations

Following the removal of the impacted soil and filling of the excavated area, Delphi Thermal retained GZA to provide environmental consulting services to investigate the AOC. Work plans were prepared and reviewed by the NYSDEC prior to the start of investigation activities. This section provides a summary of the investigations at the AOC and subsequent groundwater monitoring sampling events.

During our first phase of work, GZA completed the following tasks.

- Reviewed existing data provided by Delphi Thermal.
- Developed a Sampling and Analysis Plan (SAP) and a Health and Safety Plan (HASP).
- Completed soil probes and collected samples of soil and utility bedding material (August - September 1995 and April 1996).
- Conducted a soil gas survey along buried utilities (August - September 1995).
- Installed shallow groundwater monitoring wells MW-1 (August 1995), MW-2 (August 1995), MW-3 (August 1995), MW-4 (April 1996), MW-5 (April 1996), MW-6 (April 1996) and MW-7 (April 1996).
- Installed deep groundwater monitoring well MW-3D (December 1995 through January 1996).
- Abandoned monitoring well MW-1 (December 1995) and installed replacement monitoring well MW-7 (April 1996).
- Abandoned monitoring well MW-2 (December 1995). No replacement well was required.
- Analytical testing of soil and groundwater samples.

The locations of Site monitoring wells are shown on Figure 2.

The key findings of the above described work, between August 1995 and April 1996, are summarized below.

- VOCs were detected in groundwater and subsurface soil in the immediate vicinity of the AOC above respective NYSDEC drinking water standards and soil cleanup guidance values. These contaminants included TCE and its breakdown products.

- The contaminant levels generally decrease with distance from the reported spill area.

- The extent of soil contamination was defined and it was found to be limited to the immediate area around the AOC.

- Utility beddings were not found to be providing a significant pathway for migration of contamination.

- Shallow bedrock groundwater is impacted with TCE and its breakdown products. The extent of shallow bedrock groundwater contamination downgradient (to the east) was not determined.

- Deep bedrock groundwater, at monitoring well MW-3D, was not found to be impacted by the AOC.

- DNAPL was detected in shallow bedrock at the location of monitoring well MW-5.

These studies were documented in GZA's September 11, 1996 report, which was forwarded to NYSDEC. Based on recommendations in this report, GZA conducted additional studies to further assess the horizontal extent of shallow bedrock groundwater contamination east of the AOC. The following is a summary of the work conducted.

- October 1996 – Work included the installation, hydraulic conductivity testing, and surveying of three monitoring wells (MW-8, MW-9 and MW-10); and, water level measurements, sampling and analysis of groundwater samples from these three wells and selected existing wells.

- August 1997 – Work included the installation, hydraulic conductivity testing, and surveying of two monitoring wells (MW-11 and MW-12); and water level measurements, sampling and analysis of groundwater samples from these two wells and selected existing wells.

As requested by NYSDEC in an October 21, 1998 letter to Delphi Thermal, additional analytical testing was conducted to further assess natural attenuation

processes at the Site. Two additional sample rounds were conducted in December 1998 and October 1999.

- December 1998 – Work included the sampling and analysis of groundwater samples from nine existing wells. Analytical test parameters included target VOCs (TCE, PCE, 1-2 DCE, vinyl chloride, benzene, toluene, ethylbenzene, and xylenes) and parameters associated with the evaluation of natural attenuation.

- October 1999 - Work included the sampling and analysis of groundwater samples from nine existing wells and one background upgradient well (TK-2). (See Figure 1 for the location of well TK-2). Analytical test parameters included target VOCs and parameters associated with the evaluation of natural attenuation. The upgradient well was tested only for chloride and alkalinity to confirm background concentrations for these parameters.

The results of these sampling events indicated that conditions conducive to and supporting natural attenuation exist at the Site. The results of the December 1998 sampling are contained in GZA's May 1999 report; results of the October 1999 sampling are contained in our August 2000 report.

In addition, as required by the FRI/FFS Work Plan, two additional groundwater sample rounds were conducted in August 2001 and October 2001.

- August 2001 – Work included the installation, hydraulic conductivity testing, and surveying of three monitoring wells (MW-13, MW-14 and MW-15); and water level measurements and sampling and analysis of groundwater samples from these three wells and select existing wells. Analytical test parameters included target VOCs and parameter associated with the evaluation of natural attenuation.

- October 2001 – Work included the sampling and analysis of groundwater samples from eight existing wells. Analytical test parameters included target VOCs and parameters associated with the evaluation of natural attenuation.

The results of these sampling events, contained in GZA's October 2001 and December 2001 reports respectively, further indicated that conditions conducive to and supporting natural attenuation exist at the Site.

Following NYSDEC and NYSDOH review of the October 2001 sample round data, NYSDEC suggested that Delphi Thermal proceed with the FRI report in a letter dated February 8, 2002. The FRI final report was approved by the NYSDEC in a

letter dated August 12, 2002. Copies of the noted correspondence are included in Appendix A.

In response to source area issues raised by DEC during review of the first draft of the FFS Report, GZA sampled monitoring wells MW-3S, MW-4, MW-5, MW-6, and MW-7 on April 7, 2003. Groundwater samples were analyzed for the CVOCs. The results of this sampling indicated a continued overall decrease in the concentration of the parent compounds (TCE and PCE) in the source area.

1.4.2.1.2 Groundwater Sampling Project Documents

GZA conducted thirteen groundwater sample rounds at the Site (September 1995, October 1995, April 1996, June 1996, October 1996, November 1996, August 1997, October 1997, December 1998, October 1999, August 2001, October 2001, and April 2003). Major project documents submitted and reviewed by NYSDEC included the following.

- Sampling and Analysis Plan, Phase III Extent of Contamination Study, August 1995.
- Addendum to Sampling and Analysis Plan, Phase III Extent of Contamination Study, February 1996.
- Phase III Extent of Contamination Study, September 1996.
- Supplemental Phase III Extent of Contamination Studies and Evaluation of Alternatives, February 1997.
- Supplemental Phase III Extent of Contamination Studies Data Report, May 1998.
- Supplemental Phase III Extent of Contamination Studies Data Report (December 1998 Sample Round), May 1999.
- Supplemental Phase III Extent of Contamination Studies Data Report (October 1999 Sample Round), August 2000.
- Supplemental Groundwater Sampling Data Report (August 2001 Sample Round), October 2001.
- Supplemental Groundwater Sampling Data Report (October 2001 Sample Round), December 2001.

It should be noted that the results of the April 2003 groundwater-sampling event

have been incorporated into the appropriate tables and figures of this document. The laboratory report is included as Appendix B.

1.4.3 Nature and Extent of Contamination

VOCs were detected in groundwater and subsurface soil in the immediate vicinity of the AOC above respective NYSDEC drinking water standards and soil cleanup guidance values. These contaminants included TCE, PCE, and their breakdown products. Groundwater flow in the vicinity of the Site appears to be generally towards the east, as depicted on Figure 3.

The source area identified for purposes of the FRI was defined as the groundwater contamination associated with the AOC and the DNAPL identified in MW-5. Contaminants in the vicinity of the AOC and the DNAPL at MW-5 will continue to contribute to the groundwater plume at the Site until sources are depleted.

Analytical testing results (See Table 1) of samples from shallow bedrock monitoring wells indicate the presence of AOC-related contaminants (chlorinated solvents) in the majority of the wells installed as part of this study; and petroleum related compounds in wells MW-3S and MW-4. Compounds reported above NYSDEC Class GA drinking water criteria include; TCE, PCE 1,2-DCE, Vinyl Chloride, and petroleum related compounds (benzene, toluene, ethylbenzene and xylenes).

In general, concentrations of parent compounds (TCE and PCE) are highest near the AOC. Moving eastward from the AOC, concentrations of parent compounds decrease consistently. Parent compounds were not detected at the four furthest downgradient wells (MW-11, MW-12, MW-13 and MW-14). PCE was detected at low concentrations in MW-15, located at the northern downgradient edge of the plume.

Parent compound breakdown products (daughter compounds), 1,2-DCE and Vinyl Chloride, reach maximum concentrations at intermediate wells such as MW-4, then decrease at downgradient wells (MW-10, MW-11, and MW-12). Daughter compounds were not detected in well MW-13, at the furthest downgradient edge of the plume (at the Delphi Thermal property line). Daughter compound 1,2-DCE was detected at a low concentration in MW-14. No daughter compounds were detected in MW-15. Figure 4 shows a Site Plan with the analytical results from the twelve-groundwater sampling rounds.

a statement about no measurable DNAPL layer is Key to eliminating further migration of DNAPL

A sample of DNAPL was collected from monitoring well MW-5. The sample exhibited a brownish black appearance and was observed to sink in water. Test results indicate the DNAPL contains approximately 430,000 mg/kg of TCE and 640,000 mg/kg of PCE. It is not known how many of the fractures monitored by MW-5 contain DNAPL.

Twelve groundwater sample rounds have been completed to date between the period of September 1995 and October 2001. The total chlorinated compound concentrations between the first sample round and October 2001 sample round were compared for the monitoring wells. In general, the concentrations in the groundwater samples from the evaluated wells did not

significantly change. Minor fluctuations in concentrations are noted within the data and are to be expected given the analytical laboratory accepted accuracy for the test procedures. Therefore, the Site groundwater plume is considered to be in a "steady state". If DNAPL were migrating at the Site, down gradient concentrations would likely increase over time. The steady state conditions observed at the Site suggest that DNAPL found at MW-5 is not migrating.

A supplemental sampling round of source area and near-source area monitoring wells performed in April 2003 shows that CVOC concentrations have decreased by more than 50% in each of the three most contaminated wells compared to concentrations found during the previous sampling round. At MW-3S total CVOCs (primarily 1,2 DCE) decreased from 273 mg/l to 100 mg/l, at MW-5 total CVOCs (primarily TCE) decreased from 382 mg/l to 162 mg/l, and at MW-7 CVOCs (primarily TCE) decreased from 584 mg/l to 123 mg/l.

1.4.4 Contaminant Fate and Transport

The primary routes of contaminant migration at the Site are via the shallow bedrock groundwater and volatilization to soil gas/air.

The primary source of the groundwater passing through/beneath the AOC is anticipated to originate from flow upgradient of the AOC in the shallow bedrock. Groundwater flow through the bedrock beneath the facility is controlled primarily by fractures and/or bedding planes within the rock. Based on the bedrock core samples observed and hydraulic conductivity test results, the rate of flow beneath the AOC is expected to be relatively low.

The data suggest that groundwater contaminant transport is in a near steady-state condition and significant increases in the concentrations with time are not expected. As migration of TCE and PCE occurs away from the AOC, natural attenuation occurs resulting in a reduction of concentrations and mass of contaminant.

DNAPL was observed in MW-5 and is trapped within fractures monitored by MW-5. It is not believed that the DNAPL is migrating. Through dissolution it will provide a continuing source of groundwater contamination, until it is depleted.

Volatilization is expected to occur at the Site; however, the potential for volatilization decreases with distance from the AOC. Due to the depth to impacted groundwater (approximately 5 to 15 feet bgs), that groundwater is located in shallow bedrock, and that much of the Site area is paved, the extent of potential vapor migration is expected to be limited.

Physical, chemical and biological processes affect the migration of contaminants within the fractured bedrock flow system at the Delphi Thermal Site. The primary natural attenuation process occurring at the Site is biochemical degradation. Analytical data indicate that degradation of TCE and PCE is occurring at the Site, as is demonstrated by the presence of breakdown products including 1,2-DCE and vinyl chloride downgradient of the AOC. Furthermore, based on monitored natural attenuation field and analytical data, there is supportive

evidence that biochemical degradation is occurring at the Site and is responsible for the reductive dechlorination of chlorinated volatile organic compounds.

The extent of contamination along the majority of the plume is currently established as being within the Delphi Thermal property (concentrations of chlorinated solvents in well MW-13 were not detected above detection limits), except potentially within the area of MW-15 on the northern downgradient area of the plume. It is expected that the PCE concentration at the Delphi Thermal property line at Route 93 would decrease to less than 5 ppb (the NYSDEC Class GA criterion). However, since less biochemical degradation is occurring in the area of MW-15 than at other areas of the Site, the actual concentration at the property line is difficult to estimate.

1.4.5 Qualitative Exposure Assessment

A qualitative baseline human health exposure assessment was completed based on the information and data obtained during the FRI study. This exposure assessment discusses potential migration routes by which chemicals in the environment may be able to reach human receptors. This discussion is based on current and hypothetical future Site conditions, and the risks identified are expected to be "worse case scenarios". These risks are expected to be mitigated through potential future remedial activities at the Site. A summary of the results of the exposure assessment, listed by media is presented below.

Shallow Bedrock Groundwater

The potential for exposure to chemical substances within the groundwater at the Site appears low, due to institutional controls (i.e., excavation permit) and site conditions. Institutional controls require on-site excavation work be issued a work permit prior to excavation to limit the potential exposure at a point of groundwater discharge into an excavation and at underground facilities/utilities or structure work. Additionally, the exposure to and the subsequent inhalation of volatile vapors are also considered low based on soil gas results.

The potential for exposure due to use of groundwater as a drinking water source is not expected, and the likelihood of human exposure via the stream is considered low. Groundwater wells in the area are not used for drinking water/potable water. Surface water samples collected from the stream did not contain detectable contaminants of concern.

Volatile Vapors

Vapor migration associated with VOC contamination in groundwater may potentially impact underground structures and facilities.

1.4.6 FRI Conclusions

Based on the FRI summarized above, the following are conclusions regarding the Site and the nature and extent of soil and groundwater contamination.

- VOCs were detected in groundwater and subsurface soil in the immediate vicinity of the AOC above respective NYSDEC drinking water standards and soil cleanup guidance values. These contaminants included TCE and its breakdown products.

- The contaminant levels generally decrease with distance from the reported spill area (AOC).

- The extent of soil contamination was defined and it was found to be limited to the immediate area around the AOC. The impacted soil in the vicinity of the AOC is not considered a significant source of contamination.

- Utility beddings were not found to be providing a significant pathway for migration of contamination.

- Shallow bedrock groundwater is impacted with TCE, PCE and their breakdown products.

- Deep bedrock groundwater, at monitoring well MW-3D, was not found to be impacted by the AOC.

- DNAPL exists in the shallow bedrock in the area of monitoring well MW-5. The groundwater in the main part of the plume (near MW-5), containing higher concentrations of the contaminants of concern, and the DNAPL are primary sources of contamination on-Site.

- Groundwater contaminant transport is in a steady-state condition.

- Natural attenuation is occurring at the Site, between the source of contamination and the Delphi Thermal property line, resulting in a reduction of concentrations and mass of chlorinated VOC contaminants. Contaminant concentrations at the property line are below or near the NYSDEC Class GA drinking water standard. This reduction is primarily associated with natural attenuation processes.

- There are no significant exposure scenarios from the source of contamination to the property line. The potential exposure scenarios are limited (e.g., construction and maintenance projects) and can be addressed by administrative controls.

- Off-Site inhalation exposure from vapor migration is not expected due to the non-detect or low downgradient groundwater concentrations (at or below the groundwater standard). Exposure to off-site groundwater is not expected.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

2.1 INTRODUCTION

This section presents potentially applicable Standards, Criteria and Guidelines (SCGs); and establishes cleanup goals and remedial action objectives for contaminated Site media. Also presented are estimates of areas and volumes of contaminated on-Site groundwater and subsurface soils to assist in evaluating remedial alternatives later in this report.

2.2 POTENTIALLY APPLICABLE STANDARDS, CRITERIA, AND GUIDELINES (SCGs) AND OTHER CRITERIA

Standards, Criteria and Guidelines (SCGs) are used at inactive hazardous waste sites to establish the locations where remedial actions are warranted and to establish cleanup goals. SCGs include State requirements and Federal requirements that are more stringent then State requirements.

- *Applicable Requirements* are legally enforceable standards or regulations that have been promulgated under State law, such as groundwater standards for drinking water.

- *Relevant and Appropriate Requirements* include those requirements, which have been promulgated under State law which may not be "applicable" to the specific contaminant released or the remedial action contemplated, but are sufficiently similar to site conditions to be considered relevant and appropriate. If a relevant and appropriate requirement is well suited to a site, it carries the same weight as an applicable requirement during the evaluation of remedial alternatives.

- *Other Criteria* that can be considered are those non-promulgated advisories or guidance issued by State agencies that may be used to evaluate whether a remedial alternative is protective of human health and the environment in cases where there are no standards or regulations for a particular contaminant or site condition.

The following sections present the three categories of SCGs: chemical-specific, location-specific, and action-specific.

2.2.1 Chemical-Specific SCGs

Chemical-specific SCGs are typically technology or health-risk based numerical limitations on the contaminant concentrations in the ambient environment. They are used to assess the extent of remedial action required and to establish cleanup goals for a site. Chemical-specific SCGs may be directly used as actual cleanup goals, or as a basis for establishing appropriate cleanup goals for the contaminants of concern at a site. Chemical-specific SCGs for subsurface soil and groundwater at the Delphi Thermal Site are identified in Table 2. The SCGs include applicable TAGM 4046 RSCOs and NYSDEC Class GA groundwater criteria.

2.2.2 Location-Specific SCGs

Location-specific SCGs apply to sites that contain features such as wetlands, flood plains, sensitive ecosystems or historic buildings that are located on, or in close proximity to the Site. Based on the FRI, wetlands, flood plains, sensitive ecosystems or historic buildings are not located on, or in close proximity to the Site. Thus, location-specific SCGs were not identified for this Site.

2.2.3 Action-Specific SCGs

Action-specific SCGs are usually administrative or activity-based limitations that guide how remedial actions are conducted. These may include record keeping and reporting requirements; permitting requirements; design and performance standards for remedial actions; and treatment, storage and disposal practices. Action-specific SCGs identified for the Site are provided in Table 2. These SCGs may vary for remedial design, based on the remedy(s) selected for the Site.

2.3 REMEDIAL ACTION OBJECTIVES

This section presents the objectives for remedial actions that may be taken at the Site to protect human health and the environment. To develop the remedial action objectives, GZA conducted the following as part of the FRI and FFS.

- Identified contaminants present in the groundwater at the Site study area.
- Evaluated existing or potential exposure pathways in which the contaminants may effect human health and the environment.
- Identified pathways having a moderate to high likelihood for exposure.
- Identified chemical-specific SCGs that apply to the likely exposure routes to establish the contaminants of concern and proposed cleanup goals for purposes of remediation.
- Established remedial action objectives for the contaminants of concern to reduce the potential for future exposure.

As discussed in Section 1.4.2, unsaturated soil contamination was removed from the AOC at the Site in 1994. No remedial actions are proposed for the soil at the Site.

Remedial action objectives are presented for the groundwater at the Site, based on the contaminants of concern and SCG Goals. Remedial action objectives are summarized at the end of this section.

2.3.1 Contaminants of Concern and SCG Goals

Contaminants of concern identified during the investigation for the Site include TCE, PCE, 1,2-DCE, and vinyl chloride, which are furthered referenced as chlorinated VOCs

(CVOCs). While other compounds were detected, specifically BTEX compounds (benzene, toluene, ethylbenzene, and xylenes), they were identified in monitoring wells MW-3s and MW-4 and are not considered significant in this study or for the remedial effort.

Table 3 lists the contaminants of concern detected in the groundwater samples collected at the Site and the chemical-specific SCGs (NYSDEC Class GA groundwater standards) that apply to the likely exposure routes for the environmental media of interest. Potential exposure pathways are discussed in Subsection 2.3.2

2.3.2 Contaminated Media and Exposure Pathways

This subsection addresses the groundwater at the Site and describes the types of contaminants present and the potential exposure pathways as described in the Qualitative Exposure Assessment in the FRI Report.

2.3.2.1 Shallow Groundwater

Shallow groundwater sampling and laboratory analyses were completed as part of the FRI. Table 1 identifies the contaminants of concern detected in the Site shallow groundwater samples. Based on qualitative exposure assessment presented in the FRI study, the contaminants of concern for groundwater are the target chlorinated VOCs, specifically TCE, PCE, and their breakdown products. Although, petroleum related VOCs were detected at groundwater monitoring locations, MW-3 and MW-4, they will not be discussed further in the report.

The potential exposure pathway for shallow groundwater appears to be via contact with contaminated groundwater at points of possible groundwater discharge (i.e., streams, excavations). The likelihood of exposure to groundwater due to construction activity is considered low since excavation work is not permitted unless the facility's excavation permit program is executed.

No potential for exposure due to use of groundwater as a drinking water source is expected. Private drinking water wells within the vicinity of the Site were identified by NYSDEC as not being utilized. Additionally, a permit is required by the Niagara County Department of Health prior to the installation of a drinking water well.

2.3.2.2 Volatile Vapors

Potential exposure to volatile vapors via inhalation are considered low. Based on the concentrations of contamination present and the depth to groundwater, it is possible for vapors to accumulate in enclosed on-Site areas (e.g., sanitary sewer lift station manhole). However, based on the soil gas survey conducted at and proximate to the AOC, utility beddings were not found to provide a significant pathway for the migration of contamination and vapors are not expected to be a significant concern in the Site buildings.

2.3.3 Remedial Action Objectives

This subsection presents the proposed remedial action objectives to reduce the potential for future exposure to groundwater contaminants. Due to the presence of DNAPL in the fractured bedrock at the Site, attainment of the SCG goal throughout the plume is not a realistic remedial action objective. GZA believes the more appropriate objective is to achieve reasonable groundwater clean-up goals at the Site property boundary. However, we have considered source remediation in this FFS.

The remedial action objectives for on-Site shallow groundwater are:

(1) Prevent further migration of contaminated shallow bedrock groundwater to the extent practical;

(2) Reduce levels of contamination in shallow bedrock groundwater to the extent practical;

(3) Attain proposed cleanup goals for shallow bedrock groundwater to the extent possible; and

(4) Limit risk of exposure to shallow bedrock groundwater contaminants by reducing the potential for inhalation of organic vapors.

2.4 REMEDIAL ACTION AREAS AND VOLUMES

This subsection presents the estimated area of contaminated groundwater and soils at the Site to assist in evaluating remedial alternatives later in the report. The estimates are based on the information presented in the FRI report, as summarized in Section 1.0 herein.

The area of the Site occupied by contaminated groundwater above the NYSDEC Class GA Standards is estimated to be approximately 21 acres. Due to the varying nature of the subsurface conditions, primarily fractured bedrock, a volume of water is difficult to calculate.

The volume of contaminated subsurface soils removed from the AOC at the Site was approximately 165 cubic yards. The remedial action of removing the contaminated soil was completed in 1994, when Delphi Thermal became aware of the TCE spill.

2.5 PRELIMINARY SCREENING OF REMEDIAL TECHNOLOGIES

2.5.1 Introduction

This section presents the preliminary screening of remedial technologies that may be used to control and/or reduce the contaminants of concern to achieve the remedial action objectives for the Site. This FFS Report will expand upon the remedial technologies discussed in the GZA

February 1997 report[2]. Potential remedial actions are evaluated during the preliminary screening on the basis of effectiveness, implementability, and relative cost. The purpose of the preliminary screening is to eliminate remedial actions that may not be effective based on anticipated site conditions, or that cannot be implemented technically at the site; and, to narrow the list of alternatives that will be evaluated in greater detail later in Sections 3.0 and 4.0 of this report.

The remedial actions include general response actions (e.g., containment, in-situ treatment) that may be accomplished using various remedial technologies. During the preliminary screening, the intent is to identify general response actions and remedial technologies that may be appropriate for Site conditions. A select, focused group of general response actions and remedial technologies for groundwater are considered.

Evaluations of the analytical and field data for Site groundwater indicate that concentrations of TCE and PCE and their breakdown products are present above the SCGs in groundwater at the Site. In addition, contamination in the form of DNAPL has been identified at one on-site groundwater location. Groundwater restoration in the presence of DNAPL is often considered impractical, because no remedial technologies are available for completely removing subsurface DNAPL in bedrock. Several Site factors, including the complex characteristics of the bedrock fracture system and limits of DNAPL, limit the potential remedial technologies that would be viable. Other innovative technologies (e.g., in-situ chemical oxidation) may be effective at remediating a portion of the DNAPL contamination; however, these technologies are unlikely to provide for complete DNAPL mass reduction without extensive effort and expense, can cause the mobilization of DNAPL and may impact the naturally occurring attenuation. In-situ chemical oxidation will be considered as a remedial technology for both DNAPL and dissolved phase reduction.

2.5.2 General Response Actions

To satisfy the remedial objectives for the Site, remedial action will be required for the Site groundwater. General response actions that are available to meet the remedial action objectives and that are under consideration are identified below.

- No Further Action;
- Institutional Controls/Actions (e.g., subsurface work permits, confined space permits) ;
- Monitoring (e.g., Monitored Natural Attenuation);
- Extraction/Containment (e.g., groundwater extraction, vertical barrier wall);
- In-Situ Treatment (e.g., in-situ chemical oxidation, co-solvent flushing, steam injection); and
- Ex-Situ Treatment (e.g., air stripping, activated carbon).

2.5.3 Preliminary Screening

In accordance with guidance documents issued by NYSDEC (TAGM HWR-4030, revised

[2] "Supplemental Phase III Extent of Contamination Studies and Evaluation of Alternatives, Delphi Thermal West Lockport Complex, Lockport, New York" dated February 1997.

May 1990) and the USEPA (Guidance for Conducting RI/FS Studies under CERCLA, dated October 1988), the criteria used for preliminary screening of general response actions and remedial technologies include the following.

Effectiveness - The effectiveness evaluation focuses on the degree to which a remedial action is protective of human health and the environment. An assessment is made of the extent to which an action: (1) reduces the mobility, toxicity and volume of contamination at the site; (2) meets the remediation goals identified in the remedial action objectives; (3) effectively handles the estimated areas and volumes of contaminated media; (4) reduces impacts to human health and the environment in the short-term during the construction and implementation phase; and (5) is proven or reliable and how the proposed action may be in the long-term with respect to the contaminants and conditions at the site. Alternatives that do not provide adequate protection of human health and the environment are eliminated from further consideration.

Implementability - The implementability evaluation focuses on the technical and administrative feasibility of a remedial action. Technical feasibility refers to the ability to construct and operate a remedial action for the specific conditions at the site and the availability of necessary equipment and technical specialists. Technical feasibility also includes the future maintenance, replacement and monitoring that may be required for a remedial action. Administrative feasibility refers to compliance with applicable rules, regulations, statutes and the ability to obtain permits or approvals from other government agencies or offices; and the availability of adequate capacity at permitted treatment, storage and disposal facilities and related services. Remedial actions that do not appear to be technically or administratively feasible, or that would require equipment, specialists or facilities that are not available within a reasonable period of time, are eliminated from further consideration.

Relative Cost - In the preliminary screening of remedial actions, relative costs are considered rather than detailed cost estimates. The capital costs and operation and maintenance costs of the remedial actions are compared on the basis of engineering judgement, where each action is evaluated as to whether the costs are high, moderate or low relative to other remedial actions based on knowledge of site conditions. A remedial action is eliminated during preliminary screening on the basis of cost if other remedial actions are comparably effective and implementable at a much lower cost.

2.5.4 Source Area Reduction Remedial Technologies

The following subsections describe the various general response actions and remedial technologies that were considered for remediation of the apparent DNAPL Source Area. Table 4 contains the preliminary screening of the remedial technologies that were considered.

2.5.4.1 No Further Action

Delphi Thermal excavated contaminated soil in the AOC following the identification of Spill No. 9410972 in late 1994. The No Further Action alternative involves doing no additional work to remedy source area conditions at the Site. NYSDEC and USEPA guidance requires that the No Action alternative automatically passes through the preliminary screening and be compared to other alternatives in the detailed analysis of alternatives (Section 3.0).

2.5.4.2 Institutional Controls/Actions

Institutional controls/actions (e.g., access restriction or work permits) could be used to limit the encounter of site workers with DNAPL. Institutional controls/actions will be involved in the three remedial alternatives further evaluated in Section 3.0 with the exception of No Further Action.

2.5.4.3 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) refers to the reliance on the natural attenuation processes (within the context of a controlled and monitored site cleanup approach) to achieve site specific remedial objectives within a timeframe that is reasonable, compared to that of other more active methods such as DNAPL extraction and treatment. Natural attenuation processes include a variety of physical, chemical and biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume or concentration of contamination in groundwater. These processes include biodegradation, dispersion, dilution, sorption, volatilization, and/or chemical or biological stabilization, transformation, or destruction.

Natural attenuation can be considered as a remedial technology for the apparent DNAPL source area when one or more of the following conditions are present at the site.

- Natural attenuation processes are observed or strongly expected to be occurring.
- There are no receptors that will be adversely impacted in the vicinity of the DNAPL contamination.
- A continuing source exists that cannot be easily and cost-effectively removed and will require a long-term remedial effort.
- Alternative remedial technologies are not cost effective or are technically impractical.

- Alternative remedial technologies pose added risk by transferring or spreading contamination.
- Minimal disruption of facility operations or infrastructure is desired.

Natural attenuation is generally evaluated using a "line of evidence" approach that forms the basis for current protocols and guidance documents. The suggested lines of evidence include the following.

- Documentation of loss of contaminants through reviewing historical trends in contaminant concentration and distribution in conjunction with site geology and hydrogeology, to show the reduction in total mass of contaminants is occurring.
- Presence and distribution of geochemical and biological indicators that have been correlated to natural attenuation. This is done by evaluating change in concentration and distribution of geochemical and biochemical indicator parameters that have been shown to indicate natural attenuation.

As mentioned in Section 1.4.2.1.1, an evaluation of MNA was conducted during the FRI to evaluate whether conditions supporting the biodegradation of TCE are present in the aquifer. The results of this evaluation indicate that aquifer conditions are supportive of biodegradation.

Monitored natural attenuation is a viable alternative for reduction of the apparent DNAPL source contamination at the Site and will be considered further in the detailed analysis.

2.5.4.4 DNAPL Source Extraction

DNAPL source extraction is a method used to reduce the presence of a DNAPL contaminant source. Extraction wells are generally installed with a drill rig. Well screens and filter packs intercept the saturated thickness of the contaminated water-bearing zone. Source extraction can be coupled with an ex-situ treatment system, which are discussed further in Section 2.5.4.12.

Groundwater extraction at the source area (DNAPL) in large quantities is not considered a viable alternative because the apparent DNAPL source area may not be intersected by the extraction wells or the procedure used to install and operate the extraction wells may cause the apparent DNAPL source material to move and compromise the remedial effort. Periodic low flow pumping from an existing monitoring well where DNAPL was observed (MW-5) would be a viable method to reduce the apparent DNAPL source amount.

Limited DNAPL extraction is a viable alternative for reduction of the apparent DNAPL source contamination at the Site and will be considered further in the detailed analysis.

2.5.4.5 Vertical Barrier Wall

Vertical barrier walls are installed to provide a low permeability subsurface barrier to contain and isolate source area contamination. Barrier walls are typically installed to surround the source areas (DNAPL). Typical vertical barrier walls include:

- Slurry Walls: soil/bentonite clay mixture is placed in a narrow vertical trench to form a low permeability barrier.

- Steel Sheetpile Walls: interlocking sheets of steel, often with sealable joints, are driven into the ground using vibratory or drop hammers.

- Grout Curtains: grout (e.g., cement, bentonite, polymers, etc.) is injected under pressure to form a series of overlapping columns.

These barriers are most effective when they can be keyed into an underlying stratum of less permeable soil, thus the combination of the barrier wall and low permeability soil limit horizontal and vertical migration of contaminated groundwater. However, these conditions do not exist at the Site and these technologies will not be considered further for evaluation.

2.5.4.6 Bedrock Permeability Enhancement

The permeability of discrete zones of bedrock may be enhanced through blasting of bedrock to aid in the apparent DNAPL source collection. This technology has been used to increase pumping rate and zones of influence for groundwater containment and extraction. However, this technology would not be viable in the presence of DNAPL, since they may result in the creating of new fractures or enlarging existing fractures thus allowing further migration of DNAPL. The current "steady state" conditions that exist at the Site could be upset by further mobilization of DNAPL. Therefore, these technologies will not be further considered in the detailed analysis.

2.5.4.7 In-Situ Chemical Oxidation

In-situ chemical oxidation is a technology whereby an oxidant is applied/injected into an aquifer. Oxidants are capable of oxidizing complex organic compounds such as TCE and are amenable to remediating the primary compound detected at the Site. The process includes placing injection points in the area to be treated, and injecting an oxidant into the contaminated source.

The use of this innovative technology to treat DNAPL in fractured bedrock, as is the case at the Delphi Thermal Site, is still unproven. Case studies have shown a rebound of dissolve phase concentrations in groundwater once the injected oxidant has been depleted. Other concerns are the potential to mobilize DNAPL and the occurrence of 1,1-DCE. These concerns are described in more detail in Section 4.3.4.

The injection of a chemical oxidation agent could be effective if used to treat specific areas of the Source Area contamination (although rebound is still a concern). Limited application of in-situ oxidation appears to be a reasonable approach for use of this technology at the Site.

2.5.4.8 Surfactant/Co-solvent Flushing

In-situ surfactant/co-solvent flushing is a chemically enhanced groundwater extraction technology in which surfactants/co-solvents are flushed through aquifers contaminated with DNAPL. A series of wells are installed to deliver the co-solvent solution to the contaminated zone of the aquifer, and recovery wells are installed to pump fluids to the surface for treatment and disposal. Water-miscible alcohols such as ethyl alcohol, isopropyl alcohol, and tert butyl alcohol are commonly recommended co-solvents for groundwater remediation. Surfactants/co-solvents generally increase the quantity of contaminants transported in the groundwater by increasing the solubility and mass transfer rate of the DNAPL components. Surfactants/co-solvent flushing also increases free-phase mobilization of contaminants through reduction of the DNAPL-water interfacial tension.

Surfactant/Co-solvent flushing of the subsurface has potential to mobilize DNAPL, which would cause contamination to spread. Hydraulic containment would need to be used to contain mobilized DNAPL.

Bedrock fracture distribution may inhibit the surfactant/co-solvent from contacting the DNAPL. Complete removal of DNAPL using this technology is not expected. Some degree of rebound of contamination concentration is expected to occur after the surfactant/co-solvent treatment is stopped.

This technology will not be considered in the detailed analysis, due to the relative high cost of this technology, issues related to potential DNAPL mobilization.

2.5.4.9 Steam Stripping

Steam stripping is an in-situ thermal technology, which involves the injection of steam to heat the subsurface and enhance the recovery of organic

contaminants like TCE. A series of wells are installed to deliver steam to the contaminated zone of the aquifer. Recovery wells are installed to pump groundwater to the surface for treatment and disposal.

Steam injection increases the quantity of contaminants transported in the groundwater and through the vapor phase. TCE, that is directly contacted by steam, can be destroyed by in-situ oxidation and the increased temperature would volatilize TCE contamination. The increased temperature also increases the solubility of the TCE in groundwater, and allows additional contamination to enter the aqueous phase. Steam is generated on-Site using boilers. Extracted steam is condensed and the liquid is treated along with extracted groundwater, if extraction wells are utilized. Soil vapor (following the condensing of the steam) would be treated by the appropriate method (i.e., catalytic oxidation, carbon, etc). Soil vapor technologies were not evaluated as part of this study.

Steam injection generates heat at temperatures that will damage HDPE. Therefore, pipes associated with monitoring wells, utilities etc. could be damaged from the heat generated during steam injection. Steam injection pipes would be constructed of steel.

Injection of steam into the subsurface has the potential to mobilize DNAPL, which would cause contamination to spread. Hydraulic containment would need to be used to contain mobilized DNAPL. Additionally, bedrock fracture distribution may inhibit the steam from contacting the TCE contamination, decreasing its effectiveness, and also make hydraulic containment difficult.

This technology will not be considered in detailed analysis, due to concerns regarding its cost and issues related to potential DNAPL mobilization.

2.5.4.10 Hydrogen Release Compounds ®

Hydrogen Release Compounds (HRC) are used to enhance in-situ biodegradation rates for chlorinated hydrocarbons by creating or enhancing anaerobic conditions, which allow reductive dechlorination to occur. Reductive dechlorination is an attenuation mechanism, which causes the breakdown of chlorinated solvents in groundwater. HRC is a proprietary polylactate ester created by Regenesis that upon being deposited/injected into the subsurface will release lactate. Lactate is metabolized by naturally occurring microorganisms that result in the creation of anaerobic conditions and the production of hydrogen. The naturally occurring microorganisms use the hydrogen to remove chlorine atoms from chlorinated hydrocarbon contaminants.

This technology will not be considered in the detailed analysis because anaerobic conditions are currently ongoing at the Site. Existing conditions appear to be effectively breaking down the CVOCs at the Site.

2.5.5 Groundwater Remedial Technologies

The following subsections describe the various general response actions and remedial technologies that were considered for remediation of groundwater. Table 5 contains the preliminary screening of the remedial technologies that were considered.

2.5.5.1 No Further Action

Delphi Thermal excavated contaminated soil in the AOC following the identification of Spill No. 9410972 in late 1994. The No Further Action alternative involves doing no additional work to remedy groundwater conditions at the Site. NYSDEC and USEPA guidance requires that the No Action alternative automatically passes through the preliminary screening and be compared to other alternatives in the detailed analysis of alternatives (Section 3.0).

2.5.5.2 Institutional Controls/Actions

Institutional controls/actions (e.g., access restriction or work permits) could be used to limit the encounter of site workers with contaminated groundwater (e.g., sanitary lift station). Institutional controls/actions will be involved in the three remedial alternatives further evaluated in Section 3.0 with the exception of No Further Action.

2.5.5.3 Monitored Natural Attenuation

Monitored Natural Attenuation (MNA) is explained in Section 2.5.4.3. Similar to the source reduction discussion, natural attenuation can be considered as a remedial technology for groundwater when one or more of the following conditions are present at the site.

- Natural attenuation processes are observed or strongly expected to be occurring.
- There are no receptors that will be adversely impacted in the vicinity of the groundwater contamination.
- A continuing source that cannot be easily and cost-effectively removed and will require a long-term remedial effort.
- Alternative remedial technologies are not cost effective or are technically impractical.
- Alternative remedial technologies pose added risk by transferring or

spreading contamination.

- Minimal disruption of facility operations or infrastructure is desired.

The biodegradation of constituents in groundwater occurs when compounds are biologically or chemically converted from one compound to another. TCE is biodegraded into its daughter compounds (e.g., DCE, vinyl chloride) when geochemical and groundwater conditions are favorable (i.e., anaerobic conditions). As mentioned in Section 1.4.2.1.1, an evaluation of MNA was conducted during the FRI to evaluate whether conditions supporting the biodegradation of TCE are present in the aquifer. The results of this evaluation indicate that aquifer conditions are supportive of biodegradation.

At locations where MNA does not appear to be sufficient in reducing the concentrations of the contaminants of concern to meet the SCG at the Site property line, enhanced biodegradation may be used. An enhanced biodegradation remedial strategy would involve injecting a biostimulant to create an anaerobic treatment area to assist with the breakdown of the parent compound (TCE).

Monitored natural attenuation is a viable alternative for TCE contamination at the Site and will be considered further in the detailed analysis.

2.5.5.4 Groundwater Extraction

Groundwater extraction is a commonly used method to control the migration of contaminated groundwater and to collect contaminated groundwater for subsequent treatment. Groundwater extraction wells are generally installed with a drill rig. Well screens and filter packs are generally installed to intercept the saturated thickness of the contaminated water-bearing zone. Extraction wells can also be installed to provide a hydraulic barrier for control of migration of contaminated groundwater, or at specific locations at the Site property. Groundwater extraction is typically coupled with an ex-situ treatment system which are discussed further in the section (Section ~~2.5.4.12~~ 2.5.5.11)

Downgradient groundwater collection may be used for hydraulic control and will be considered further. It should be noted, however that additional study including the completion of pump tests would be necessary in order to better evaluate the feasibility of groundwater extraction.

Groundwater extraction is a viable alternative for TCE contamination at the Site and will be considered further in the detailed analysis.

2.5.5.5 Vertical Barrier Wall

As noted in Section 2.5.4.5, vertical barrier walls are installed to provide a low permeability subsurface barrier to contain and isolate contaminated groundwater, and are often used in conjunction with a groundwater extraction system. Barrier walls are typically installed to surround the area of contaminated groundwater. Typical vertical barrier walls were summarized earlier.

These barriers are most effective when they can be keyed into an underlying stratum of less permeable soil, thus the combination of the barrier wall and low permeability soil limit horizontal and vertical migration of contaminated groundwater. However, these conditions do not exist at the Site and these technologies will not be considered further for evaluation.

2.5.5.6 Bedrock Permeability Enhancement

The permeability of discrete zones of bedrock may be enhanced through blasting of bedrock to aid in the collection of groundwater. This technology has been used to increase pumping rate and zones of influence for groundwater containment and extraction. However, this technology would not be viable in the presence of DNAPL, since they may result in the creating of new fractures or enlarging existing fractures thus allowing further migration of DNAPL. The current "steady state" conditions that exist at the Site could be upset by further mobilization of DNAPL. Therefore, these technologies will not be further considered in the detailed analysis.

2.5.5.7 In-Situ Chemical Oxidation

In-situ chemical oxidation is a technology whereby an oxidant is applied/injected into an aquifer. Oxidants are capable of oxidizing complex organic compounds such as TCE and are amenable to remediating the primary compound detected at the Site. The process includes placing injection points throughout the area to be treated, and injecting an oxidant into the aquifer. In-situ chemical oxidation is often coupled with groundwater extraction and ex-situ treatment, to capture oxidant material and potentially mobilized DNAPL.

Utilization of this would involve the treatment of soluble phase CVOCs in the groundwater at the Site. Case studies have shown a rebound of dissolve phase concentrations in groundwater once the injected oxidant has been depleted. Other concerns are:

- The potential to mobilize DNAPL from bedrock fractures by the injected fluid and;

- The potential to create1,1-DCE. GZA's experience is that when chemical oxidation is used where TCE is present as a DNAPL, significant concentrations of 1,1-DCE can be created. This is apparently due to the significant loading of dissolved TCE in the vicinity of the DNAPL which rapidly consumes the oxidant leading to incomplete reactions. Once the 1,1-DCE is created, it can, due to its higher mobility, migrate relatively rapidly from the oxidation zone.

The injection of a chemical oxidation agent could be effective if used to treat specific areas of dissolved phase contamination (although rebound is still a concern). Limited application of in-situ oxidation appears to be a reasonable approach for use of this technology at the Site.

2.5.5.8 Surfactant/Co-solvent Flushing

Refer to section 2.5.4.8 for discussion of in-situ surfactant/co-solvent flushing.

This technology will not be considered in the detailed analysis, due to the relative high cost of this technology, issues related to potential DNAPL mobilization and issues related to capture of the highly contaminated groundwater during flushing.

2.5.5.9 Steam Stripping

Refer to Section 2.5.4.9 for discussion of Steam stripping as an in-situ thermal technology.

This technology will not be considered in the detailed analysis, due to concerns regarding its high cost, issues related to potential DNAPL mobilization, and issues related to capture of highly contaminated groundwater during injection.

2.5.5.10 Hydrogen Release Compounds ®

Refer to Section 2.5.4.10 for discussion of Hydrogen Release Compounds.
This technology will not be considered in the detailed analysis because anaerobic conditions are currently ongoing at the Site. Existing conditions appear to be effectively breaking down the CVOCs at the Site.

2.5.5.11 Ex-Situ Groundwater Treatment

This general response action involves treating removed groundwater from the subsurface using other technologies and conducting above-ground treatment prior to disposal. This could involve: (1) treating the groundwater to the cleanup goals and discharging the treated water back into the Site groundwater;

(2) treating the groundwater and discharging the treated water to a nearby water body or stormwater sewer in substantive conformance with the State Pollutant Discharge Elimination System (SPDES) permit requirements; or (3) pretreating the water sufficient to meet the pretreatment standards for the Publicly Owned Treatment Works (POTW) prior to discharge to the existing sanitary sewer system.

The following subsections describe the preliminary screening of technologies that were considered for ex-situ pretreatment and treatment of groundwater.

Air Stripping

Air stripping involves passing air through the contaminated groundwater to induce volatilization and removal of VOCs. Air that contains organic vapors stripped from the groundwater can be treated by either filtration with granular activated carbon, or catalytic oxidation, prior to discharge to the atmosphere. Air stripping is most appropriate for situations where the contaminants to be treated are volatile and where there are not significant concentrations of dissolved ions that may precipitate (e.g., iron).

Air stripping would appear to be an effective and implementable technology for ex-situ pretreatment of contaminated groundwater prior to discharge to the on-site drainage swale. However, air stripping will not be evaluated further in the detailed analysis of this alternative because it is not as cost effective as the use of activated carbon for groundwater treatment, which is discussed below.

Liquid Phase Carbon Adsorption

Liquid phase carbon adsorption is used to remove organic compounds from groundwater by adsorbing the organic compounds onto the surface of granular activated carbon. Water is treated as it flows through the granular activated carbon. Granular activated carbon can be packed into a treatment column or placed in properly sized drums or pressure vessels connected in series. On a regular basis, the granular activated carbon must be changed since its adsorption capacity is depleted with use.

The use of liquid phase carbon adsorption for pretreatment of the groundwater would be cost effective as compared to other available pretreatment technologies for the TCE concentrations detected in the groundwater.

2.6 RESULTS OF PRELIMINARY SCREENING

Several remedial technologies have been evaluated during the preliminary screening process. Feasible remedial technologies for the Site that will be considered as Remedial Alternatives for

further development (Section 3.0) and detailed analysis (Section 4.0) are summarized in Table 6. The table identifies the remedial alternative and the proposed remedial action.

3.0 DEVELOPMENT OF REMEDIAL ALTERNATIVES

3.1 INTRODUCTION

Four on-Site remedial action alternatives have been assembled using the general response actions and remedial technologies that passed the preliminary screening. Table 6 provides a summary of the alternatives. An expanded description of each of the alternatives is provided below.

3.2 ALTERNATIVE NO. 1 – NO FURTHER ACTION

The No Further Action alternative involves taking no further action to remedy Site conditions. As stated earlier, Delphi Thermal completed a soil removal remedial effort in 1994 by excavating contaminated soil encountered in the AOC. The excavated soil was replaced with clean crushed stone. NYSDEC and USEPA guidance requires that the No Action alternative be considered in the detailed analysis of alternatives. However, the No Action alternative is considered a No Further Action alternative. It is considered an unacceptable alternative, as the Site would remain in its present condition without environmental monitoring. Therefore, human health and the environment may not be adequately protected.

3.3 ALTERNATIVE NO. 2 – MONITORED NATURAL ATTENUATION WITH ANNUAL GROUNDWATER MONITORING

Monitored Natural Attenuation (MNA) refers to the reliance on the natural attenuation processes (within the context of a controlled and monitored site cleanup approach) to achieve proposed cleanup goals within a timeframe that is reasonable, compared to that of other more active methods such as groundwater extraction and treatment or sparging. Natural attenuation processes include a variety of physical, chemical and biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume or concentration of contamination in groundwater. These processes include biodegradation, dispersion, dilution, sorption, volatilization, and/or chemical or biological stabilization, transformation, or destruction of constituents in groundwater.

As discussed in Section 2.5.4.3 and 2.5.5.3, natural attenuation can be considered as a remedial technology for the source area and for groundwater when certain conditions are present at a site. These conditions have been demonstrated to be at the Delphi Thermal Site. In addition, as discussed earlier and as demonstrated in the FRI report, when evaluated using a "line of evidence" approach MNA is considered a suitable alternative for the Site.

Figure 5 presents a conceptual sketch of the remedial action for Remedial Alternative No. 2. The primary component to MNA is groundwater sampling and testing. It is assumed that 8 monitoring

wells will be sampled annually as described below.

The groundwater sampling events would include analytical laboratory test parameters (primarily CVOCs) and measuring natural attenuation parameters using a down hole water quality meter. Natural attenuation parameters to be measured include dissolved oxygen, pH, conductivity, and oxidation-reduction potential. An evaluation will be done to determine if processes supportive of natural attenuation, are still occurring, using natural attenuation lines of evidence (as described in Section 2.5.4.3). Subsequent data evaluations and reports would be completed on an annual basis as the natural attenuation processes are monitored. If analytical results indicated that groundwater concentrations were increasing or conditions for biodegradation were becoming unfavorable, a contingency plan for application of HRC (discussed in Section 2.5.4.10) would be developed.

HRC was not carried through.

In addition to the groundwater monitoring, institutional controls would also be put into place as part of this alternative. For the purposes of cost estimating for this FFS, it is assumed that this remedial action would be conducted for a 30-year duration (the maximum time period specified for evaluation) as specified in USEPA guidance. However, the Source Area will likely persist for greater than 30 years and contribute to the groundwater plume at the Site until depleted. The shallow bedrock groundwater plume, as discussed in the FRI, appears to be in a 'steady state' condition at the monitoring locations.

In response to issues raised by NYSDEC regarding a time over distance relationship of the plume attenuation and the plumes potential continued migration, Delphi/GZA reevaluated the Site's condition using the computer codes (models): BIOCHLOR – Natural Attenuation Decision Support System (BIOCHLOR, Version 1.1); and BIOSCREEN - Natural Attenuation Decision Support System (BIOSCREEN, Version 1.4). Groundwater data collected in April 2003 from the source area (See Appendix D) was used in our evaluation. The output plots of the BIOCHLOR model, which assumes a continuous source area, showed the plume length up to about 1,500 feet after 10 year and up to about 2,000 feet after 100 years. However, the BIOSCREEN model which accounts for degradation of source area using first order kinetics showed the plume length up to about 1,500 feet over a 50 year time frame before the groundwater conditions attenuated and the plume did not continue moving. The current Site conditions show a steady state plume length of about 1,200-feet.

Limited value of these models. Modeled out put does not closely match real data

3.4 ALTERNATIVE NO.3 –SOURCE AREA DNAPL AND/OR GROUNDWATER EXTRACTION AND EX-SITU TREATMENT WITH GROUNDWATER MONITORING

This alternative has been divided into two alternatives to address concerns regarding the presence of DNAPL and the dissolve phase groundwater plume at the Site. Alternative 3A will address the source area DNAPL and Alternative 3B will address the groundwater plume.

3.4.1 Alternative No. 3A – Source Area DNAPL Extraction with Groundwater Monitoring

Figure 6 presents the location of the remedial actions for Alternative No. 3A. Source area DNAPL extraction would be done at existing monitoring well, MW-5, to assist in the DNAPL mass reduction.

The following is a description of the remedial actions for source area DNAPL extraction included in Alternative No. 3A.

Source Area DNAPL Remedial Actions

- Existing monitoring well MW-5, where DNAPL has been encountered would be used to extract DNAPL/groundwater using a low-flow peristaltic pump. Flow rates would be on the order of 0.2 gallons per minute (gpm) to minimize draw down in the well and remove DNAPL that has accumulated in the well.

- Recovered DNAPL/groundwater will be pumped into a 55-gallon drum to be disposed of off-Site.

- A DNAPL extraction event would consist of removing approximately 50 gallons of DNAPL/groundwater per event. Extraction events would be conducted monthly for the first 3 months, quarterly for the next two years, and semi-annually for the remaining 30 years or until DNAPL is no longer present.

- This alternative assumes that annual groundwater monitoring would be conducted in select monitoring wells for 30 years.

- Groundwater monitoring parameters as described in Alternative No. 2 would be collected. The monitoring program would consist of annual monitoring for years 1 through 30.

3.4.2 Alternative 3B – Groundwater Extraction and Ex-situ Treatment with Groundwater Monitoring

Figure 7 present conceptual sketches of the remedial actions for Alternative No. 3B Groundwater extraction with ex-situ treatment of dissolve phase groundwater. Extraction wells for dissolve phase groundwater remediation would be located downgradient of monitoring well MW-5 and operated for the purpose of containment of impacted Site groundwater in addition to limiting further migration of the contaminated groundwater associated with the DNAPL source area.

The following is a description of the remedial actions for groundwater included in Alternative No. 3B.

Groundwater Remedial Actions:

- A geophysical study would be considered at the site for the purpose of better defining the bedrock subsurface fracture system. Locating the fracture system in the bedrock would provide information to efficiently design the groundwater extraction system. The geophysical methods considered would be resistivity and/or ground penetrating radar. However, due to the presence of the utilities, pavement, building structures, etc. and depth to bedrock, these methods may not be suitable.

- A groundwater extraction system pilot study would be performed at the Site. The pilot study would consist of 24- or 48-hour pump tests. Results of the pump tests would be used to assess optimum pump rates and well layouts for the extraction wells.

- A treatability study would be performed on representative groundwater samples collected during the pump tests. The treatment technologies should be assessed for applicability (e.g., activated carbon design).

- Six groundwater extraction wells (including the well installed for the pilot study) would be installed to provide containment of contaminated groundwater based on the current understanding of the Site (see Figure 6). The wells would be located downgradient of the suspected DNAPL area to prevent further downgradient migration of dissolve phase contamination. The extraction system would be operated for long-term groundwater control (i.e., 30 years) by extracting groundwater at a rate of approximately 10 to 15 gallons per minute (gpm), with a maximum extraction flow rate not to exceed 3 gallons per minute per well.

- Extraction wells would be constructed of 6-inch stainless steel casing. The wells would be screened from above the top of the groundwater table (approximately 8 feet bgs) to approximately 25 feet bgs, to intercept the more pervious portion of the shallow fractured bedrock. Groundwater would be pumped from the extraction wells via 4-inch submersible pumps through underground piping to a treatment system located on Site.

- A groundwater treatment system would be installed inside a treatment building. The building would be located in the eastern portion of the parking area as shown on Figure 6. The treatment building would be approximately 400 square feet in order to house the treatment system and equipment.

- The groundwater treatment system is expected to consist of three granular activated carbon system vessels. At any given time, two of the vessels would be connected in series and the third would either be off site for changeout of spent carbon, or inside the building to be used when one of the two operating units required changeout or maintenance. In addition, an instrumentation and controls system for the extraction wells and treatment system would be housed within the building. Treated water would be discharged to the on-Site drainage swale identified on Figure 6.

- Operation and maintenance activities are necessary for the extraction and treatment systems (e.g., activated carbon change out, pump maintenance and repair, etc.). This work is necessary to maintain treatment performance and life span. This work should be performed monthly or as required by the manufacturer.

- This alternative assumes that annual groundwater monitoring would be conducted in select monitoring wells for 30 years.

- Groundwater monitoring parameters as described in Alternative No. 2 would be collected. The monitoring program would consist of quarterly monitoring for years 1 and 2; and annually for years 3 through 30.

3.5 ALTERNATIVE NO.4 – CHEMICAL OXIDATION WITH GROUNDWATER MONITORING

This alternative has also been divided into two alternatives to address concerns regarding the presence of DNAPL and the dissolve phase groundwater plume at the Site. Alternative 4A will address the source area DNAPL and Alternative 4B will address the groundwater plume.

3.5.1 Alternative 4A – Source Area DNAPL Chemical Oxidation with Groundwater Monitoring

Conceptual sketches of the remedial actions for Alternative No. 4A are included as Figure 8 for the source area DNAPL treatment. In-situ chemical oxidation would be used to address the apparent source area DNAPL present. Injection of a chemical oxidant is an innovative technology, which provides an aggressive approach to the treatment of DNAPL. Groundwater monitoring would also be implemented to monitor the progress and effects of treatment.

For the purposes of this FFS, it is assumed that in-situ chemical oxidation via the use of sodium permanganate is effective at reducing the mass of the source area DNAPL. Some residual contamination remaining following treatment would be expected to naturally attenuate. It is expected and anticipated that a portion of the DNAPL mass present will remain fixed within the rock mass and not available for reduction through attenuation or in-situ treatment.

The following is a description of the remedial actions for the apparent source area DNAPL included in Alternative No. 4A.

In-Situ Chemical Oxidation

- As discussed with NYSDEC, for the purposes of this FFS, one in-situ chemical oxidation technology is selected for detailed analysis. The use of sodium permanganate (by Carus Chemical) is considered and evaluated herein for in-situ treatment.

- Sodium permanganate was selected because it is available/sold as a 40% liquid solution rather than a granular solid like potassium permanganate. It is difficult to mix a potassium permanganate to a solution greater than a 3% solution. Thus by having a lower solubility, a greater amount of injection fluid (water) would be necessary to deliver a similar dose of permanganate and could increase the chance of DNAPL mobility due to the volume of injection fluids needed.

- GZA looked into the use of other in-situ chemical oxidants (e.g., Fenton's Reagent) but their implementation was not feasible due to Site conditions (limestone bedrock).

- A phased approach towards in-situ chemical oxidation would be implemented, starting with a pilot treatment, in order to assess the feasibility of the process. A pilot study (which would be focused on the apparent source area DNAPL) is a less costly approach to implement than a full-scale injection process to evaluate its effectiveness.

General Treatment Approach:

- Sodium permanganate would be injected into monitoring wells MW-3S, MW-4, MW-5, and MW-7 to reduce the mass of DNAPL.

- This technology would be applied using the phased approach (including laboratory treatability study (demand) testing, initial injection pilot treatment additional injection events) as described below.

Laboratory Demand Testing:

- Carus Chemical would first conduct a demand test in the laboratory prior to the start of any injections. A groundwater and soil sample would be collected from the plume area and sent for laboratory analysis. Testing would include VOCs, total organic carbon (TOC), nitrate, sulfate and pH.

Pilot Treatment:

- Based on the findings of the Demand Testing, a pilot treatment would be performed to assess the feasibility of the process and to design the injection volumes of the sodium permanganate. The initial treatment would provide information regarding the effectiveness and efficiency of the process. An injection would be made at MW-5.

- Five groundwater samples would be collected for laboratory analysis following the completion of the pilot treatment injection event at well locations MW-4, MW-5, and MW-8 through MW-10. A total of three sets of samples would be collected and tested for the pilot treatment; samples would be collected 1-month, 3-months, and 6-months following the injection. This analysis would evaluate the efficiency of the process and to determine what modifications to the oxidant mix/dose or injection

locations may be required. Pending favorable results of the pilot study, a source area application or full-scale application would be implemented as discussed below.

Source Area Application

- Source area DNAPL in-situ chemical oxidation would be done using existing monitoring wells MW-3S, MW-4, MW-5 and MW-7. Sodium permanganate would be injected into each monitoring well in an attempt to reduce the DNAPL present.

- Post-injection groundwater samples would be tested similar to those of the pilot study to monitor the remedial progress. It is assumed, based on the nature and extent of groundwater contamination, that the concentration present after in-situ chemical oxidation would be allowed to naturally attenuate and would be monitored and evaluated following applicable MNA procedures as described in Section 3.3. Natural attenuation of the remaining groundwater is expected to occur. However, the length of time that the monitoring will be need is difficult to predict. Model results indicate a 50-year time frame could be expected.

Groundwater Monitoring:

- This alternative assumes that groundwater monitoring would be conducted in select monitoring wells for 30 years. Use of the 30 year time frame may be appropriate depending on the amount of DNAPL mass removed. However, this technology will likely not be successful in removing all DNAPL. Residual DNAPL may continue to impact plume length for up to about 50-years based on modeling. A 30-year time period is used for comparative purposes.

- Groundwater monitoring parameters as described in Alternative No. 2 would be collected. The monitoring program would consist of quarterly monitoring for the first and second year; and annually for years three through 30.

- If the analytical sample results indicted that groundwater concentrations were increasing from the presence of DNAPL or DNAPL was detected in any of the monitoring wells downgradient of MW-5 (i.e., MW-9, or MW-10) an extraction well contingency plan may be considered. The extraction wells would attempt to remove the DNAPL or at least provide hydraulic containment from further migration at the Site.

- An extraction well contingency plan consisting of six-groundwater extraction wells has been proposed with this alternative, because the mobilization of DNAPL may occur and begin to migrated downgradient at the Site. This mobilization could be caused by a disturbance to the aquifer by the oxidant injections. The oxidant injections would require a significant amount of water to be injected under pressure to deliver the oxidant, which may open bedrock fractures and/or impact surface tensions, causing the DNAPL to mobilize. Cost for the extraction wells are not included in the total cost for

Alternative 4A, but could be assumed to be similar to the extraction well costs in Alternative 3B.

3.5.2 Alternative No. 4B – Groundwater In-situ Chemical Oxidation with Groundwater Monitoring.

Figures 9 and 10 are conceptual sketches of the remedial actions for Alternative No. 4B for the treatment of the groundwater plume. In-situ chemical oxidation would be used to address the contaminated groundwater with CVOCs concentrations greater than 100 ppm. Injection of a chemical oxidant is an innovative technology, which provides an aggressive approach to the treatment of the dissolved phase CVOCs contaminated saturated area. Groundwater monitoring would also be implemented to monitor the progress and effects of treatment.

As mentioned in section 3.5.1, it is assumed that in-situ chemical oxidation would be done via sodium permanganate and is effective at treating the CVOCs contaminated groundwater to a concentration of 1 ppm. Residual contamination remaining following treatment would be expected to naturally attenuate to 5 ppb (CVOCs) at the Site property line. The untreated portion of the groundwater plume (with CVOCs concentrations less than 100 ppm) would also be allowed to attenuate naturally by current mechanisms.

The following is a description of the remedial actions for the apparent DNAPL source area and dissolve phase groundwater included in Alternative No. 4B.

- Similar to Alternative 4A, a phased approach towards in-situ chemical oxidation would be implemented, starting with a pilot study which is a less costly approach to implement than a full-scale injection process to evaluate its effectiveness.

General Treatment Approach:

- Sodium permanganate would be injected to reduce the volume of contaminated groundwater associated with the TCE plume with concentrations greater than 100 ppm.

- The oxidant would be applied into the groundwater table at approximately 20-foot depth intervals through injection wells. The injection wells would be spaced approximately 20 feet apart. This technology would be applied using the phased approach (including a laboratory treatability study, pilot treatment study, additional injection events) as described below.

Laboratory Demand Testing:

- As discussed in Section 3.5.1, a demand test would need to be conducted in the laboratory prior to the start of any injections. Testing would include VOCs, total organic carbon (TOC), nitrate, sulfate and pH.

Pilot Study:

- Based on the findings of the Demand Testing, a pilot study would be performed to assess the feasibility of the process and to design the injection volumes of the sodium permanganate. The study would provide information regarding the effectiveness and efficiency of the process. Approximately nine injection locations would be made within the vicinity of MW-5.

- Five groundwater samples would be collected for laboratory analysis following the completion of the pilot study injection event at well locations MW-4, MW-5, and MW-8 through MW-10. A total of three sets of samples would be collected and tested for the pilot study; samples would be collected at 1-month, 3-months, and 6-months after the injection. This analysis would evaluate the efficiency of the process and to determine what modifications to the oxidant mix/dose or injection locations may be required. Pending favorable results of the pilot study, a source area application or full-scale application would be implemented as discussed below.

Full-Scale Groundwater Application:

- A full-scale/phased application of the technology would be implemented and include two additional injection events to address dissolve phase contaminated groundwater would be conducted. Approximately 180 injection points would be utilized to deliver the oxidant as part of the full-scale application.

- Due to the large number of injection wells to complete, it is assumed that two air rotary drill rigs and two installation crews would be utilized for the full-scale applications to reduce the duration of the well installation event. As such, it is assumed the injection well installation event would take more than three weeks to complete.

- After installation of the injection wells is complete, the oxidant injection events would begin. It is also assumed that two injection crews would be utilized due to the large number of injection points. As such, it is assumed the injection events would also take more than three weeks to complete.

- Post-injection groundwater samples would be tested similar to those of the pilot study to monitor the remedial progress.

- It is expected that the second injection event would be conducted within six months of the first full-scale injection. The second injection event would be completed similar to the first, unless post-injection analytical sampling showed a sufficient decrease in concentrations to warrant a decrease in the amount of oxidant needed to be injected or a need to concentrate the injection to specific area due to the varying results.

- It is assumed, based on the nature and extent of groundwater contamination, that the concentration present after in-situ chemical oxidation (less than 1 ppm total CVOCs) would be allowed to naturally attenuate and would be monitored and evaluated following applicable MNA procedures as described in Section 3.3. Natural attenuation of the remaining groundwater (concentrations 1 ppm or less) is expected to occur. However the time frame is difficult to predict.

Groundwater Monitoring:

- This alternative assumes that groundwater monitoring would be conducted in select monitoring wells for 30 years. This technology may not be successful in removing all DNAPL available to become dissolved in groundwater. Residual DNAPL may continue to impact groundwater. Computer modeling indicates the groundwater plume length may be impacted for up to about 50-years. A 30-year time period is assessed for comparative purposes.

- Groundwater monitoring parameters as described in Alternative No. 2 would be collected. The monitoring program would consist of quarterly monitoring for the first and second year; and annually for years three through 30.

- If the analytical sample results indicted that groundwater concentrations were increasing from the presence of DNAPL or DNAPL was detected in any of the monitoring wells downgradient of MW-5 (i.e., MW-9, or MW-10) an extraction well contingency plan may be considered. The extraction wells would attempt to remove the DNAPL or at least provide hydraulic containment from further migration at the Site.

- An extraction well contingency plan consisting of six-groundwater extraction wells has been proposed with this alternative, because the mobilization of DNAPL may occur and begin to migrated downgradient at the Site. This mobilization could be caused by a disturbance to the aquifer by the oxidant injections. The oxidant injections would require a significant amount of water to be injected under pressure to deliver the oxidant, which may open bedrock fractures and/or impact surface tensions, causing the DNAPL to mobilize. Cost for the extraction wells are not included in the total cost for Alternative 4B, but could be assumed to be similar to the extraction well costs in Alternative 3B.

4.0 DETAILED ANALYSIS OF REMEDIAL ALTERNATIVE

4.1 INTRODUCTION

The purpose of the detailed analysis of remedial action alternatives is to present the relevant information to select an on-Site remedy. During the detailed analysis, the alternatives established in

Section 3.0 are compared on the basis of environmental benefits and costs using criteria established by NYSDEC in TAGM HWR-4030. This approach is intended to provide needed information to compare the merits of each alternative and select an appropriate remedy that satisfies the remedial action objectives.

This section first presents a summary of the seven evaluation criteria (six environmental criteria and cost) in TAGM HWR-4030 to be used to compare the alternatives. Two additional criteria, State and Community Acceptance, will be evaluated as part of the FFS regulatory review process.

4.2 DESCRIPTION OF EVALUATION CRITERIA

Each remedial alternative is evaluated with respect to the seven criteria outlined in TAGM HWR-4030, as summarized below.

1. Short-Term Impacts and Effectiveness: This criterion addresses the impacts of the alternative during the construction and implementation phase until the remedial action objectives are met. Factors to be evaluated include protection of the community during the remedial actions; protection of workers during the remedial actions; and the time required to achieve the remedial action objectives. For remedial alternatives that are not effective in meeting remedial action objectives in less than 30 years, references to short-term impacts and effectiveness may include discussions of impacts/effectiveness over a period of 30 years.

2. Long-Term Effectiveness and Permanence: This criterion addresses the long-term protection of human health and the environment after completion of the remedial action. An assessment is made of the effectiveness of the remedial action in managing the risk posed by untreated wastes and/or the residual contamination remaining after treatment, and the long-term reliability of the remedial action.

3. Reduction of Toxicity, Mobility, and Volume: This criterion addresses NYSDEC's preference for selecting "remedial technologies that permanently and significantly reduce the toxicity, mobility and volume" of the contaminants of concern at the site. This evaluation consists of assessing the extent that the treatment technology destroys toxic contaminants, reduces mobility of the contaminants using irreversible treatment processes, and/or reduces the total volume of contaminated media.

4. Implementability: This criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of services and materials. Technical feasibility refers to the ability to construct and operate a remedial action for the specific conditions at the site and the availability of necessary equipment and technical specialists. Technical feasibility also includes the future operation and maintenance, replacement and monitoring that may be required for a remedial action. Administrative feasibility refers to compliance with applicable rules, regulations, statutes and the ability to obtain permits or approvals from other government agencies or offices; and the availability of adequate capacity at permitted treatment, storage and disposal facilities and related services.

5. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals: This criterion is used to evaluate the extent to which each alternative may achieve the proposed cleanup goals. The cleanup goals were developed based on the SCGs noted in Section 3.0.

6. Overall Protection of Human Health and the Environment: This criterion provides an overall assessment of protection with respect to long-term and short-term effectiveness and compliance with cleanup goals.

7. Cost: The estimated capital costs, long-term operation and maintenance costs, and environmental monitoring costs are evaluated. The estimates included herein assume remedial engineering costs would equal 15% of the capital costs; and Contingency/Administrative costs would equal 10% of the capital costs. A present worth analysis is made to compare the remedial alternatives on the basis of a single dollar amount for the base year. For the present worth analysis, assumptions are made regarding the interest rate applicable to borrowed funds and the average inflation rate. It is also assumed that a 30-year operational period would be necessary for groundwater control systems and site monitoring. The comparative cost estimates are intended to reflect actual costs with an accuracy of +50 percent to -30 percent.

The following two additional criteria will be evaluated as part of the regulatory/public review process.

1. State Acceptance: This criterion evaluates the technical and administrative issues and concerns of the State regarding the alternatives, and is addressed in the PRAP based on comments regarding the RI/FS and proposed remedial action plan.

2. Community Acceptance: This criterion evaluates the comments of the public regarding the alternatives, and is also addressed in the PRAP similar to the State Acceptance criteria above.

4.3 DETAILED ANALYSIS OF OFF-SITE REMEDIAL ALTERNATIVES

Alternatives No. 1 through 4 are evaluated individually in terms of the seven environmental/cost criteria described above. Descriptions of the alternatives are provided in Section 3.0.

4.3.1 Alternative No. 1 – No Further Action

1. Short-Term Impacts and Effectiveness:

   No short-term impacts (other than those existing) are anticipated during the implementation of this alternative since there are no construction activities involved.

   This alternative does not include treatment but previous investigations at the Site have shown that natural attenuation is occurring and remedial action goals (e.g., NYSDEC Class GA groundwater standards) are been met at the Site property line. The duration of natural cleanup would depend on the natural attenuation rate of VOCs in the groundwater. There are uncertainties in the rate and interaction of the various natural

attenuation processes. Therefore, the length of time required for natural cleanup or attenuation of groundwater contamination is unknown, but expected to be on the order of greater than 30 years to reach the remedial action objectives on-Site. Consequently, in accordance with USEPA guidance, a 30-year duration (the maximum time period specified for evaluation) is assumed for this alternative.

2. Long-Term Effectiveness and Permanence:

   Because this alternative does not involve removal or treatment of the contaminated groundwater, the risks involved with the migration of contaminants and direct contact with contaminants would remain essentially the same. Given the presence of a DNAPL source at the Site, reduction in contaminants associated with the natural attenuation process is not expected in a timeframe of less than 30 years.

3. Reduction of Toxicity, Mobility, and Volume:

   This alternative does not involve the removal or treatment of Site contamination. Therefore, the toxicity, mobility, and volume of contamination are expected to be reduced through the natural attenuation of contaminants. This reduction in on-Site concentrations in groundwater is expected to occur slowly over time.

4. Implementability:

   This alternative is readily implementable on a technical basis, in that it involves no further actions.

5. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals:

   This alternative is in compliance with the chemical-specific SCGs for the Site groundwater (NYSDEC Class GA groundwater standards) at the Site property line. The contaminant levels in the groundwater are expected to meet chemical-specific SCGs at the Site property line, as natural attenuation is expected to reduce the levels of contamination from the source area. However, chemical-specific SCGs for the Site groundwater will not be met in some areas of the groundwater plume in the foreseeable future due to the continuing presence of DNAPL.

   No location-specific or action-specific SCGs were identified for this alternative.

6. Overall Protection of Human Health and the Environment:

   This alternative is likely protective of human health and the environment. Groundwater contaminants are naturally attenuating to chemical SCGs at the Site property line. However, the presence of DNAPL at the Site will be a continuing source of groundwater contamination. This alternative will mitigate the environmental impact to

groundwater but continued environmental monitoring is not provided to assess attenuation.

7. Cost:

Estimated costs for comparative purposes are presented in Table C-1 (Appendix C). No capital costs are anticipated for this alternative. The total present worth of operation and maintenance (O&M) costs are estimated to be approximately $0.

4.3.2 Alternative No. 2 – Monitored Natural Attenuation

1. Short-term Impacts and Effectiveness:

No short-term impacts (other than those existing) are anticipated during the implementation of the monitored natural attenuation (MNA) alternative, since there are no construction activities involved, only sampling. MNA procedures as described in Section 2.5.4.3 and 2.5.5.3 would be performed to monitor system effectiveness.

Field personnel would wear appropriate personal protective equipment during groundwater sampling in order to limit health risks due to exposure to contaminants and physical hazards. In addition, equipment used for sampling purposes would be decontaminated prior to leaving the locations of the wells, as necessary, in order to avoid the transport of contaminants.

Regarding effectiveness, the environment (in terms of affecting habitat or vegetation) would be protected under this alternative although VOCs contamination will still impact Site groundwater. The duration of natural cleanup would depend on the natural attenuation rate of the VOCs in the groundwater. There are uncertainties in the rate and interaction of the various natural attenuation processes. Therefore, the length of time required for natural cleanup or attenuation of groundwater contamination is unknown, but expected to be on the order of greater than 30 years, due to the presence of DNAPL at the Site. However, the remedial action objectives for the Site, NYSDEC groundwater standard, are being met at the Site property line.

2. Long-Term Effectiveness and Permanence:

Annual collection of groundwater samples would be performed to assess the natural attenuation of groundwater contamination as part of MNA. The MNA process does not involve the use or installation of long-term mechanical or electrical components that have a potential to malfunction or breakdown. Due to the presence of DNAPL at the Site, groundwater concentrations would likely remain constant until the DNAPL source has depleted. Therefore, natural attenuation is expected to reduce the concentration over time and is anticipated to reduce but not eliminate the environmental impact to groundwater.

3. Reduction of Toxicity, Mobility, and Volume:

The toxicity, mobility and volume of contamination are expected to be reduced over time. However, the presence of DNAPL on-Site which will continue to act as a source until it is depleted. Natural attenuation of contaminants is expected to slowly reduce the concentrations in groundwater.

4. Implementability:

This alternative is readily implementable on a technical basis, in that it involves groundwater sampling and natural attenuation monitoring. In terms of administrative concerns, this alternative is also considered to be implementable.

Institutional controls, such as monitoring lift stations for VOCs prior to entry or the issuance of subsurface excavation permits, should be required or continued to be used, to limit contact with potentially contaminated groundwater.

5. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals:

Chemical-specific SCGs (NYSDEC Class GA groundwater standards) for groundwater are expected to be met at the Site property line. The groundwater contamination at the Site appears to be naturally attenuating to the SCGs at the Site property line. However, chemical-specific SCGs for the Site groundwater will not be met in some areas of the groundwater plume in the foreseeable future due to the continuing presence of DNAPL.

No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) would be met during sampling or on-Site activities.

6. Overall Protection of Human Health and the Environment:

This alternative is considered protective to human health and the environment (in terms of affecting habitat or vegetation); but is not considered fully protective of the environment in terms of protecting the groundwater, since a portion of Site groundwater would remain contaminated with VOCs, due to the presence of DNAPL.

Natural attenuation is occurring at the Site. Given the presence of DNAPL, reduction in risk associated with natural attenuation is occurring by groundwater standards being met at the Site property line. Therefore, this alternative will mitigate the environmental impacts due to groundwater.

7. Cost:

Estimated costs for comparative purposes are presented in Table C-2 (Appendix C). The capital cost for this alternative is estimated to total approximately $ 0

The total present worth of operation and maintenance (O&M) costs is estimated to be approximately $ 255,000, which is the total estimated present worth cost of this alternative assuming 30-years. However, the time frame associated with this remedial alternative may take longer than 30-years for remediation. The total worth of O&M costs assuming 75-years of remediation is approximately $324,000.

4.3.3 Alternative No. 3A – Source Area DNAPL Extraction with Groundwater Monitoring

1. Short-Term Impacts and Effectiveness:

There are several potential short-term impacts associated with this alternative.

- Contamination of equipment used for well installation purposes could carry contamination beyond the Site work zones. Therefore, equipment would be decontaminated prior to leaving the work zones, as necessary, in order to avoid the transport of contaminants.

- Field personnel would wear appropriate personal protective equipment during groundwater sampling in order to limit health risks due to exposure to contaminants and physical hazards. In addition, equipment used for sampling purposes would be decontaminated prior to leaving the locations of the wells, as necessary, in order to avoid the transport of contaminants.

The extraction of DNAPL from monitoring well MW-5 would serve to reduce the impact that the source area DNAPL is currently having on groundwater.

Regarding effectiveness, the environment (in terms of affecting habitat or vegetation) would be protected under this alternative although CVOC contamination will still impact Site groundwater. Remedial action objectives for the Site, NYSDEC groundwater standard, are currently being met at the Site property line.

2. Long-Term Effectiveness and Permanence:

If source area DNAPL can be extracted, its continued impact on groundwater over the long term may be lessened. The entire source area DNAPL mass cannot be recovered.

Annual collection of groundwater samples would be performed to assess the natural attenuation of the CVOC contamination. Current Site conditions seem to indicate that groundwater contamination is naturally attenuating. Therefore, this alternative would likely reduce but not eliminate the environmental impacts due to groundwater.

The length of time required for natural cleanup or attenuation of groundwater contamination would be expected to be on the order of 30-years or greater, due to the continued presence of DNAPL at the Site. The extraction of DNAPL, if achieved, may shorten the overall remediation time frame. However, modeling has shown that a 50% reduction of DNAPL source area mass would have little effect to shorten the overall remediation time frame.

3. Reduction of Toxicity, Mobility, and Volume:

The toxicity, mobility and volume of the apparent source area DNAPL are expected to be reduced through the extraction of DNAPL from MW-5. However, this alternative will not provide for complete removal of Site DNAPL, which will continue to act as a source until it is depleted. Natural attenuation of contaminants is expected to slowly reduce the concentrations in groundwater over time.

4. Implementability:

This alternative is readily implementable on a technical basis. The apparent source area DNAPL extraction can be attempted using existing well, MW-5. Confirmatory groundwater sampling would be performed to monitor the effectiveness of the remedial system.

In terms of administrative concerns, this alternative is also considered to be implementable through the required coordination for drum disposal. Disruption of current Site operations (i.e., parking lots and Site roads) is expected to be minimal and not a concern.

Institutional controls, such as monitoring lift stations for VOCs prior to entry or subsurface permits, should be required or continued to be used to limit contact with potentially contaminated groundwater.

5. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals:

Chemical-specific SCGs (NYSDEC Class GA groundwater standards) for groundwater are expected to be met at the Site property line. Source area DNAPL extraction from MW-5 would assist to decrease the DNAPL mass at the Site. The groundwater downgradient of the MW-5 would be allowed to naturally attenuate to the SCGs at the Site property line. However, chemical-specific SCGs for the Site groundwater will not be met in some areas of the groundwater plume in the foreseeable future due to the

continuing presence of DNAPL.

No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) would be met during construction activities.

6. Overall Protection of Human Health and the Environment:

This alternative is considered protective of human health and the environment (in terms of affecting habitat or vegetation); but is not considered fully protective of the environment in terms of protecting the groundwater, since a portion of Site groundwater would remain contaminated with VOCs.

Given the presence of DNAPL, reduction in risk associated with natural attenuation is occurring by groundwater standards being met at the Site property line. Implementation of this alternative would result in a decrease of source area DNAPL at the Site. Therefore, this alternative will mitigate the environmental impacts due to groundwater.

7. Cost:

The costs (which include quantities, unit costs, subtotal costs, and associated assumptions for this alternative) have been estimated for comparative purposes and are presented in Table C-3A (Appendix C). The capital cost for this alternative is estimated to total approximately $ 0.

The total present worth of operation and maintenance (O&M) costs is estimated to be approximately $ 304,000.

4.3.4 Alternative No. 3B – Groundwater Extraction and Ex-Situ Treatment with Groundwater Monitoring

1. Short-Term Impacts and Effectiveness:

There are several potential short-term impacts associated with this alternative.

- During installation of extraction wells at the Site, disruptions to some areas are expected. Such disruptions could include limited closure of the parking lots and Site access roads.

- Contamination of equipment used for well installation purposes could carry contamination beyond the Site work zones. Therefore, equipment would be decontaminated prior to leaving the work zones, as necessary, in order to avoid the transport of contaminants.

- Field personnel would wear appropriate personal protective equipment during

groundwater sampling in order to limit health risks due to exposure to contaminants and physical hazards. In addition, equipment used for sampling purposes would be decontaminated prior to leaving the locations of the wells, as necessary, in order to avoid the transport of contaminants.

Installation of additional extraction wells where DNAPL is present may create migration pathways where they don't currently exist. This could result in spreading of the DNAPL zone and increases in dissolved phase contaminant concentrations.

The extraction of Site groundwater, using a series of extraction wells, would serve to contain and remediate a portion of the contaminant plume with total VOCs concentrations greater than 50 ppm. Based on the proposed location of the extraction wells and the extraction rate, groundwater contamination less than 50 ppm will not be contained. It is assumed that groundwater contamination in this area would continue to naturally attenuate as it is presently occurring at the Site.. Also, the ex-situ treatment of contaminated groundwater via activated carbon treatment is expected to be effective in achieving the discharge limits.

Regarding effectiveness, the environment (in terms of affecting habitat or vegetation) would be protected under this alternative although VOC contamination will still impact Site groundwater. The length of time required for natural cleanup or attenuation of groundwater contamination would be expected to be on the order of greater than 30 years, due to the continued presence of DNAPL at the Site. The extraction of DNAPL, if achieved, would shorten the overall remediation time frame. Remedial action objectives for the Site, NYSDEC groundwater standard, are being met at the Site property line.

In the event that the Site groundwater extraction and ex-situ treatment systems fail to operate, monthly maintenance and inspections of the groundwater treatment system would be performed. Also, control systems could be automated with remote access capabilities to minimize the potential for system failures to go unnoticed.

2. Long-Term Effectiveness and Permanence:

If DNAPL is encountered in the source area and can be extracted, its continued impact on groundwater over the long term may be lessened.

Because this alternative also involves the containment and treatment of a portion of the contaminated Site groundwater, the risks involved with the migration and direct contact with contaminants would be decreased, provided the Site groundwater remedy can effectively reduce the migration. Annual collection of groundwater samples would be performed to assess the natural attenuation of remaining contamination (less than 1 ppm). Due to the continued presence of DNAPL at the Site, groundwater concentrations could rebound at monitoring locations down gradient of the extraction wells once the system was turned off. Current Site conditions seem to indicate that

groundwater contamination is naturally attenuating. It is not know if Site conditions, supportive of natural attenuation, would be altered by operation of the extraction system. Therefore, this alternative would likely reduce but not eliminate the environmental impacts due to groundwater.

3. Reduction of Toxicity, Mobility, and Volume:

The toxicity, mobility and volume of the apparent source area DNAPL and/or dissolved phase groundwater contamination are expected to be reduced through the use of the extraction wells and subsequent ex-situ treatment. However, this alternative may not provide for removal of the DNAPL, which will continue to act as a source until it is depleted. Natural attenuation of contaminants is expected to slowly reduce the concentrations in groundwater over time.

Residual wastes (primarily associated with spent carbon) would be generated through groundwater treatment, and would be disposed of off Site. The nature of this waste (i.e., hazardous vs. non-hazardous) is not known, but would be determined as part of the on-Site treatment system treatability study.

4. Implementability:

This alternative is readily implementable on a technical basis. Construction and installation of the groundwater extraction and ex-situ treatment systems would involve standard construction methods and equipment; and materials and services necessary for construction are readily available. With regard to operation and maintenance, the materials and services required for the systems are also readily available. The instrumentation and control systems could be automated with remote access capabilities, such that the effect of possible system shut-downs would be minimized. Confirmatory groundwater sampling would be performed to monitor the effectiveness of the remedial system.

In terms of administrative concerns, this alternative is also considered to be implementable through the required coordination and approval by local county and city agencies (e.g., Sewer Department) and utility companies. However, we have assumed that there are no anticipated, specific problems associated with obtaining permits or approvals from the various agencies and other concerns. Disruption of current Site operations (i.e., parking lots and Site roads) is expected to be a concern; however, the disruption is expected to be minimal.

Institutional controls, such as monitoring lift stations for VOCs prior to entry or subsurface permits, should be required or continued to be used to limit contact with potentially contaminated groundwater.

5. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals:

Chemical-specific SCGs (NYSDEC Class GA groundwater standards) for groundwater are expected to be met at the Site property line. Groundwater extraction wells are proposed at locations in the vicinity of the 50 ppm total VOC concentration. Therefore these wells will be used to contain and extract groundwater with concentrations greater than about 50 ppm. The groundwater downgradient of the extraction wells would be allowed to naturally attenuate to the SCGs at the Site property line. However, chemical-specific SCGs for the Site groundwater will not be met in some areas of the groundwater plume in the foreseeable future due to the continuing presence of DNAPL.

No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) would be met during construction activities.

6. Overall Protection of Human Health and the Environment:

This alternative is considered protective to human health and the environment (in terms of affecting habitat or vegetation); but is not considered fully protective of the environment in terms of protecting the groundwater, since a portion of Site groundwater would remain contaminated with VOCs.

Given the presence of DNAPL, reduction in risk associated with natural attenuation is occurring by groundwater standards being met at the Site property line. Implementation of this alternative would result in containment and remediation of a contaminated Site groundwater. Therefore, this alternative will mitigate the environmental impacts due to groundwater.

7. Cost:

The costs (which include quantities, unit costs, subtotal costs, and associated assumptions for this alternative) have been estimated for comparative purposes and are presented in Table C-3B (Appendix C). The capital cost for this alternative is estimated to total approximately $ 285,000.

The total present worth of operation and maintenance (O&M) costs is estimated to be approximately $ 1,384,000.

The total present worth of this alternative is based on a 30-year period and a discount rate of five percent. The total estimated present worth cost of this alternative is $ 1,669,000.

4.3.5 Alternative No. 4A – Source Area DNAPL In-Situ Chemical Oxidation with

1. Short-Term Impacts and Effectiveness:

There are several potential short-term impacts associated with this alternative.

- Short-term disruptions to current operations at portions of the Site property (e.g., parking lot and Site roads) are expected to occur during the implementation of this alternative, due to pilot study activitiesduring the two injection events.

- Application of sodium permanganate may require the storage of the product (an oxidizer) and other chemicals during applications. Experienced personnel would use special handling procedures. Appropriate labels and MSDS sheets would be required.

- Field personnel would wear appropriate personal protective equipment during groundwater sampling in order to limit health risks due to exposure to contaminants and physical hazards. In addition, equipment used for sampling purposes would be decontaminated prior to leaving the locations of the wells, as necessary, in order to avoid the transport of contaminants.

Depending upon the results of the pilot study, DNAPL source area application under this alternative is expected to decrease the mass of DNAPL at the Site.Drawbacks to the remedial option include the following.

- Rebound of contaminant levels is likely due to the continued presence of DNAPL.

- The present natural attenuation, which is demonstrated to be occurring will likely be altered.

Regarding effectiveness, the environment (in terms of affecting habitat or vegetation) would be protected under this alternative, although the groundwater would continue to be impacted by VOCs. Therefore, the length of time required for natural cleanup or attenuation of groundwater contamination is unknown, but expected to be on the order of 30 years or more due to the presence of DNAPL at the Site. Modeling indicates a reduction of the DNAPL source area mass by 50% does not decrease the overall remedial time frame. The remedial action objectives for the Site, NYSDEC groundwater standard, are currently being met at the Site property line.

2. Long-Term Effectiveness and Permanence:

Because this alternative involves the treatment of the apparent source area DNAPL, the risks involved with the migration and direct contact with contaminants would be somewhat decreased. Annual collection of groundwater samples would be performed to assess the natural attenuation of remaining contamination. However, due to the likelihood that DNAPL will still be present at the Site, groundwater concentrations may rebound at monitoring locations once the injections were completed. Current Site conditions seem to indicate that groundwater contamination is naturally attenuating. It is possible that Site conditions, supportive of natural attenuation, could be altered by the injection of sodium permanganate. It is also possible that this remedy may mobilize the on-Site DNAPL. However, this alternative is anticipated to reduce but not eliminate the environmental impact to groundwater.

3. Reduction of Toxicity, Mobility, and Volume:

The toxicity and volume of the apparent source area DNAPL would be reduced if the chemical oxidant contacts the DNAPL directly. A portion of the Site groundwater contamination would also likely be reduced through the use of in-situ chemical oxidation. (The effectiveness to reduce the mass of dissolve phase contamination and possibly DNAPL would be evaluated during the pilot study and throughout the phased approach.) The portion of the groundwater contamination outside of the source area DNAPL would be left to naturally attenuate. Additionally, this alternative may need to provide hydraulic containment, if DNAPL mobilization occurs from the oxidant injections.

4. Implementability:

This alternative is readily implementable on a technical basis for much of the target area. The oxidant selected for this the Site has a limited number of vendors and obtaining competitive bids would be difficult due to differences in vendor products (e.g., product specifications and concentrations). Materials and services associated with completion of the injection wells are readily available. Confirmatory groundwater sampling would be performed to monitor the effectiveness of the remedial applications.

However, this alternative may not be easy to implement in the area of DNAPL at MW-5. The hydraulic conductivity in this area was measured to be 10^{-5} cm/sec, which is below the optimum range for this technology. The inability to deliver sufficient oxidant will limit the effectiveness of this remedial alternative.

In terms of administrative concerns, this alternative is also considered to be implementable. Implementation of this alternative may require coordination with and approval by NYSDEC, and various Niagara County agencies (e.g., Health Department). However, there are no anticipated, specific problems associated with obtaining permits

or approvals from the various agencies and other concerns. Disruption of current Site operations is expected to be a concern (e.g., parking lots, site roads).

Institutional controls, such as monitoring lift stations for VOCs prior to entry or issuing subsurface excavation permits, should be required or continued to be used to limit contact with potentially contaminated groundwater.

5. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals:

Chemical-specific SCGs (NYSDEC Class GA groundwater standards) for groundwater are expected to be met at the Site property line. This alternative is expected to reduce the mass of DNAPL at the Site. However, the amount of mass reduction or effectiveness is unknown. It is unknown if injections of sodium permanganate will alter the subsurface natural attenuation conditions or mobilize DNAPL which may prevent chemical-specific SCGs for groundwater from being met. However, chemical-specific SCGs for the Site groundwater will not be met in some areas of the groundwater plume in the foreseeable future due to the continuing presence of DNAPL.

No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) would be met during construction activities.

6. Overall Protection of Human Health and the Environment:

This alternative is considered protective to human health and the environment (in terms of affecting habitat or vegetation); but is not considered fully protective of the environment in terms of protecting the groundwater, since Site groundwater would remain contaminated. Therefore, this alternative would mitigate the environmental impacts (in terms of affecting habitat or vegetation) due to groundwater.

7. Cost:

The costs (which include quantities, unit costs, subtotal costs and associated assumptions for this alternative) have been estimated for comparative purposes and are presented in Table C-4A (Appendix C). The capital cost for this alternative is estimated to total approximately $ 45,000.

The total present worth of operation and maintenance (O&M) costs is estimated to be approximately $ 272,000.

The total present worth of this alternative is based on a 30-year period and a discount rate of five percent. The total estimated present worth cost of this alternative is $ 317,000.

These costs do not include a contingent cost to install monitoring wells and/or

extraction points should DNAPL be mobilized.

4.3.6 Alternative No. 4B – Full Scale In-Situ Chemical Oxidation with Monitored Natural

1. Short-Term Impacts and Effectiveness:

There are several potential short-term impacts associated with this alternative.

- Contamination of equipment used for installation of injection wells and oxidant injection purposes could carry contamination beyond the limits of the Site plume. Therefore, equipment would be decontaminated prior to leaving the treatment area, as necessary, in order to avoid the transport of contaminants.

- Short-term disruptions to current operations at portions of the Site property (e.g., parking lot and Site roads) are expected to occur during the implementation of this alternative, due to pilot study activities, the installation of the injection wells and during the two injection events.

- Application of sodium permanganate may require the storage of the product (an oxidizer) and other chemicals during applications. Experienced personnel would use special handling procedures. Appropriate labels and MSDS sheets would be required.

- Field personnel would wear appropriate personal protective equipment during groundwater sampling in order to limit health risks due to exposure to contaminants and physical hazards. In addition, equipment used for sampling purposes would be decontaminated prior to leaving the locations of the wells, as necessary, in order to avoid the transport of contaminants.

Depending upon the results of the pilot study, DNAPL source area application and/or full-scale application, this alternative is expected to decrease the dissolved phase groundwater concentrations of CVOCs from greater than 100 ppm to less than 1 ppm. Some DNAPL destruction may also occur due to the area where the injections are occurring. Drawbacks to the remedial option include the following.

- Rebound of contaminant levels is likely due to the continued presence of DNAPL.

- The present natural attenuation, which is demonstrated to be occurring will likely be altered.

Regarding effectiveness, the environment (in terms of affecting habitat or vegetation) would be protected under this alternative, although the groundwater would continue to be impacted by CVOCs. The length of time required for cleanup of groundwater

contamination is unknown due to likely presence of DNAPL at the Site. Modeling indicates a reduction of source area DNAPL of 50% would still require a remedial time frame greater than 30-years (about 50-years). However, the remedial action objectives for the Site, NYSDEC groundwater standard, are being met at the Site property line.

2. Long-Term Effectiveness and Permanence:

Because this alternative involves the treatment of the apparent DNAPL source area and/or treatment of the dissolve phase contaminated groundwater, the risks involved with the migration and direct contact with contaminants would be somewhat decreased. Annual collection of groundwater samples would be performed to assess the natural attenuation of remaining contamination. However, due to the likely presence of DNAPL remaining at the Site, groundwater concentrations may rebound at monitoring locations once the injections were completed. Current Site conditions seem to indicate that groundwater contamination is naturally attenuating. It is possible that Site conditions, supportive of natural attenuation, would be altered by the injection of sodium permanganate. It is also possible that this remedy may mobilize the on-Site DNAPL. However, this alternative is anticipated to reduce but not eliminate the environmental impact to groundwater.

3. Reduction of Toxicity, Mobility, and Volume:

The toxicity and volume of the apparent source area DNAPL would be reduced if the chemical oxidant contacts the DNAPL directly. A portion of the Site groundwater contamination would also likely be reduced through the use of in-situ chemical oxidation. (The effectiveness to reduce the mass of dissolve phase contamination and possibly DNAPL would be evaluated during the pilot study and throughout the phased approach to the full-scale application.). However, this alternative does not provide for treatment of the portion of the Site with contamination less than 100 ppm. This portion of the groundwater contamination would be left to naturally attenuate. Additionally, this alternative may need to provide hydraulic containment, if DNAPL mobilization occurs from the oxidant injections.

4. Implementability:

This alternative is readily implementable on a technical basis for much of the target area. The oxidant selected for this the Site has a limited number of vendors and obtaining competitive bids would be difficult due to differences in vendor products (e.g., product specifications and concentrations). Materials and services associated with completion of the injection wells are readily available. Confirmatory groundwater sampling would be performed to monitor the effectiveness of the remedial applications.

However, this alternative is not easy to implement in the area of the plume where the DNAPL was sampled (MW-5). The hydraulic conductivity in this area was measured to be 10^{-5} cm/sec, which is below the optimum range for this technology. The inability to

deliver sufficient oxidant will limit the effectiveness of this remedial alternative.

In terms of administrative concerns, this alternative is also considered to be implementable. Implementation of this alternative may require coordination with and approval by NYSDEC, and various Niagara County agencies (e.g., Health Department). However, there are no anticipated, specific problems associated with obtaining permits or approvals from the various agencies and other concerns. Disruption of current Site operations is expected to be a concern (e.g., parking lots, site roads).

Institutional controls, such as monitoring lift stations for VOCs prior to entry or issuing subsurface excavation permits, should be required or continued to be used to limit contact with potentially contaminated groundwater.

5. Compliance with Applicable or Relevant and Appropriate SCGs and Remediation Goals:

Chemical-specific SCGs (NYSDEC Class GA groundwater standards) for groundwater are expected to be met at the Site property line. This alternative is expected to reduce the amount of dissolved phase TCE and PCE contamination greater the 100 ppm. Because heterogeneities in the bedrock will likely limit the effectiveness in some Site areas (e.g., due to incomplete injection distribution), some of the contamination may not be treated by the applications. These areas and those less than 100 ppm are expected to naturally attenuate, which appears to be occurring at the Site. It is unknown if injections of sodium permanganate will alter the subsurface natural attenuation conditions or mobilize DNAPL which may prevent chemical-specific SCGs for groundwater from being met. However, chemical-specific SCGs for the Site groundwater will not be met in some areas of the groundwater plume in the foreseeable future due to the continuing presence of DNAPL.

No location-specific SCGs were identified. Action-specific SCGs (e.g., OSHA regulations) would be met during construction activities.

6. Overall Protection of Human Health and the Environment:

This alternative is considered protective to human health and the environment (in terms of affecting habitat or vegetation); but is not considered fully protective of the environment in terms of protecting the groundwater, since a portion of Site groundwater would remain contaminated. Therefore, this alternative would mitigate the environmental impacts (in terms of affecting habitat or vegetation) due to groundwater.

7. Cost:

The costs (which include quantities, unit costs, subtotal costs and associated assumptions for this alternative) have been estimated for comparative purposes and are

presented in Table C-4 (Appendix C). The capital cost for this alternative is estimated to total approximately $ 819,000.

The total present worth of operation and maintenance (O&M) costs is estimated to be approximately $ 272,000.

The total present worth of this alternative is based on a 30-year period and a discount rate of five percent. The total estimated present worth cost of this alternative is $ 1,091,000.

These costs do not include a contingent cost to install monitoring wells and/or extraction points should DNAPL be mobilized.

5.0 COMPARATIVE ANALYSIS OF REMEDIAL ALTERNATIVE

The Alternatives are compared below on the basis of the six environmental and one cost criteria, based on the detailed analysis provided in Section 4.0.

5.1 SHORT-TERM EFFECTIVENESS

Alternatives No. 3B and 4B involve subsurface work, which could cause releases of contamination during the installation of the remedial systems or during remedial activities. Alternatives No. 3B and 4A & B will also disrupt current Site operations (i.e., parking lots and Site roads). Alternatives No. 1, 2, and 3A are not expected to cause releases of contamination or disruption to Site operations.

Alternatives No. 1, 2, 3A & B and 4A & B are expected to meet the remedial action objectives (e.g., NYSDEC groundwater standards) at the Site property line. However, Alternative No. 3A & B and 4A & B involve on-Site subsurface remedial actions that may alter the current physical or chemical Site conditions, which may prevent the remedial action objective from being met at the property line.

Assuming Alternative No. 3A and 4A are able to reduce some of the DNAPL mass present at the Site or Alternative No. 4B is able to reduce the amount of DNAPL mass and dissolved phase groundwater contamination, it would reduce the amount of contamination at the Site. Alternative No. 3B would reduce the DNAPL mass through dissolve phase groundwater extraction/treatment. Alternative No. 2 reduces the DNAPL mass through natural attenuation.

5.2 LONG-TERM EFFECTIVENESS AND PERMANENCE

Alternatives No. 2, 3A & B and 4A & B are considered reliable remedies to meeting the remedial action objective for the Site, assuming natural attenuation continues to reduce the contaminant levels at the Site boundary to groundwater standards. However, due to the presence of DNAPL

at the Site and the uncertainty involved in the proposed source area DNAPL remediation alternatives, the groundwater in the interior of the plume could remain impacted for an indefinite period of time (i.e., these alternatives may not be permanent groundwater remedies) and groundwater concentrations may rebound in Alternative No. 3A & B and 4A & B, once the remedial actions are complete.

Alternative No. 1 may be a reliable remedy to meeting the remedial action objective for the Site, assuming natural attenuation continues, but without any monitoring the status of site contamination would be unknown.

5.3 REDUCTION OF TOXICITY, MOBILITY, AND VOLUME

Alternatives No. 3A and 4A would provide for a reduction in the source area DNAPL mass and minimize the potential to mobilize DNAPL and/or alter existing on-Site natural attenuation process compared to Alternatives No. 3B and 4B.

Alternatives No. 3B and 4B appear to provide for the greatest reduction of toxicity, mobility and volume of groundwater contamination. However, these alternatives have a potential to mobilize DNAPL and/or alter existing on-Site natural attenuation process.

Alternatives No. 1 and 2 would not reduce the toxicity, mobility or volume of Site contaminants any quicker than the rate at which natural attenuation is already occurring.

5.4 IMPLEMENTABILITY

Alternatives No. 1, 2, 3A & B and 4A & B are technically implementable with readily available method, equipment, materials, and services. The use of sodium permanganate as the in-situ chemical oxidant in Alternative No. 4A & B is limited because few vendors exist for the selected application and it is still considered an innovative technology. However, Alternatives 4A & B may not be easy to implement in the area of DNAPL at MW-5. The hydraulic conductivity in this area was measured to be 10^{-5} cm/sec, which is below the optimum range for this technology. The inability to deliver sufficient oxidant will limit the effectiveness of this remedial alternative.

5.5 COMPLIANCE WITH APPLICABLE OR RELEVANT AND APPROPRIATE SCGs AND REMEDIATION GOALS

Alternatives No. 1, 2, 3A & B and 4A & B are expected to achieve compliance with the chemical-specific SCG/remedial action objective for groundwater at the Site boundary. None of the alternatives would likely achieve SCGs compliance throughout the contaminant plume due to the anticipated remaining presence of DNAPL.

5.6 OVERALL PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT

Alternatives No. 1, 2, 3A & B and 4A & B will be protective of human health and the environment. However, the presence of DNAPL at the Site will be a continuing source of

groundwater contamination. Alternative No. 1 does not allow for the detection of a change Site conditions that could cause potential harm to human health or the environment.

5.7 COST

The estimated costs associated with the implementation of each alternative are summarized on tables in Appendix C (for 30-year time period) and provide more detailed information.

Alternative No. 1 does not include remedial actions other than natural attenuation. No groundwater monitoring is included in this alternative to assist in understanding Site conditions. The present worth of this alternative is $0.

The cost for Alternative No. 2 includes monitored natural attenuation with groundwater monitoring. It is estimated to cost approximately $ 255,000. This cost is a total present worth estimate assuming a 30-year period and a discount rate of five percent. However, the time frame associated with this remedial alternative may take longer than 30-years for remediation. Therefore, we estimated total worth of O&M costs assuming 75-years of remediation to be approximately $324,000.

Alternative No. 3A, which includes source area DNAPL extraction and groundwater monitoring, is estimated to have a total present worth of $ 304,000. This assumes a 30-year period and a discount rate of five percent. However, the monitoring associated with this alternative would continue past the 30-year period due to the remaining presence of DNAPL. An estimated total worth of O&M costs assuming 50-years and 60-years of remediation is approximately$360,000 and $373,000, respectively.

Alternative No. 3B, which includes dissolve phase groundwater extraction with ex-situ treatment of dissolve phase groundwater and groundwater monitoring, is estimated to have a total present worth of $ 1,669,000. This assumes a 30-year period and a discount rate of five percent. However, the monitoring associated with this alternative could also continue past the 30-year period due to the remaining presence of DNAPL. Assuming a 40-year and 50-year time period for remedial efforts, the associated estimated present worth cost is $1,825,000 and $1,921,000, respectively.

Alternative No. 4A, which includes source area DNAPL in-situ chemical oxidation (sodium permanganate) with groundwater monitoring, is estimated to have a total present worth of $317,000. This assumes a 30-year period and a discount rate of five percent. In case the monitoring associated with this alternative would continue past the 30-year period due to the remaining presence of DNAPL, the total worth of Alternative 4A assuming 50-years of O&M costs associated with the remediation is estimated to be approximately $348,000.

Alternative No. 4B, which includes full-scale in-situ chemical oxidation with groundwater monitoring, is estimated to have a total present worth of $1,091,000. This assumes a 30-year period and a discount rate of five percent. The effectiveness of the alternative is unknown, but

may decrease the duration to less than 30-years. However, if monitoring associated with this alternative would continue past 30-years period due to the remaining presence of DNAPL, the total worth of Alternative 4B assuming 40-years and 50-years of O&M costs associated with the remediation is approximately $1,117,000 and $1,132,000, respectively.

The following table presents costs representative of the present day worth for the remedial alternatives for 30-years, 50-years, and a select time period that may be more representative of the time period for that specific alternative.

Alternative	30-year Cost	50-year Cost	Select Time Period & Cost
1	$ 0	$ 0	NA
2	$ 255,000	$ 303,000	75-yr.; $ 324,000
3A	$ 373,000	$ 360,000	60-yr.; $373,000
3B	$ 1,669,000	$ 1,921,000	40-yr; $ 1,825,000
4A	$ 317,000	$ 348,000	NA
4B	$ 1,091,000	$ 1,132,000	40-yr.; $ 1,117,000

6.0 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

6.1 SUMMARY AND CONCLUSIONS

This report presents the results of the Focused Feasibility Study (FFS) of alternatives for the environmental remediation of the Delphi Harrison Thermal Systems (Delphi Thermal) West Lockport Complex (Site) located in Lockport, New York. The Site is listed as a Class 3 site on the NYSDEC Registry of Inactive Hazardous Waste Sites, Site No. 932113. Delphi Thermal has been voluntarily assessing a release of trichloroethylene (TCE) since November 1994. In response to groundwater contamination at the Site, Delphi Thermal entered a Remedial Investigation/Feasibility Study Order on Consent with NYSDEC in July 2001.

Several sampling rounds have been completed to evaluate the Site conditions and natural attenuation. The results of the sample rounds indicate that the Site is in a steady state with CVOC concentrations consistent at monitoring locations between sample rounds and natural attenuation is occurring. The results are supportive of MNA

An aboveground TCE storage tank, closed in May 1994, was situated within a concrete containment dike with a concrete bottom. The tank was located at the southeast corner of Building 8 (AOC). During excavation to repair a ruptured fire protection line, a solvent odor was detected. Subsequently, soils from an approximate 27 by 22-foot area were excavated to a depth of about 7.5 feet bgs and disposed by Delphi Thermal as a hazardous waste. The excavation was then backfilled with a manufactured crushed stone product. VOCs were detected in groundwater and subsurface soil in the immediate vicinity of the AOC above respective NYSDEC drinking water standards and

soil cleanup guidance values. These contaminants included TCE, PCE, and their breakdown products.

The source area identified for purposes of the FFS, is defined as groundwater contamination associated with the AOC and DNAPL identified in MW-5. Contaminants in the vicinity of the AOC and the DNAPL at MW-5 will continue to contribute to the groundwater plume at the Site until sources are depleted. Analytical testing results (See Table 1) of samples from shallow bedrock monitoring wells indicate the presence of AOC-related contaminants (chlorinated solvents) in the majority of the wells installed as part of this study.

Thirteen groundwater sample rounds have been completed to date between the period of September 1995 and April 2003. The total chlorinated compound concentrations between the first sample round and October 2001 sample round were compared for the monitoring wells. In general, the concentrations in the groundwater samples from the evaluated wells did not significantly change. Minor fluctuations in concentrations are noted within the data and are to be expected given the analytical laboratory accepted accuracy for the test procedures. Therefore, the Site groundwater is considered to be in a "steady state". However, the April 2003 groundwater sampling results identified an order of magnitude decrease in the TCE concentration in MW-7 in the AOC.

In general, concentrations of parent compounds (TCE and PCE) are highest near the AOC. Moving eastward from the AOC, concentrations of parent compounds decrease consistently. Parent compounds were not detected at the four furthest downgradient wells (MW-11, MW-12, MW-13 and MW-14). PCE was detected at low concentrations in MW-15, located at the northern downgradient area of the plume.

Parent compound breakdown products (daughter compounds), 1,2-DCE and Vinyl Chloride, reach maximum concentrations at intermediate wells such as MW-4, then decrease at downgradient wells (MW-10, MW-11, and MW-12). Daughter compounds were not detected in well MW-13, at the furthest downgradient edge of the plume (at the Delphi Thermal property line). Daughter compound 1,2-DCE was detected at a low concentration in MW-14. No daughter compounds were detected in MW-15.

Preliminary screening of remedial technologies that may be used to control the contaminants of concern and to achieve the remedial action objectives for the Site were evaluated. This FFS Report expands upon the remedial technologies discussed in the GZA February 1997 report.

Several Site factors, including the complex characteristics of the bedrock fracture system and presence of DNAPL, limit the potential remedial technologies that would be viable. Other innovative technologies (e.g., in-situ chemical oxidation) may be effective at remediating a portion of the DNAPL contamination; however, these technologies are unlikely to provide for complete DNAPL mass reduction without extensive effort and expense, and could cause the mobilization of DNAPL.

Four remedial alternatives were assembled for remediating the Site. These are discussed below.

Alternative No. 1 – No Further Action

The No Further Action alternative involves taking no further action to remedy the condition of the Site, other than those that have already been preformed (i.e., soil excavation in the AOC). NYSDEC and USEPA guidance requires that the No Action alternative automatically passes through the preliminary screening and be compared to other alternatives in the detailed analysis of alternatives.

Alternative No. 2 – Monitored Natural Attenuation with Groundwater Monitoring

Monitored natural attenuation is the primary component of this alternative coupled with groundwater monitoring and institutional controls that would also be put into place. For the purposes of the FFS cost estimate, it is assumed that this remedial action would be conducted for at least a 30-year duration (the maximum time period specified for evaluation) as specified in USEPA guidance. However, due to the presence of DNAPL at the Site, this alternative may extend past the 30-year duration and could continue on for upwards of 50-years or more.

This alternative assumes that annual groundwater monitoring would be conducted on the 8 selected monitoring wells for 30 years. Groundwater monitoring would include sampling for the CVOCs and collection of field data through the use of a down-hole meter. If analytical results indicated that groundwater concentrations were increasing or conditions for biodegradation were becoming unfavorable, a contingency plan for application of HRC would be developed.

Alternative No. 3A – Source Area DNAPL Extraction with Groundwater Monitoring

Attempted source area DNAPL extraction, off-Site disposal of DNAPL, and groundwater monitoring are the main components of this alternative. Institutional controls would also be implemented. Attempts to extract DNAPL from existing monitoring well MW-5 using a low-flow peristaltic pump would be conducted. This alternative would attempt to reduce the mass of DNAPL at the Site.

DNAPL extracted from MW-5 would be pumped in to a 55-gallon drum for off-Site disposal.

Groundwater monitoring would be performed to evaluate the remedial alternative. Quarterly groundwater monitoring would be conducted in years 1 and 2; and annually in years 3 through 30. Groundwater monitoring parameters as described in Alternative No. 2 would be collected. However, due to the presence of DNAPL at the Site, this alternative may extend past the 30-year duration and could continue on for upwards of 50-years.

Alternative No. 3B – Groundwater Extraction and Ex-Situ Treatment with Groundwater Monitoring

Extraction of dissolve phase groundwater, ex-situ treatment of dissolve phase groundwater and groundwater monitoring are the main components of this alternative. Institutional controls would also be implemented. Dissolve phase groundwater extraction wells would be located downgradient

of the suspected DNAPL area (MW-5). The extraction wells would be operated for the purposes of containment of impacted Site groundwater and to limit further migration of the contaminated groundwater associated with the source area DNAPL. Contaminated groundwater not captured by the extraction system would be remediated by natural attenuation.

Groundwater would be pumped from the extraction wells to a treatment system, which would use granular activated carbon system for groundwater treatment. Treated water would be discharged to the on-Site drainage swale.

Groundwater monitoring would be performed to evaluate the remedial alternative. Quarterly groundwater monitoring would be conducted in years 1 and 2; and annually in years 3 through 30. Groundwater monitoring parameters as described in Alternative No. 2 would be collected. However, due to the presence of DNAPL at the Site, this alternative may extend past the 30-year duration and could continue on for upwards of 40 to 50-years.

Alternative No. 4A – Source Area DNAPL In-situ Chemical Oxidation with Groundwater Monitoring

The primary component of this alternative is in-situ chemical oxidation in an attempt to reduce the source area DNAPL mass. Injection of a chemical oxidant (sodium permanganate) is an innovative technology, which provides an aggressive approach to treatment/reduction of DNAPL mass. Groundwater monitoring would also be implemented to monitor the progress and effects of treatment.

The oxidant would be applied into existing monitoring wells MW-3S, MW-4, MW-5, and MW-7. This technology would be applied using the phased approach (including a laboratory treatability study, pilot treatment study, and two injection events).

This alternative assumes that groundwater monitoring would be conducted in select monitoring wells for 30 years. The monitoring program would consist of quarterly monitoring for years 1 and 2; and annual monitoring for in years 3 through 30. However, due to the presence of DNAPL at the Site, this alternative may extend past the 30-year duration and could continue on for upwards of 50-years.

If the analytical sample results indicted that groundwater concentrations were increasing from the presence of DNAPL or DNAPL was detected in any of the monitoring wells downgradient of MW-5 (i.e., MW-9, or MW-10) an extraction well contingency plan may be considered. The extraction wells would attempt to remove the DNAPL or at least provide hydraulic containment from further migration downgradient at the Site.

Alternative No. 4B – Full-Scale In-situ Chemical Oxidation with Groundwater Monitoring

The primary component of this alternative is in-situ chemical oxidation in an attempt to reduce the DNAPL source area and to address the dissolve phase contaminated groundwater with CVOCs concentrations greater than 100 ppm. Injection of a chemical oxidant (sodium permanganate) is an

innovative technology, which provides an aggressive approach to treatment of the dissolved phase CVOCs contaminated saturated areas. Groundwater monitoring would also be implemented to monitor the progress and effects of treatment.

The oxidant would be applied into the groundwater table at approximately 20-foot depth intervals through injection wells. The injection wells would be spaced approximately 30 feet apart. This technology would be applied using the phased approach (including a laboratory treatability study, pilot treatment study, and two full-scale injection events).

This alternative assumes that groundwater monitoring would be conducted in select monitoring wells for 30 years. The monitoring program would consist of quarterly monitoring for years 1 and 2; and annual monitoring for in years 3 through 30. However, due to the presence of DNAPL at the Site, this alternative may extend past the 30-year duration and could continue on for upwards of 40 to 50-years.

If the analytical sample results indicted that groundwater concentrations were increasing from the presence of DNAPL or DNAPL was detected in any of the monitoring wells downgradient of MW-5 (i.e., MW-9, or MW-10) an extraction well contingency plan may be considered. The extraction wells would attempt to remove the DNAPL or at least provide hydraulic containment from further migration downgradient at the Site.

Alternatives No. 2, 3A & B and 4A & B are considered to be protective of human health and the environment. Alternatives No. 3A provides for some removal of source area DNAPL mass while Alternatives No. 3B provides containment and ex-situ treatment of dissolved phase groundwater contamination and removal of some DNAPL in the source area. Alternative No. 4A provides for some in-situ treatment of source area DNAPL. Alternative No. 4B provides in-situ treatment of the DNAPL source area and/or dissolved phase groundwater contamination at the Site. Alternative No. 2 provides for the groundwater contamination to naturally attenuate while monitoring the site conditions and contamination.

Alternatives No. 1 may not adequately be protective of human health and the environment due to the lack of environmental monitoring.

The costs for Alternatives No 3A and 3B are in the range of 300,000 to 1,700,000 while Alternative 4A and 4B are in the range of approximately $320,000 to $1,100,000. Treatability and pilot studies would be necessary to refine the estimated costs and design for these alternatives. Alternative No. 2, which has no capital costs, is estimated to be less than $255,000. The costs associated with these alternatives assume a 30-year duration. However, due to the likely remaining presence of DNAPL, these alternatives may require monitoring that extends past the 30-year time frame. Estimated costs for remedial efforts past a 30-year timeframe are presented in Section 5.

6.2 RECOMMENDATIONS

Delphi Thermal supports the GZA recommendation that natural attenuation is occurring at the

Site and should be allowed to continue unaltered. Alternative No. 2, Monitored Natural Attenuation, is a viable alternative for the remedial action at the Site. However, monitored natural attenuation could be coupled with a Alternative 3A - DNAPL source area extraction or Alternative 4A - DNAPL source area in-situ chemical oxidation application to attempt to assist in decreasing the amount of DNAPL present at the Site. It would not be possible to remove all the remaining DNAPL source with current in-situ technology.

The detailed analysis completed on the four alternatives selected as part of the FFS, did not indicate that any one specific alternative was clearly more protective to human health and the environment, provided for better long-term effectiveness, or was more in compliance with SCGs and remediation goals. All of the alternatives selected were implementable but at various costs to achieve the remedial objective.

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TABLES

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Table 3
Contaminants of Concern and SCG Goals - Overburden Groundwater
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Parameter	Minimum	Maximum	Selected SCG Goal	Number of Samples Exceeding	Number of Samples Tested
Volatile Organics (mg/l)					
Vinyl chloride	0.0010	40	0.002	70	90
1,2-Dichloroethene (total)	0.008	310	0.005	79	90
Trichloroethene (TCE)	0.008	6500	0.005	65	90
Tetrachloroethene	0.011	120	0.005	38	90

Notes:

1) Selected SCG goals based on the NYSDEC Class GA groundwater standards.
2) The range of concentrations shown represents the maximum and minimum for those samples in which the contaminant was detected. Samples with "non-detect" results were not considered in the range.
3) "Number of Samples Exceeding" denotes the number of samples tested that exceed the select SCG goal.
4) Selected SGC Goal is the NYSDEC Class GA Groundwater Standards as promulgated in 6 NYCRR 703, dated June 1998.

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Table 2
Potentially Applicable SCGs
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

ACT/AUTHORITY	CRITERIA/ISSUES	CITATION	BRIEF DESCRIPTION	STATUS	COMMENTS
LOCAL CHEMICAL-SPECIFIC SCGs					
None Identified.					
STATE CHEMICAL-SPECIFIC SCGs					
	Determination of Soil Cleanup Objectives and Cleanup Levels	NYSDEC TAGM HWR-94-4046 (January 1994)	Establishes Recommended Soil Cleanup Objectives (RSCOs) for soil.	Applicable	
	Contained-In Action Levels	NYSDEC TAGM 3028 (August 4, 1997)	It is the purpose of this policy to set minimum criteria (i.e., action levels, cover requirements, and restricted access) for an environmental medium contaminated by listed hazardous waste which must be met in order to preclude its management as hazardous waste.	Potentially Applicable	The "contained in" criteria does not imply that these levels are cleanup levels.
	Determination of Groundwater Cleanup Objectives and Guidance Values	NYSDEC TOGS 1.1.1 (Reissue Date June 1998); 6 NYCRR 706	Establishes Groundwater Effluent Limitations for Class GA Groundwater.	Applicable	
FEDERAL CHEMICAL-SPECIFIC SCGs					
Comprehensive Environmental Responsibility Cleanup and Liability Act (CERCLA)	Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities	USEPA OSWER Directive #9355.4-12, Response, July 1994	USEPA-recommended residential screening level for lead (400 ppm, based on permissible exposure to children).	Applicable	USEPA (1996) also suggests somewhat higher levels (750 to 1500 ppm) are acceptable for adults.
National Primary and Secondary Regulations	USEPA Maximum Contaminant Levels (MCLs) and Maximum Contaminant Level Goals (MCLGs)	USEPA OSWER Directive #9355.4-12, Response, July 1994; 40 CFR 141, November 24, 1999.	National primary drinking water regulations are legally enforceable standards that apply to public water systems. National secondary drinking water regulations are non-enforceable guidelines regulating contaminants that may cause cosmetic or aesthetic effects	Potentially Applicable	
USEPA Office of Water	Drinking Water Regulations and Health Advisories	USEPA, EPA/822/B/96/002, October 1996	USEPA health advisories are nonregulatory concentrations of drinking water contaminants considered protective of adverse noncarcinogenic health effects.	Potentially Applicable	
USEPA Region 9	Preliminary Remediation Goals	USEPA, dated October 1, 1999.	USEPA Region 9 PRGs are used for evaluating contaminated sites in terms of exposure pathways (for ingestion of tap water and inhalation/dermal contact/ingestion of soil).	Applicable	
USEPA Region 3 Risk Assessment Guidance	Risk-Based Concentrations (RBCs) Table	USEPA, dated October 7, 1999.	USEPA Region 3 RBCs are based on adult occupational exposure (ingestion of) commercial/industrial soil; for use with "Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening" (EPA/903/R-93/001)	Applicable	
LOCAL ACTION-SPECIFIC SCGs					
Niagara County Department of Public Works	Effluent discharge to a county stormwater system/detention basin		A permit must be filed with the County or Town for discharge into county- or town-owned stormwater system/detention basin.	Potentially Applicable	
Town of Lockport/Niagara County	Permissible Sound Levels	Building Zone Ordinance	Establishes allowable noise emissions from construction equipment and property line noise limits.	Potentially Applicable	
Niagara County/Lockport Fire Commission			Establishes requirement for fire alarms and sprinkler Systems.	Potentially Applicable	For systems required in treatment buildings.

Table 2
Potentially Applicable SCGs
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

ACT/AUTHORITY	CRITERIA/ISSUES	CITATION	BRIEF DESCRIPTION	STATUS	COMMENTS
STATE ACTION-SPECIFIC SCGs					
	Transportation of Hazardous Materials	6 NYCRR 364	Regulates transportation of hazardous materials.	Potentially Applicable	Relevant to off-site transport of remediation derived wastes
New York State Vehicle and Traffic Law, Article 386; Environmental Conservation Law Articles 3 and 19.	Noise from Heavy Motor Vehicles	6 NYCRR 450	Defines maximum acceptable noise levels.	Potentially Applicable	Marginally applicable; appears to apply to over-the-road vehicles, not construction equipment.
Environmental Conservation law, Articles 3, 15, 17, 19 and 70; Administrative Procedures Act, Article 301	Uniform Procedures	6 NYCRR 621	Establishes the procedures used in the processing of applications for permits.	Applicable	
Environmental Conservation Law, Articles 3, 15, and 17	New York State Pollution Discharge Elimination System	6 NYCRR 750 - 758	Establishes permit requirements for point source discharges into state waters.	Potentially Applicable	Supercedes need to obtain NPDES permits since New York has an approved SPDES program. New York SPDES program does not require a permit for discharge of uncontrolled stormwater runoff as per 6 NYCRR 751.3(a)(7). Discharge to municipal sewers appears to be under local jurisdiction.
Environmental Conservation Law, Articles 3 and 19.	Prevention and Control of Air Contaminants and Air Pollution	6 NYCRR 200 - 202	Establishes general provisions and requires construction and operation permits for emission of air pollutants.	Potentially Applicable	
Environmental Conservation Law, Article 15; also Public Health Law Articles 1271 and 1276 (Part 288 only)	Air Quality Classifications and Standards	6 NYCRR 256, 257, and 288	Establishes air quality classification system and air quality standards for various pollutants including particulates and non-methane hydrocarbons.	Potentially Applicable	
Environmental Conservation Law, Articles 3, 19, 23, 27, and 70	Hazardous Waste Management System General	6 NYCRR 370	Provides definition of terms and general standards applicable to 6 NYCRR 370 - 374, 376.	Potentially Applicable	
	Identification and Listing of Hazardous Waste	6 NYCRR 371	Identifies characteristic hazardous waste and lists specific wastes.	Potentially Applicable	
	Hazardous Waste Manifest System and Related Standards	6 NYCRR 372	Establishes manifest system and recordkeeping standards for generators and transporters of hazardous waste and for treatment, storage, and disposal facilities.	Potentially Applicable	Relevant to transportation and off-site treatment of hazardous waste
	Hazardous Waste Treatment, Storage, and Disposal Facility Permitting Requirements	6 NYCRR 373	Regulates treatment, storage, and disposal of hazardous waste.	Potentially Applicable	Relevant to off-site treatment/disposal of hazardous waste
	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities	6 NYCRR 374	Subpart 374-1 establishes standards for the management of specific hazardous wastes. (Subpart 374-2 establishes standards for the management of used oil.)	Potentially Applicable	
Environmental Conservation Law, Articles 3 and 27.	Land Disposal Restrictions	6 NYCRR 376	Identifies hazardous wastes which are restricted from land disposal. Defines treatment standards for hazardous waste.	Potentially Applicable	
FEDERAL ACTION-SPECIFIC SCGs					
Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and Superfund Amendments and Reauthorization Act of 1986 (SARA)	National Contingency Plan	40 CFR 300, Subpart E	Outlines procedures for remedial actions and for planning and implementing off-site removal actions.	Potentially Applicable	
Occupational Safety and Health Act	Worker Protection	29 CFR 1904, 1910, and 1926	Specifies minimum requirements to maintain worker health and safety during hazardous waste operations. Includes training requirements and construction safety requirements.	Potentially Applicable	Under 40 CFR 300.38, requirements of OSHA apply to all activities which fall under jurisdiction of the National Contingency Plan.

Table 2
Potentially Applicable SCGs
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

ACT/AUTHORITY	CRITERIA/ISSUES	CITATION	BRIEF DESCRIPTION	STATUS	COMMENTS
Executive Order	Delegation of Authority	Executive Order 12316 and Coordination with Other Agencies	Delegates authority over remedial actions to Federal Agencies		
Clean Water Act	National Pollution Discharge Elimination System (NPDES)	40 CFR 122 and 125	Issues permits for discharge into navigable waters. Establishes criteria and standards for imposing treatment requirements on permits.	Potentially Applicable	New York SPDES program incorporates the NPDES program by reference.
Safe Drinking Water Act	Underground Injection Control Program	40 CFR 144	Establishes performance standards, well requirements, and permitting requirements for groundwater re-injection wells.	Potentially Applicable	Potentially applicable for remedial alternatives utilizing in situ chemical oxidation in which non-hazardous reagents are introduced to the subsurface via injection wells.
	Underground Injection Control Program: Technical Criteria and Standards	40 CFR 146	Establishes technical criteria and standards that must be met in groundwater re-injection permits for Class V wells. Class V wells include wells used in experimental technologies.	Potentially Applicable	
Clean Air Act	National Primary and Secondary Ambient Air Quality Standards	40 CFR 50	Establishes emission limits for six pollutants (SO_2, PM_{10}, CO, O_3, NO_2, and Pb).	Potentially Applicable	
	National Emission Standards for Hazardous Air Pollutants	40 CFR 61	Provides emission standards for 8 contaminants. Identifies 25 additional contaminants, including PCE and TCE, as having serious health effects but does not provide emission standards for these contaminants.	Potentially Applicable	
Resource Conservation and Recovery Act	Criteria for Municipal Solid Waste Landfills	40 CFR 258	Establishes minimum national criteria for management of non-hazardous waste.	Potentially Applicable	Applicable for remedial alternatives which involve generation of non-hazardous waste. Non-hazardous waste must be hauled and disposed of in accordance with RCRA.
	Hazardous Waste Management System General	40 CFR 260	Provides definition of terms and general standards applicable to 40 CFR 260 - 265, 268.	Potentially Applicable	Applicable for remedial alternatives which involve generation of a hazardous waste (*e.g.*, contaminated soil). Hazardous waste must be handled and disposed of in accordance with RCRA.
	Identification and Listing of Hazardous Waste	40 CFR 261	Identifies solid wastes which are subject to regulation as hazardous wastes.	Potentially Applicable	
	Standards Applicable to Generators of Hazardous Waste	40 CFR 262	Establishes requirements (e.g., EPA ID numbers and manifests) for generators of hazardous waste.	Potentially Applicable	
	Standards Applicable to Transporters of Hazardous Waste	40 CFR 263	Establishes standards which apply to persons transporting manifested hazardous waste within the United States.	Potentially Applicable	
	Standards Applicable to Owners and Operators of Treatment, Storage, and Disposal Facilities	40 CFR 264	Establishes the minimum national standards which define acceptable management of hazardous waste.	Potentially Applicable	
	Standards for owners of hazardous waste facilities	40 CFR 265	Establishes interim status standards for owners and operators of hazardous waste treatment, storage and disposal facilities.	Potentially Applicable	
	Land Disposal Restrictions	40 CFR 268	Identifies hazardous wastes which are restricted from land disposal.	Potentially Applicable	
	Hazardous Waste Permit Program	40 CFR 270, 124	USEPA administers hazardous waste permit program for CERCLA/Superfund Sites. Covers basic permitting, application, monitoring, and reporting requirements for off-site hazardous waste management facilities.	Potentially Applicable	

Note: No location specific SCGs identified.

Table 1
Summary of Groundwater Analytical Test Results for Target Volatile Organic Compounds
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Location		Sample Date	Target Chlorinated VOC Concentrations: Trichloroethylene (mg/l)	Tetrachloroethylene (mg/l)	Total 1,2-Dichloroethene (mg/l)	cis - 1, 2 - Dichloroethene (mg/l)	trans - 1, 2 - Dichloroethene (mg/l)	Vinyl Chloride (mg/l)
MW-1		09/19/1995	6500	<0.5	11			<1.0
		10/11/1995	870	<0.5	19			<1.0
	DUP	10/11/1995	900	<0.5	21			<1.0
MW-2		09/19/1995	590	<0.5	93			3.5
		10/11/1995	450	<0.5	77			2.2
	DUP	10/11/1995	470	<0.5	77			1.7
MW-3S		09/19/1995	0.6	<0.5	160			1.1
	DUP	09/19/1995	0.6	<0.5	170			<1.0
		10/11/1995	0.7	<0.5	230			1.4
	DUP	10/11/1995	0.7	<0.5	220			1.7
		04/30/1996	0.6	<0.5	310			2.6
		06/20/1996	<0.5	<0.5	200			<1
		10/30/1996	<0.5	<0.5	210			1.3
		11/21/1996	<0.5	<0.5	190			1.6
		08/28/1997	<0.2	<0.2	200			1.9
	DEC	08/28/1997	0.008	<0.01	150			1.8
		10/10/1997	<0.2	<0.2	230			4.7
		12/03/1998	0.73	<0.02	240			2.3
		10/07/1999	0.04	<0.02	270.09	270	0.09	2.9
		08/10/2001						
		10/30/2001						
		04/07/2003	1.5	<0.2	97	97	<0.2	1.8
MW-3D		01/16/1996	<0.005	<0.005	<0.005			<0.010
		01/30/1996	<0.005	<0.005	<0.005			<0.010
		08/10/2001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
MW-4		04/30/1996	32	<0.5	170			40
		06/20/1996	19	<0.5	110			19
	DUP	06/20/1996	19	<0.5	120			20
		10/30/1996	34	<0.5	120			14
	DUP	10/30/1996	36	<0.5	120			13
		11/21/1996	37	<0.5	120			18
		08/28/1997	29	<0.2	100			14
	DEC	08/28/1997	54	<0.01	190			23
		10/10/1997	33	<0.2	110			27
		12/02/1998	21	<0.2	110			12
	DUP	12/02/1998	20	<0.2	120			13
		10/07/1999	20	<0.05	100.14	100	0.14	14
		08/09/2001	30	0.003	93.28	93	0.28	18
		10/31/2001	22	<0.002	84.25	84	0.25	18
		04/07/2003	39	0.08	110.32	110	0.32	26
	DUP	04/07/2003	34	0.07	96	96	0.28	27
MW-5		04/30/1996	33	27	0.7			<1
		06/20/1996	680	110	4.3			<1
		10/31/1996	390	89	3.4			<1
		11/21/1996	260	120	1.8			<1
		04/07/2003	96	64	1.5	1.5	<0.2	<0.2
MW-6		04/30/1996	6.9	57	5.3			3.4
	DUP	04/30/1996	5.6	48	5.8			2.1
		06/20/1996	8.5	64	7.9			2.6
		10/30/1996	1.8	8.4	3.9			1.9
		11/21/1996	11	57	8.2			3.1
		08/28/1997	1.2	2.0	10			5.3
		10/10/1997	12	44	16			5.5
		12/02/1998	18	60	16			0.76
		10/07/1999	19	44	14	14	<0.05	1.6
		04/07/2003	7.4	31	7.3	7.3	<0.2	1.4
NYSDEC Class GA Criteria			0.005	0.005	0.005	0.005	0.005	0.002

Notes:
1. < - Indicates compound not detected above the specified detection limit.
2. Analytical Testing completed by Free-Col Laboratories, Inc.
3. DUP = Indicates that the presented results are from a duplicate sample.
4. DEC = Indicates that the presented results are from a split sample collected by GZA for the NYSDEC and tested by Recra Environmental, Inc.
5. Blank = Not tested.
6. NYSDEC Class GA Groundwater Criteria as promulgated in 6 NYCRR 703; Table 1 in Technical and Operational Guidance Series (1.1.1): Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, dated October 1993; revised June 1998; errata dated January 1999; addendum dated April 2000.
7. Concentrations presented for Total 1,2-Dichloroethene are the sum of the concentrations presented for cis- and trans-1,2-Dichloroethene, when analyzed for and reported separately.

Table 1
Summary of Groundwater Analytical Test Results for Target Volatile Organic Compounds
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Location		Sample Date	Target Chlorinated VOC Concentrations: Trichloroethylene (mg/l)	Tetrachloroethylene (mg/l)	Total 1,2-Dichloroethene (mg/l)	cis - 1, 2 - Dichloroethene (mg/l)	trans - 1, 2 - Dichloroethene (mg/l)	Vinyl Chloride (mg/l)
MW-7		04/30/1996	1300	<0.5	37			1.8
		06/20/1996	1100	<0.5	24			2.4
		10/30/1996	790	<0.5	32			2.3
		11/21/1996	850	<0.5	35			3.1
		08/28/1997	820	<0.2	22			1.1
		10/10/1997	720	<0.2	43			4.8
		12/03/1998	570	<0.2	55			4.2
		10/07/1999	540	<0.05	41	41	<0.05	3.5
		04/07/2003	75	<0.2	45	45	<0.2	2.8
MW-8		10/30/1996	0.20	0.024	1.5			0.047
		11/21/1996	0.22	0.022	2.6			0.049
		08/28/1997	0.30	0.028	2.8			0.062
		10/10/1997	0.35	0.018	4.3			0.11
		12/02/1998	0.22	0.012	1.6			0.062
		10/07/1999	0.20	0.011	2.802	2.8	0.002	0.18
MW-9		10/30/1996	2.2	0.21	3.3			0.1
		11/21/1996	2.0	0.06	3.2			0.16
	DUP	11/21/1996	1.9	0.07	2.9			0.15
		08/28/1997	1.4	0.027	2.5			0.056
		10/10/1997	1.6	0.047	2.7			0.12
		12/02/1998	1.9	0.066	2.5			0.030
	DUP	10/06/1999	1.4	0.058	1.608	1.6	0.008	0.11
		10/06/1999	1.2	0.062	1.508	1.5	0.008	0.091
MW-10		10/30/1996	0.98	0.12	1.8			0.11
		11/21/1996	0.87	0.22	1.7			<0.1
		08/28/1997	0.38	0.16	1.1			0.070
		10/10/1997	0.35	0.28	0.76			0.047
		12/01/1998	0.46	0.016	1.3			0.11
		10/06/1999	0.23	0.24	0.722	0.72	0.002	0.200
		08/09/2001	0.21	0.21	0.514	0.51	0.004	0.057
		10/31/2001	0.25	0.023	0.473	0.47	0.003	0.053
MW-11		08/28/1997	<0.0005	<0.0005	0.0045			0.0039
	DEC	08/28/1997	<0.01	<0.01	0.002			0.002
		10/10/1997	<0.0005	<0.0005	0.0032			0.0012
	DUP	10/10/1997	<0.0005	<0.0005	0.0030			0.0010
		12/01/1998	<0.0005	<0.0005	0.013			0.0046
		10/05/1999	<0.0005	<0.0005	0.010	0.010	<0.0005	0.0019
		08/08/2001	<0.002	<0.002	0.009	0.009	<0.002	0.008
		10/30/2001	<0.002	<0.002	0.008	0.008	<0.002	0.006
MW-12		08/28/1997	<0.0005	<0.0005	0.089			0.11
	DUP	08/28/1997	<0.005	<0.005	0.13			0.19
	DEC	08/28/1997	<0.01	<0.01	0.076			0.1
		10/10/1997	<0.0005	<0.0005	0.16			0.17
		12/01/1998	<0.0005	<0.0005	0.047			0.088
		10/06/1999	<0.0005	<0.0005	0.027	0.027	<0.0005	0.032
		08/08/2001	<0.002	<0.002	0.14	0.14	<0.002	0.13
	DUP	08/08/2001	<0.002	<0.002	0.13	0.13	<0.002	0.12
		10/30/2001	<0.002	<0.002	0.032	0.032	<0.002	0.011
MW-13		08/08/2001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
		10/29/2001	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002
MW-14		08/10/2001	<0.002	<0.002	0.005	0.005	<0.002	<0.002
		10/30/2001	<0.002	<0.002	0.004	0.004	<0.002	<0.002
MW-15		08/08/2001	<0.002	0.013	<0.002	<0.002	<0.002	<0.002
		10/30/2001	<0.002	0.018	<0.002	<0.002	<0.002	<0.002
	DUP	10/30/2001	<0.002	0.020	<0.002	<0.002	<0.002	<0.002
NYSDEC Class GA Criteria			0.005	0.005	0.005	0.005	0.005	0.002

Notes:
1. < - Indicates compound not detected above the specified detection limit.
2. Analytical Testing completed by Free-Col Laboratories, Inc.
3. DUP = Indicates that the presented results are from a duplicate sample.
4. DEC = Indicates that the presented results are from a split sample collected by GZA for the NYSDEC and tested by Recra Environmental, Inc.
5. Blank = Not tested.
6. NYSDEC Class GA Groundwater Criteria as promulgated in 6 NYCRR 703; Table 1 in Technical and Operational Guidance Series (1.1.1): Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations, dated October 1993; revised June 1998; errata dated January 1999; addendum dated April 2000.
7. Concentrations presented for Total 1,2-Dichloroethene are the sum of the concentrations presented for cis- and trans-1,2-Dichloroethene, when analyzed for and reported separately.

Table 4
Source Area Preliminary Screening of Remedial Technologies
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Groundwater General Response Actions	Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Alternative will be further evaluated in Detail Analysis Section 4.3
No Further Action	None	Not Applicable	Does not achieve remedial action objective	Not likely acceptable to public or local government	None	YES
Institutional Controls	Access Restriction	Deed Restrictions	Effectiveness depends on continued future implementation. Does not reduce contamination.	Readily Implementable	Low Capital Costs, and Low O&M Costs	YES
		Work Permits	Effectiveness depends on continued future implementation. Does not reduce contamination.	Readily Implementable	Low Capital Costs, and Low O&M Costs	YES
Monitoring	Monitored Natural Attenuation	Groundwater and Geochemical Monitoring	Natural attenuation appears to be effective at reducing concentrations of TCE in the source area to meet the remedial action objectives at the Site property line. Groundwater monitoring along with an evaluation following applicable MNA procedures would be used to evaluate the effectiveness.	Readily Implementable	Low Capital Costs, and low O&M costs	YES
Extraction/Containment	DNAPL Source Extraction	DNAPL Extraction	Effective for removing DNAPL source mass if well intersects/encounters DNAPL area. Extraction technologies applied to sites with DNAPL have a limited effectiveness.	Readily Implementable. However, identifying DNAPL during well installation is very difficult. Exisitng wells where DNAPL has been encountered could be used for extraction.	Moderate Capital Costs, moderate to high O&M Costs	YES
	Vertical Barrier Wall	Slurry Wall Steel Sheetpile Walls Grout Curtain	Limited effectiveness in isolating DNAPL because contamination is located within fractured bedrock. Additionally, a barrier wall would require other remedial technologies to improve its effectiveness.	Installation of vertical barrier walls is not expected to be implementable since DNAPL is within bedrock and excavation may require blasting or fracturing which may create new fractures and mobilize DNAPL.	Not Applicable because it is difficult to implement.	NO
	Bedrock Permeability Enhancement	Blast-Enhanced Fracturing	Blast-Enhanced Fracturing would not be a effective technology in the presence of DNAPL. The creation of new fractures would likely cause the mobilization of DNAPL and spread of dissolved phase contamination.	NA	NA	NO

See Notes on bottom of Page 2.

Table 5
Groundwater Preliminary Screening of Remedial Technologies
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Groundwater General Response Actions	Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Alternative will be further evaluated in Detail Analysis Section 4.3
No Further Action	None	Not Applicable	Does not achieve remedial action objective	Not likely acceptable to public or local government	None	YES
Institutional Controls	Access Restriction	Deed Restrictions	Effectiveness depends on continued future implementation. Does not reduce contamination.	Readily Implementable	Low Capital Costs, and Low O&M Costs	YES
		Work Permits	Effectiveness depends on continued future implementation. Does not reduce contamination.	Readily Implementable	Low Capital Costs, and Low O&M Costs	YES
Monitoring	Monitored Natural Attenuation	Groundwater and Geochemical Monitoring	Natural attenuation appears to be effective at reducing concentrations of TCE in groundwater to meet the remedial action objectives at the Site property line. Groundwater monitoring along with an evaluation following applicable MNA procedures would be used to evaluate the effectiveness.	Readily Implementable	Low Capital Costs, and low O&M costs	YES
Extraction/Containment	Groundwater Extraction	Groundwater Extraction and Treatment	Effective for dissolve phase contamination in conjunction with a groundwater treatment system (see below). Extraction wells can also be installed to provide a hydraulic barrier for control of migration of contaminated groundwater. Extraction technologies applied to sites with DNAPL have a limited effectiveness.	Readily Implementable. However, the completion of pump tests would be necessary in order to better evaluate the feasibility of groundwater extraction	Moderate Capital Costs, moderate to high O&M Costs	YES
	Vertical Barrier Wall	Slurry Wall Steel Sheetpile Walls Grout Curtain	Limited effectiveness in reducing the mobility of contaminated groundwater and in isolating groundwater from surroundings because contamination is located within fractured bedrock. Additionally, a barrier wall would require other remedial technologies to improve its effectiveness.	Installation of vertical barrier walls is not expected to be implementable since contaminated groundwater is within bedrock and excavation may require blasting or fracturing which may create new fractures and mobilize DNAPL.	Not Applicable because it is difficult to implement.	NO
	Bedrock Permeability Enhancement	Blast-Enhanced Fracturing	Blast-Enhanced Fracturing would not be a effective technology in the presence of DNAPL. The creation of new fractures would likely cause the mobilization of DNAPL and spread of dissolved phase contamination.	NA	NA	NO

See Notes on bottom of Page 2.

Table 5
Groundwater Preliminary Screening of Remedial Technologies
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Groundwater General Response Actions	Remedial Technology	Process Option	Effectiveness	Implementability	Cost	Alternative will be further evaluated in Detail Analysis Section 4.3
In-Situ Treatment	Chemical Oxidation	Chemical Oxidation	Effective for treatment of the dissolve phase contamination at the Site. Calcium carbonate (limestone) may make maintenance of appropriate pH difficult; and oxidation may impact natural attenuation properties. Effectiveness in bedrock aquifer reduced because contaminant mass which has diffused into the bedrock matrix is protected from exposure to the oxidant.	Chemical oxidation for the dissolved phase contamination is implementable, however, mobilization of the DNAPL source could occur. Limited by the volume of the reagent able to be delivered to dissolved phase contamination due to heterogeneity within the bedrock.	Moderate Capital Costs, and Moderate O&M Costs	YES
	Flushing	Co-Solvent/Surfactant	Co-Solvent/Surfactant flushing would be effective for treatment of the dissolve phase contamination. However, fractured bedrock patterns may not allow for full extraction/capture and treatment of groundwater contamination. Additionally, because co-solvent flushing will reduce the interfacial tension between DNAPL and water, mobilization of DNAPL is likely.	Implementable. A pilot-scale treatability would be necessary to assess system design. Confirmatory sampling would be required to assess performance.	High Capital Costs, moderate O&M costs	NO
	Enhanced Bioremediation	Hydrogen Release Compounds	Hydrogen Release Compounds (HRC) are used to enhance in-situ biodegradation rates for chlorinated hydrocarbons. Reductive dechlorination is an attenuation mechanism, which causes the breakdown of chlorinated solvents in groundwater by the creation of anaerobic conditions and the production of hydrogen. The naturally occurring microorganisms use the hydrogen to remove chlorine atoms from chlorinated hydrocarbon contaminants.	Implementable. Confirmatory sampling would be required to assess performance.	Low to Moderate Capital Costs, moderate O&M costs	NO
	Thermal Injection	Steam Injection	Steam Injection may be effective on dissolve phase groundwater contamination, however limited information on treatment in bedrock is available. Low permeabilities and heterogeneities (fractured bedrock) would likely reduce the effectiveness of the process.	Implementable. A pilot-scale treatability would be necessary to assess system design. Confirmatory sampling would be required to assess performance.	High Capital Costs, and Moderate O&M Costs	NO
Ex-Situ Treatment	Physical Treatment	Air Stripper	Air stripping would be an effective technology for pretreating groundwater to achieve the pretreatment standards.	Implementable	Moderate to high Capital costs compared to other pretreatment options, moderate O&M costs	NO
		Activated Carbon	Activated carbon would be an effective technology for pretreating groundwater to achieve the pretreatment standards.	Implementable	Moderate Capital Costs, low to moderate O&M costs	YES

NOTES:
1) NA = not applicable. No evaluation necessary because remedial technology was already ruled out.
2) Refer to Section 2.5.5 for further description of the remedial technologies described in the table.

See Notes on bottom of Page 2.

NOTE:
BASE MAP ADAPTED FROM DeLORME 3-D TOPOQUADS ON CD, COPYRIGHT 1999. U.S.G.S. QUADRANGLE MAPS LOCKPORT, N.Y. - 1980 AND CAMBRIA, N.Y. - 1980.

DRAWN BY: DEW

DATE: NOVEMBER 2003

GZA GeoEnvironmental of New York

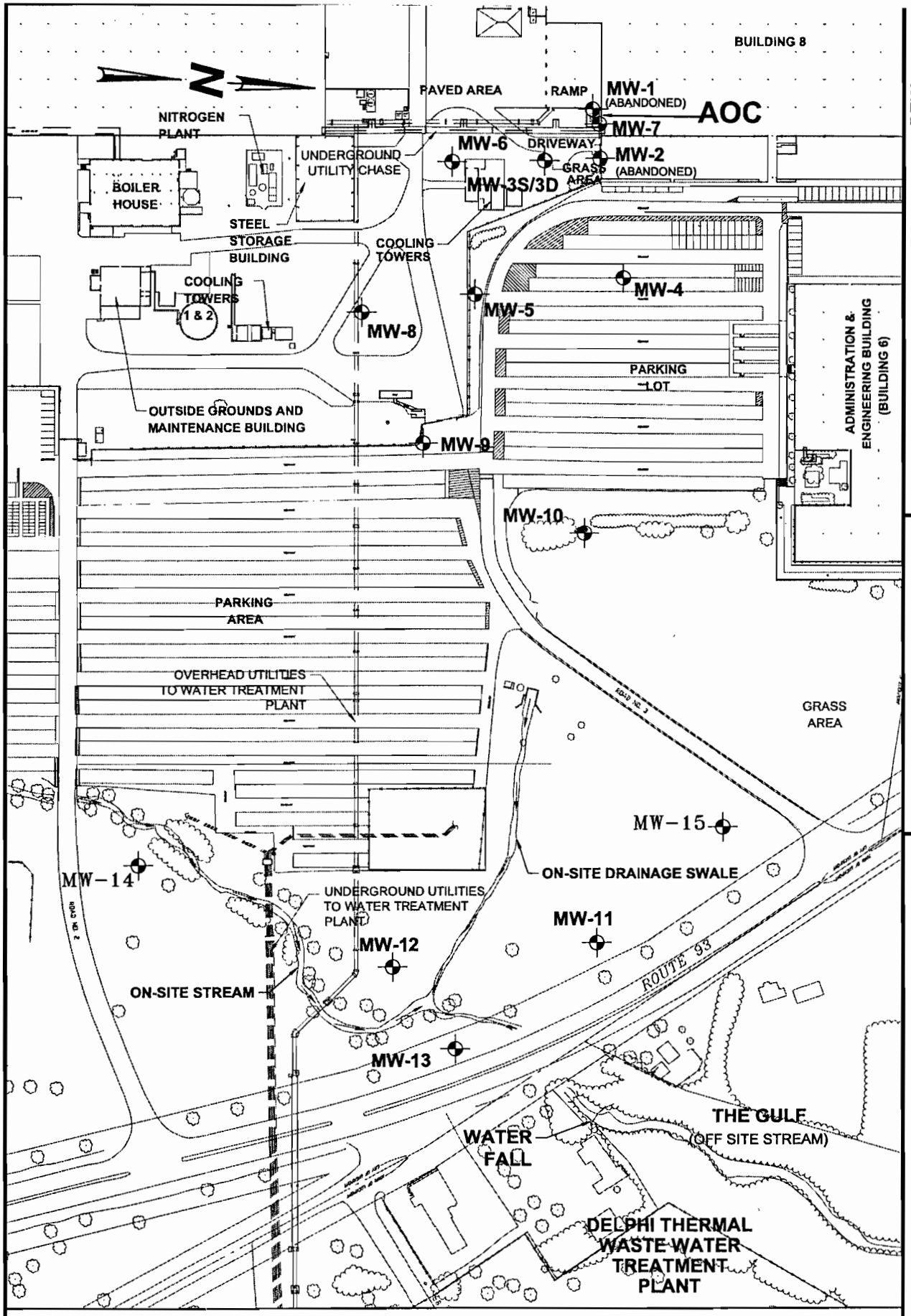
DELPHI HARRISON THERMAL SYSTEMS
LOCKPORT, NEW YORK

FOCUSED FEASIBILITY STUDY

LOCUS PLAN

PROJECT No.
21.0055731.00

FIGURE No.
1



LEGEND:

MW-3S APPROXIMATE LOCATION AND DESIGNATION OF EXISTING MONITORING WELL INSTALLED BY GZA

AOC DENOTES AREA OF CONCERN

NOTES:

1. BASE MAP ADAPTED FROM AN AUTOCAD FILE PROVIDED BY DELPHI HARRISON THERMAL SYSTEMS.

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DATE: NOVEMBER 2003

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SCALE IN FEET

0 100 200 400

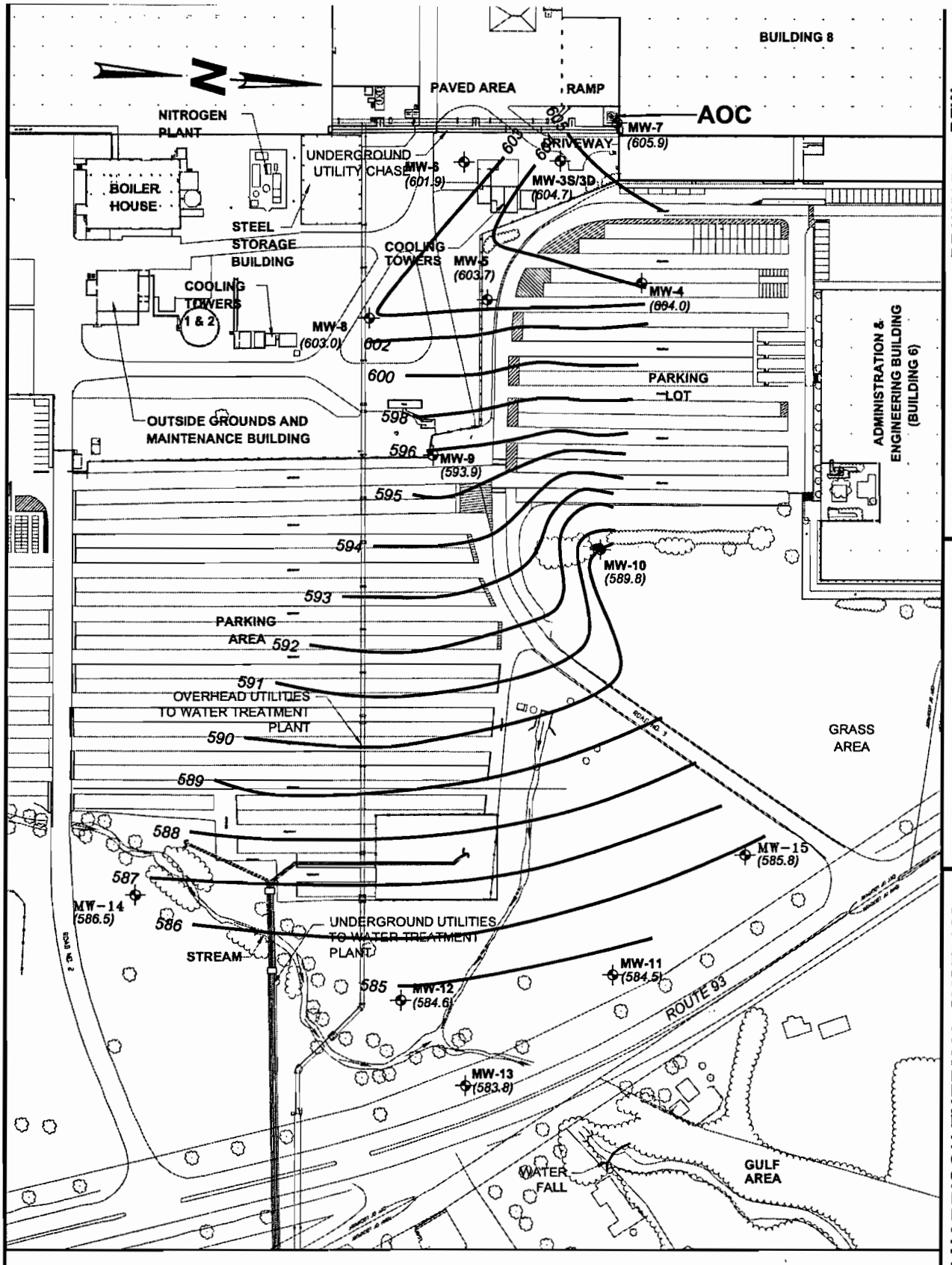
DELPHI HARRISON THERMAL SYSTEMS
LOCKPORT, NEW YORK

FOCUSED FEASIBILITY STUDY

SITE PLAN/MONITORING WELL LOCATION PLAN

PROJECT No.
21.0055731.00

FIGURE No.
2



DRAWN BY: DEW

DATE: NOVEMBER 2003

GZA GeoEnvironmental of New York

SCALE IN FEET

0 100 200 400

DELPHI HARRISON THERMAL SYSTEMS

LOCKPORT, NEW YORK

FOCUSED FEASIBILITY STUDY

GROUNDWATER CONTOUR PLAN (OCTOBER 29, 2001)

PROJECT No.

21.0055731.00

FIGURE No.

3

LEGEND:

MW-3S (604.7) — APPROXIMATE LOCATION AND DESIGNATION OF EXISTING MONITORING WELL INSTALLED BY GZA

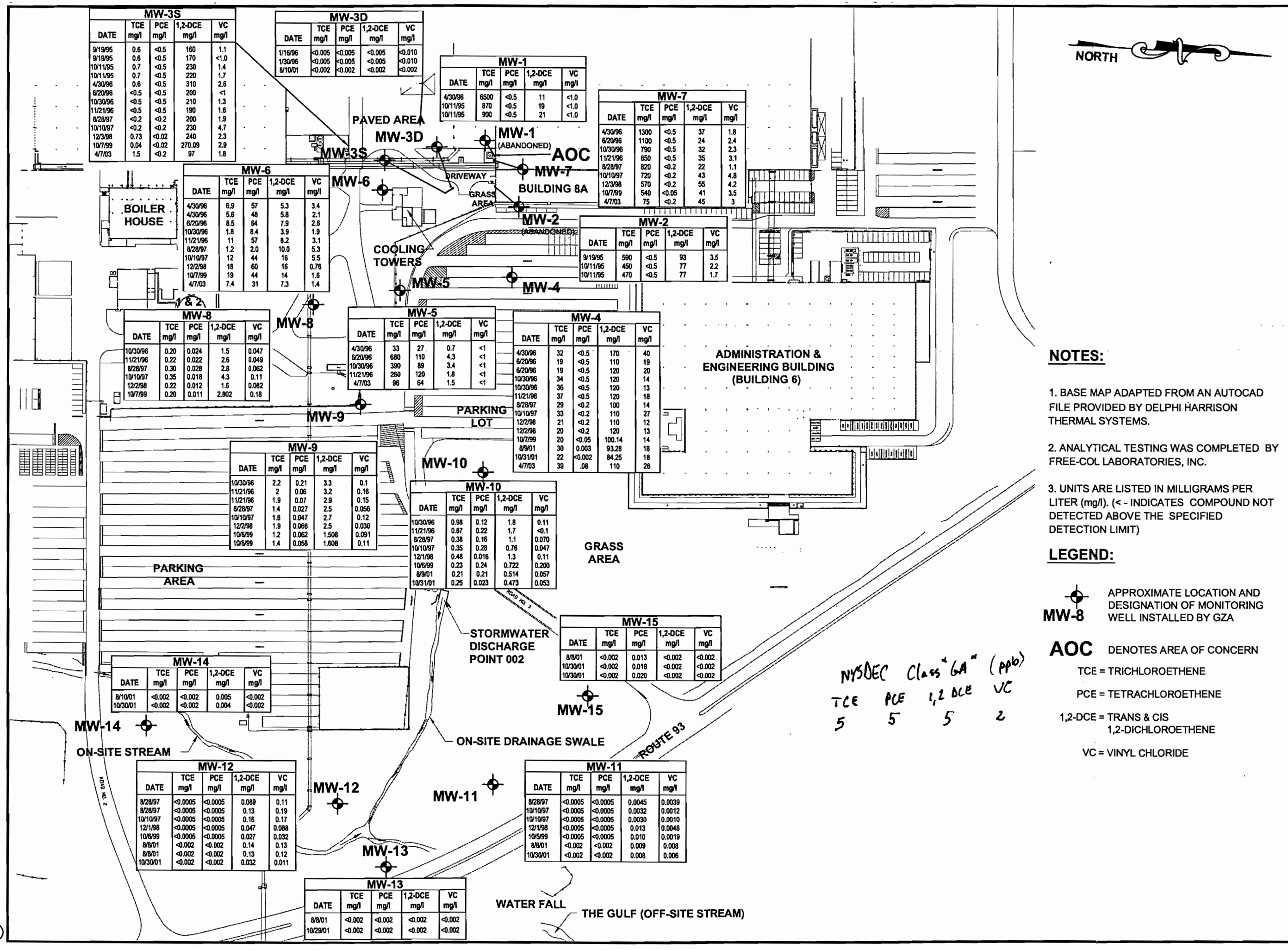
APPROXIMATE GROUNDWATER ELEVATION MEASURED ON OCTOBER 29, 2001

AOC DENOTES AREA OF CONCERN

NOTES:

1. BASE MAP ADAPTED FROM AN AUTOCAD FILE PROVIDED BY DELPHI HARRISON THERMAL SYSTEMS.

2. WATER LEVEL READINGS HAVE BEEN MADE IN WELLS AT TIMES AND UNDER CONDITIONS PRESENTED IN THE REPORT. FLUCTUATIONS IN GROUNDWATER ELEVATIONS MAY OCCUR DUE TO VARIATIONS IN RAINFALL, BAROMETRIC PRESSURE, AND OTHER FACTORS.



MW-3S

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
9/19/95	0.6	<0.5	160	1.1
9/19/95	0.6	<0.5	170	<1.0
10/11/95	0.7	<0.5	230	1.4
10/11/95	0.7	<0.5	220	1.7
4/30/96	0.6	<0.5	310	2.6
6/20/96	<0.5	<0.5	200	<1
10/30/96	<0.5	<0.5	210	1.3
11/21/96	<0.5	<0.5	190	1.6
8/28/97	<0.2	<0.2	200	1.9
10/10/97	<0.2	<0.2	230	4.7
12/3/98	0.73	<0.02	240	2.3
10/7/99	0.04	<0.02	270.09	2.9
4/7/03	1.5	<0.2	97	1.8

MW-3D

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
1/16/96	<0.005	<0.005	<0.005	<0.010
1/30/96	<0.005	<0.005	<0.005	<0.010
8/10/01	<0.002	<0.002	<0.002	<0.002

MW-1

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
4/30/96	6500	<0.5	11	<1.0
10/11/95	870	<0.5	19	<1.0
10/11/95	900	<0.5	21	<1.0

MW-7

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
4/30/96	1300	<0.5	37	1.8
6/20/96	1100	<0.5	24	2.4
10/30/96	790	<0.5	32	2.3
11/21/96	850	<0.5	35	3.1
8/28/97	820	<0.2	22	1.1
10/10/97	720	<0.2	43	4.8
12/3/98	570	<0.2	55	4.2
10/7/99	540	<0.05	41	3.5
4/7/03	75	<0.2	45	3

MW-6

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
4/30/96	8.9	57	5.3	3.4
4/30/96	5.6	48	5.8	2.1
6/20/96	8.5	64	7.9	2.6
10/30/96	1.8	8.4	3.9	1.9
11/21/96	11	57	8.2	3.1
8/28/97	1.2	2.0	10.0	5.3
10/10/97	12	44	16	5.5
12/2/98	18	60	16	0.76
10/7/99	19	44	14	1.6
4/7/03	7.4	31	7.3	1.4

MW-2

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
9/19/95	590	<0.5	93	3.5
10/11/95	450	<0.5	77	2.2
10/11/95	470	<0.5	77	1.7

MW-8

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
10/30/96	0.20	0.024	1.5	0.047
11/21/96	0.22	0.022	2.6	0.049
8/28/97	0.30	0.028	2.8	0.062
10/10/97	0.35	0.018	4.3	0.11
12/2/98	0.22	0.012	1.6	0.082
10/7/99	0.20	0.011	2.802	0.18

MW-5

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
4/30/96	33	27	0.7	<1
6/20/96	680	110	4.3	<1
10/30/96	390	89	3.4	<1
11/21/96	260	120	1.8	<1
4/7/03	96	64	1.5	<1

MW-4

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
4/30/96	32	<0.5	170	40
6/20/96	19	<0.5	110	19
6/20/96	19	<0.5	120	20
10/30/96	34	<0.5	120	14
10/30/96	36	<0.5	120	13
11/21/96	37	<0.5	120	18
8/28/97	29	<0.2	100	14
10/10/97	33	<0.2	110	27
12/2/98	21	<0.2	110	12
12/2/98	20	<0.2	120	13
10/7/99	20	<0.05	100.14	14
8/9/01	30	0.003	93.28	18
10/31/01	22	<0.002	84.25	18
4/7/03	39	.08	110	26

MW-9

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
10/30/96	2.2	0.21	3.3	0.1
11/21/96	2	0.06	3.2	0.16
11/21/96	1.9	0.07	2.9	0.15
8/28/97	1.4	0.027	2.5	0.056
10/10/97	1.8	0.047	2.7	0.12
12/2/98	1.9	0.066	2.5	0.030
10/6/99	1.2	0.062	1.508	0.091
10/6/99	1.4	0.058	1.608	0.11

MW-10

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
10/30/96	0.98	0.12	1.8	0.11
11/21/96	0.87	0.22	1.7	<0.1
8/28/97	0.38	0.16	1.1	0.070
10/10/97	0.35	0.28	0.76	0.047
12/1/98	0.48	0.016	1.3	0.11
10/6/99	0.23	0.24	0.722	0.200
8/9/01	0.21	0.21	0.514	0.057
10/31/01	0.25	0.023	0.473	0.053

MW-15

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
8/8/01	<0.002	0.013	<0.002	<0.002
10/30/01	<0.002	0.018	<0.002	<0.002
10/30/01	<0.002	0.020	<0.002	<0.002

MW-14

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
8/10/01	<0.002	<0.002	0.005	<0.002
10/30/01	<0.002	<0.002	0.004	<0.002

MW-12

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
8/28/97	<0.0005	<0.0005	0.089	0.11
8/28/97	<0.0005	<0.0005	0.13	0.19
10/10/97	<0.0005	<0.0005	0.16	0.17
12/1/98	<0.0005	<0.0005	0.047	0.088
10/6/99	<0.0005	<0.0005	0.027	0.032
8/8/01	<0.002	<0.002	0.14	0.13
8/8/01	<0.002	<0.002	0.13	0.12
10/30/01	<0.002	<0.002	0.032	0.011

MW-11

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
8/28/97	<0.0005	<0.0005	0.0045	0.0039
10/10/97	<0.0005	<0.0005	0.0032	0.0012
10/10/97	<0.0005	<0.0005	0.0030	0.0010
12/1/98	<0.0005	<0.0005	0.013	0.0046
10/5/99	<0.0005	<0.0005	0.010	0.0019
8/8/01	<0.002	<0.002	0.009	0.008
10/30/01	<0.002	<0.002	0.008	0.006

MW-13

DATE	TCE mg/l	PCE mg/l	1,2-DCE mg/l	VC mg/l
8/8/01	<0.002	<0.002	<0.002	<0.002
10/29/01	<0.002	<0.002	<0.002	<0.002

NYSDEC Class "GA" (ppb)

TCE	PCE	1,2 DCE	VC
5	5	5	2

NOTES:

1. BASE MAP ADAPTED FROM AN AUTOCAD FILE PROVIDED BY DELPHI HARRISON THERMAL SYSTEMS.

2. ANALYTICAL TESTING WAS COMPLETED BY FREE-COL LABORATORIES, INC.

3. UNITS ARE LISTED IN MILLIGRAMS PER LITER (mg/l). (< - INDICATES COMPOUND NOT DETECTED ABOVE THE SPECIFIED DETECTION LIMIT)

LEGEND:

MW-8 — APPROXIMATE LOCATION AND DESIGNATION OF MONITORING WELL INSTALLED BY GZA

AOC — DENOTES AREA OF CONCERN

TCE = TRICHLOROETHENE

PCE = TETRACHLOROETHENE

1,2-DCE = TRANS & CIS 1,2-DICHLOROETHENE

VC = VINYL CHLORIDE

REV No.	DESCRIPTION	BY	DATE

DRAWN BY: DEW

DATE: NOVEMBER 2003

SCALE IN FEET: 0, 85, 170, 340

GZA GeoEnvironmental of New York

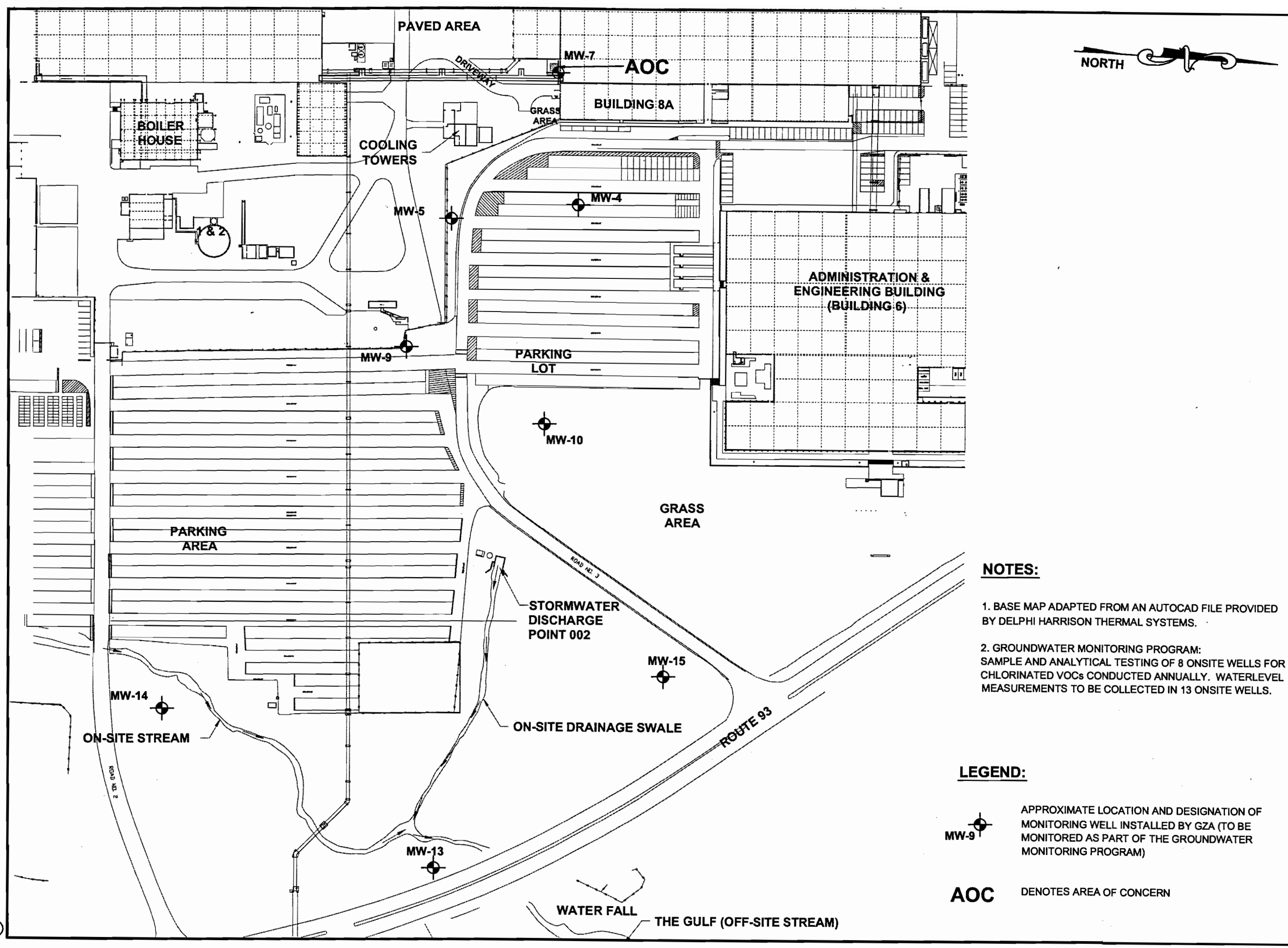
DELPHI HARRISON THERMAL SYSTEMS
LOCKPORT, NEW YORK

FOCUSED FEASIBILITY STUDY

GROUNDWATER ANALYTICAL TEST RESULTS FOR CHLORINATED VOLATILE ORGANIC COMPOUNDS (CVOCs)

PROJECT No.
21.0055731.00

FIGURE:
4



NOTES:

1. BASE MAP ADAPTED FROM AN AUTOCAD FILE PROVIDED BY DELPHI HARRISON THERMAL SYSTEMS.

2. GROUNDWATER MONITORING PROGRAM:
SAMPLE AND ANALYTICAL TESTING OF 8 ONSITE WELLS FOR CHLORINATED VOCs CONDUCTED ANNUALLY. WATERLEVEL MEASUREMENTS TO BE COLLECTED IN 13 ONSITE WELLS.

LEGEND:

MW-9	APPROXIMATE LOCATION AND DESIGNATION OF MONITORING WELL INSTALLED BY GZA (TO BE MONITORED AS PART OF THE GROUNDWATER MONITORING PROGRAM)
AOC	DENOTES AREA OF CONCERN

DESCRIPTION | BY | DATE

REV No.

DRAWN BY: DEW

DATE: NOVEMBER 2003

SCALE IN FEET 0 75 150 300

GZA GeoEnvironmental of New York

DELPHI HARRISON THERMAL SYSTEMS
LOCKPORT, NEW YORK

FOCUSED FEASIBILITY STUDY

ALTERNATIVE No. 2
MONITORED NATURAL ATTENUATION WITH GROUNDWATER MONITORING

PROJECT No.
21.0055731.00

FIGURE:
5

PAVED AREA
DRIVEWAY
MW-7
AOC
BUILDING 8A
MW-3S
GRASS AREA
MW-6
BOILER HOUSE
COOLING TOWERS
MW-4
MW-5
1 & 2
MW-8
ADMINISTRATION & ENGINEERING BUILDING (BUILDING 6)
MW-9
PARKING LOT
MW-10
GRASS AREA
PARKING AREA
ROAD NO. 3
STORMWATER DISCHARGE POINT 002
MW-15
MW-14
ON-SITE DRAINAGE SWALE
ROUTE 93
ON-SITE STREAM
ROAD NO. 2
MW-12
MW-11
MW-13
WATER FALL
THE GULF (OFF-SITE STREAM)

NORTH

NOTES:

1. BASE MAP ADAPTED FROM AN AUTOCAD FILE PROVIDED BY DELPHI HARRISON THERMAL SYSTEMS.

2. CHEMICAL OXIDATION INJECTIONS WOULD OCCUR IN EXISTING WELLS MW-3S, MW-4, MW-5 AND MW-7.

3. GROUNDWATER MONITORING PROGRAM:
SAMPLE AND ANALYTICAL TESTING OF 8 ONSITE WELLS FOR CHLORINATED VOCs. SAMPLING TO BE CONDUCTED QUARTERLY IN YEARS 1 & 2 AND ANNUALLY IN YEARS 3 THROUGH 30. WATER LEVEL MEASUREMENTS TO BE COLLECTED IN ALL 13 ONSITE WELLS.

LEGEND:

MW-9 — APPROXIMATE LOCATION AND DESIGNATION OF MONITORING WELL INSTALLED BY GZA (TO BE MONITORED AS PART OF THE GROUNDWATER MONITORING PROGRAM)

AOC — DENOTES AREA OF CONCERN

DESCRIPTION	BY	DATE

DRAWN BY: DEW
DATE: NOVEMBER 2003

GZA GeoEnvironmental of New York

REV No.

SCALE IN FEET
0 75 150 300

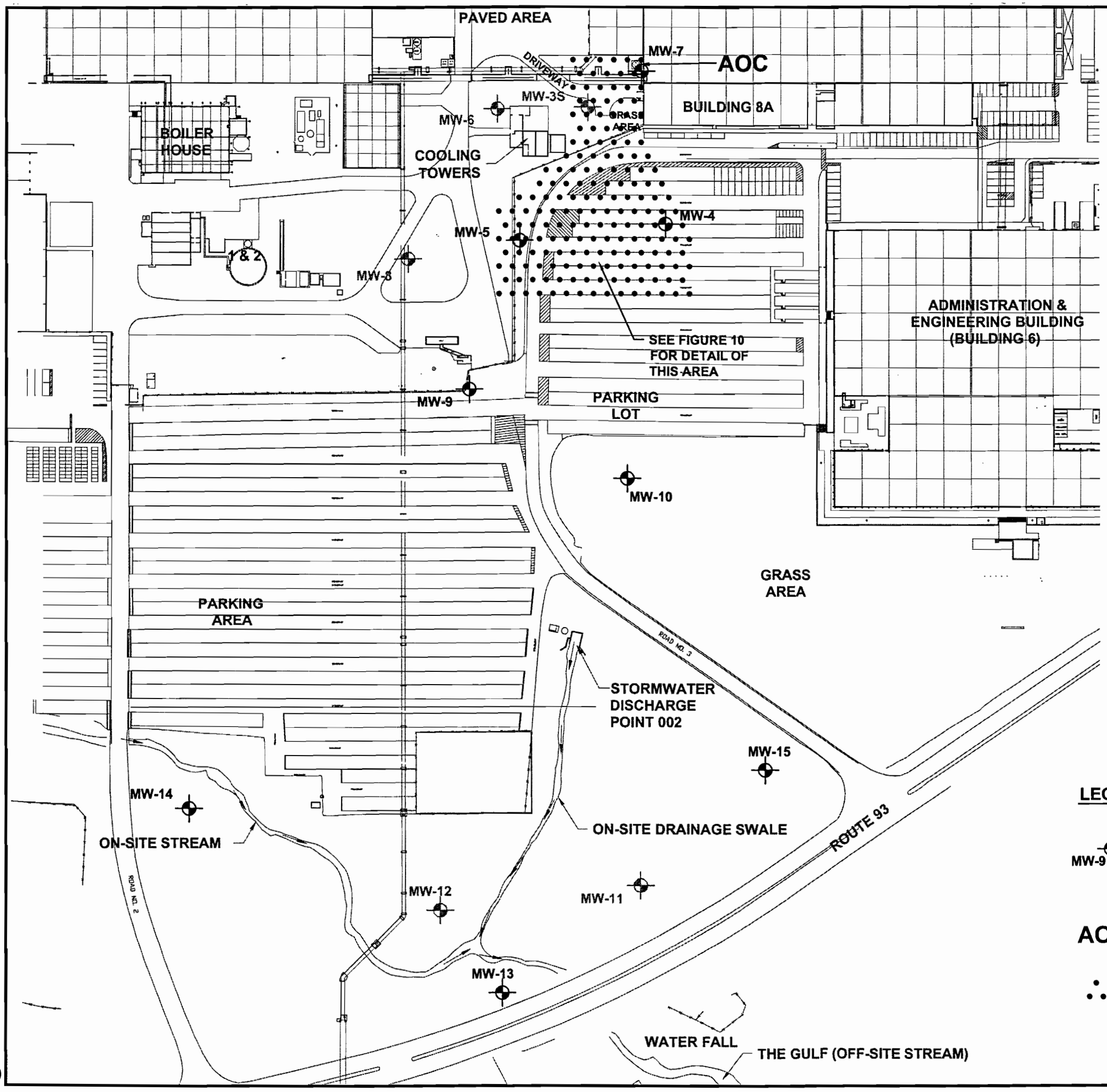
DELPHI HARRISON THERMAL SYSTEMS
LOCKPORT, NEW YORK

FOCUSED FEASIBILITY STUDY

ALTERNATIVE No. 4A
SOURCE AREA IN-SITU CHEMICAL OXIDATION WITH GROUNDWATER MONITORING

PROJECT No.
21.0055731.00

FIGURE:
8



NORTH

NOTES:

1. BASE MAP ADAPTED FROM AN AUTOCAD FILE PROVIDED BY DELPHI HARRISON THERMAL SYSTEMS.

2. APPROXIMATE LOCATION OF CHEMICAL OXIDATION INJECTION WELLS ARE INDICATED. ACTUAL LOCATIONS MAY VARY FOR REMEDIAL DESIGN, AS NECESSARY.

3. GROUNDWATER MONITORING PROGRAM: SAMPLE AND ANALYTICAL TESTING OF 8 ONSITE WELLS FOR CHLORINATED VOCs. SAMPLING TO BE CONDUCTED QUARTERLY IN YEARS 1 & 2 AND ANNUALLY IN YEARS 3 THROUGH 30. WATER LEVEL MEASUREMENTS TO BE COLLECTED IN ALL 13 ONSITE WELLS.

LEGEND:

MW-9 — APPROXIMATE LOCATION AND DESIGNATION OF MONITORING WELL INSTALLED BY GZA (TO BE MONITORED AS PART OF THE GROUNDWATER MONITORING PROGRAM)

AOC — DENOTES AREA OF CONCERN

APPROXIMATE LOCATION OF CHEMICAL OXIDATION INJECTION POINTS

REV No.	DESCRIPTION	BY	DATE

DRAWN BY: DEW

DATE: NOVEMBER 2003

GZA GeoEnvironmental of New York

SCALE IN FEET: 0 75 150 300

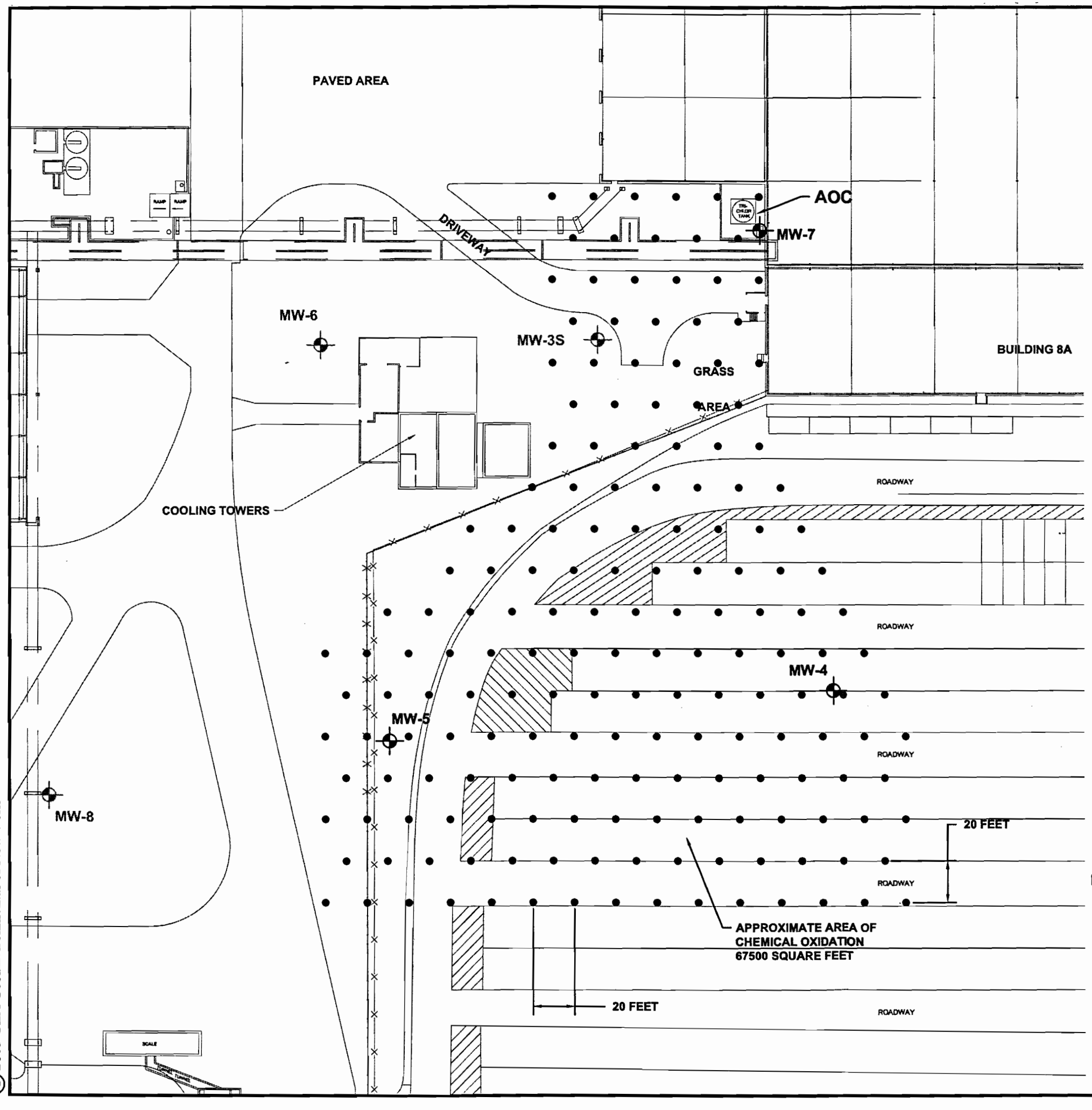
DELPHI HARRISON THERMAL SYSTEMS
LOCKPORT, NEW YORK

FOCUSED FEASIBILITY STUDY

ALTERNATIVE No. 4B
FULLSCALE GROUNDWATER IN-SITU CHEMICAL OXIDATION WITH GROUNDWATER MONITORING

PROJECT No.
21.0055731.00

FIGURE:
9



NOTES:

1. BASE MAP ADAPTED FROM AN AUTOCAD FILE PROVIDED BY DELPHI HARRISON THERMAL SYSTEMS.

2. APPROXIMATE LOCATION OF CHEMICAL OXIDATION INJECTION WELLS ARE INDICATED. ACTUAL LOCATIONS MAY VARY FOR REMEDIAL DESIGN, AS NECESSARY.

LEGEND:

MW-5 — APPROXIMATE LOCATION AND DESIGNATION OF MONITORING WELL INSTALLED BY GZA (TO BE MONITORED AS PART OF THE GROUNDWATER MONITORING PROGRAM)

AOC — DENOTES AREA OF CONCERN

• — APPROXIMATE LOCATION OF PROPOSED CHEMICAL OXIDATION INJECTION POINT

REV No. | DESCRIPTION | BY | DATE

DRAWN BY: DEW

DATE: NOVEMBER 2003

GZA GeoEnvironmental of New York

SCALE IN FEET 0 25 50 100

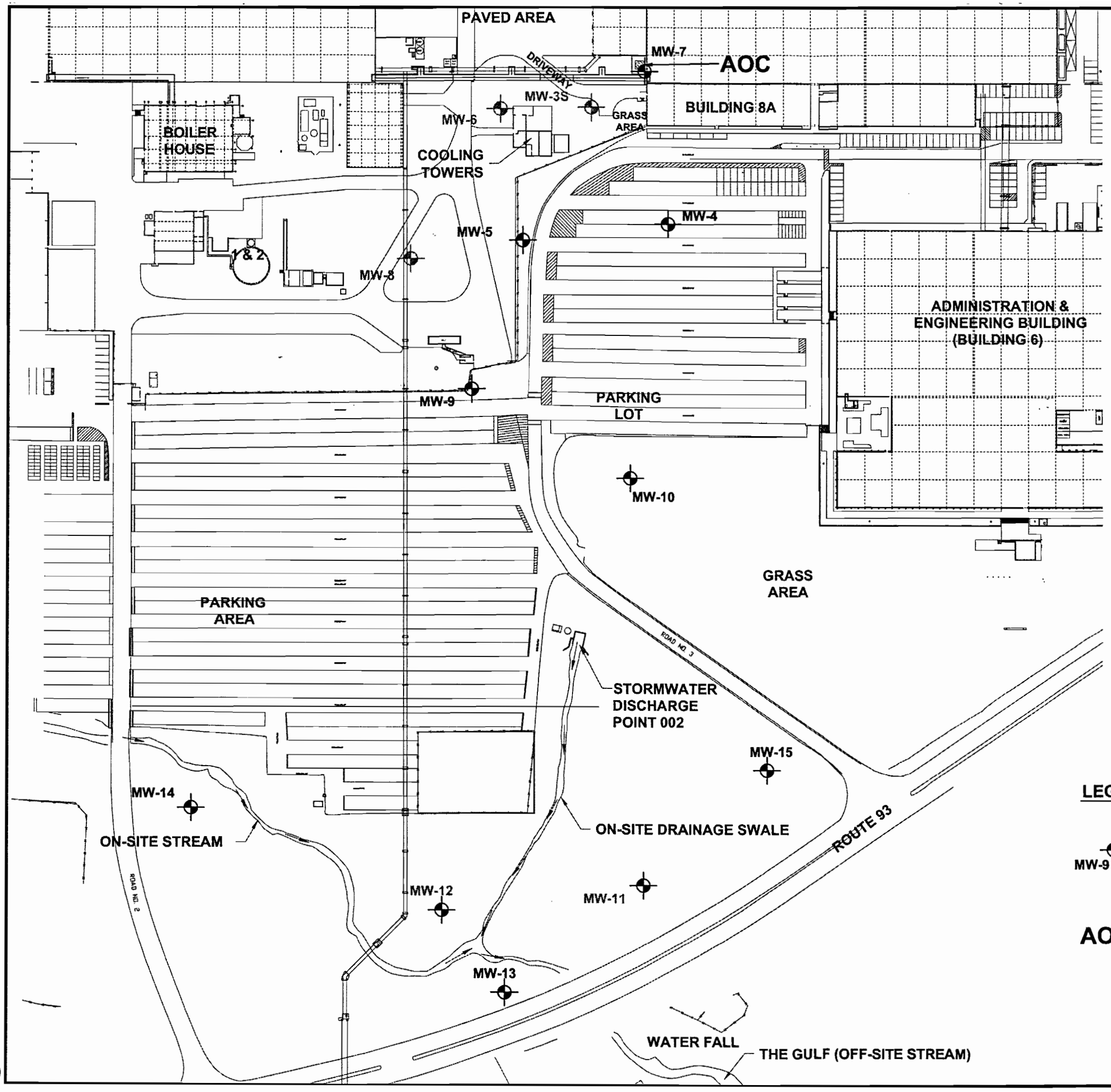
DELPHI HARRISON THERMAL SYSTEMS
LOCKPORT, NEW YORK

FOCUSED FEASIBILITY STUDY

ALTERNATIVE No. 4B
FULL SCALE GROUNDWATER IN-SITU CHEMICAL OXIDATION INJECTION AREA

PROJECT No.
21.0055731.00

FIGURE:
10



NORTH

NOTES:

1. BASE MAP ADAPTED FROM AN AUTOCAD FILE PROVIDED BY DELPHI HARRISON THERMAL SYSTEMS.

2. SOURCE AREA DNAPL EXTRACTION WILL CONSIST OF LOW FLOW EXTRACTION VIA PERISTALTIC PUMP FROM EXISTING MONITORING WELL MW-5.

3. GROUNDWATER MONITORING PROGRAM:
SAMPLE AND ANALYTICAL TESTING OF 8 ONSITE WELLS FOR CHLORINATED VOCs. SAMPLING TO BE CONDUCTED QUARTERLY IN YEARS 1 & 2 AND ANNUALLY IN YEARS 3 THROUGH 30. WATER LEVEL MEASUREMENTS TO BE COLLECTED IN ALL 13 ONSITE WELLS.

LEGEND:

MW-9 — APPROXIMATE LOCATION AND DESIGNATION OF MONITORING WELL INSTALLED BY GZA (TO BE MONITORED AS PART OF THE GROUNDWATER MONITORING PROGRAM)

AOC — DENOTES AREA OF CONCERN

DESCRIPTION	BY	DATE

DRAWN BY: DEW

DATE: NOVEMBER 2003

GZA GeoEnvironmental of New York

REV No.

SCALE IN FEET: 0 75 150 300

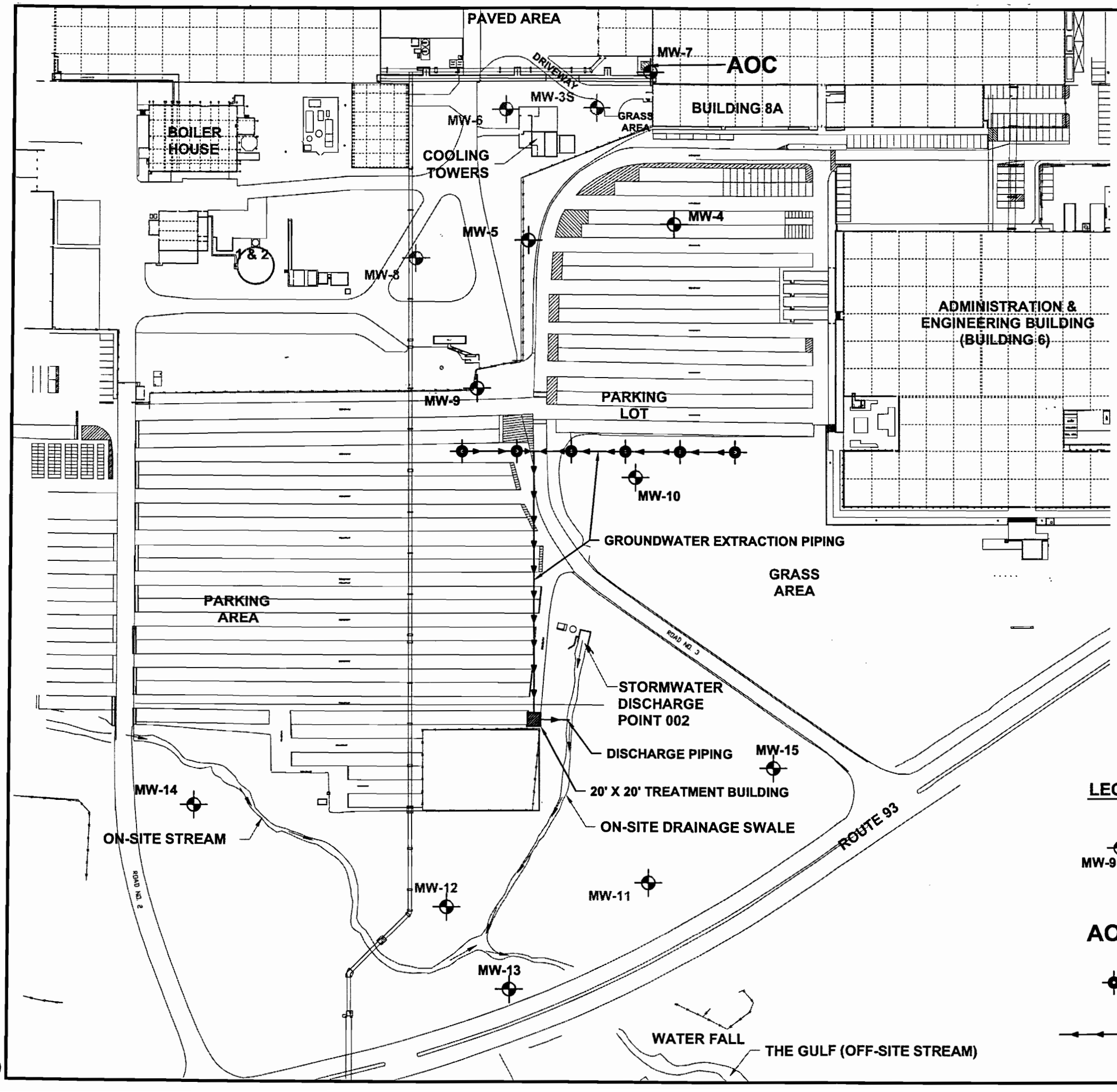
DELPHI HARRISON THERMAL SYSTEMS
LOCKPORT, NEW YORK

FOCUSED FEASIBILITY STUDY

ALTERNATIVE No. 3A
SOURCE AREA DNAPL EXTRACTION WITH GROUNDWATER MONITORING

PROJECT No.
21.0055731.00

FIGURE:
6



NORTH

NOTES:

1. BASE MAP ADAPTED FROM AN AUTOCAD FILE PROVIDED BY DELPHI HARRISON THERMAL SYSTEMS.

2. APPROXIMATE LOCATIONS AND DIMENSIONS OF GROUNDWATER EXTRACTION WELLS AND TREATMENT BUILDING ARE INDICATED. ACTUAL LOCATIONS AND DIMENSIONS MAY VARY FOR REMEDIAL DESIGNS, AS NECESSARY.

3. GROUNDWATER MONITORING PROGRAM:
SAMPLE AND ANALYTICAL TESTING OF 8 ONSITE WELLS FOR CHLORINATED VOCs. SAMPLING TO BE CONDUCTED QUARTERLY IN YEARS 1 & 2 AND ANNUALLY IN YEARS 3 THROUGH 30. WATER LEVEL MEASUREMENTS TO BE COLLECTED IN ALL 13 ONSITE WELLS.

4. GROUNDWATER EXTRACTION AND DISCHARGE PIPING TO BE INSTALLED AT A DEPTH OF APPROXIMATELY 4' BGS.

LEGEND:

- MW-9 — APPROXIMATE LOCATION AND DESIGNATION OF MONITORING WELL INSTALLED BY GZA (TO BE MONITORED AS PART OF THE GROUNDWATER MONITORING PROGRAM)
- AOC — DENOTES AREA OF CONCERN
- APPROXIMATE LOCATION AND DESIGNATION OF PROPOSED 25' DEEP EXTRACTION WELL.
- PROPOSED GROUNDWATER EXTRACTION / DISCHARGE PIPING WITH FLOW DIRECTION

REV No.	DESCRIPTION	BY	DATE

DRAWN BY: DEW

DATE: NOVEMBER 2003

GZA GeoEnvironmental of New York

SCALE IN FEET: 0 75 150 300

DELPHI HARRISON THERMAL SYSTEMS
LOCKPORT, NEW YORK

FOCUSED FEASIBILITY STUDY

ALTERNATIVE No. 3B
GROUNDWATER EXTRACTION WITH GROUNDWATER MONITORING

PROJECT No.
21.0055731.00

FIGURE:
7

APPENDIX A

NYSDEC AND DELPHI THERMAL LETTERS

INCLUDING LETTERS DATED:

- December 2, 1994;
- December 22, 1994;
- April 13, 1995;
- April 11, 1996;
- May 15, 1998;
- October 21, 1998;
- August 12, 1999;
- March 10, 2000;
- June 20, 2000;
- September 18, 2000;
- September 25, 2000;
- November 16, 2000;
- February 2, 2001;
- June 5, 2001;
- June 20, 2001;
- July 9, 2001;
- February 8, 2002;
- December 17,2002;
- January 28, 2003; and
- July 22, 2003.

New York State Department of Environmental Conservation
270 Michigan Avenue, Buffalo, New York 14203-2999
(716) 851-7220

Langdon Marsh
Commissioner

December 2, 1994

HARRISON DIV.
GENERAL MOTORS CORP.
RECEIVED
DEC 9 1994
ENVIRONMENTAL ACTIVITIES

Ms. Amy S. Buckenheimer
Senior Environmental Engineer
Environmental Activities
Harrison Division
General Motors Corporation
Lockport, NY 14094

Dear Ms. Buckenheimer:

Spill Number 9410972
SE Corner of Building 8-Trichlor
Lockport
Niagara

On December 1, 1994, we discussed the above referenced spill and you must do the following:

1. Submit a copy of the results for the analyses on the soil.

2. Submit a copy of a site plan indicating the affected area and where samples have been taken.

Based on the documentation provided, further remediation may be required. Please submit the documentation by December 23, 1994.

Your cooperation is appreciated. If you have any questions, please call me at 851-7220.

Sincerely,

Salvatore A. Calandra

Salvatore A. Calandra
Environmental Engineer I

SAC/ad
cc: Mr. David Drust, NCHD

HARRISON

Harrison Division
General Motors Corporation
200 Upper Mountain Road
Lockport, New York 14094

CERTIFIED
P 884 920 573
MAIL

December 22, 1994

Mr. Salvatore A. Calandra
Environmental Engineer I
New York State Department of Environmental Conservation
270 Michigan Avenue
Buffalo, New York 14203-2999

Subject: ***SPILL NUMBER 9410972***
SE CORNER OF BUILDING 8
LOCKPORT, NEW YORK

Dear Mr. Calandra:

As per your request, please find enclosed:

1.) Site Plan of excavation area on the SE corner of Building 8 showing where samples were taken.
2.) Facility Plan showing excavation area in relation to entire West Lockport facility.
3.) Results of soil analysis - Total trichloroethylene and TCLP trichloroethylene for four samples.

Summary of Events

Please refer to the attached site plan. The six inch fire protection line which is located approximately six feet below ground, failed causing water to fill a containment area located directly above the line. The above-ground tank 8-18, which previously held trichloroethylene and was closed-in-place on 5-1-94, was located in the containment area.

In order to repair the water line, our maintenance crew removed the tank, containment pad, and soil above the water lines.

During excavation to repair the water line, solvent fumes were noticed. Excavation was completed and soil samples were taken from the bottom of the site as shown in the site plan to determine if trichloroethylene existed in the soil. As discussed in our December 1, 1994, telephone conversation, Harrison needed to protect the water lines from movement and freezing by backfilling the hole with sand and crushed stone. The excavation area was backfilled on December 3, 1994, with 2 feet of sand to cover the pipes and then crushed concrete to fill to grade.

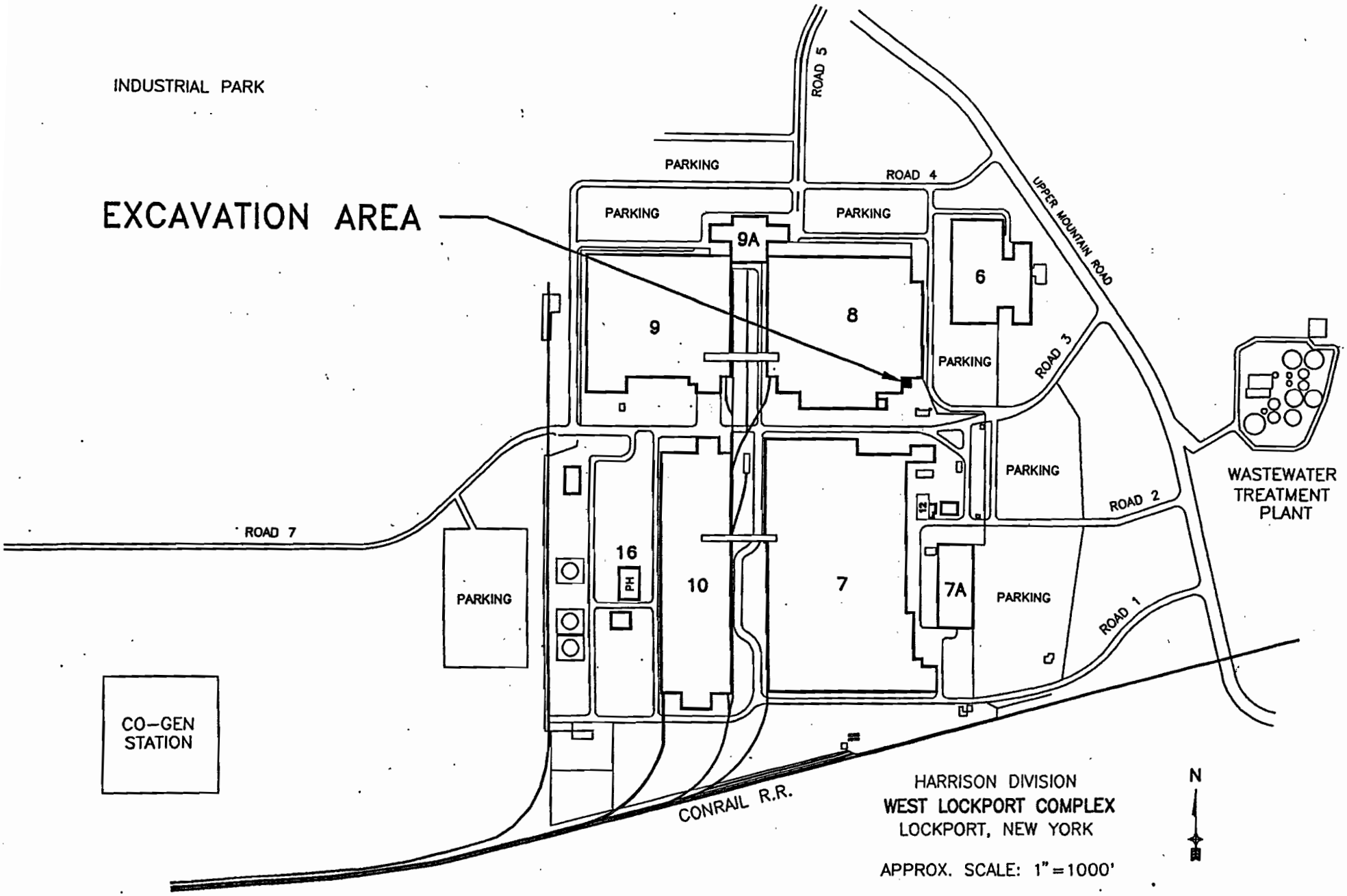
Preliminary results suggest that additional investigation may be warranted to determine the extent of trichloroethylene contamination in this area. The investigation could include the development of a work plan for further actions if deemed necessary. In early 1995, we will be retaining the services of an area environmental consulting firm to lead us in this review.

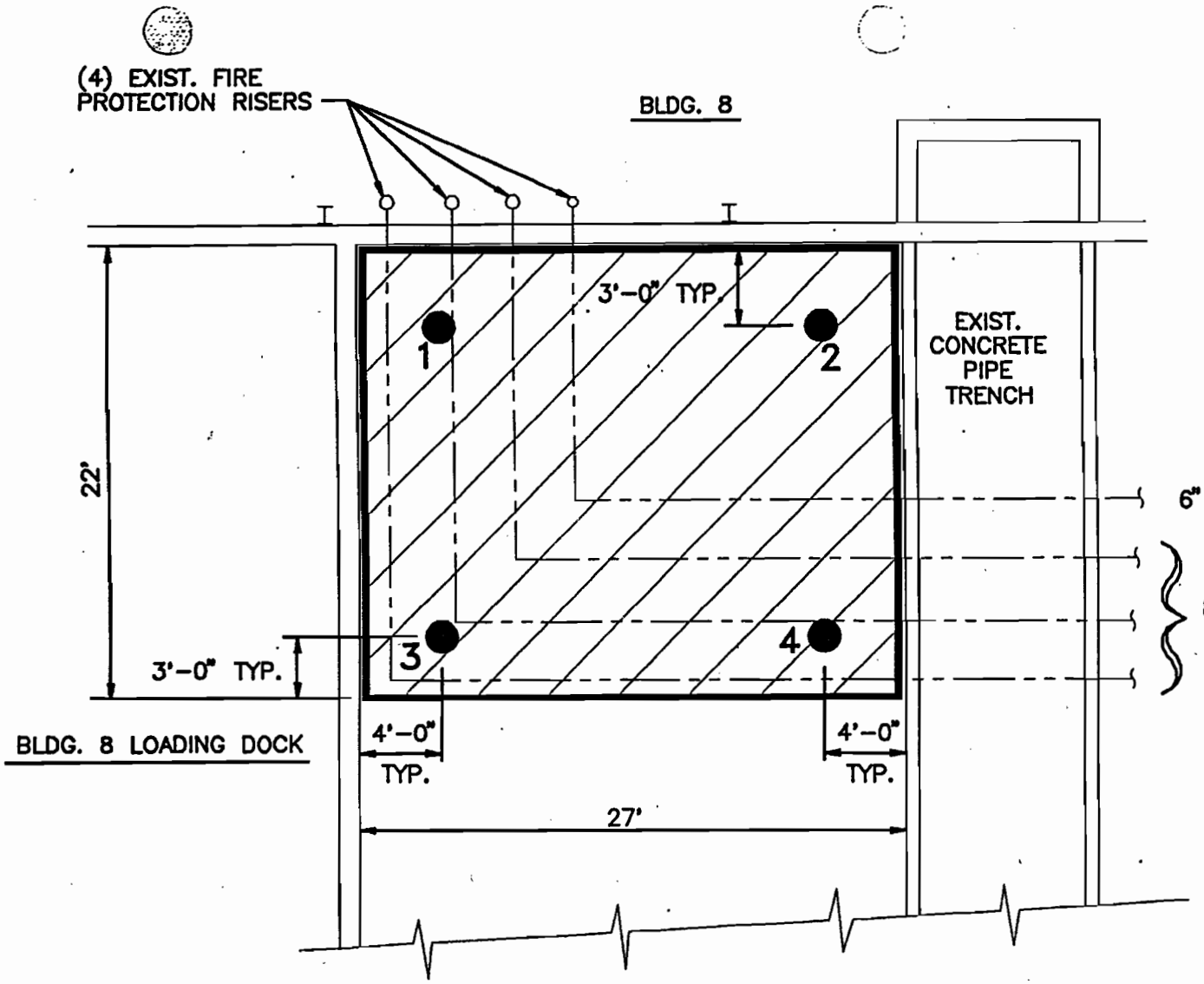
Harrison will continue to keep the Department of Environmental Conservation informed as to the progress of the assessment of this area and resulting recommended work plans.

If you have any questions, please call me at (716) 439-2689. Please note that our office will be closed for the holidays from December 24, 1994 thru January 2, 1995.

Amy S. Buckenheimer
Sr. Environmental Engineer

Lets Get It Together
SAFETY BELTS SAVE LIVES
Enclosures


INDUSTRIAL PARK
EXCAVATION AREA
ROAD 5
PARKING
ROAD 4
PARKING
PARKING
9A
UPPER MOUNTAIN ROAD
6
9
8
PARKING
ROAD 3
WASTEWATER TREATMENT PLANT
PARKING
ROAD 2
ROAD 7
16
PH
10
7
7A
PARKING
ROAD 1
PARKING
CO-GEN STATION
CONRAIL R.R.
HARRISON DIVISION
WEST LOCKPORT COMPLEX
LOCKPORT, NEW YORK
APPROX. SCALE: 1"=1000'
N



LOCATION #	TOTAL TRICHLOROETHYLENE
1	1800 mg/Kg
2	38 mg/Kg
3	0.62 mg/Kg
4	99 mg/Kg

SAMPLE DATE: 11/30/94

APPROX. EXCAVATION DEPTH: 7'-6"

PRESENT EXCAVATION SITUATION: AREA BACKFILLED WITH: 2' OF SAND FOR PIPE BEDDING, AND #2 CRUSHER RUN (CRUSHED CONCRETE) TO GRADE.

SITE PLAN
EXCAVATION AREA
SOUTH EAST CORNER
OF BLDG. 8

12-20-94

DELPHI
Automotive Systems

Certified Mail # P884 920 580

April 13, 1995

Mr. Abul Barkat, PE
Remediation Group
New York State Department of Environmental Conservation
270 Michigan Avenue
Buffalo, New York 14203-2999

Subject: **SPILL NUMBER 9410972**
SE CORNER OF BUILDING 8
LOCKPORT, NEW YORK

Dear Mr. Barkat:

As part of the continuing communication on Spill Number 9410972 reported on November 16, 1994 and in follow-up to the letter sent to Mr. Salvatore Calandra on December 22, 1994, Delphi Harrison Thermal Systems is providing this update.

General Motors recommends a phased approach. Phases One and Two are identification and confirmation of the potential area of environmental concern (PAOC's) at the site. These Phases have been completed. Based on Phases One and Two, Phase Three is recommended.

Phase Three is determination of the extent and magnitude of the PAOC . This Phase shall include the consolidation and development of data to characterize the nature, extent and magnitude of the contaminant and assess potential risks to human health and the environment.

Phase Four involves a Feasibility study which develops, screens and performs a detailed evaluation of an array of protective and practicable remedial alternatives to address potential areas of environmental concern identified in Phase Two. Phase Four also includes, if necessary, treatability studies to evaluate technologies, development of a residual and transient remedy risk assessment and recommends a selected remedial action.

Delphi Harrison Thermal Systems is in the process of preparing a bid package to area consultants for assessment of the SE Corner of Building 8 area and their recommended work plans. It is anticipated that bids will be received and the consultant selected to complete Phase Three by early June.

Based on the outcome of Phase Three , a decision will be made if Phase Four will be necessary. Delphi Thermal will continue to keep the Department of Environmental Conservation informed as to the progress of the assessment of this area and the resulting Feasibility Study.

Please call me at (716) 439- 2942 if you have any questions. Please note that our office will be closed for the holidays from April 14, 1995 through April 17, 1995.

Sincerely,

Catherine A. Ver

Catherine A. Ver
Sr. Environmental Engineer

New York State Department of Environmental Conservation
270 Michigan Avenue, Buffalo, New York, 14203-2999

Michael D. Zagata
Commissioner

April 11, 1996

Ms. Cathy Ver
Delphi Harrison Thermal Systems
200 Upper Mountain Road
Lockport, New York 14094

Community Well Assessment, Spill Number 9410972

Dear Ms. Ver:

This letter is a follow up to our recent conversation concerning the location and status of private drinking wells near the Delphi Harrison Thermal Systems facility in Lockport. Delphi, in the Addendum to the Phase III Sampling and Analysis Plan dated March 16, 1996, discusses their intent to conduct an exposure assessment to identify potential risks to human health or the environment related to the subject spill. Identification of private drinking wells near the facility is part of this assessment.. The Department, by way of letter dated March 25, 1996, informed Delphi that such a compilation was completed during the City of Lockport Landfill investigation. During our conversation, however, I indicated that a recent summary of this information had been completed as part of the Department's reclassification package for the Harrison inactive hazardous waste site (Site Number 932017). Following are excerpts from this memo that deal specifically with the private drinking water wells in the area.

Assessment

Based upon the direction of groundwater flow under the Harrison inactive hazardous waste site (Figures 2-5), eleven wells are located downgradient of the site. Information concerning these wells is summarized in Table 1. Of these wells, none are known to be utilized; two have been abandoned/plugged, two are open, and the status of the remainder is unknown. Although private wells downgradient of the Harrison site are not being utilized, additional assessment on the potential impact of the site on private wells has been completed. The general stratigraphy of the area is shown in Figure 3-4. At the Harrison site, the principal groundwater flow zone occurs within the Lockport Dolostone; this unit is absent at the Lockport City Landfill site located approximately one mile to the northeast (Figure C-1). At the latter site, located near seven of the private wells of concern, the principal groundwater flow zone occurs within the Rochester Shale, which is stratigraphically older than (below) the Lockport Dolostone (Figure 3-4). As a result, two distinct groundwater flow regimes characterize the two sites. For potentially contaminated groundwater from the Harrison site to impact the downgradient private wells near the Lockport City

Landfill site, downward migration of contaminants from the Lockport Dolostone to the Rochester Shale would have to take place. Information from the Harrison site does not address this issue, however, information regarding regional groundwater flow provides insight on the ultimate fate of this groundwater.

Located between the Harrison and Lockport City Landfill sites is a large topographic depression known as "the Gulf" (Figures 3-10 and 3-13). This feature acts as a giant sink to regional groundwater flow; groundwater at the Harrison site flows east toward the Gulf (Figures 2-5), while groundwater at the Lockport City Landfill site flows west toward this depression (Plate 6). In addition, the Gulf completely bisects the Rochester Shale and the underlying Irondequoit Formation. As a result, even if potentially contaminated groundwater at the Harrison site was migrating downward into the Rochester Shale, it would discharge into the Gulf. The presence of the Gulf, therefore, would prevent potentially contaminated groundwater from the Harrison site from impacting the private wells farther east (locations 3,4,8,10,11,14, and 38). The only wells, therefore, that could be potentially impacted by the Harrison site are locations 21-24 (Figure C-1), which as stated above are not being utilized (Table 1).

Conclusion

Of principal concern to the reclassification of the Harrison inactive hazardous waste site is the potential impact on downgradient private wells. A detailed evaluation of this issue, however, suggests that health impacts from potentially contaminated groundwater leaving the Harrison site are extremely unlikely. Proof of this statement includes the following:

1. Of the eleven private wells located downgradient, none are actively being utilized.

2. Two distinct flow regimes characterize the Harrison and Lockport City Landfill sites. Groundwater underlying the Harrison site flows east toward the Gulf, while groundwater beneath the Lockport City Landfill site flows west toward this topographic depression. As a result, seven private wells located downgradient of the Harrison site could not be impacted by the site as groundwater discharges to the Gulf before reaching the wells.

Please feel free to contact me at 851-7220 if you have any comments of questions.

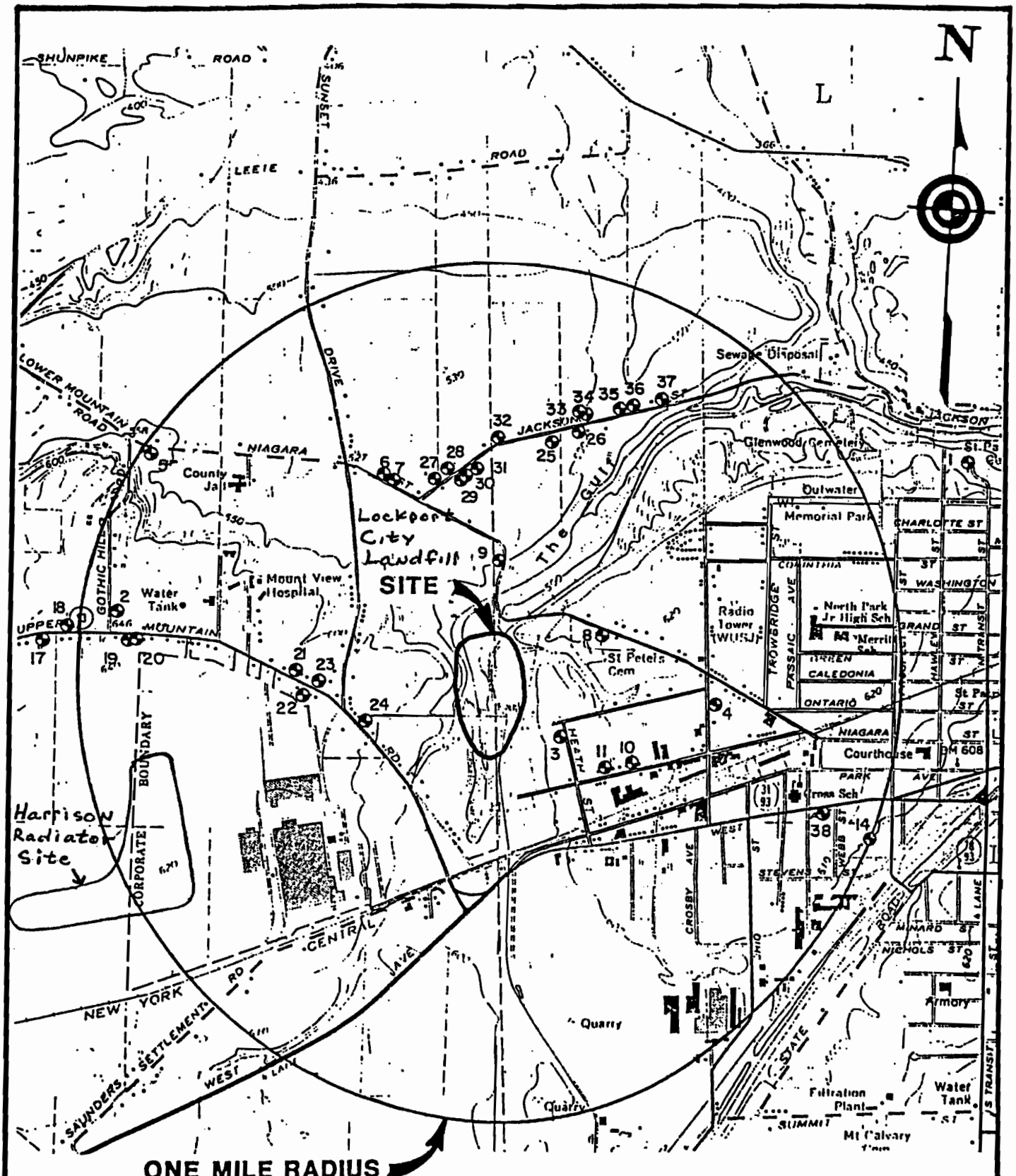
Sincerely yours,

Glenn M May

Glenn M. May, CPG
Engineering Geologist I

Attachments

cc: Mr. Abul Barkat



SOURCE:
LOCKPORT 1965
15 MINUTE QUADRANGLE

● RESIDENTIAL WELLS

SCALE
0 1,000' 2,000'

A-4179

URS CONSULTANTS, INC.	COMMUNITY WELL SURVEY - KNOWN WELL LOCATIONS LOCKPORT CITY LANDFILL	FIGURE C-1

LOCKPORT LANDFILL RI/FS
COMMUNITY WELL SURVEY
(6/21/91)
RESPONDENTS WITH WELLS

Location Number	Address
1	162 Glenwood Avenue
2	4895 Gothic Hill Road
3	38 Heath Street
4	166 Michigan Street
5	5463 Niagara Street
6	5631 Niagara Street
7	5633 Niagara Street
8	646 Niagara Street
9	998 Niagara Street
10	249 S. Niagara Street
11	285 S. Niagara Street
12*	5291 Saunders Settlement Road
13*	5324 Saunders Settlement Road
14	27 Sunnyside Street
15*	5285 Upper Mt Road
16*	5317 Upper Mt Road
17	5360 Upper Mt Road
18	5377 Upper Mt Road
19	5428 Upper Mt Road
20	5434 Upper Mt Road
21	5515 Upper Mt Road
22	5526 Upper Mt Road
23	5533 Upper Mt Road
24	5621 Upper Mt Road
25	1101 W. Jackson Street
26	1201 W. Jackson Street
27	5733 W. Jackson Street
28	5745 W. Jackson Street
29	5750 W. Jackson Street
30	5762 W. Jackson Street
31	5766 W. Jackson Street
32	5785 W. Jackson Street
33	5853 W. Jackson Street
34	5861 W. Jackson Street
35	5871 W. Jackson Street
36	5873 W. Jackson Street
37	5903 W. Jackson Street
38	280 West Avenue

* Off the map shown in Figure C-1

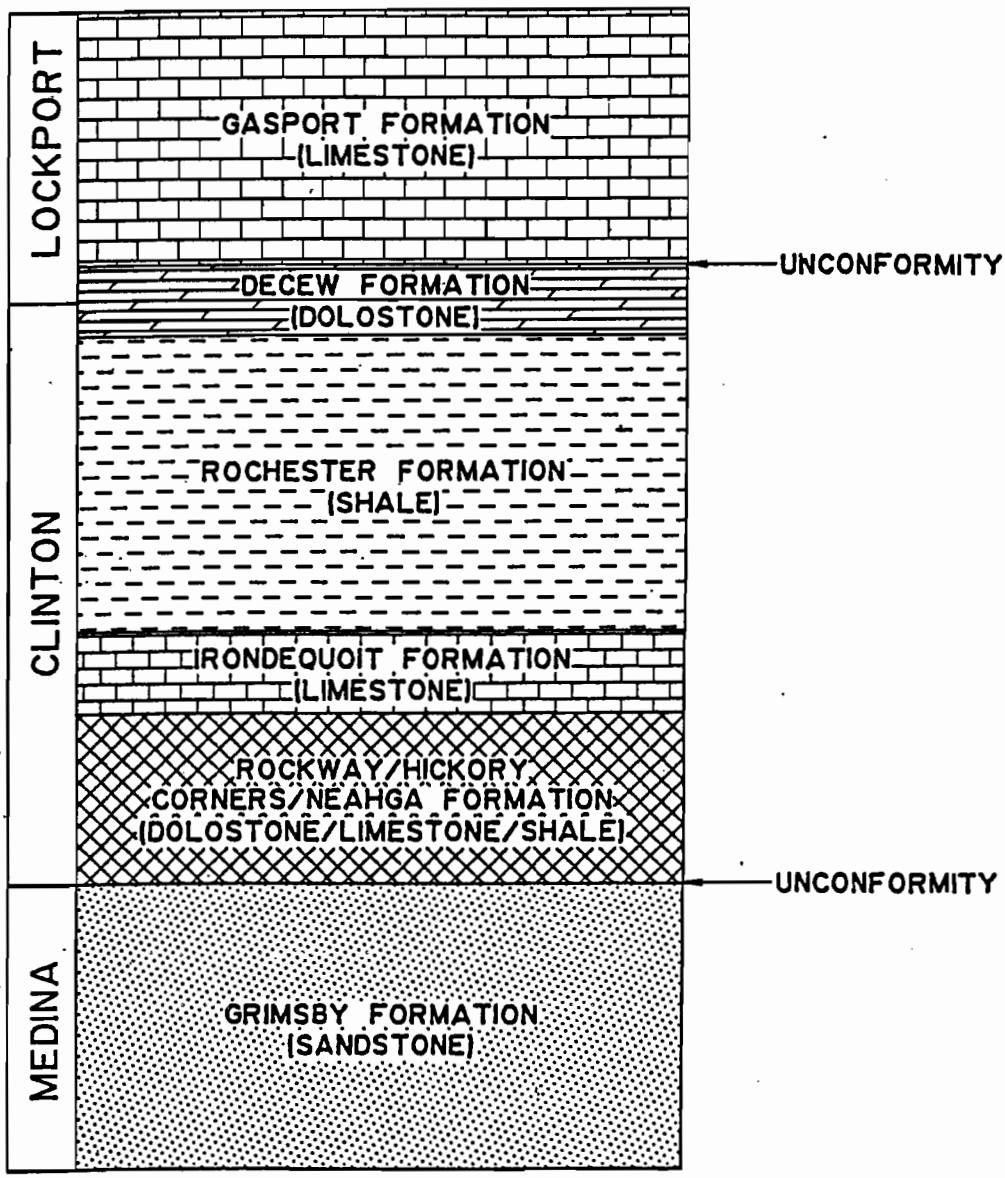
LOCKPORT LANDFILL RI/FS
COMMUNITY WELL SURVEY
(6-21-91)

ELL ESENT Y/N)		ADDRESS	GROUNDWATER USES	WELL ABANDONED CAPPED,OPEN, PLUGGED	YEAR DRILLED	METHOD	DEPTH OF WELL	LITHOLOGIC UNIT	USING CITY WATER (Y/N)	SUMPPUMP PRESENT (Y/N)	WATER IN BASEMENT (Y/N)
	162	GLENWOOD AVE	NONE	O	1933	DRILLED	60	BEDROCK	Y	Y	Y
	4895	GOTHIC HILL RD	2 WELLS - NOT USED	?	?	DUG	56	?	?	?	?
	38	HEATH ST	NOT USED	?	1949	?	40	?	?	?	?
	166	MICHIGAN ST	ABANDONED	Y	?	?	?	?	?	?	?
	5463	NIAGARA ST	NOT USED	?	?	?	?	?	?	?	?
	5463	NIAGARA ST	NONE	C	?	DRILLED	20'	BEDROCK	Y	N	Y
	5631	NIAGARA ST	NOT USED	?	?	?	?	?	?	?	?
	5633	NIAGARA ST	NOT USED	O	?	DRILLED	?	?	Y	N	?
	646	NIAGARA ST	NOT USED	?	1960	?	23	BEDROCK	?	?	?
	998	NIAGARA ST	DOMESTIC, LIVESTOCK, AGRICULTURE	?	?	?	500	?	?	?	?
f	249	S. NIAGARA ST	?	?	?	?	?	?	?	?	?
f	285	S. NIAGARA ST	NOT USED	O	?	?	?	?	Y	Y	Y
f	5291	SAUNDERS SETTLEMENT RD	NONE	C	1946	?	?	?	Y	Y	N
f	5324	SAUNDERS SETTLEMENT RD	LIVESTOCK, AGRICULTURE, DRINKING	?	1930	DRILLED	56	BEDROCK	Y	Y	Y
f	27	SUNNYSIDE ST	?	P	?	DUG	?	?	Y	N	Y
f	5285	UPPER MT RD	?.	C	1900	DUG	40	?	Y	N	Y
f	5317	UPPER MT RD	WASHING CARS	O	?	DUG	?	?	Y	N	Y
f	5360	UPPER MT RD	WATERING PLANTS	?	1930	DUG	50	BEDROCK	Y	N	Y
f	5377	UPPER MT RD	LAWN WATERING, DRIVEWAY WASHING	O	1900	BOTH	30	?	Y	N	Y
Y	5428	UPPER MT RD	WATERING LAWN AND GARDEN	?	1959	?	25+	?	Y	Y	Y
Y	5434	UPPER MT RD	NONE	C	1955	DRILLED	?	?	Y	Y	Y
Y	5515	UPPER MT RD	NOT USED	?	?	?	?	?	?	?	?
Y	5526	UPPER MT RD	NOT USED	?	?	?	?	?	?	?	?
Y	5533	UPPER MT RD	NOT USED	?	?	?	30?	?	?	?	?
Y	5621	UPPER MT RD	NOT USED	?	?	?	?	?	?	?	?
Y	1101	W. JACKSON ST	DOMESTIC, LIVESTOCK,LAWN	?	?	?	36	BEDROCK	?	?	?
Y	1201	W. JACKSON ST	DOMESTIC, LIVESTOCK, LAWN	?	1970?	?	40	BEDROCK	?	?	?
Y	5733	W. JACKSON ST	2 WELLS - ?IN USE?	?	?	?	?	?	?	?	?
Y	5745	W. JACKSON ST	DOMESTIC, LIVESTOCK, LAWN	?	?	BOTH	125	BEDROCK	?	?	?
Y	5750	W. JACKSON ST	DOMESTIC, LIVESTOCK, LAWN	?	1978?	?	?	?	?	?	?
Y	5762	W. JACKSON ST	DOMESTIC, LIVESTOCK	?	?	?	?	?	?	?	?
Y	5766	W. JACKSON ST	NOT USED	?	?	?	?	?	?	?	?
Y	5785	W. JACKSON ST	LAWN WATERING	?	?	?	?	?	?	?	?
Y	5853	W. JACKSON ST	DOMESTIC, LIVESTOCK, LAWN	?	1960?	?	?	?	?	?	?
Y	5861	W. JACKSON ST	DOMESTIC, LIVESTOCK, LAWN	?	1972	DRILLED	35	BEDROCK	?	?	?
Y	5871	W. JACKSON ST	NOT USED	?	?	DRILLED	30?	?	?	?	?
Y	5873	W. JACKSON ST	?IN USE?	?	?	?	?	?	?	?	?
Y	5903	W. JACKSON ST	LIVESTOCK	?	?	DUG	?	?	?	?	?
Y	280	WEST AVE	DORMANT	O	1800	BOTH	?	?	N	N	Y

TABLE 1
SUMMARY OF COMMUNITY WELLS IN THE VICINITY OF THE HARRISON RADIATOR SITE, LOCKPORT

LOCATION NUMBER	ADDRESS	GROUNDWATER USES	WELL ABANDONED, CAPPED, OPEN, PLUGGED	WELL DEPTH (FEET)	LITHOLOGIC UNIT	USING CITY WATER
3	38 Heath Street	Not utilized	Unknown	40	Unknown	Unknown
4	166 Michigan Street	Not utilized	Abandoned	Unknown	Unknown	Unknown
8	646 Niagara Street	Not utilized	Unknown	23	Bedrock	Unknown
10	249 S. Niagara Street	Unknown	Unknown	Unknown	Unknown	Unknown
11	285 S. Niagara Street	Not utilized	Open	Unknown	Unknown	Yes
14	27 Sunnyside Street	Not utilized	Plugged	Unknown	Unknown	Yes
21	5515 Upper Mt. Road	Not utilized	Unknown	Unknown	Unknown	Unknown
22	5526 Upper Mt. Road	Not utilized	Unknown	Unknown	Unknown	Unknown
23	5533 Upper Mt. Road	Not utilized	Unknown	30?	Unknown	Unknown
24	5621 Upper Mt. Road	Not utilized	Unknown	Unknown	Unknown	Unknown
38	280 West Avenue	Dormant	Open	Unknown	Unknown	No

1"=100' 7/8/91

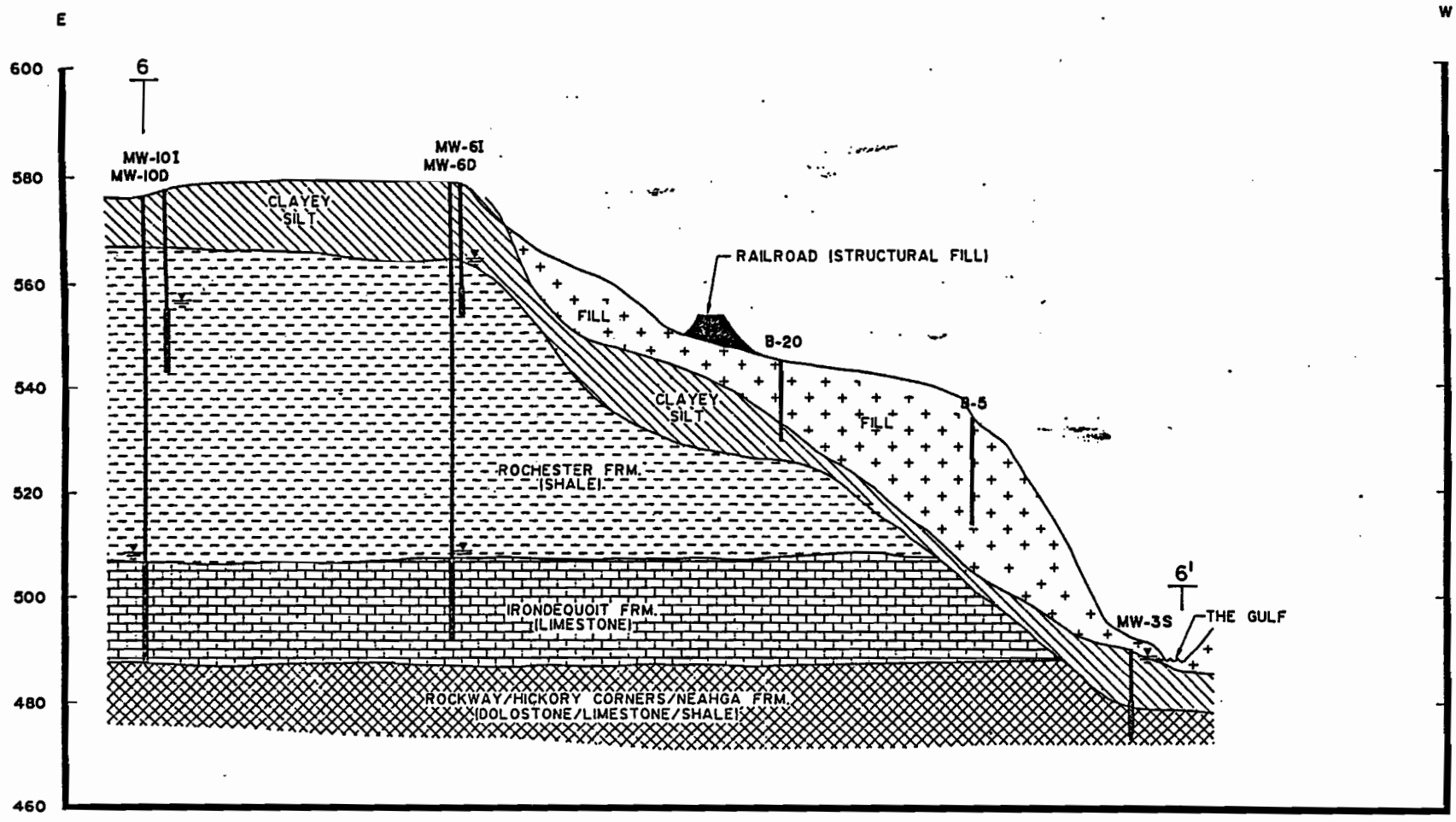


AC-3256/8

URS CONSULTANTS, INC.

STRATIGRAPHIC COLUMN OF ROCK UNITS

FIGURE 3-4



SCALE: HORIZ. 1"=100'-0"
VERT. 1"=20'-0"

LEGEND

MW-6D — BORING AND MONITORING WELL NUMBER

— GROUNDWATER ELEVATION 4/8/91

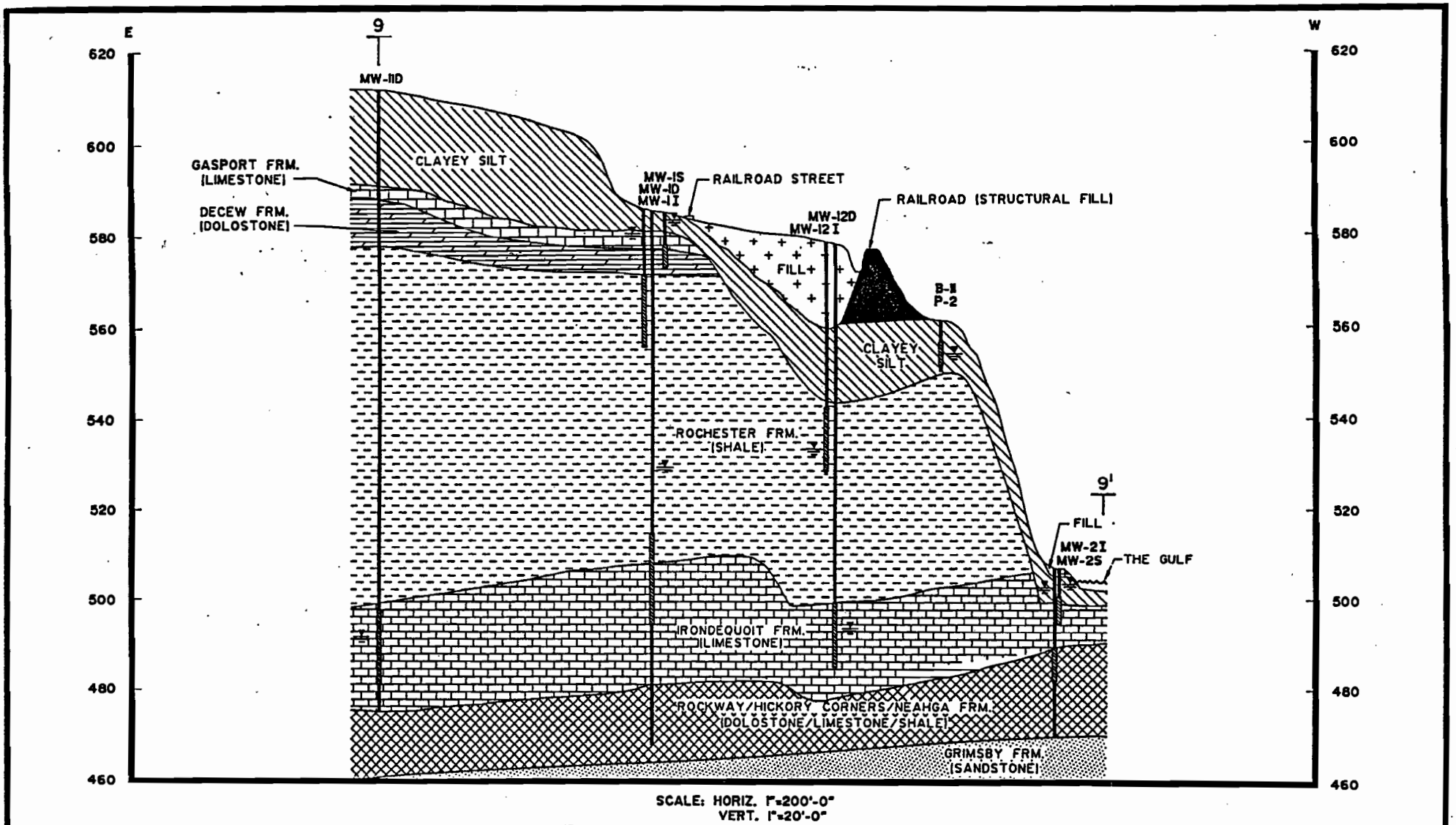
— SCREENED INTERVAL OF MONITORING WELL

NOTE:
GEOLOGIC CONDITIONS SHOWN ARE REPRESENTATIVE OF CONDITIONS ENCOUNTERED AT EACH BORING LOCATION TO THE DEPTH DRILLED. EXTRAPOLATIONS BETWEEN BORINGS HAVE BEEN INTERPRETED USING STANDARD ACCEPTED GEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY BETWEEN BORINGS FROM THOSE SHOWN.

CROSS SECTION 6-6'

URS CONSULTANTS, INC.

FIGURE 3-10



SCALE: HORIZ. 1"=200'-0"
VERT. 1"=20'-0"

LEGEND

MW-8D — BORING AND MONITORING WELL NUMBER

▽ — GROUNDWATER ELEVATION 4/8/91

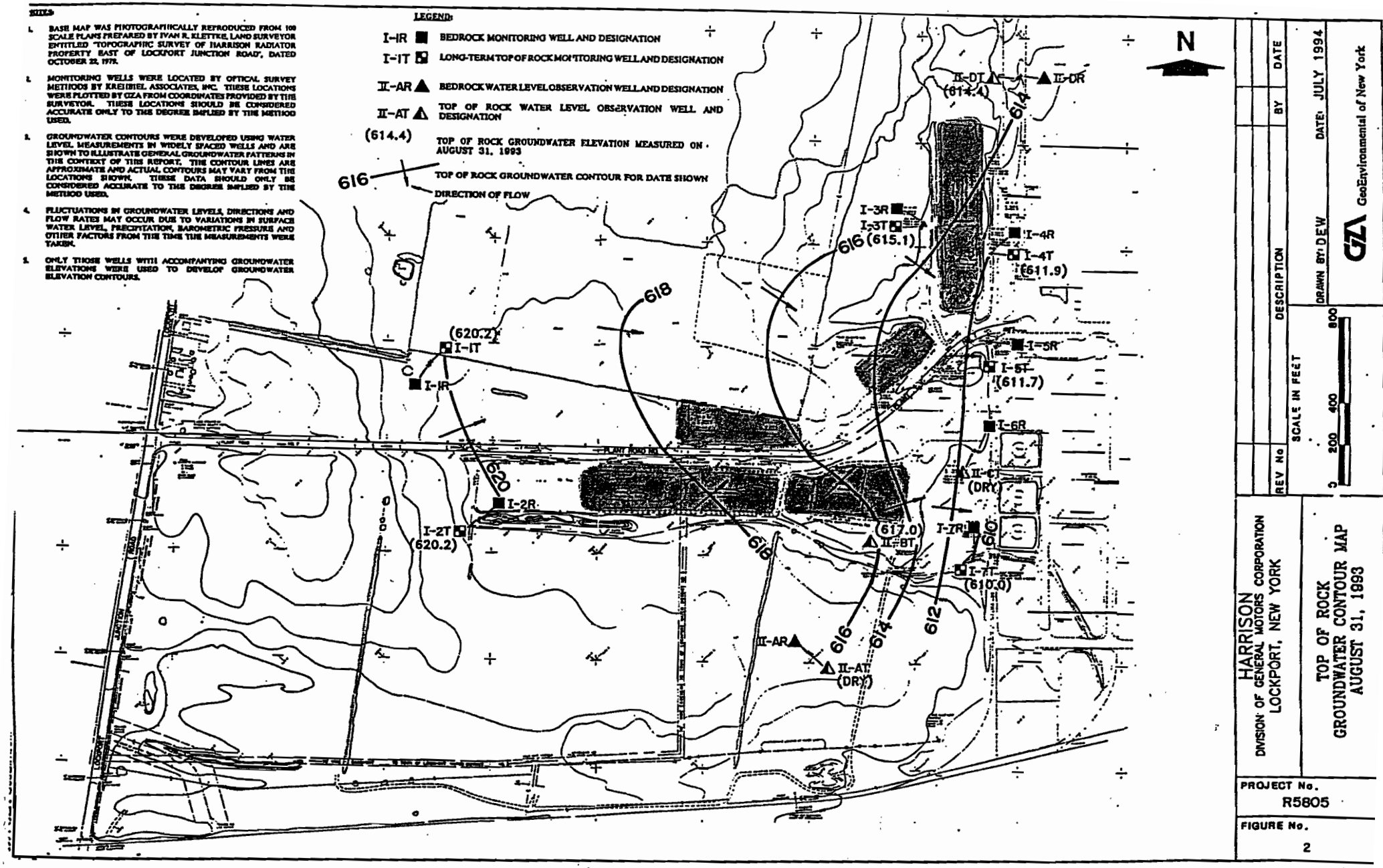
— SCREENED INTERVAL OF MONITORING WELL

NOTE:
GEOLOGIC CONDITIONS SHOWN ARE REPRESENTATIVE OF CONDITIONS ENCOUNTERED AT EACH BORING LOCATION TO THE DEPTH DRILLED. EXTRAPOLATIONS BETWEEN BORINGS HAVE BEEN INTERPRETED USING STANDARD ACCEPTED GEOLOGIC PRACTICES AND PRINCIPLES. ACTUAL CONDITIONS MAY VARY BETWEEN BORINGS FROM THOSE SHOWN.

CROSS SECTION 9-9'

URS CONSULTANTS, INC.

FIGURE 3-13


NOTES:
1. BASE MAP WAS PHOTOGRAPHICALLY REPRODUCED FROM 100 SCALE PLANS PREPARED BY IVAN R. KLETTKE, LAND SURVEYOR ENTITLED "TOPOGRAPHIC SURVEY OF HARRISON RADIATOR PROPERTY EAST OF LOCKPORT JUNCTION ROAD", DATED OCTOBER 22, 1979.
2. MONITORING WELLS WERE LOCATED BY OPTICAL SURVEY METHODS BY KREIBIEL ASSOCIATES, INC. THESE LOCATIONS WERE PLOTTED BY GZA FROM COORDINATES PROVIDED BY THE SURVEYOR. THESE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
3. GROUNDWATER CONTOURS WERE DEVELOPED USING WATER LEVEL MEASUREMENTS IN WIDELY SPACED WELLS AND ARE SHOWN TO ILLUSTRATE GENERAL GROUNDWATER PATTERNS IN THE CONTEXT OF THIS REPORT. THE CONTOUR LINES ARE APPROXIMATE AND ACTUAL CONTOURS MAY VARY FROM THE LOCATIONS SHOWN. THESE DATA SHOULD ONLY BE CONSIDERED ACCURATE TO THE DEGREE IMPLIED BY THE METHOD USED.
4. FLUCTUATIONS IN GROUNDWATER LEVELS, DIRECTIONS AND FLOW RATES MAY OCCUR DUE TO VARIATIONS IN SURFACE WATER LEVEL, PRECIPITATION, BAROMETRIC PRESSURE AND OTHER FACTORS FROM THE TIME THE MEASUREMENTS WERE TAKEN.
5. ONLY THOSE WELLS WITH ACCOMPANYING GROUNDWATER ELEVATIONS WERE USED TO DEVELOP GROUNDWATER ELEVATION CONTOURS.
LEGEND:
I-IR BEDROCK MONITORING WELL AND DESIGNATION
I-IT LONG-TERM TOP OF ROCK MONITORING WELL AND DESIGNATION
II-AR BEDROCK WATER LEVEL OBSERVATION WELL AND DESIGNATION
II-AT TOP OF ROCK WATER LEVEL OBSERVATION WELL AND DESIGNATION
(614.4) TOP OF ROCK GROUNDWATER ELEVATION MEASURED ON AUGUST 31, 1993
616 TOP OF ROCK GROUNDWATER CONTOUR FOR DATE SHOWN
DIRECTION OF FLOW
N
I-IR
I-IT (620.2)
I-2R
I-2T (620.2)
I-3R
I-3T (615.1)
I-4R
I-4T (611.9)
I-5R
I-5T (611.7)
I-6R
I-7R
I-7T (610.0)
II-DT (614.4)
II-DR
II-CT (DRY)
II-BT (617.0)
II-AR
II-AT (DRY)
PLANT ROAD NO.
JUNCTION ROAD
616
618
620
614
612
610
SCALE IN FEET
0 200 400 800
REV No
DESCRIPTION
BY
DATE
DRAWN BY: DEW
DATE: JULY 1994
GZA GeoEnvironmental of New York
HARRISON
DIVISION OF GENERAL MOTORS CORPORATION
LOCKPORT, NEW YORK
TOP OF ROCK
GROUNDWATER CONTOUR MAP
AUGUST 31, 1993
PROJECT No.
R5805
FIGURE No.
2

NOTES:

1. BASE MAP WAS PHOTOGRAPHICALLY REPRODUCED FROM 100 SCALE PLANS PREPARED BY IVAN R. KLETTKE, LAND SURVEYOR ENTITLED "TOPOGRAPHIC SURVEY OF HARRISON RADIATOR PROPERTY EAST OF LOCKPORT JUNCTION ROAD", DATED OCTOBER 23, 1979.
2. MONITORING WELLS WERE LOCATED BY OFFICAL SURVEY METHODS BY KREIENIEL ASSOCIATES, INC. THESE LOCATIONS WERE PLOTTED BY GZA FROM COORDINATES PROVIDED BY THE SURVEYOR. THESE LOCATIONS SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
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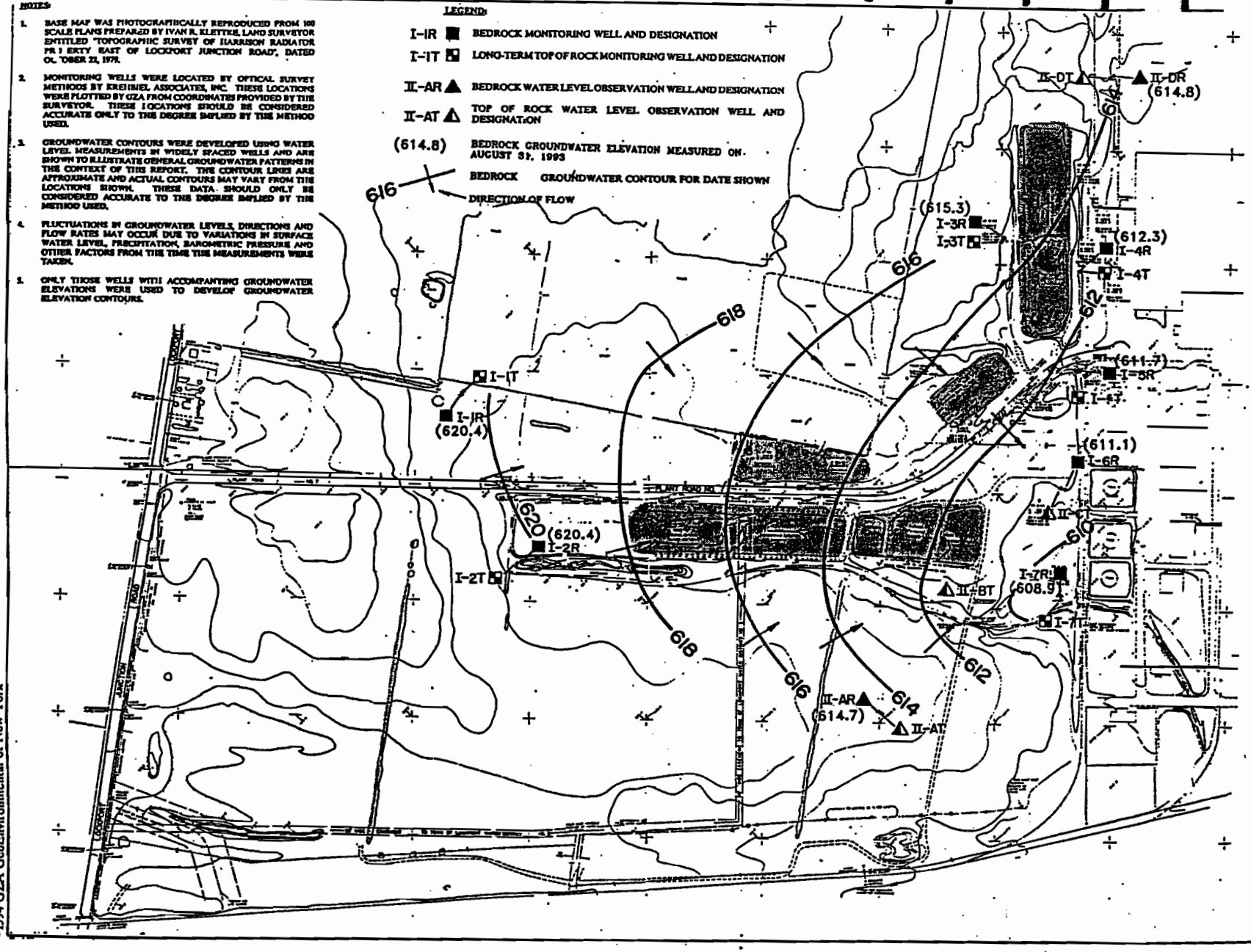
5. ONLY THOSE WELLS WITH ACCOMPANYING GROUNDWATER ELEVATIONS WERE USED TO DEVELOP GROUNDWATER ELEVATION CONTOURS.

LEGEND:

- I-IR ■ BEDROCK MONITORING WELL AND DESIGNATION
- I-IT ■ LONG-TERM TOP OF ROCK MONITORING WELL AND DESIGNATION
- II-AR ▲ BEDROCK WATER LEVEL OBSERVATION WELL AND DESIGNATION
- II-AT ▲ TOP OF ROCK WATER LEVEL OBSERVATION WELL AND DESIGNATION
- (614.8) BEDROCK GROUNDWATER ELEVATION MEASURED ON AUGUST 31, 1993
- 616 BEDROCK GROUNDWATER CONTOUR FOR DATE SHOWN
- DIRECTION OF FLOW



REV No	DESCRIPTION	BY	DATE

SCALE IN FEET: 0, 200, 400, 800

DRAWN BY: DEW

DATE: JULY 1994

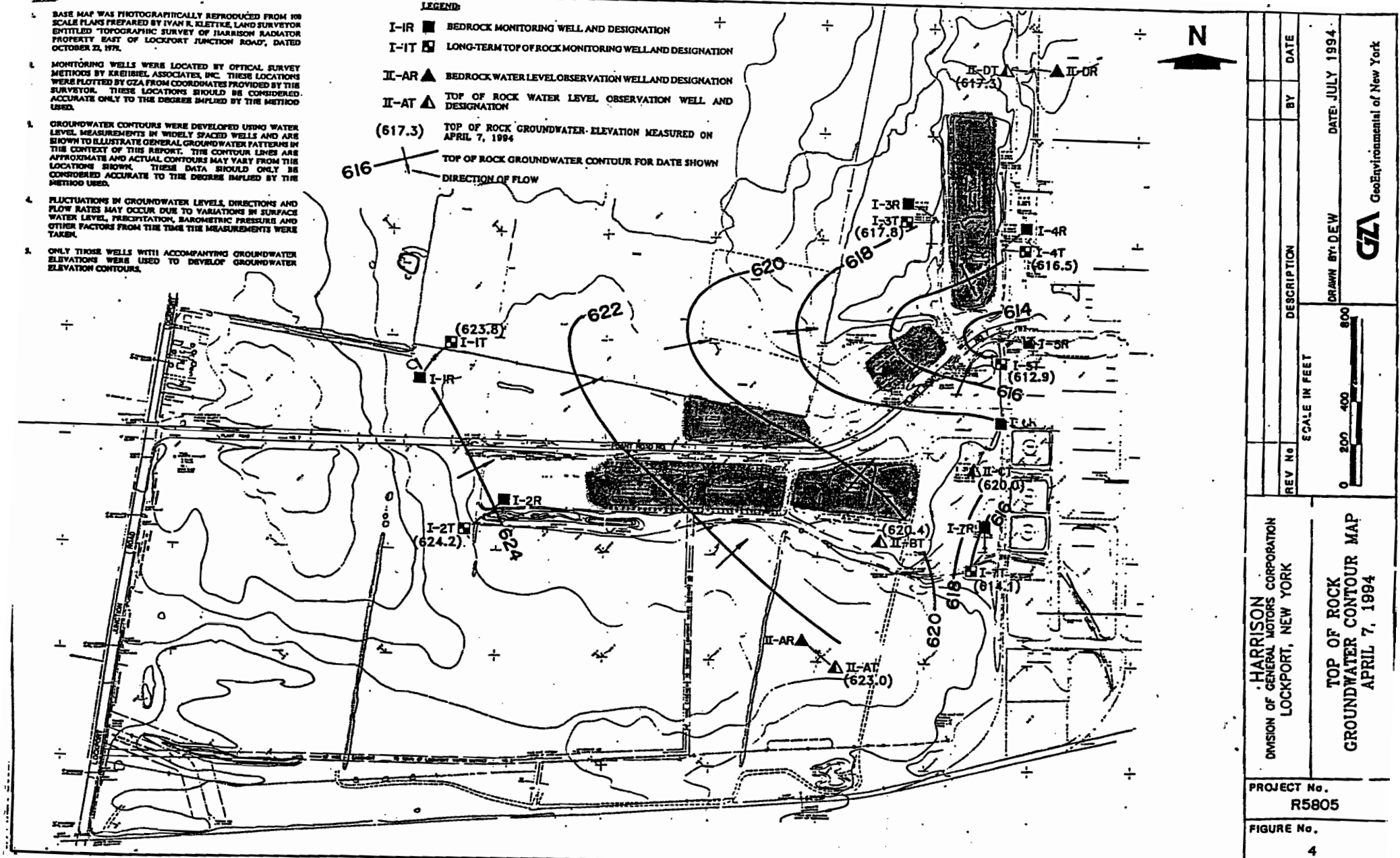
GZA GeoEnvironmental of New York

HARRISON
DIVISION OF GENERAL MOTORS CORPORATION
LOCKPORT, NEW YORK

BEDROCK
GROUNDWATER CONTOUR MAP
AUGUST 31, 1993

PROJECT No.
R5805

FIGURE No.
3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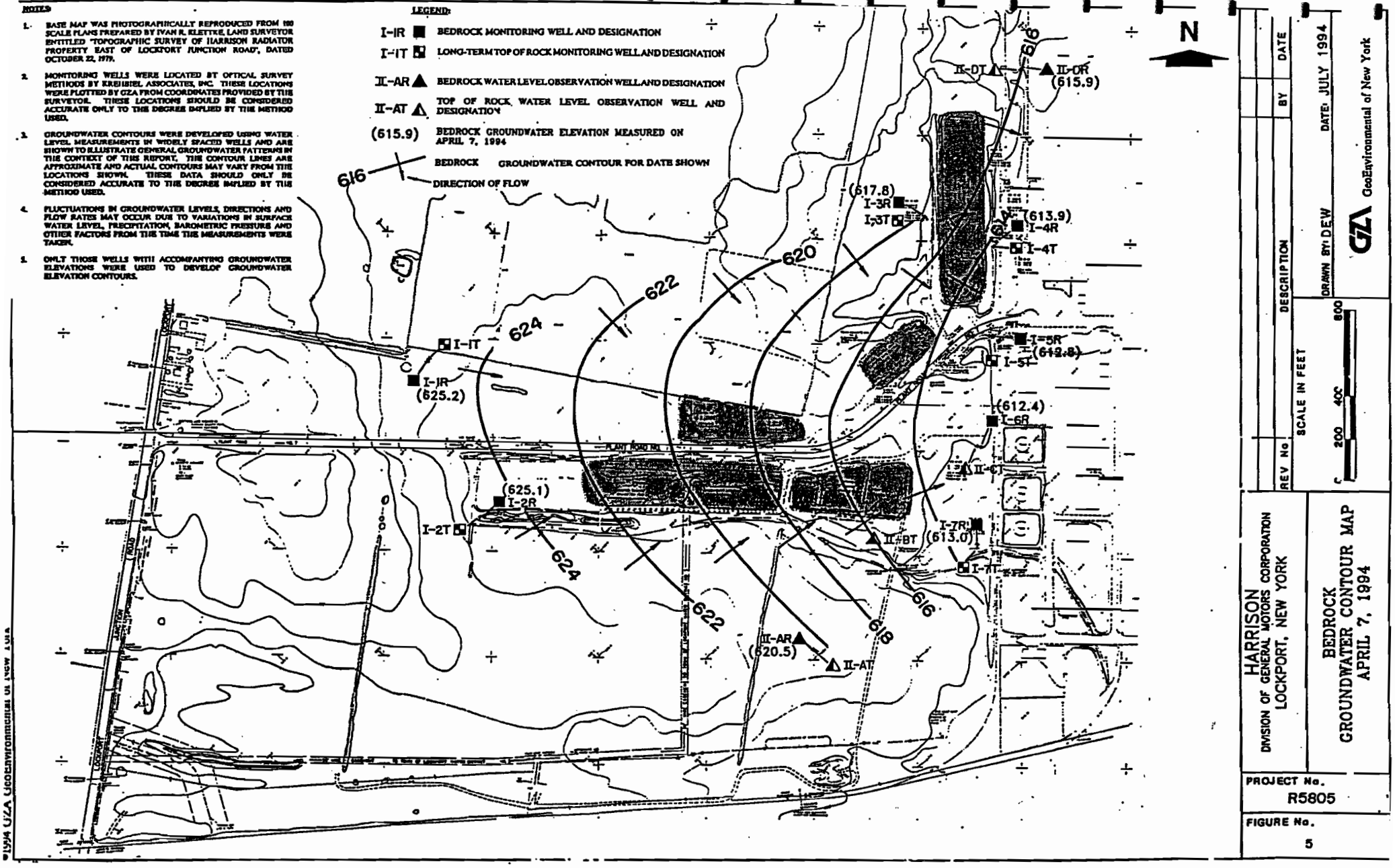
5. ONLY THOSE WELLS WITH ACCOMPANYING GROUNDWATER ELEVATIONS WERE USED TO DEVELOP GROUNDWATER ELEVATION CONTOURS.
LEGEND:
I-1R BEDROCK MONITORING WELL AND DESIGNATION
I-1T LONG-TERM TOP OF ROCK MONITORING WELL AND DESIGNATION
II-AR BEDROCK WATER LEVEL OBSERVATION WELL AND DESIGNATION
II-AT TOP OF ROCK WATER LEVEL OBSERVATION WELL AND DESIGNATION
(617.3) TOP OF ROCK GROUNDWATER ELEVATION MEASURED ON APRIL 7, 1994
616 TOP OF ROCK GROUNDWATER CONTOUR FOR DATE SHOWN
DIRECTION OF FLOW
N
II-DT
(617.3)
II-DR
I-3R
I-3T
(617.8)
I-4R
I-4T
(616.5)
620
618
622
614
(623.8)
I-1T
I-1R
I-5R
I-5T
(612.9)
616
II-CT
(620.0)
I-2R
I-2T
(624.2)
624
(620.4)
II-BT
I-7R
I-7T
(614.1)
618
620
II-AR
II-AT
(623.0)
FRONT ROAD
LOCKPORT JUNCTION ROAD
REV No
DESCRIPTION
BY
DATE
DRAWN BY: DEW
DATE: JULY 1994
SCALE IN FEET
0
200
400
800
GZA GeoEnvironmental of New York
HARRISON
DIVISION OF GENERAL MOTORS CORPORATION
LOCKPORT, NEW YORK
TOP OF ROCK
GROUNDWATER CONTOUR MAP
APRIL 7, 1994
PROJECT No.
R5805
FIGURE No.
4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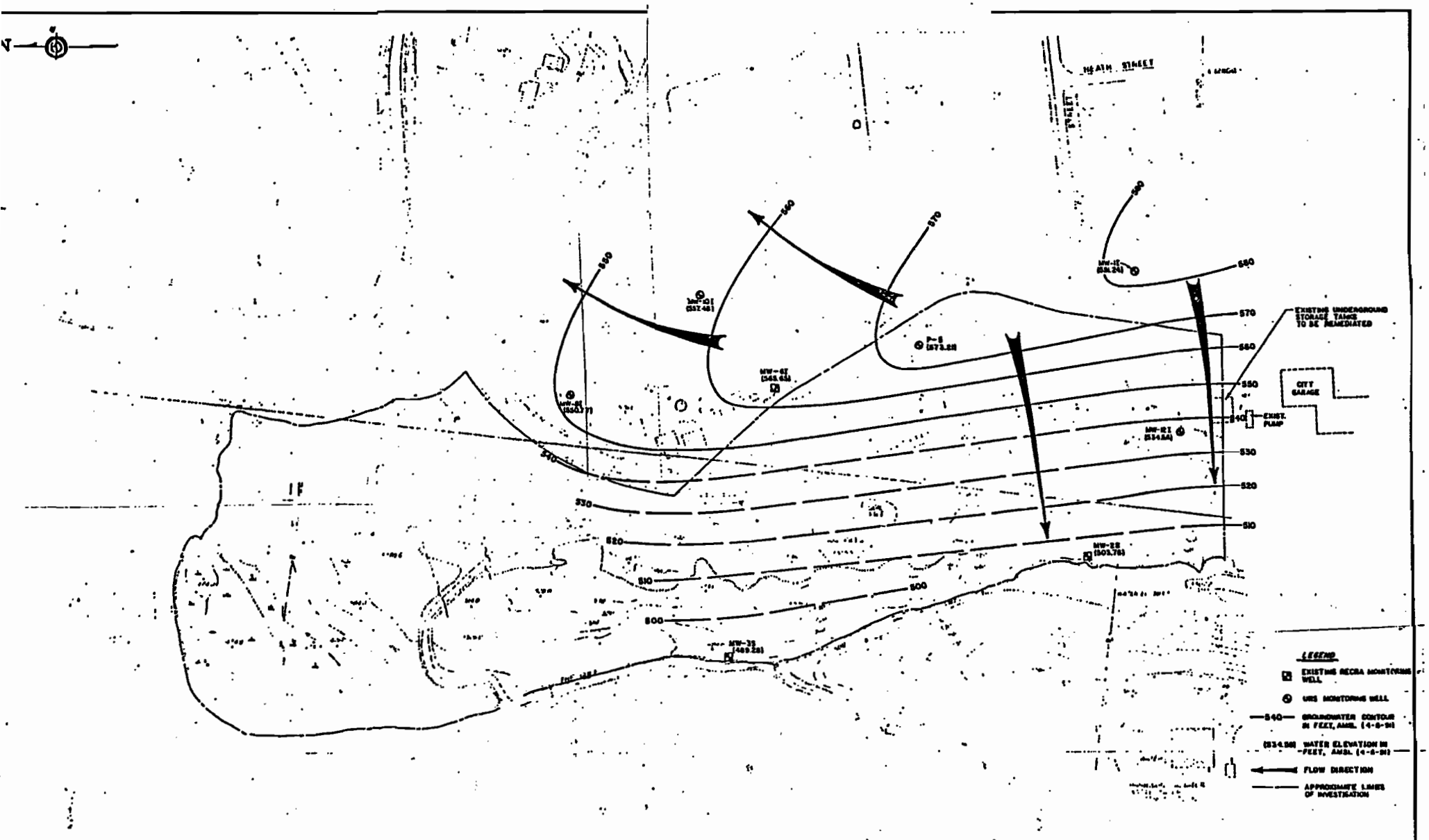
LEGEND:
I-1R BEDROCK MONITORING WELL AND DESIGNATION
I-1T LONG-TERM TOP OF ROCK MONITORING WELL AND DESIGNATION
II-AR BEDROCK WATER LEVEL OBSERVATION WELL AND DESIGNATION
II-AT TOP OF ROCK WATER LEVEL OBSERVATION WELL AND DESIGNATION
(615.9) BEDROCK GROUNDWATER ELEVATION MEASURED ON APRIL 7, 1994
616 BEDROCK GROUNDWATER CONTOUR FOR DATE SHOWN
DIRECTION OF FLOW
N
II-DT
II-DR
(615.9)
616
(617.8)
I-3R
I-3T
(613.9)
I-4R
I-4T
620
622
624
I-1T
I-1R
(625.2)
I-5R
(612.8)
I-5T
(612.4)
I-6R
II-CT
(625.1)
I-2R
I-2T
PLANT ROAD NO.
II-BT
I-7R
(613.0)
I-7T
618
II-AR
(620.5)
II-AT
SCALE IN FEET
0 200 400 800
REV No
DESCRIPTION
BY
DATE
DRAWN BY: DEW
DATE: JULY 1994
GZA GeoEnvironmental of New York
HARRISON
DIVISION OF GENERAL MOTORS CORPORATION
LOCKPORT, NEW YORK
BEDROCK
GROUNDWATER CONTOUR MAP
APRIL 7, 1994
PROJECT No.
R5805
FIGURE No.
5
©1994 GZA GeoEnvironmentals of New York



NOTE:
ALL PROPERTY LINES SHOWN ARE TAKEN FROM CITY AND TOWN OF LOCKPORT TAX MAPS AND ARE APPROXIMATE IN NATURE. LOCATION, PHYSICAL FEATURES AND CONTOURS WHICH ARE SHOWN ARE TAKEN FROM PHOTOGRAMMETRIC MAPPING COMPILED BY LOCKWOOD KAPPE SERVICES, ROCHESTER, N.Y., USING APRIL 1988 AERIAL PHOTOGRAPHS.

NO	DATE	DESCRIPTION	NO	DATE	DESCRIPTION
		Combined Phase I & Phase II			
		Updated to reflect invoice comments			

REVISIONS

DESIGNED BY: T.A.F.
DRAWN BY: K.L.W.
CHECKED BY:
PROJ. ENGR.:

URS Consultants, Inc.
CONSULTING ENGINEERS
NEW YORK NEW JERSEY

JOB No. 35180

REMEDIAL INVESTIGATION REPORT

LOCKPORT CITY LANDFILL
CITY OF LOCKPORT NIAGARA COUNTY NEW YORK

ROCHESTER FORMATION
PIEZOMETRIC SURFACE

Scale: 1"=100' Date: JULY 1991

PLATE 6

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York, 14203-2999
Phone: (716) 851-7220 FAX: (716) 851-7226

John P. Cahill
Commissioner

May 15, 1998

Mr. Roy D. Knapp
Delphi Harrison Thermal Systems
200 Upper Mountain Road
Lockport, New York 14094

Dear Mr. Knap:

Delphi Thermal; TCE Spill Investigation

A review of program files for the subject site revealed that on August 28, 1997, the Delphi Thermal Corporation (Delphi) collected groundwater samples from nine on-site monitoring wells as part of the company's investigation of a TCE spill. A confirmatory round of samples were subsequently collected by Delphi in October 1997. Our file review also revealed that a report summarizing the results of this sampling, as promised by Delphi by letter dated August 14, 1997, has not been submitted for review. Based upon our experience with sites in the Western New York area wherein quarterly or semi-annual groundwater sampling takes place, sampling reports are generally submitted within three (3) months of the sampling event. Seven (7) months to submit a sampling report, therefore, is unacceptable. By way of this letter we are requesting submittal of such a report by the end of May, 1998.

During the August sampling event the Department collected split samples from four wells for the analysis of TCL volatiles. These results were previously sent to Delphi by letter dated October 9, 1997. Two of the wells sampled (MW-3 and MW-4) are located near the spill area (95 feet and 240 feet, respectively), while the other two wells (MW-11 and MW-12) are located 1230 feet (MW-11) and 1290 feet (MW-12) downgradient from the area of concern.

The split samples collected near the spill area (MW-3 and MW-4) show significant concentrations of trichloroethene (TCE) and its breakdown products dichloroethene (DCE) and vinyl chloride (VC). Wells MW-3 and MW-4 also contain benzene, toluene, ethylbenzene and xylenes (BTEX) above groundwater standards. TCE was not detected in wells MW-11 and MW-12; however, DCE and VC were detected in these wells. While the concentration of these contaminants in well MW-11 is of minimal concern, the concentration of DCE and VC in well MW-12 exceed groundwater standards, suggesting that offsite migration might be occurring. As a result, additional investigation, including the installation of additional monitoring wells, is required.

On April 20, 1998, Department personnel collected two (2) seep samples from the west side of the Gulf for analysis of TCL volatiles (see location on attached figure) for purposes of further evaluating the

potential off-site migration of contaminated groundwater from the Delphi facility. This seep covered a large area (approximately 10 feet by 10 feet) in a bedrock outcrop located about 15 feet below the top of the embankment. DCE and VC were not detected in either sample, but TCE at a concentration of 4J μg/l was detected in one of the samples (results attached). While these results are not conclusive, they suggest that TCE is entering the Gulf through contaminated groundwater. Additional investigation of the Gulf, therefore, is also required.

In addition to submitting the sampling report, Delphi should also submit a work plan describing additional investigative activities for the Site. This plan should include, at a minimum, the installation of additional monitoring wells to determine both the length and width of the contaminant plume, well sampling, evaluation of seeps along the Gulf, and a detailed evaluation of the natural attenuation mechanism(s).

Should you have any questions, please feel free to contact me at 716-851-7220.

Sincerely yours,

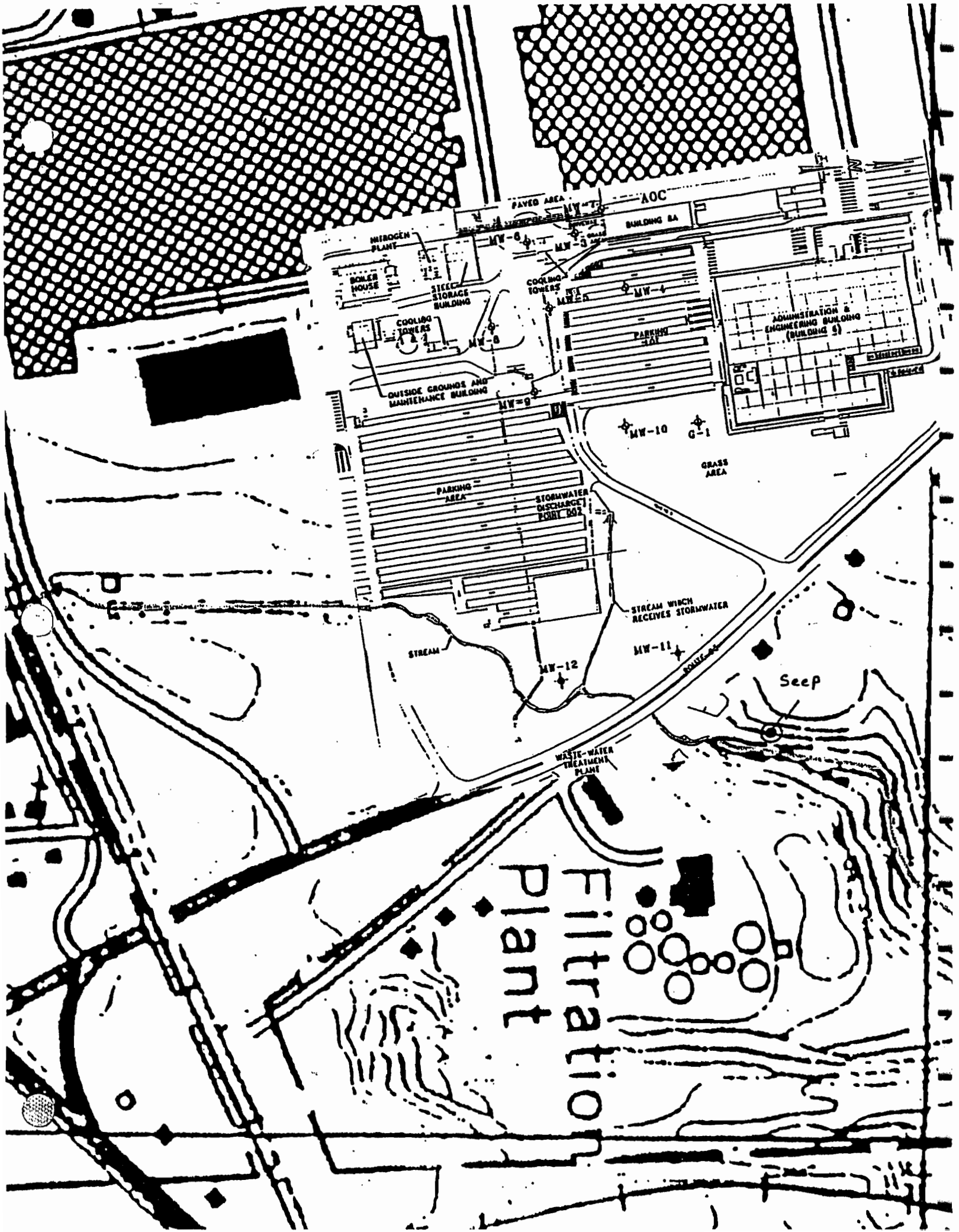
Glenn M May

Glenn M. May, CPG
Engineering Geologist I

GMM:sz

Attachment

cc: Mr. Daniel King, NYSDEC, Division of Environmental Remediation
Joseph Ryan, Esq., NYSDEC, Division of Environmental Enforcement
Mr. Matthew Forcucci, NYS Department of Health, Buffalo


AOC
PAVED AREA
MW-7
BUILDING 8A
NITROGEN PLANT
MW-6
MW-3
BOILER HOUSE
STEEL STORAGE BUILDING
COOLING TOWERS
MW-5
MW-4
COOLING TOWERS
MW-8
PARKING LOT
ADMINISTRATION & ENGINEERING BUILDING (BUILDING 9)
OUTSIDE GROUNDS AND MAINTENANCE BUILDING
MW-9
MW-10
G-1
GRASS AREA
PARKING AREA
STORMWATER DISCHARGE POINT 002
STREAM WHICH RECEIVES STORMWATER
STREAM
MW-11
MW-12
Seep
WASTE-WATER TREATMENT PLANT
Filtration Plant

ASP 95 - VOLATILES
ANALYSIS DATA SHEET

000008 Client No. B08101

I Name: Recra LabNet Contract: C003783

Lab Code: RECNY Case No.: SH998 SAS No.: _____ SDG No.: 0420

Matrix: (soil/water) WATER Lab Sample ID: A8137401

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: H6402.RR

Level: (low/med) LOW Date Samp/Recv: 04/20/98 04/20/98

% Moisture: not dec. _____ Heated Purge: N Date Analyzed: 04/23/98

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
74-87-3	Chloromethane	10	U
74-83-9	Bromomethane	10	U
75-01-4	Vinyl chloride	10	U
75-00-3	Chloroethane	10	U
75-09-2	Methylene chloride	10	U
67-64-1	Acetone	10	U
75-15-0	Carbon Disulfide	10	U
75-35-4	1,1-Dichloroethene	10	U
75-34-3	1,1-Dichloroethane	10	U
540-59-0	1,2-Dichloroethene (Total)	10	U
67-66-3	Chloroform	10	U
107-06-2	1,2-Dichloroethane	10	U
78-93-3	2-Butanone	10	U
71-55-6	1,1,1-Trichloroethane	10	U
56-23-5	Carbon Tetrachloride	10	U
75-27-4	Bromodichloromethane	10	U
78-87-5	1,2-Dichloropropane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
79-01-6	Trichloroethene	4	J
124-48-1	Dibromochloromethane	10	U
79-00-5	1,1,2-Trichloroethane	10	U
71-43-2	Benzene	10	U
10061-02-6	trans-1,3-Dichloropropene	10	U
75-25-2	Bromoform	10	U
108-10-1	4-Methyl-2-pentanone	10	U
591-78-6	2-Hexanone	10	U
127-18-4	Tetrachloroethene	10	U
108-88-3	Toluene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
100-42-5	Styrene	10	U
1330-20-7	Total Xylenes	10	U

ASP 95 - VOLATILES
TENTATIVELY IDENTIFIED COMPOUNDS

000009

Client No. B08101

Name: Recra LabNet Contract: C003783

Lab Code: RECNY Case No.: SH998 SAS No.: _____ SDG No.: 0420

Matrix: (soil/water) WATER Lab Sample ID: A8137401

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: H6402.RR

Level: (low/med) LOW Date Samp/Recv: 04/20/98 04/20/98

% Moisture: not dec. _____ Date Analyzed: 04/23/98

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 0 CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	Compound Name	RT	Est. Conc.	Q

ASP 95 - VOLATILES
ANALYSIS DATA SHEET

000010 Client No.

B08101 RE

Lab Name: Recra LabNet Contract: C003783

Lab Code: RECNY Case No.: SH998 SAS No.: _____ SDG No.: 0420

Matrix: (soil/water) WATER Lab Sample ID: A8137401RI

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: H6403.RR

Level: (low/med) LOW Date Samp/Recv: 04/20/98 04/20/98

% Moisture: not dec. _____ Heated Purge: N Date Analyzed: 04/24/98

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
74-87-3	Chloromethane	10	U
74-83-9	Bromomethane	10	U
75-01-4	Vinyl chloride	10	U
75-00-3	Chloroethane	10	U
75-09-2	Methylene chloride	10	U
67-64-1	Acetone	10	U
75-15-0	Carbon Disulfide	10	U
[illegible]-35-4	1,1-Dichloroethene	10	U
[illegible]-34-3	1,1-Dichloroethane	10	U
540-59-0	1,2-Dichloroethene (Total)	10	U
67-66-3	Chloroform	10	U
107-06-2	1,2-Dichloroethane	10	U
78-93-3	2-Butanone	10	U
71-55-6	1,1,1-Trichloroethane	10	U
56-23-5	Carbon Tetrachloride	10	U
75-27-4	Bromodichloromethane	10	U
78-87-5	1,2-Dichloropropane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
79-01-6	Trichloroethene	4	J
124-48-1	Dibromochloromethane	10	U
79-00-5	1,1,2-Trichloroethane	10	U
71-43-2	Benzene	10	U
10061-02-6	trans-1,3-Dichloropropene	10	U
75-25-2	Bromoform	10	U
108-10-1	4-Methyl-2-pentanone	10	U
591-78-6	2-Hexanone	10	U
127-18-4	Tetrachloroethene	10	U
108-88-3	Toluene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
100-42-5	Styrene	10	U
1330-20-7	Total Xylenes	10	U

ASP 95 - VOLATILES
TENTATIVELY IDENTIFIED COMPOUNDS

000011

Client No.: B08101 RE

Lab Name: Recra LabNet Contract: C003783

Lab Code: RECNY Case No.: SH998 SAS No.: _____ SDG No.: 0420

Matrix: (soil/water) WATER Lab Sample ID: A8137401RI

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: H6403.RR

Level: (low/med) LOW Date Samp/Recv: 04/20/98 04/20/98

% Moisture: not dec. _____ Date Analyzed: 04/24/98

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 0 CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	Compound Name	RT	Est. Conc.	Q

ASP 95 - VOLATILES
ANALYSIS DATA SHEET

000012 Client No.

B08102

Lab Name: Recra LabNet Contract: C003783

Lab Code: RECNY Case No.: SH998 SAS No.: _____ SDG No.: 0420

Matrix: (soil/water) WATER Lab Sample ID: A8137402

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: H6397.RR

Level: (low/med) LOW Date Samp/Recv: 04/20/98 04/20/98

% Moisture: not dec. _____ Heated Purge: N Date Analyzed: 04/23/98

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
74-87-3	Chloromethane	10	U
74-83-9	Bromomethane	10	U
75-01-4	Vinyl chloride	10	U
75-00-3	Chloroethane	10	U
75-09-2	Methylene chloride	10	U
67-64-1	Acetone	10	U
75-15-0	Carbon Disulfide	10	U
75-35-4	1,1-Dichloroethene	10	U
75-34-3	1,1-Dichloroethane	10	U
540-59-0	1,2-Dichloroethene (Total)	10	U
67-66-3	Chloroform	10	U
107-06-2	1,2-Dichloroethane	10	U
78-93-3	2-Butanone	10	U
71-55-6	1,1,1-Trichloroethane	10	U
56-23-5	Carbon Tetrachloride	10	U
75-27-4	Bromodichloromethane	10	U
78-87-5	1,2-Dichloropropane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
79-01-6	Trichloroethene	10	U
124-48-1	Dibromochloromethane	10	U
79-00-5	1,1,2-Trichloroethane	10	U
71-43-2	Benzene	10	U
10061-02-6	trans-1,3-Dichloropropene	10	U
75-25-2	Bromoform	10	U
108-10-1	4-Methyl-2-pentanone	10	U
591-78-6	2-Hexanone	10	U
127-18-4	Tetrachloroethene	10	U
108-88-3	Toluene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
100-42-5	Styrene	10	U
1330-20-7	Total Xylenes	10	U

ASP 95 - VOLATILES
TENTATIVELY IDENTIFIED COMPOUNDS

000013

Client No.
B08102

Lab Name: Recra LabNet Contract: C003783

Lab Code: RECNY Case No.: SH998 SAS No.: _____ SDG No.: 0420

Matrix: (soil/water) WATER Lab Sample ID: A8137402

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: H6397.RR

Level: (low/med) LOW Date Samp/Recv: 04/20/98 04/20/98

% Moisture: not dec. _____ Date Analyzed: 04/23/98

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 0 CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	Compound Name	RT	Est. Conc.	Q

ASP 95 - VOLATILES
ANALYSIS DATA SHEET

000014 Client No.

B08102 RE

Lab Name: Recra LabNet Contract: C003783

Lab Code: RECNY Case No.: SH998 SAS No.: _____ SDG No.: 0420

Matrix: (soil/water) WATER Lab Sample ID: A8137402RI

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: H6401.RR

Level: (low/med) LOW Date Samp/Recv: 04/20/98 04/20/98

% Moisture: not dec. _____ Heated Purge: N Date Analyzed: 04/23/98

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

CAS NO.	COMPOUND	CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L	Q
74-87-3	Chloromethane	10	U
74-83-9	Bromomethane	10	U
75-01-4	Vinyl chloride	10	U
75-00-3	Chloroethane	10	U
75-09-2	Methylene chloride	10	U
67-64-1	Acetone	10	U
75-15-0	Carbon Disulfide	10	U
[illegible]-35-4	1,1-Dichloroethene	10	U
[illegible]-34-3	1,1-Dichloroethane	10	U
540-59-0	1,2-Dichloroethene (Total)	10	U
67-66-3	Chloroform	10	U
107-06-2	1,2-Dichloroethane	10	U
78-93-3	2-Butanone	10	U
71-55-6	1,1,1-Trichloroethane	10	U
56-23-5	Carbon Tetrachloride	10	U
75-27-4	Bromodichloromethane	10	U
78-87-5	1,2-Dichloropropane	10	U
10061-01-5	cis-1,3-Dichloropropene	10	U
79-01-6	Trichloroethene	10	U
124-48-1	Dibromochloromethane	10	U
79-00-5	1,1,2-Trichloroethane	10	U
71-43-2	Benzene	10	U
10061-02-6	trans-1,3-Dichloropropene	10	U
75-25-2	Bromoform	10	U
108-10-1	4-Methyl-2-pentanone	10	U
591-78-6	2-Hexanone	10	U
127-18-4	Tetrachloroethene	10	U
108-88-3	Toluene	10	U
79-34-5	1,1,2,2-Tetrachloroethane	10	U
108-90-7	Chlorobenzene	10	U
100-41-4	Ethylbenzene	10	U
100-42-5	Styrene	10	U
1330-20-7	Total Xylenes	10	U

ASP 95 - VOLATILES
TENTATIVELY IDENTIFIED COMPOUNDS

000015 Client No.: B08102 RE

Lab Name: Recra LabNet Contract: C003783

Lab Code: RECNY Case No.: SH998 SAS No.: _____ SDG No.: 0420

Matrix: (soil/water) WATER Lab Sample ID: A8137402RI

Sample wt/vol: 5.00 (g/mL) ML Lab File ID: H6401.RR

Level: (low/med) LOW Date Samp/Recv: 04/20/98 04/20/98

% Moisture: not dec. _____ Date Analyzed: 04/23/98

GC Column: DB-624 ID: 0.53 (mm) Dilution Factor: 1.00

Soil Extract Volume: _____ (uL) Soil Aliquot Volume: _____ (uL)

Number TICs found: 0 CONCENTRATION UNITS: (ug/L or ug/Kg) UG/L

CAS NO.	Compound Name	RT	Est. Conc.	Q

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York, 14203-2999
Phone: (716) 851-7220 FAX: (716) 851-7226

John P. Cahill
Commissioner

October 21, 1998

Ms. Catherine A. Ver
Delphi Harrison Thermal Systems
200 Upper Mountain Road
Lockport, New York 14094

Dear Ms. Ver:

Meeting Minutes

This letter is in response to GZA's September 8, 1998 letter summarizing the August 3, 1998 meeting between Delphi Thermal and the Department, and your September 9, 1998 letter concerning the listing of the Delphi Thermal Site in the Registry. Regarding site listing, conversations with the Department's Albany staff indicate that a formal decision concerning the listing of the Delphi Thermal Site has not yet been made. These conversations also confirmed that a Fact Sheet describing the site can be sent with the site listing notification letter. To this end, the Department will draft the Fact Sheet and coordinate the mailings. A copy of the draft Fact Sheet will be sent to you for review.

Regarding GZA's letter, Department responses and comments are summarized by bullet as follows:

Bullet 1, Page 1: While the distribution of contaminant concentrations throughout the site suggest that natural attenuation is occurring, additional data is required (e.g., the additional parameters discussed in bullet 3 on page 2) to substantiate this; and if substantiated, to fully evaluate the natural attenuation process occurring at the Delphi Thermal site. Also, while no further private well assessment is required at this time, I cannot guarantee that such an assessment will not be required by other reviewers during the RI/FS process. As requested at the meeting, Delphi should determine whether the houses downgradient of the contaminant plume along Route 93 have basements. The absence of basements would significantly reduce/eliminate potential adverse health impacts for these residents from any contaminants that may be migrating off-site.

Bullet 3, Page 2: The additional parameters proposed for evaluating the natural attenuation process are acceptable. The Department suggests, however, that magnesium, sodium, potassium and alkalinity be added to the parameter list to facilitate the evaluation of site groundwater through graphical methods (e.g., piper plots, stiff diagrams). Such graphs have been successful in delineating multiple source areas at sites (e.g., increases in chloride concentration from the breakdown of

TCE versus increased chloride content from the solubilization of road salt). Road salt impacts are possible at the Delphi Thermal site and may need to be evaluated.

Bullet 4, Page 2: At least three copies of the report should be submitted - one for the NYSDEC Buffalo office, one for the NYSDEC Albany office and one for the NYSDOH. Elimination of piezometer G-1 from the monitoring program is acceptable.

Bullet 5, Page 2: It is correct to state that much of the work required for a Remedial Investigation (RI) has been completed. This information, however, must be incorporated into an RI Report that conforms to EPA guidance. The FS for the Delphi Thermal site must include a detailed screening of remedial alternatives and must also conform to EPA guidance. Inclusion of a discussion related to the difficulty in remediating fractured bedrock can be included, but should not be the focus of the FS.

Bullet 1, Page 3: Implementation of a long term operation and maintenance and/or monitoring program at the site would likely require formal agreement between Delphi and the Department. The agreement would likely be an Order on Consent or similar document, irrespective of whether the work is undertaken via the Interim Remedial Measure (IRM) or Remedial Design/Remedial Action (RD/RA) process.

Should you have any questions or comments concerning the above, please feel free to contact me at 716-851-7220.

Sincerely yours,

Glenn M May

Glenn M. May, CPG
Engineering Geologist I

GM:lj

cc: Mr. Daniel King, Regional Hazardous Waste Remediation Engineer
Mr. Matthew Forcucci, New York State Department of Health

(a:ver.gm)

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York, 14203-2999
Phone: (716) 851-7220 • **FAX:** (716) 851-7226
Website: www.dec.state.ny.us

John P. Cahill
Commissioner

August 12, 1999

Ms. Catherine A. Ver
Delphi Harrison Thermal Systems
200 Upper Mountain Road
Lockport, New York 14094

Dear Ms. Ver:

Delphi Thermal; Inactive Site No. 932113

This letter is a follow-up to our August 9, 1999 telephone conversation regarding the subject site and the upcoming groundwater sampling event. Since the Department has yet to issue specific guidance concerning the use of natural attenuation as a remedial option, we recommend that these groundwater samples be analyzed for the same set of parameters as the December 1998 groundwater samples. This list of parameters can be reevaluated as further guidance becomes available.

In a related matter, please find attached two articles from Soil & Groundwater Cleanup concerning the use of natural attenuation as a remedial option. Also, find attached the cover pages of two EPA guidance documents regarding natural attenuation. The Department is currently evaluating these latter documents to determine if they are consistent with program policies and procedures. In the interim, however, the Remedial Investigation work plan should be consistent with this guidance.

Should you have any questions or comments concerning the above, please feel free to contact me at 716-851-7220.

Sincerely yours,

Glenn M. May

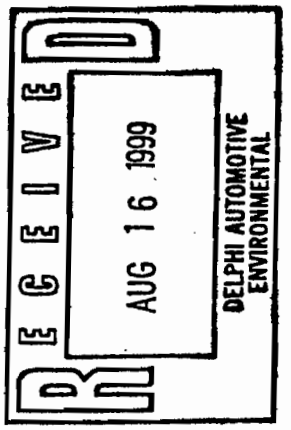
Glenn M. May, CPG
Engineering Geologist I

GM:lj

Attachments

cc: Mr. Daniel King, Division of Environmental Remediation
Mr. Matthew Forcucci, New York State Department of Health

a:Delph-16



New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York, 14203-2999
Phone: (716) 851-7220 • **FAX:** (716) 851-7226
Website: www.dec.state.ny.us

John P. Cahill
Commissioner

March 10, 2000

Ms. Catherine A. Ver
Delphi Harrison Thermal Systems
200 Upper mountain Road
Lockport, New York 14094

Dear Ms. Ver:

Focused RI/FS Work Plan
Delphi Harrison Thermal Systems Site,
Registry Number 932113

The New York State Departments of Health (DOH) and Environmental Conservation (DEC) have completed review of the RI/FS Work Plan prepared by GZA for the subject site as submitted to the Departments on January 12, 2000. Correctly stated in Section 1.10 of the work plan, the objective of a Remedial Investigation (RI) is to characterize the nature and extent of contamination identified at a site. We do not believe that the field activities completed to date, nor the field activities proposed during the RI, will accomplish that objective. While Delphi Thermal has characterized the nature of the contamination through various investigative efforts over the last six years, the Departments do not believe that the extent of the groundwater contaminant plume has been adequately determined. GZA must include specific investigative activities to delineate the dimensions of this plume in the work plan.

Although trichloroethene (TCE) contaminated soils have been excavated from the site, a significant source of groundwater contamination appears to remain within the bedrock. The extremely high concentrations of TCE (near or above the solubility limit) in wells MW-1 and MW-7 suggest DNAPL presence within the bedrock near the original source area. The presence of DNAPL in well MW-5 may indicate that DNAPL at the site is mobile, having migrated to this well from the source area. As the top of bedrock trends in elevation from west (higher near the former storage tank) to east (lower toward edge of property near Route 93), it appears that contaminant source migration, and its associated dissolved phase contamination, is a legitimate concern at this site. As dichloroethene (DCE) and vinyl chloride (VC) are already present well above groundwater standards in at least one of the westernmost monitoring wells (MW-12), the potential for relatively significant groundwater contaminant migration from the site exists.

The work plan proposes to focus the Feasibility Study (FS) on two remedial alternatives; natural attenuation and groundwater extraction. GZA cites technical impracticability of removing DNAPL from fractured bedrock as the justification for this focus. This approach is common and reasonable; however, it appears that GZA is already demonstrating a propensity toward the natural attenuation approach. While the distribution of contaminant concentrations throughout the site suggests that natural attenuation is occurring, the RI will need to prove conclusively that such an attenuation mechanism is occurring. If substantiated, GZA must fully evaluate the natural attenuation process occurring at the Delphi Thermal site. We require such evaluation to support the selection of natural attenuation over other applicable alternatives in the FS screening process. In addition, natural attenuation remedies are not necessarily appropriate for sites with a remaining contaminant source (i.e., DNAPL). As a result, the remedial alternatives considered in the focused FS should include efforts to reduce the mass of the contaminant source further. We suggest that the focused FS include, at a minimum, the evaluation of in-situ chemical oxidation. While relatively new in their application, two such oxidants - potassium permanganate and sodium permanganate, may reduce/eliminate the mass of contaminant contributing to groundwater contamination.

We summarize specific comments regarding the RI/FS work plan as follows:

Section 1.10, Purpose and Objective:

RI, 1st Bullet: The data do not support the statement that contaminant concentrations are "near" the Class GA water standards near the property line. Concentrations of DCE and VC in well MW-12 are significantly greater (almost two orders of magnitude greater during the October 1997 sampling event) than the Class GA water standards.

RI, 2nd Bullet: The work plan states that "the on-site contamination is limited to TCE, tetrachloroethene (PCE) and their degradation products." Besides these compounds, however, BTEX has been detected in groundwater at an isolated area of the site and 2-butanone was detected in some soil samples during early investigation activities. Also, previous analyses for other contaminants (i.e., semivolatiles, PCBs, pesticides and metals) have not been completed. Therefore, GZA cannot make this statement.

RI, 4th Bullet: The work plan states that "there are no significant exposure scenarios from the source of the contamination to the property line." As the original contaminant source area is immediately adjacent to Building 8A, are there any health concerns to be considered such as indoor air quality, sump water, etc? Also, depending upon building construction, might there be residual product under the limits of the building? GZA should include such issues in the scope of work.

RI, 6th Bullet: While scientists widely recognize that the complete removal of DNAPL from the subsurface environment is nearly impossible, DNAPL left in place will continue to act as a source of groundwater contamination. The presence of DNAPL in monitoring well MW-5, therefore, needs to be further evaluated. Such evaluation should include thickness, extent and composition. In addition, the source of this DNAPL has not been satisfactorily determined.

FS, 2nd Bullet: As discussed above, GZA should include in-situ chemical oxidation as a potentially applicable technology for the destruction of DNAPL.

Section 1.20, Project Description, History and Location, 2nd Bullet, Page 4: From the groundwater chemistry data provided by MW-3D, deep bedrock groundwater has not been impacted at this location. However, does other information support an assessment that the former storage tank has not affected deep bedrock groundwater? Specifically, did fractures observed in bedrock cores indicate the lack of vertical fracturing? Do groundwater elevations within MW-3D and MW-3S indicate an upward gradient from the deep to the shallow bedrock? The answers to these questions may dictate the need for additional deep bedrock monitoring wells.

Section 2.10, Task 1, Work Plans: The work plan states that GZA will develop a Field Activities Plan for work completed after October 1999. As stated earlier, specific investigative activities to further evaluate the groundwater contaminant plume, DNAPL in well MW-5, and the natural attenuation process must be included in the RI/FS work plan before its approval.

Utilization of the previously approved Sampling and Analysis Plan (SAP) and Health and Safety Plan (HASP) is acceptable if these plans cover the additional field activities proposed during the RI. If not, an addendum to these plans will be required, and should be incorporated into the revised RI/FS work plan. We will require copies of the previously approved SAP and HASP for distribution to the other reviewers, for attachment to the Order on Consent when finalized, and for the document repository.

Regarding the Citizen Participation Plan, please be reminded that the development and execution of the Citizen Participation Plan (CP), with Department oversight, is the responsibility of the Potentially Responsible Party (PRP). Besides developing the fact sheets, Delphi Thermal will also be responsible for mailing. The Department will assist Delphi Thermal in the preparation of the fact sheets, will coordinate internal Department review, and will provide Delphi Thermal with an initial mailing list. Delphi Thermal will be responsible for updating that list as appropriate. Also note that the Department reserves the right to amend the CP Plan to reflect public interest and issues. We may request additional CP activities, including fact sheets, public notices, public availability sessions, and public meetings.

Section 2.20, Task 2, Focused Remedial Investigation:

General: To further delineate the extent (e.g., width and length) of the groundwater contaminant plume, we will require additional monitoring wells. Regarding downgradient wells, previous discussions between the Department and Delphi Thermal have focused on spatial constraints. It appears from Figure 1, however, that an additional well or wells could be installed on Delphi's Waste Water Treatment Plant property. This location is critical because DCE and VC were detected above groundwater standards in well MW-12, which is immediately upgradient of this property. In addition, GZA should evaluate and sample seeps along the Gulf.

Public and Private Well Assessment: Delphi proposes to examine public records to locate and inventory private basements and sumps along Route 93. The mailing or hand delivery of a questionnaire may prove an expedient and reliable way to supplement such a records search.

Section 2.40, Task 4, Focused Feasibility Study: Besides the two alternatives discussed, DNAPL removal/destruction from well MW-5 should be considered for the reasons discussed above (i.e., continuing source of groundwater contamination). While we recognize that residual DNAPL may remain in the subsurface environment based upon the remedial alternative utilized, natural biological activity could further reduce this residual DNAPL, thus reducing the time required for long-term groundwater monitoring.

Section 2.50, Task 5, FFS Report: The Focused FS Report should be complete and be a "stand alone" document. Despite previous screening and evaluations included in previous reports, the FFS should function as a complete Feasibility Study on its own, and not be "Part 2" of an FS that picks up from parts of another report. In addition, in-situ chemical oxidation should be included and considered in the FFS.

Should you have any comments or questions, please feel free to contact me at 716-851-7220.

Sincerely yours,

Glenn M May

Glenn M. May, CPG.
Engineering Geologist I

cc: Mr. Daniel King, NYSDEC
Mr. Brian Sadowski, NYSDEC
Mr. Jeff Konsella, NYSDEC
Mr. Matthew Forcucci, NYSDOH

DELPHI
Automotive Systems

June 20, 2000

Mr. Glenn M. May
New York State Department of Environmental Conservation
270 Michigan Avenue
Buffalo, New York 14203 -2999

Dear Mr. May:

Delphi Harrison Thermal Systems is submitting our response to your March 10, 2000 letter on the Focused Remedial Investigation (FRI) and Focused Feasibility Study (FFS) Work Plan for NYSDEC Inactive Hazardous Waste Registry Site #932113 located at the Lockport Site.

I would like to propose an onsite meeting with NYSDEC, Delphi Thermal, and GZA GeoEnvironmental personnel to be held after July 17, 2000. The Delphi Thermal facility will be closed on July 1 with normal production scheduled to resume after July 16. I will contact you during the week of June 26 to set the meeting date and time.

Please call me at (716) 439 - 2942 if you have any questions.

Sincerely,

Catherine A. Ver
Sr. Environmental Engineer

Harrison Thermal Systems
World Headquarters
200 Upper Mountain Road Lockport, New York 14094 USA

GZA
GeoEnvironmental
of New York

*Engineers and
Scientists*

June 19, 2000
File No. 55039.20

Ms. Cathy Ver
Delphi Harrison Thermal Systems
World Headquarters
200 Upper Mountain Road
Lockport, New York 14094-1896

Re: Focused Remedial Investigation and
Focused Feasibility Study Work Plan
Response to NYSDEC Comments
Delphi Harrison Thermal Systems West Lockport Complex
NYSDEC Registry Site # 932113

364 Nagel Drive
Buffalo
New York 14225
716-685-2300
FAX 716-685-3629
http://www.gza.net

Dear Ms. Ver:

This letter is in response to comments made by the New York State Department of Environmental Conservation (NYSDEC) in its letter to Delphi Thermal (dated March 10, 2000) regarding the Focused Remedial Investigation (FRI) and Focused Feasibility Study (FFS) Work Plan prepared by GZA GeoEnvironmental of New York (GZA), dated January 12, 2000.

In general, NYSDEC comments relate to the following key items:

- Delineation of the extent (width and length) of the trichloroethylene (TCE) (and TCE degradation constituents) groundwater plume at the Site.
- DNAPL evaluation and remediation.
- FFS evaluation related to consideration of in-situ chemical oxidation as a possible remedial technology for use at this site.

We have addressed these items as follows:

- Two additional monitoring wells will be added on the plant side of Route 93 to complete the task of delineating the extent of the groundwater plume. The round of FRI sampling that will include the two wells should allow us to assess the full nature and extent of the contamination at issue.
- The available data indicate that the observed DNAPL is not migrating and that it is not technically feasible to use in-situ chemical oxidation to address this contaminant source.
- Although in-situ chemical oxidation is not technically feasible for the treatment of DNAPL (in fractured bedrock), it will be considered in the FFS evaluation for the dissolved phase contamination detected at the Site.

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Technologies, Inc.

With respect to the specific questions/comments posed by the NYSDEC, we have set forth in the following discussion specific responses for NYSDEC's consideration. In this regard, note that several of the questions/comments relate to topics previously discussed with NYSDEC during various meetings attended by NYSDEC, Delphi Thermal and GZA. GZA has included information from those discussions in our responses as appropriate.

It should also be noted that the FRI/FFS work plan and consent order are being negotiated after much work has been completed. Delphi Thermal has performed this work on a voluntary basis in consultation with the NYSDEC since the detection of the TCE release in 1994. The field work and the reports that have been completed and submitted to NYSDEC have included a significant number of tasks normally associated with the RI/FS process.

Section 1.10. Purpose and Objective:

RI. 1st Bullet: The data do not support the statement that contaminant concentrations are "near" the Class GA water standards near the property line. Concentrations of DCE and VC in well MW-12 are significantly greater (almost two orders of magnitude greater during the October 1997 sampling event) than the Class GA water standards.

Detected concentrations at the downgradient wells MW-11 and MW-12 are set forth in the following Table:

MW-11			MW-12		
	Total 1,2 DCE	VC		Total 1,2 DCE	VC
Date	(ug/l)	(ug/l)	Date	(ug/l)	(ug/l)
8/28/97	5	4	8/28/97	130	190
10/10/97	3	1	10/10/97	160	170
12/1/98	13	5	12/1/98	47	88
10/5/99	10	2	10/5/99	27	32

With respect to the information in the Table, note the following:

1) ug/l is equivalent to ppb.
2) PCE (tetrachloroethene) and TCE were not detected.
3) The NYSDEC groundwater standard is 5 ug/l for both cis-1,2 dichloroethene (DCE) and trans-1,2 DCE. The DCE detected at the Site is primarily cis-1,2 DCE.
4) The NYSDEC groundwater standard for vinyl chloride is 2 ug/l.

As indicated in the Table, the concentrations of DCE and VC at monitoring wells MW-11 and MW-12 are at or near (generally within about one order of magnitude) the NYSDEC groundwater standard (6 NYCRR §703.5) for the last two rounds completed. Additionally, it appears that the constituent concentrations at MW-12 are on a general decreasing trend.

Attenuation is expected to continue to occur in a downgradient direction (to the east) between wells MW-11 and MW-12 and the properties located across Route 93. These wells are located about 300 feet (MW-12) and 170 feet (MW-11) from the nearest buildings/structures located across Route 93.

GZA

RI, 2nd Bullet: The work plan states that "the on-site contamination is limited to TCE, tetrachloroethene (PCE) and their degradation products." Besides these compounds, however, BTEX has been detected in groundwater at an isolated area of the site and 2-butanone was detected in some soil samples during early investigation activities. Also, previous analyses for other contaminants (i.e. semivolatiles, PCBs, pesticides and metals) have not been completed. Therefore, GZA cannot make this statement.

Delphi Thermal's investigation was prompted by its detection of a release of TCE in the area of Building 8 (the Area of Concern or AOC) and so the constituents of concern for this Registry Site have been identified as TCE and its degradation products (the "project constituents"). Therefore, as previously agreed with NYSDEC, it is not necessary to undertake any additional testing for contaminants other than the project constituents. However, GZA will modify its statement to "the on-site contamination associated with the TCE release is limited to TCE and its degradation products."

BTEX was detected in samples collected from monitoring well MW- 3S at about 8 mg/l total BTEX. No BTEX was detected in downgradient monitoring wells MW-4 and MW-5 or other (sidegradient) wells that were sampled in the vicinity. An underground gasoline storage tank was formerly located next to Building 8, near the former TCE tank (see GZA's Phase III Extent of Contamination Studies Report, dated February 1997). Delphi Thermal is not aware of any petroleum releases or any other petroleum spills from this tank, which the facility believes was removed in the early 1980s. No other petroleum sources of contamination exist in this area and we therefore cannot identify the source of the BTEX.

2-butanone (MEK) was detected at one auger probe (AP) sample collected above the water table (AP-1, 4-5 feet below ground surface). MEK was not detected at the same location at or below the water table (AP-2, 7-8 feet below ground surface). Additionally, MEK is a common laboratory contaminant and its presence is therefore suspect.

GZA and Delphi Thermal previously reviewed the BTEX and MEK findings with NYSDEC and the consensus was that the presence of these compounds did not require further action. However, GZA will include a brief discussion of BTEX and 2-butanone detections in the FRI report.

RI, 4th Bullet: The work plan states that "there are no significant exposure scenarios from the source of the contamination to the property line." As the original contaminant source area is immediately adjacent to Building 8A, are there any health concerns to be considered such as indoor air quality, sump water, etc? Also, depending upon building construction, might there be residual product under the limits of the building? GZA should include such issues in the scope of work.

GZA completed an evaluation of TCE impacted soil inside of Building 8 (see GZA Phase III Extent of Contamination Report dated September 1996). GZA tested 13 soil samples (four inside Building 8 and nine outside Building 8 in the AOC) from the unsaturated soil zone for the presence of TCE. Two samples (both located outside Building 8) exceeded the NYSDEC cleanup guidance criteria for TCE of 0.7 mg/kg. No product was observed in test holes completed inside the building.

No groundwater collection sumps are located in Buildings 8 (manufacturing building) or the contiguous 8A (office building). A concrete lined underground utility chase is located south of Building 8 (running north-south) in the AOC. The utility chase is constructed on top of bedrock. A concrete lined dewatering sump is located in the chase adjacent to Building 8. Groundwater from the AOC is not anticipated to enter the chase dewatering sump. Therefore, health concerns in Buildings 8 or 8A are not expected. However, GZA will include an evaluation/discussion of Buildings 8 and 8A in the exposure assessment section of the FRI report.

Delphi Thermal utilizes an excavation permit program at the facility. Excavation work is monitored and assessed for potential hazards prior to issuing a permit. This would include air monitoring and proper personnel protective equipment consideration prior to work. This program would limit the potential for exposure scenarios related to excavation work in the AOC.

RI, 6th Bullet [Actually FS, 1st Bullet]: While scientists widely recognize that the complete removal of DNAPL from the subsurface environment is nearly impossible, DNAPL left in place will continue to act as a source of groundwater contamination. The presence of DNAPL in monitoring well MW-5, therefore, needs to be further evaluated. Such evaluation should include thickness, extent and composition. In addition, the source of this DNAPL has not been satisfactorily determined.

The presence of DNAPL in the subsurface will provide an ongoing source of groundwater contamination. However, the studies completed indicate that the contamination is naturally attenuating. Studies to identify the extent of DNAPL are very risky because intrusive activities in DNAPL areas can cause mobilization/migration/spread of DNAPL. GZA attempted to measure the layer of DNAPL in monitoring well MW-5 (using an interface probe) on September 13, and October 10, 1997 and found that the layer was too thin to be measured. Based on visual observation during well purging and sampling, it is anticipated

that the DNAPL is less than 1/8 inch thick. The layer DNAPL was not observed at other locations. Concentrations in wells located sidegradient (MW-8) and downgradient (MW-9 and MW-10) of MW-5 do not indicate the presence of DNAPL.

The DNAPL likely reached its current location during and/or shortly after the TCE release occurred. The DNAPL is not expected to move significantly further unless it is disturbed by intrusive activities. Subsurface activities such as remedial or monitoring well installation (rock coring with fluids) or other remedial activities (injection of agents such as oxidizers) could result in the disruption and mobilization of the DNAPL.

Due to the lack of evidence supporting ongoing DNAPL migration, there is no additional DNAPL investigation planned. This decision reflects our prior conversations with NYSDEC in which it concurred with our conclusion.

FS, 2nd Bullet: As discussed above, GZA should include in-situ chemical oxidation as a potentially applicable technology for the destruction of DNAPL.

In-situ chemical oxidation is considered an innovative technology. There have been relatively few full scale applications using Fenton's Reagent (hydrogen peroxide with a catalyst), and potassium or sodium permanganate for in-situ groundwater treatment.

According to the vendors of these technologies, DNAPL remediation in a fractured bedrock environment is not considered practical. At best, some percentage of the total mass would be consumed/treated. Given the heterogeneities of the rock, we would anticipate less than 50% of the DNAPL mass would be treated.

GZA discussed the potential applicability for in-situ chemical oxidation of DNAPL with NYSDEC personnel including those from the NYSDEC Division of Environmental Remediation (Region 9 and Albany). It is generally agreed that it is not yet technically feasible to completely eliminate the presence of DNAPL using in-situ chemical oxidation processes. Available literature obtained by GZA at a recent USEPA and Groundwater Remediation Technologies Analysis Center conference ("Advances In Innovative Groundwater Remediation Technologies", June 6, 2000) supports the inherent limitations and difficulty associated with remediating DNAPL in fractured bedrock using chemical oxidation processes.

The use of in-situ chemical oxidation is not considered technically feasible for DNAPL remediation at this site due to the presence of fractured bedrock. However, it may be applicable for remediation of dissolved phase contamination. Therefore, GZA will include a discussion/evaluation of in-situ chemical oxidation (for dissolved phase contamination and not for DNAPL) in its technology screening/review in the FS.

Section 1.20 Project Description, History and Location 2nd Bullet, Page 4: From the groundwater chemistry data provided by MW-3D, deep bedrock groundwater has not been impacted at this location. However, does other information support an assessment that the former storage tank has not affected deep bedrock groundwater? Specifically, did fractures observed in bedrock cores indicate that lack of vertical fracturing? Do groundwater elevations within MW-3D and MW-3S indicate an upward gradient from the deep to the shallow bedrock? The answers to these questions may dictate the need for additional deep bedrock monitoring wells.

The majority of fractures noted at the site were horizontal or low angle (i.e., lack of vertical fractures). Some minor vertical fractures were noted, but they are not suspected to be continuous (which is typical for this formation). Water levels in MW-3D are deeper than in MW-3S and contamination was not detected in monitoring well MW-3D. This supports a lack of communication between the upper and lower bedrock. NYSDEC representatives observed the rock core samples collected from monitoring well MW-3D.

As previously agreed upon with NYSDEC, one deep well downgradient of the AOC was installed (MW-3D) to assess deep groundwater. Based on the information obtained from the sampling of this well, no additional deep groundwater monitoring wells are planned.

Section 2.10 Task 1, Work Plans: The work plan states that GZA will develop a Field Activities Plan for work completed after October 1999. As stated earlier, specific investigative activities to further evaluate the groundwater contaminant plume, DNAPL in well MW-5, and the natural attenuation process must be included in the RI/FS work plan before its approval.

Several groundwater sampling rounds using commonly accepted natural attenuation parameters have been previously completed at this site. The data indicate that natural attenuation is occurring. Two additional sample rounds, which will include target compound VOC analysis and natural attenuation parameters on selected wells (MW-11, MW-12, MW-10 and MW-4), will be completed as part of the FRI following the installation of two monitoring wells near MW-11 and MW-12. These monitoring wells (MW-13 and MW-14) will be installed in the same manner as the wells installed previously. The proposed well locations are shown on the attached Figure. The selected locations reflect the fact that access is limited near Route 93 due to the presence of utilities and the highway right of way.

It is anticipated that monitoring well MW-13 will provide additional information regarding the downgradient edge of the plume. Monitoring well MW-14 will provide information regarding the southern edge of the plume. Existing well MW-11 generally defines the north edge of the plume.

GZA will assess the need for possible additional monitoring wells following a review of the proposed rounds of ground water monitoring that includes monitoring wells MW-13 and MW-14. GZA and Delphi Thermal will discuss the need for any additional work with NYSDEC following our review.

For the reasons previously described, no additional DNAPL delineation is planned.

GZA

Utilization of the previously approved Sampling and Analysis Plan (SAP) and Health and Safety Plan (HASP) is acceptable if these plans cover the additional field activities proposed during the RI. If not, an addendum to these plans will be required, and should be incorporated into the revised RI/FS work plan. We will require copies of the previously approved SAP and HASP for distribution to the other reviewers, for attachment to the Order on Consent when finalized, and for the document repository

GZA has previously submitted these documents to NYSDEC in connection with previous investigations at the site. GZA will amend the existing plans as appropriate and include these amended documents in the form of attachments to the revised FRI/FFS work plan.

Regarding the Citizen Participation Plan, please be reminded that the development and execution of the Citizen Participation Plan (CP), with Department oversight, is the responsibility of the Potentially Responsible Party (PRP). Besides developing the fact sheets, Delphi Thermal will also be responsible for mailing. The Department will assist Delphi Thermal in the preparation of the fact sheet, will coordinate internal Department review, and will provide Delphi Thermal with an initial mailing list. Delphi Thermal will be responsible for updating that list as appropriate. Also note that the Department reserves the right to amend the CP Plan to reflect public interest and issues. We may request additional CP activities, including fact sheets, public notices, public availability sessions, and public meetings.

Delphi Thermal will develop and mail the fact sheets as needed. Delphi Thermal will provide a copy of each fact sheet for prior review by the NYSDEC. It is anticipated that the NYSDEC will provide Delphi Thermal an electronic copy of the mailing list. The list may be modified as agreed between NYSDEC and Delphi Thermal.

GZA will develop the CP Plan after it has a copy of the final mailing list. The CP Plan will be submitted with the revised FRI/FFS work plan for NYSDEC approval. It is anticipated that any modifications to the CP Plan (based on public interest) should be discussed and agreed to between NYSDEC and Delphi Thermal prior to implementation.

Section 2.20, Task 2, Focused Remedial Investigations;

General: To further delineate the extent (e.g., width and length) of the groundwater contaminant plume, we will require additional monitoring wells. Regarding downgradient wells, previous discussions between the Department and Delphi Thermal have focused on spatial constraints. It appears for Figure 1, however, that an additional well or wells could be installed on Delphi's Waste Water Treatment Plant property. This location is critical because DCE and VC were detected above groundwater standards in well MW-12, which is immediately upgradient of this property. In additional, GZA should evaluate and sample seeps along the Gulf.

GZA has visited the Gulf area to make observations and collect seep samples. GZA did not observe any flowing seeps in the area downgradient of monitoring wells MW-11 or MW-12. The bedrock face exposed in the Gulf was noted to be moist but no apparent free water seeps were observed. Access to the rock face in the Gulf is limited and difficult.

As previously described, two additional proposed monitoring wells (MW-13 and MW-14) will be installed to further delineate the plume. These wells will be located between existing monitoring wells MW-11 and MW-12 and near Route 93. A figure showing the proposed location for these wells is attached.

It is anticipated that groundwater flow (near the Gulf) in the area of the Delphi Thermal Wastewater Treatment Plant (Treatment Plant) is to the northwest toward the Gulf. (See the attached Figure, which shows the conceptual groundwater flow direction in the area of the Gulf.) Therefore, monitoring wells placed in the area of the Treatment Plant would not be expected to provide any additional insights on the plume that originates on the manufacturing plant side of Route 93.

Public and Private Well Assessment: Delphi proposes to examine public records to locate and inventory private basements and sumps along Route 93. The mailing or hand delivery of a questionnaire may prove an expedient and reliable way to supplement such a records search.

GZA will use a phased approach to collect information regarding the presence of basements and sumps downgradient of the site. GZA will first complete an assessment of the basements and sumps by examining public records. If the RI investigation indicates potential exposure issues for residences for which there is not publicly available information on the presence of basements or sumps, GZA will prepare a questionnaire (regarding the presence of sumps and basements) for the potentially affected property owners to complete. The questionnaire will be submitted to Delphi Thermal and NYSDEC for review and approval.

Section 2.40, Task 4, Focused Feasibility Study: Besides the two alternatives discussed, DNAPL removal/destruction from well MW-5 should be considered for the reasons discussed above (i.e., continuing source of groundwater contamination). While we recognize that residual DNAPL may remain in the subsurface environmental based upon the remedial alternative utilized, natural biological activity could further reduce this residual DNAPL, thus reducing the time required for long-term groundwater monitoring.

Groundwater concentrations at the Site are not likely to decrease significantly from their current levels until the mass of DNAPL is practically eliminated. This issue has been discussed with NYSDEC and it was agreed that groundwater restoration in the presence of DNAPL is considered impractical, because of technical limitations associated with attempts to remove subsurface DNAPL in fractured bedrock. The technical limitations associated with DNAPL destruction at this site will be discussed in the context of the FFS. The currently proven methods for remediating DNAPL contaminated sites like Delphi Thermal consist of natural attenuation and groundwater extraction.

Section 2.50, Task 5, FFS Report: The Focused FS Report should be complete and be a "stand alone" document. Despite previous screening and evaluations included in previous reports, the FFS should function as a complete Feasibility Study on its own, and not be "Part 2" of an a FS that picks up from parts of another report. In addition, in-situ chemical oxidation should be included and considered in the FFS.

As requested, the FFS Report will be completed as a stand-alone document. A reference section will be included regarding earlier reports.

As previously described herein, GZA will include consideration of in-situ chemical oxidation for dissolved phase contamination as a potential remedial technology in the FFS.

The NYSDEC comment letter included the following statement: "GZA cites technical impracticability of removing DNAPL from fractured bedrock as the justification for this focus (two remedial alternatives, natural attenuation and groundwater extraction). This approach is common and reasonable; however, it appears that GZA is already demonstrating a propensity toward the natural attenuation approach."

GZA's February 1997 report included screening of remedial technologies and development and analysis of alternatives. No promising proven remedial technologies have been developed since 1997, except that in-situ chemical oxidation could possibly be used to treat dissolved phase contamination at the site. Previous discussions between Delphi Thermal, GZA and NYSDEC reflect a consensus that existing data supports the natural attenuation approach.

Following NYSDEC's review of this submittal, GZA suggests that Delphi Thermal schedule a meeting with NYSDEC to discuss this project and items included in this letter.

Please let us know of convenient dates and times after you have discussed the proposed meeting with NYSDEC.

Please call if you have any questions regarding this submittal.

Very truly yours,

GZA GEOENVIRONMENTAL OF NEW YORK

Gary J. Klawinski
Project Manager

Raymond F. Laport, P.E.
Project Reviewer

Ernest R. Hanna, P.E.
Associate Principal

Attachments: Figure 1 Site Plan/Proposed Monitoring Well Location Plan

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York 14203-2999
Phone: (716) 851-7220 • **FAX:** (716) 851-7226
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John P. Cahill
Commissioner

September 18, 2000

Ms. Catherine A. Ver
Delphi Harrison Thermal Systems
200 Upper mountain Road
Lockport, New York 14094

Dear Ms. Ver:

Focused RI/FS Work Plan, Delphi Responses to
NYSDEC Comments, Delphi Harrison Thermal Systems
Site, Registry Number 932113

The New York State Departments of Health (DOH) and Environmental Conservation (DEC) are in receipt of your June 20, 2000 letter containing responses to the Department's March 10, 2000 letter regarding the Focused RI/FS Work Plan for the subject site. While most of GZA's responses are acceptable to the Departments, a few remaining issues must still be resolved. These issues are summarized as follows:

- Delphi proposes to install two additional monitoring wells along Route 93 to determine the extent of the groundwater contaminant plume. The groundwater analytical data collected to date, however, indicate that the width of the contaminant plume has not yet been determined. Two additional monitoring wells, placed in the proper locations, should be sufficient to make this determination. As such, the Department suggest one well in the grass area east of Building 6 and one well in the parking lot southeast of existing well MW-9 (see attached figure). If Delphi desires, proposed monitoring well MW-14 could be moved to one of these sidegradient locations.

- It is stated that the DNAPL in monitoring well MW-5 "likely reached its current location during and/or shortly after the TCE release occurred." This statement implies that the DNAPL is related to the former aboveground storage tank, and that a sizeable quantity of DNAPL could be present in the subsurface environment (based upon the distance from the former tank to well MW-5). The Departments, however, do not believe that the DNAPL in well MW-5 is related to the former storage tank. Analytical results from the DNAPL indicate that it contains both TCE and PCE at significant concentrations. Groundwater from wells located near the former tank, however, do not contain PCE, suggesting that the DNAPL is not related to the former aboveground storage tank. Is there another potential source for this DNAPL?

  Since DNAPL has only been encountered in one on-site well, and considering the fact that PCE concentrations in groundwater are non-detect in the two farthest downgradient wells (MW-11 and

MW-12), the Departments will not require additional DNAPL investigation at this time. Please note that should site conditions change (e.g., DNAPL detected in other wells; detectable concentrations of PCE in downgradient wells MW-11 and MW-12), additional DNAPL investigation will be required.

- GZA proposes to sample only select wells for compounds of concern and natural attenuation parameters. In order to fully assess contaminant trends and natural attenuation indicators, all wells should be included in the proposed sampling round. This also includes well MW-3D to confirm that conditions in the deep bedrock have not changed since the well was sampled in 1996.

As stated in our March 10th letter, "utilization of the previously approved Sampling and Analysis Plan (SAP) and Health and Safety Plan (HASP) is acceptable if these plans cover the additional field activities proposed during the RI." Because the additional field activities proposed are covered by these plans, utilization of the previously approved SAP and HASP is acceptable. However, since the SAP and HASP will become part of the approved RI/FS work plan, the Department will require copies of these plans for distribution to the other reviewers, for attachment to the Order on Consent when finalized, and for the document repository. These documents should be submitted with the revised RI/FS work plan. The revised work plan should also contain a schedule indicating when the proposed field activities will be conducted and when submittal of milestone reports will occur.

While the Departments typically require an approved work plan and executed Order on Consent before the completion of field work, this site is atypical as a significant amount of investigation has already been completed under a previously approved work plan. Since the proposed additional field activities are consistent with the work already completed at the site, we will not require prior approval of the RI/FS work plan if Delphi wishes to complete these activities this field season, so long as the additional field activities discussed in this letter are acceptable to Delphi. Should you have any comments or questions regarding the RI/FS, please feel free to contact me at 716-851-7220. Information concerning the Citizen Participation activities should be directed to Mr. Podd at the same number. Mr. Podd should be contacted directly to obtain an electronic copy of the mailing list.

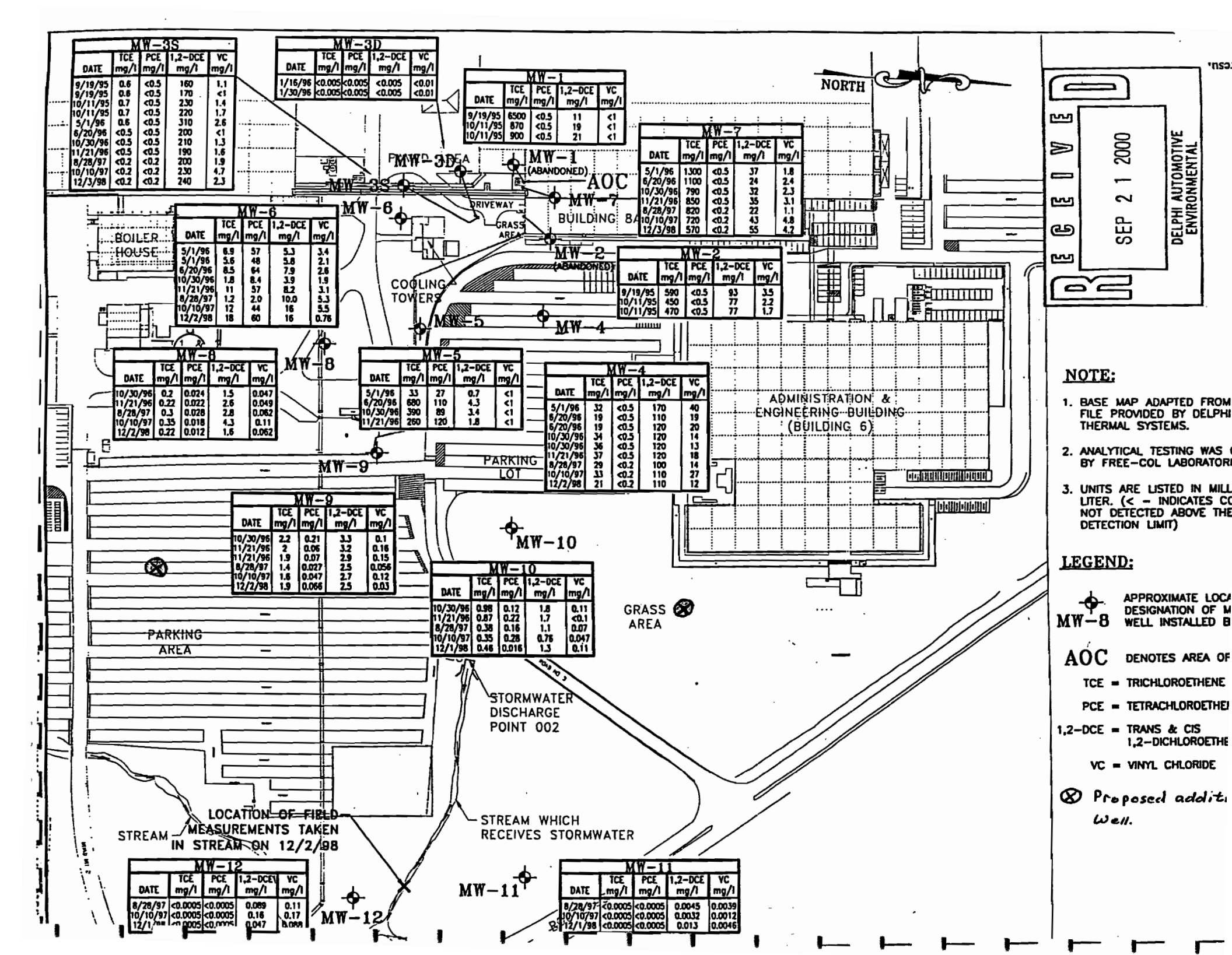
Sincerely yours,

Glenn M May

Glenn M. May, CPG.
Engineering Geologist I

Attachment

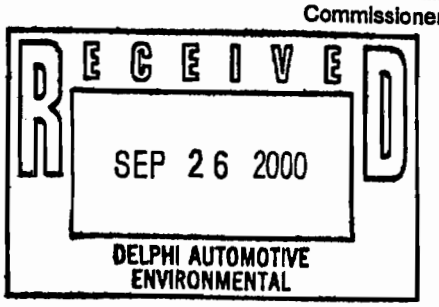
cc: Mr. Daniel King, NYSDEC, Region 9 with attachment
Mr. Jeff Konsella, NYSDEC, Albany with attachment
Mr. Matthew Forcucci, NYSDOH, Buffalo with attachment
Mr. Michael Podd, NYSDEC, Region 9 w/o attachment


MW-3S
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
9/19/95 | 0.6 | <0.5 | 160 | 1.1
9/19/95 | 0.6 | <0.5 | 170 | <1
10/11/95 | 0.7 | <0.5 | 230 | 1.4
10/11/95 | 0.7 | <0.5 | 220 | 1.7
5/1/96 | 0.6 | <0.5 | 310 | 2.6
6/20/96 | <0.5 | <0.5 | 200 | <1
10/30/96 | <0.5 | <0.5 | 210 | 1.3
11/21/96 | <0.5 | <0.5 | 190 | 1.6
8/28/97 | <0.2 | <0.2 | 200 | 1.9
10/10/97 | <0.2 | <0.2 | 230 | 4.7
12/3/98 | <0.2 | <0.2 | 240 | 2.3
MW-3D
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
1/16/96 | <0.005 | <0.005 | <0.005 | <0.01
1/30/96 | <0.005 | <0.005 | <0.005 | <0.01
MW-1
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
9/19/95 | 6500 | <0.5 | 11 | <1
10/11/95 | 870 | <0.5 | 19 | <1
10/11/95 | 900 | <0.5 | 21 | <1
MW-7
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
5/1/96 | 1300 | <0.5 | 37 | 1.8
6/20/96 | 1100 | <0.5 | 24 | 2.4
10/30/96 | 790 | <0.5 | 32 | 2.3
11/21/96 | 850 | <0.5 | 35 | 3.1
8/28/97 | 820 | <0.2 | 22 | 1.1
10/10/97 | 720 | <0.2 | 43 | 4.8
12/3/98 | 570 | <0.2 | 55 | 4.2
MW-6
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
5/1/96 | 6.9 | 57 | 5.3 | 3.4
5/1/96 | 5.6 | 48 | 5.8 | 2.1
6/20/96 | 8.5 | 64 | 7.9 | 2.6
10/30/96 | 1.8 | 8.4 | 3.9 | 1.9
11/21/96 | 11 | 57 | 8.2 | 3.1
8/28/97 | 1.2 | 2.0 | 10.0 | 5.3
10/10/97 | 12 | 44 | 16 | 5.5
12/2/98 | 18 | 60 | 16 | 0.76
MW-2
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
9/19/95 | 590 | <0.5 | 93 | 3.5
10/11/95 | 450 | <0.5 | 77 | 2.2
10/11/95 | 470 | <0.5 | 77 | 1.7
MW-8
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
10/30/96 | 0.2 | 0.024 | 1.5 | 0.047
11/21/96 | 0.22 | 0.022 | 2.6 | 0.049
8/28/97 | 0.3 | 0.028 | 2.8 | 0.062
10/10/97 | 0.35 | 0.018 | 4.3 | 0.11
12/2/98 | 0.22 | 0.012 | 1.6 | 0.062
MW-5
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
5/1/96 | 33 | 27 | 0.7 | <1
6/20/96 | 680 | 110 | 4.3 | <1
10/30/96 | 390 | 89 | 3.4 | <1
11/21/96 | 260 | 120 | 1.8 | <1
MW-4
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
5/1/96 | 32 | <0.5 | 170 | 40
6/20/96 | 19 | <0.5 | 110 | 19
6/20/96 | 19 | <0.5 | 120 | 20
10/30/96 | 34 | <0.5 | 120 | 14
10/30/96 | 36 | <0.5 | 120 | 13
11/21/96 | 37 | <0.5 | 120 | 18
8/28/97 | 29 | <0.2 | 100 | 14
10/10/97 | 33 | <0.2 | 110 | 27
12/2/98 | 21 | <0.2 | 110 | 12
MW-9
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
10/30/96 | 2.2 | 0.21 | 3.3 | 0.1
11/21/96 | 2 | 0.06 | 3.2 | 0.16
11/21/96 | 1.9 | 0.07 | 2.9 | 0.15
8/28/97 | 1.4 | 0.027 | 2.5 | 0.056
10/10/97 | 1.6 | 0.047 | 2.7 | 0.12
12/2/98 | 1.9 | 0.066 | 2.5 | 0.03
MW-10
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
10/30/96 | 0.98 | 0.12 | 1.8 | 0.11
11/21/96 | 0.87 | 0.22 | 1.7 | <0.1
8/28/97 | 0.38 | 0.16 | 1.1 | 0.07
10/10/97 | 0.35 | 0.28 | 0.76 | 0.047
12/1/98 | 0.46 | 0.016 | 1.3 | 0.11
MW-12
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
8/28/97 | <0.0005 | <0.0005 | 0.089 | 0.11
10/10/97 | <0.0005 | <0.0005 | 0.16 | 0.17
12/1/98 | <0.0005 | <0.0005 | 0.047 | 0.088
MW-11
DATE | TCE mg/l | PCE mg/l | 1,2-DCE mg/l | VC mg/l
8/28/97 | <0.0005 | <0.0005 | 0.0045 | 0.0039
10/10/97 | <0.0005 | <0.0005 | 0.0032 | 0.0012
12/1/98 | <0.0005 | <0.0005 | 0.013 | 0.0046
NORTH
MW-3S
MW-3D
AREA
MW-1
(ABANDONED)
AOC
MW-7
BUILDING 8A
MW-6
DRIVEWAY
GRASS AREA
BOILER HOUSE
MW-2
(ABANDONED)
COOLING TOWERS
MW-5
MW-4
MW-8
ADMINISTRATION & ENGINEERING BUILDING (BUILDING 6)
MW-9
PARKING LOT
MW-10
GRASS AREA
PARKING AREA
STORMWATER DISCHARGE POINT 002
LOCATION OF FIELD MEASUREMENTS TAKEN IN STREAM ON 12/2/98
STREAM
STREAM WHICH RECEIVES STORMWATER
MW-12
MW-11
RECEIVED
SEP 21 2000
DELPHI AUTOMOTIVE ENVIRONMENTAL
NOTE:
1. BASE MAP ADAPTED FROM
FILE PROVIDED BY DELPHI
THERMAL SYSTEMS.
2. ANALYTICAL TESTING WAS
BY FREE-COL LABORATORI
3. UNITS ARE LISTED IN MILL
LITER. (< - INDICATES CO
NOT DETECTED ABOVE THE
DETECTION LIMIT)
LEGEND:
MW-8 APPROXIMATE LOCA
DESIGNATION OF M
WELL INSTALLED B
AOC DENOTES AREA OF
TCE = TRICHLOROETHENE
PCE = TETRACHLOROETHE
1,2-DCE = TRANS & CIS
1,2-DICHLOROETHE
VC = VINYL CHLORIDE
⊗ Proposed additi
Well.

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York 14203-2999
Phone: (716) 851-7220 • **FAX:** (716) 851-7226
Website: www.dec.state.ny.us

John P. Cahill
Commissioner

September 25, 2000



Ms. Catherine A. Ver
Delphi Harrison Thermal Systems
200 Upper mountain Road
Lockport, New York 14094

Dear Ms. Ver:

October 1999 Groundwater Sampling Report,
Delphi Thermal Site, Registry No. 932113

The New York State Departments of Health (DOH) and Environmental Conservation (DEC) have completed review of the Supplemental Phase III Extent of Contamination Studies Data Report submitted by Delphi Harrison Thermal Systems (Delphi) on August 29, 2000. This report presents the analytical results for groundwater samples collected from on-site wells and further evaluates natural attenuation parameters for the site.

The results for trichloroethene (TCE) and its breakdown products are consistent with previous analytical results for the site; groundwater samples collected from well MW-7 at the area of concern (AOC) contain the highest concentrations of TCE, while samples collected from wells downgradient of the AOC (MW-3 and MW-4) show significant concentrations of TCE breakdown products (dichloroethene (DCE) and vinyl chloride (VC)). These results also indicate that TCE was not detected in the most downgradient wells (MW-11 and MW-12), although DCE and VC were detected. The relatively high concentrations of chloride (138 to 1220 μg/l) compared to the 20.2 μg/l background concentration appear to be direct evidence of the reductive dechlorination process.

We note in Table 3 that the concentrations of calcium, magnesium and sodium in monitoring well MW-10 are significantly lower than detected in this well during December 1998, and also significantly lower than the dissolved concentrations for these compounds. The dissolved concentrations are consistent with the previous sampling event, suggesting a possible reporting error for the non-dissolved concentrations.

Should you have any questions, please feel free to contact me at 716-851-7220.

Sincerely yours,

Glenn M May

Glenn M. May, CPG.
Engineering Geologist I

cc: Mr. Daniel King, NYSDEC, Region 9
Mr. Jeff Konsella, NYSDEC, Albany
Mr. Matthew Forcucci, NYSDOH, Buffalo

DELPHI
Automotive Systems

November 16, 2000

Mr. Glenn M. May
New York State Department of Environmental Conservation
270 Michigan Avenue
Buffalo, New York 14203 -2999

Dear Mr. May:

Delphi Harrison Thermal Systems (Delphi Thermal) is submitting our response to your letters dated September 18 and September 25, 2000 concerning the NYSDEC Inactive Hazardous Waste Registry Site #932113 located at the Lockport Site.

As we discussed yesterday, the well locations have been modified and are shown in the attached drawing.

Please call me at (716) 439 - 2942 if you have any questions. Please note that Delphi Thermal will be closed for the Thanksgiving Day holiday, November 23 -24 and that I will be out of the office from November 17 through November 26, returning on November 27, 2000.

Sincerely,

Catherine A. Ver
Sr. Environmental Engineer

Harrison Thermal Systems
World Headquarters
200 Upper Mountain Road Lockport, New York 14094 USA

GZA
GeoEnvironmental
of New York

Engineers and Scientists

November 16, 2000
File No. 55039.20

Ms. Cathy Ver
Delphi Harrison Thermal Systems
World Headquarters
200 Upper Mountain Road
Lockport, New York 14094-1896

Re: Focused Remedial Investigation and
Focused Feasibility Study Work Plan
Response to NYSDEC Letters Dated September 18 and 25, 2000
Delphi Harrison Thermal Systems West Lockport Complex
NYSDEC Registry Site # 932113

364 Nagel Drive
Buffalo
New York 14225
716-685-2300
FAX 716-685-3629
http://www.gza.net

Dear Ms. Ver:

This letter is in response to comments made by the New York State Department of Environmental Conservation (NYSDEC) and the New York State Department of Health (NYSDOH) in their letters to Delphi Thermal, dated September 18, 2000 (commenting on the results of the October 1999 groundwater sampling) and dated September 25, 2000 (commenting on the Focused Remedial Investigation and Focused Feasibility Study Work Plan) (the "Departments' Letters").

We have addressed the Departments' comments (shown below in italics) in the discussion that follows by reference to the issues raised in their letters.

NYSDEC Letter Dated September 18, 2000

Delphi proposes to install two monitoring wells along Route 93 to determine the extent of the groundwater contamination plume. The groundwater analytical data collected to date, however, indicated that the width of the contaminant plume has not yet been determined. Two additional monitoring wells, placed in the proper locations, should be sufficient to make this determination. As such, the Departments suggest one well in the grass area east of Building 6 and one well in the parking lot southeast of the existing well MW-9 (see attached figure). If Delphi desires, proposed monitoring well MW-14 could be moved to one of these sidegradient locations.

As discussed with the Departments, GZA is providing information related to the alternate agreed upon locations (conversation between Cathy Ver and Glenn May on November 15, 2000) for monitoring wells MW-14 and MW-15 to those noted by the Departments in their September 18, 2000 letter to Delphi Thermal. The reasons for the alternate locations are described below. The location for monitoring well MW-13 will remain unchanged (as shown on the attached figure). It should be noted that monitoring well MW-13 is anticipated

to provide additional information regarding the groundwater concentration at the downgradient edge of the plume (at the Delphi Thermal property line).

Monitoring wells MW-14 and MW-15 are anticipated to provide additional information regarding the width (north and south) of the plume. Proposed locations are described below.

GZA

Monitoring Well MW-14

The Departments' proposed location of MW-14 is in a parking lot area that is heavily used. Snow removal in this parking lot is likely to damage the upper part of the well and the potential exists for access to the well to be blocked by vehicles. The alternate proposed location for MW-14 is in a grass area. It is anticipated that the alternate location will provide sufficient information regarding the width of the plume to the south.

Monitoring Well MW-15

The Departments' proposed location of MW-15 is the area of a memorial grove (stone marker). Delphi Thermal requests that the area of the memorial grove be avoided. Underground utilities are located near facility Road No. 3. The alternate proposed location for MW-15 is in a grass area directly east of the Departments' proposed location. GZA anticipates that the alternate location will provide sufficient information regarding the width of the plume to the north.

Delphi Thermal would like to avoid the use of flush mount protective casings (often used at locations in parking lots/paved areas) because they generally do not provide as good a surface seal as stick-up protective casings. It should be noted that the wells included in the project monitoring program are constructed with stick-up type protective casings. The alternate locations for monitoring wells MW-14 and MW-15 can be completed using stick-up protective casings (preferred by Delphi Thermal).

GZA proposes to sample only select wells for compounds of concern and natural attenuation parameters. In order to fully assess contaminant trends and natural attenuation indicators, all wells should be included in the proposed sample round. This also includes well MW-3D to confirm that conditions in the deep bedrock have not changed since the well was sampled in 1996.

Two full rounds of natural attenuation parameter testing have been completed to date (December 1998 and October 1999). With the exception of the data noted below for monitoring well MW-10 (December 1998 round), the data between the rounds has been consistent. As noted in GZA's reports regarding the natural attenuation parameters, the data support that natural attenuation is occurring at the site.

In addition to the natural attenuation parameter testing, GZA has completed four full rounds (August 1997, October 1997, December 1998 and October 1999) of sampling and analytical testing for compounds of concern from the existing shallow bedrock groundwater monitoring wells at the site.

GZA proposes to complete the Spring 2001 sampling event on wells located in the downgradient area of the plume (existing wells MW-11and MW-12, and new wells MW-13, MW-14 and MW-15) and selected wells in the main part of the plume (MW- 10 and MW-4). As noted by the Departments, the areas of the plume that require additional study are the downgradient edge and the south and north extents. Sampling of these seven monitoring wells for both natural attenuation and compounds of concern testing would provide adequate information to assess contaminant trends in the main part of the plume and evaluate the downgradient part of the plume.

As requested, sampling of deep bedrock monitoring well MW-3D will be included in the next sample round. If contamination is not detected in this well, future sampling of this well should not be required.

GZA suggests that several natural attenuation parameters be eliminated from future sampling rounds for the following reasons:

Dissolved Inorganics: The groundwater results from the December 1998 and October 1999 sample rounds indicate similar total and dissolved inorganics (calcium, iron, magnesium, manganese, sodium and potassium) concentrations. This is likely due to sampling the monitoring wells using low flow sampling techniques which yield low turbidity, thus minimizing the total inorganic sediment interference. Therefore, the dissolved inorganics testing should be eliminated from future sampling events.

Calcium: The parameter calcium provides little information regarding natural attenuation at the site. Therefore, calcium should be eliminated from future sampling events.

Since the proposed additional field activities are consistent with the work already completed at the site, we will not require prior approval of the RI/FS work plan if Delphi wishes to complete these activities this field season, so long as the additional field activities discussed in this letter are acceptable to Delphi.

Under the current schedule, the three new wells (MW-13, MW-14 and MW-15) will be installed concurrent with the next groundwater sampling event in the Spring of 2001. This decision was based in part on the fact that current colder weather (including freezing temperatures) could potentially increase the well installation costs and make work difficult (i.e., snow/ice removal, freezing rock coring drilling lines).

NYSDEC Letter Dated September 25, 2000

We note in Table 3 that the concentrations of calcium, magnesium and sodium in monitoring well MW-10 are significantly lower than detected in this well during December 1998, and also significantly lower than dissolved concentrations for these compounds. The dissolved concentrations are consistent with the previous sampling event, suggesting a possible reporting error for the non-dissolved concentrations.

GZA has reviewed the data described above. Our review included checking the data presented in Table 3 with the laboratory data sheets and the laboratory. There was no reporting error found. GZA agrees that the December 1998 data from monitoring well MW-10 for calcium, total magnesium and total sodium appear lower than expected. GZA will sample this well for these (total and dissolved) parameters (excluding calcium as noted above) as part of the next sample round planned for the Spring 2001. GZA will compare the new data to the historic data and make a determination as to whether the December 1998 data is usable or anomalous.

Please let us know if and when the Departments have approved the proposed changes in the work plan that are described in this letter. Once Delphi Thermal has received approval, we will proceed with the preparation of a revised work plan and time schedule.

Very truly yours,

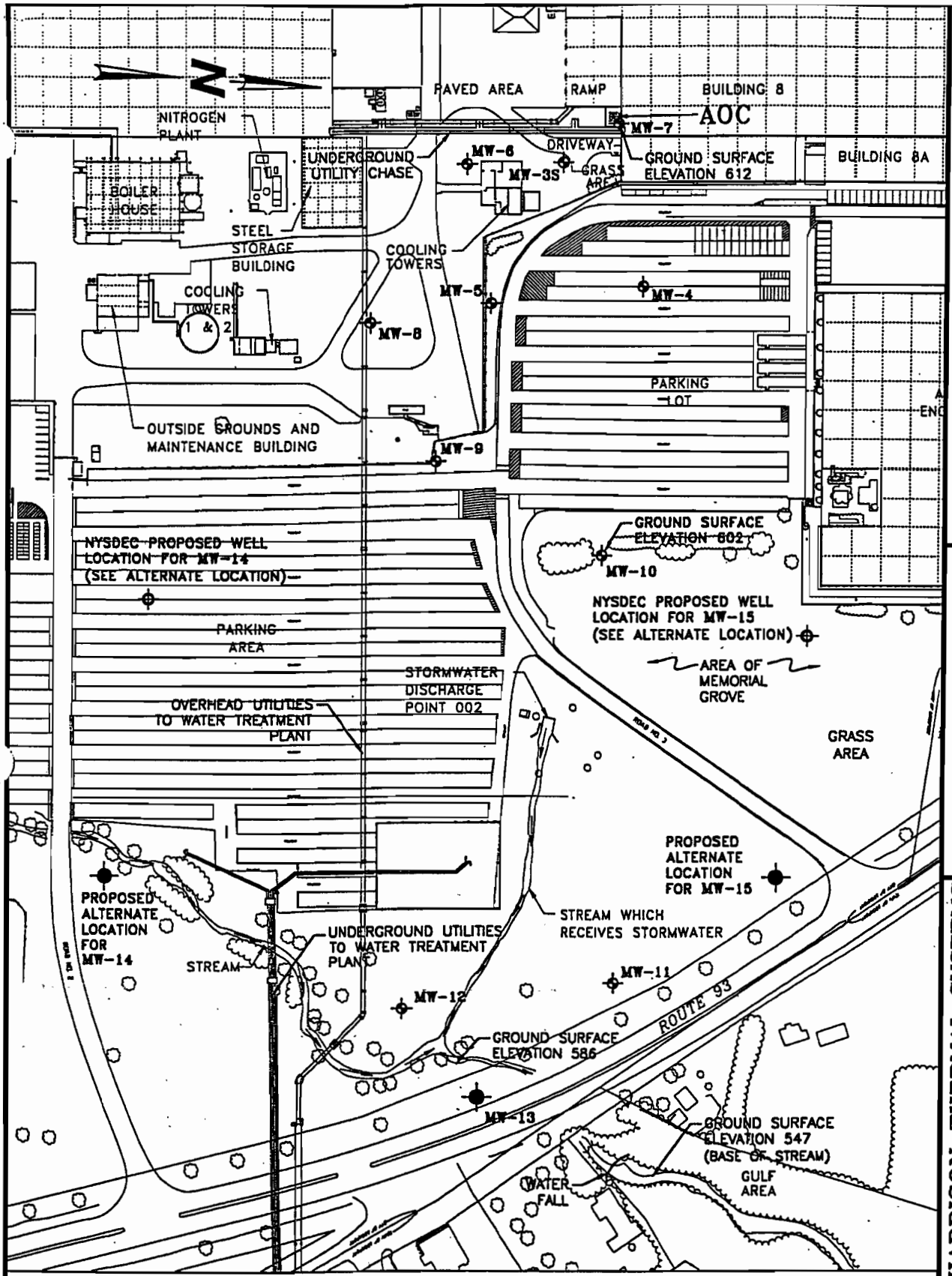
GZA GEOENVIRONMENTAL OF NEW YORK

Gary J. Klawinski
Project Manager

Raymond F. Laport, P.E.
Project Reviewer

Ernest R. Hanna, P.E.
Associate Principal

Attachments: Figure 1 Site Plan/Proposed Monitoring Well Location Plan
NYSDEC Letters Dated September 18 and 25, 2000



LEGEND:

MW-13 — APPROXIMATE LOCATION AND DESIGNATION OF PROPOSED MONITORING WELL

MW-3S — APPROXIMATE LOCATION AND DESIGNATION OF MONITORING WELL INSTALLED BY GZA

AOC DENOTES AREA OF CONCERN

NOTES:

1. BASE MAP ADAPTED FROM AN AUTOCADFILE PROVIDED BY DELPHI HARRISONTHERMAL SYSTEMS.

2. WATER LEVEL READINGS HAVE BEEN MADE IN WELLS AT TIMES AND UNDER CONDITIONS STATED IN THE TEXT. IT MUST BE NOTED THAT FLUCTUATIONS IN THE GROUNDWATER ELEVATIONS MAY OCCUR DUE TO VARIATIONS IN RAINFALL, BAROMETRIC PRESSURE AND OTHER FACTORS.

3. WATER LEVEL FOR MW-11 WAS MEASURED ON OCTOBER 4, 1999.

DRAWN BY: BWS

DATE: OCTOBER 2000

GZA GeoEnvironmental of New York

SCALE IN FEET 0 100 200 400

DELPHI HARRISON THERMAL SYSTEMS
LOCKPORT, NEW YORK
FOCUSED REMEDIAL INVESTIGATION/FEASABILITY STUDY

PROPOSED MONITORING WELL LOCATION PLAN

PROJECT No. 55039.2

FIGURE No. 1

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York 14203-2999
Phone: (716) 851-7220 • **FAX:** (716) 851-7226
Website: www.dec.state.ny.us

John P. Cahill
Commissioner

February 2, 2001

Ms. Catherine A. Ver
Delphi Harrison Thermal Systems
200 Upper mountain Road
Lockport, New York 14094

Focused RI/FS Work Plan,
Delphi Responses to NYSDEC Comments,
Delphi Harrison Thermal Systems Site,
Registry Number 932113

Dear Ms. Ver:

The New York State Departments of Health (DOH) and Environmental Conservation (DEC) have reviewed GZA's responses that were contained in your November 16, 2000 letter and find them to be acceptable. Incorporation of these and previous GZA responses into the January 2000 Focused RI/FS Work Plan will result in an acceptable document. For your convenience in preparing the final work plan, the following items should be included:

- A revision to the January 2000 Focused RI/FS Work Plan that incorporates Department comments transmitted to Delphi by letters dated March 10 and September 18, 2000; and Delphi's responses transmitted to the Department by letters dated June 20 and November 16, 2000.

- The Sampling and Analysis Plan dated August 1995, which was accepted as part of the Focused RI/FS Work Plan by letter dated March 10, 2000. Among other items this plan includes well installation protocols, soil and groundwater sampling protocols, laboratory quality controls procedures, and a site specific health and safety plan.

- A project schedule that includes dates for implementation of field work and submittal of milestone reports.

- A Citizen Participation Plan.

Seven copies of the final Focused RI/FS Work Plan will be required for distribution.

Should you have any comments or questions regarding this letter or the RI/FS process, please feel free to contact me at 716-851-7220. Information concerning the Citizen Participation activities should be directed to Mr. Podd at the same number. Mr. Podd should be contacted directly to obtain an electronic copy of the mailing list.

Sincerely yours,

Glenn M May

Glenn M. May, CPG.
Engineering Geologist I

cc: Mr. Daniel King, NYSDEC, Region 9
Mr. Jeff Konsella, NYSDEC, Albany
Mr. Matthew Forcucci, NYSDOH, Buffalo
Mr. Michael Podd, NYSDEC, Region 9
Ms. Maura Desmond, NYSDEC, Buffalo Field Unit

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York 14203-2999
Phone: (716) 851-7220 • **FAX:** (716) 851-7226
Website: www.dec.state.ny.us

Erin M. Crotty
Commissioner

June 5, 2001

Mr. Rick Eisemann
Delphi Energy and Chassis Systems
P.O. Box 92700
Rochester, New York 14692

Dear Mr. Eisemann:

Focused RI/FS Work Plan;
Delphi Harrison Thermal Systems Site;
Registry Number 932113

The New York State Departments of Health (DOH) and Environmental Conservation (DEC) have reviewed the April 2001 Focused RI/FS Work Plan and find it to be acceptable with the exception that the Health and Safety Plan does not contain a Community Air Monitoring Plan. Such a plan is required at all inactive hazardous waste sites during intrusive activities and is implemented to protect residents living near a site. I have attached a copy of DOH's Generic Community Air Monitoring Plan that should be utilized during the upcoming site investigation. Revision of the Focused RI/FS Work Plan to incorporate the Community Air Monitoring Plan will not be required. Instead, this plan will be appended to said work plan and incorporated into the Order on Consent.

Should you have any comments or questions regarding the Community Air Monitoring Plan or the RI/FS process, please feel free to contact me at 716/851-7220.

Sincerely yours,

Glenn M. May

Glenn M. May, CPG
Engineering Geologist I

Attachment
cc: Mr. Daniel King, NYSDEC, Region 9
Mr. Jeff Konsella, NYSDEC, Albany
Mr. Matthew Forcucci, NYSDOH, Buffalo
Ms. Maura Desmond, NYSDEC, Buffalo Field Unit

VOC Monitoring, Response Levels, and Actions

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

- If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

- If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less - but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

- If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

All 15-minute readings must be recorded and be available for State (DEC and DOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

- If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls

New York State Department of Health
Generic Community Air Monitoring Plan

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical-specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for volatile organic compounds (VOCs) and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate NYSDEC/NYSDOH staff.

Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. "Periodic" monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m³ of the upwind level and in preventing visible dust migration.

All readings must be recorded and be available for State (DEC and DOH) personnel to review.

DELPHI
Automotive Systems

June 20, 2001

Mr. Glenn May
New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue
Buffalo, New York 14203-2999

Re: Work Plan Attachments
Focused Remedial Investigation and Focused Feasibility Study Work Plan
Delphi Harrison Thermal Systems West Lockport Complex
NYSDEC Registry Site # 932113

Dear Mr. May:

Delphi Harrison Thermal Systems (Delphi) is pleased to provide the enclosed attachments to the Focused Remedial Investigation (FRI) and Focused Feasibility Study (FFS) Work Plan for the above referenced site at Delphi's West Lockport Complex. The attachments are hard copies of electronic files already reviewed by the Department. Verbal approval of these documents was given to GZA on June 19, 2001. The following items are enclosed:

- Revised Project Schedule (FRI/FFS Work Plan Figure 2): Per your request, Figure 2 is revised to identify durations of project tasks rather than calendar dates. This revised schedule supercedes the schedule included in the FRI/FFS Work Plan.

- Community Air Monitoring Plan (CAMP): As requested in your letter dated June 5, 2001, a site-specific CAMP is included. The CAMP includes revised Table 1 (Air Monitoring Action Levels) from the Health and Safety Plan (FRI/FFS Work Plan Attachment D). Please note that the generation of dust/particulates is not expected during the proposed intrusive work (i.e., test boring/monitoring well installation). Therefore, dust/particulate monitoring is not planned. However, GZA GeoEnvironmental of New York will have a particulate monitor available, if needed. With the exception of these guidelines, the CAMP follows the NYSDOH suggested guidance.

Please attach the above items to the FRI/FFS Work Plan. You may contact me at (716) 647-4766 if you have any questions regarding this submittal.

Sincerely,

Richard C. Eisenman

Richard C. Eisenman
Senior Environmental Engineer

Enclosure: Revised Figure 2 (Project Schedule)
Community Air Monitoring Plan

cc: Ms. Maura Desmond (NYSDEC, Buffalo Field Unit)
Mr. Daniel King (NYSDEC, Region 9)
Mr. Jeff Konsella (NYSDEC, Albany)
Mr. Matthew Forcucci (NYSDOH, Buffalo)
Mr. Barry Kogut (Bond, Schoeneck & King)
Mr. Gary Klawinski (GZA GeoEnvironmental of New York)
Mr. James Walle (Delphi Automotive Systems, Troy MI)
Ms. Catherine Ver (Delphi)

FIGURE 2 (REVISED)
PROJECT SCHEDULE
FOCUSED REMEDIAL INVESTIGATION AND
FOCUSED FEASIBILITY STUDY
DELPHI HARRISON THERMAL SYSTEMS
WEST LOCKPORT COMPLEX
LOCKPORT, NEW YORK

ID	Task Name	Duration (Work Days)
1	**Monitoring Well Installation ***	**10 days**
2	Well Installation	5 days
3	Well Development	5 days
4	**Supplemental Groundwater Sampling Round 1****	**31 days**
5	Field Work	5 days
6	Lab Analysis	21 days
7	Data Report	5 days
8	**Supplemental Groundwater Sampling Round 2****	**31 days**
9	Field Work	5 days
10	Lab Analysis	21 days
11	Data Report	5 days
12	**Focused Remedial Investigation (FRI) Report *****	**120 days**
13	**Focused Feasibility Study (FFS) Report ********	**150 days**

* The start date for Monitoring Well Installation work will be within fifteen work days following the signing date of the Consent Order; unless the fifteenth day falls between the dates of July 2 – 6, 2001 (Delphi Thermal facility shut-down), whereby the well installation start date will be July 9, 2001.

** The start date for Supplemental Groundwater Sampling Round 1 will be within ten to twenty work days following the end of Monitoring Well Installation/Development work. The start date for Supplemental Groundwater Sampling Round 2 will be within fifty to sixty-five work days following the end of Supplemental Groundwater Sampling Round 1 field work.

*** GZA will need about four work weeks, following receipt of analytical data from the last sample round (Supplemental Groundwater Sampling Round 2), to complete a draft FRI Report. The referenced duration assumes overlap of this task with other FRI/FFS tasks. The referenced duration assumes that the completion of the supplemental groundwater monitoring set forth in the FRI/FFS Work Plan will allow GZA to complete the characterization of the TCE-related contamination at the Site. The duration for submittal of the FRI Report is an estimate, because it will depend upon the result of GZA's evaluation of the need for further groundwater monitoring (see page 8 of the FRI/FFS Work Plan).

**** The referenced duration assumes overlap of this task with other FRI/FFS tasks. The FFS Report shall be submitted within thirty (30) days after Delphi's receipt of NYSDEC's written approval of the FRI Report (or revised FRI Report, whichever one applies). The duration for submittal of the FFS Report is an estimate, because it is dependent on: (a) the time required by NYSDEC to review and approve the FRI Report and (b) whether there is a need for revisions to be made to the initial draft of the FRI Report.

COMMUNITY AIR MONITORING PLAN

ATTACHMENT TO THE HEALTH AND SAFETY PLAN APPENDIX D - FOCUSED REMEDIAL INVESTIGATION AND FOCUSED FEASIBILITY STUDY WORK PLAN DELPHI HARRISON THERMAL SYSTEMS WEST LOCKPORT COMPLEX LOCKPORT, NEW YORK DATED APRIL 2001

1.00 INTRODUCTION

In addition to real-time time air monitoring and personal exposure monitoring requirements (specified in HASP Section 5.0), community air monitoring will be conducted at the Delphi Harrison Thermal Systems Site (Site) during field activities to be performed in accordance with the Focused Remedial Investigation/Focused Feasibility Study (FRI/FFS) Work Plan. Table 1 (Revised) summarizes these three types of environmental monitoring, as well as appropriate response actions applicable to the Site. Additional details regarding community air monitoring are presented below.

2.00 COMMUNITY AIR MONITORING

Real-time air monitoring for volatile compounds at the perimeter of the work area will be conducted as follows. Volatile organic compounds will be monitored at the downwind perimeter of the work area at a minimum of once per hour. If total organic vapor levels exceed 5 ppm above background, work activities must be halted and monitoring continued under the provisions of a Vapor Emission Response Plan. Readings shall be recorded and will be available for State (NYSDEC and NYSDOH) personnel to review.

Intrusive work with potential to generate dust/particulates at the Site is expected to include test boring/monitoring well installation. Considering that the subsurface soils encountered during previous work at the Site are moist to wet and rock coring is done with water, GZA does not expect the generation of dust/particulates during our work. Therefore, GZA does not plan to conduct dust/particulate monitoring as part of the NYSDOH Community Air Monitoring Plan requirements. With the exception of the dust/particulate monitoring requirements, the Community Air Monitoring Plan requirements included below follow the NYSDOH suggested guidance.

2.10 Vapor Emission Response Plan

If the ambient air concentration of organic vapors exceeds 5 ppm above background at the perimeter of the work area, activities will be halted and monitoring increased to every 15 minutes. If the organic vapor level decreases below 5 ppm above background, work activities can resume. If the organic vapor levels are greater than 5 ppm over background but less than 10 ppm over background at the perimeter of the work

area, activities can resume provided that the organic vapor level 200 feet downwind of the work area or half the distance to the nearest residential or commercial structure, whichever is less, is below 5 ppm over background.

If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown. When work shutdown occurs, downwind air monitoring as directed by the Safety Officer will be implemented.

2.20 Major Vapor Emissions

If organic levels greater than 5 ppm over background are identified 200 feet downwind from the work area or half the distance to the nearest residential or commercial property, whichever is less, all work activities must be halted.

If, following the cessation of the work activities or as a the result of an emergency, organic levels persist above 5 ppm above background at a location 200 feet downwind or half the distance to the nearest residential or commercial property from the work area, then the air quality must be monitored within 20 feet of the perimeter of the nearest residential or commercial structure (20-Foot Zone).

If efforts to abate the emission source are unsuccessful and levels above 5 ppm above background persist for more than 30 minutes in the 20-Foot Zone, then the Major Vapor Emission Response Plan shall automatically be placed into effect (See Section 2.30).

2.30 Major Vapor Emissions Response Plan

Upon activation, the following activities will be undertaken:

- Notification of Emergency Response Contacts (including NYSDEC and NYSDOH) and as listed in Section 11.20 of this HASP will go into effect, as specified.

- Local police authorities will immediately be contacted by the Safety Officer and advised of the situation.

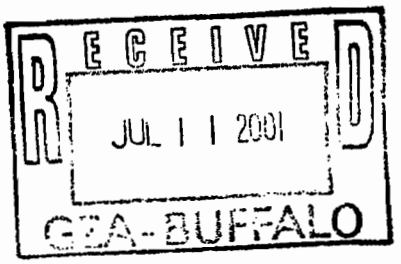
- Frequent air monitoring will be conducted at 30-minute intervals within the 20-Foot Zone. If two successive readings below action levels are measured, air monitoring may be halted or modified by the Safety Officer.

TABLE 1 (REVISED)
ACTION LEVELS
DELPHI HARRISON THERMAL SYSTEMS WEST LOCKPORT COMPLEX SITE

	Monitoring Type	Concentration	Instrument	Monitoring Location	Monitoring Frequency	Required Action
Real time Monitoring	Total VOCs	< 1 ppm sustained above background	PID (10.2 eV)	EZ	at least every 15 minutes	Continue monitoring.
Real time Monitoring	Total VOCs	> 1 ppm sustained above background	PID (10.2 eV)	EZ	continuous	Test for specific compounds with detector tubes (vinyl chloride and trichloroethylene). Set new action level after consulting with SSO.
Community Air Monitoring (intrusive activities only)	Total VOCs	< 5 ppm sustained above background	PID (10.2 eV)	Downwind of EZ	at least every one hour	Continue monitoring of EZ (potential source) and downwind perimeter of the EZ (work zone).
Community Air Monitoring (intrusive activities only)	Total VOCs	> 5 ppm sustained above background (downwind > 5 ppm above upwind)	PID (10.2 eV)	Upwind and Downwind of EZ	at least every 15 minutes	Stop work. Increase monitoring to every 15 minutes. If organic vapor levels are > 5 ppm over background but less than 10 ppm over background at the perimeter of the work area, then work can resume provided the organic vapor level 200 feet downwind of the work area or half the distance to the nearest structure is < 5 ppm. If the level is > 5 ppm 200 feet downwind, follow procedures outlined in Major Vapor Emissions section of this HASP attachment.
Community Air Monitoring (intrusive activities only)	Total VOCs	> 25 ppm sustained above background	PID (10.2 eV)	Downwind of EZ	continuous	Stop work. Follow air monitoring procedures outlined in Major Vapor Emissions section of this HASP attachment.
Real time Monitoring	Combustible Gas	<10% LEL	CGI	EZ	at least every 15 minutes	Eliminate all ignition sources.
Real time Monitoring	Combustible Gas	>10% LEL	CGI	EZ	continuous	Eliminate all ignition sources. Stop work and contact SSO. Evaluate cause of gas. Verify LEL readings have abated prior to resumption of activities.
Particulate Monitoring	Not Planned					Not Planned

NOTES: EZ = Exclusion Zone (work zone); LEL = Lower Explosive Limit; VOCs = Volatile Organic Compounds; SSO = Site Safety Officer

DELPHI
Automotive Systems



July 9, 2001

Mr. Peter Buechi, Region 9
Division of Environmental Remediation
New York State Department of Environmental Conservation
270 Michigan Avenue
Buffalo, New York 14203

Re: Order On Consent # B9-0553-99-06
Delphi Harrison Thermal Systems West Lockport Complex
NYSDEC Registry Site # 932113

Dear Mr. Buechi:

As required by the Consent Order referenced above, Delphi Harrison Thermal Systems (Delphi) is providing notification of the commencement of fieldwork to be conducted pursuant to the order. Installation of monitoring wells is expected to begin on July 24, 2001.

You may contact me at (716) 647-4766 if you have any questions.

Sincerely,

Richard C. Eisenman
Senior Environmental Engineer

cc: Mr. Glenn May (NYSDEC, Region 9)
Ms. Maura Desmond (NYSDEC, Buffalo Field Unit)
Mr. Barry Kogut (Bond, Schoeneck & King)
Mr. Gary Klawinski (GZA GeoEnvironmental of New York)
Mr. James Walle (Delphi Automotive Systems, Troy MI)
Ms. Catherine Ver (Delphi)

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York 14203-2999
Phone: (716) 851-7220 • **FAX:** (716) 851-7226
Website: www.dec.state.ny.us

Erin M. Crotty
Commissioner

February 8, 2002

Mr. Richard Eisemann
Delphi Energy and Chassis Systems
P.O. Box 92700
Rochester, New York 14692

Dear Mr. Eisemann:

Supplemental Groundwater Sampling Report
October 2001 Sample Round
Delphi Thermal Site, Registry No. 932113

The New York State Departments of Health and Environmental Conservation have completed review of the subject report submitted by Delphi Harrison Thermal Systems (Delphi) in December 2001. This report presents the analytical results of groundwater samples collected from selected on-site wells and further evaluates natural attenuation parameters for the site. This work was completed as part of the Remedial Investigation (RI) being conducted at the site. Since the submittal of the Supplemental Groundwater Sampling Report completes the RI field activities, Delphi should have its consultant proceed with the completion of the RI Report.

The analytical results from the October 2001 sample round are consistent with previous analytical results for the site; concentrations of trichloroethene (TCE) and its breakdown products dichloroethene (DCE) and vinyl chloride (VC) decrease with increasing distance from the source area. While TCE was not detected in the most downgradient wells (MW-11, MW-12, MW-13, MW-14 and MW-15), low concentrations of DCE and VC were detected in some of these wells, thereby remaining a source of potential future off-site migration of TCE breakdown products. Low concentrations of tetrachloroethene (PCE) were also detected in downgradient well MW-15. Given these results, it is premature to conclude that further off-site monitoring is not needed. Rather, the potential for future off-site impacts should be discussed in the RI Report and evaluated in detail in the Feasibility Study (FS) Report.

Should you have any questions, please feel free to contact me at 716/851-7220.

Sincerely yours,

Glenn M May

Glenn M. May, CPG
Engineering Geologist I

GMM/tml

cc: Mr. Daniel King, NYSDEC, Region 9
Mr. Jeff Konsella, NYSDEC, Albany
Mr. Matthew Forcucci, NYSDOH, Buffalo

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York 14203-2999
Phone: (716) 851-7220 • FAX: (716) 851-7226
Website: www.dec.state.ny.us

Erin M. Crotty
Commissioner

August 12, 2002

Mr. Richard Eisemann
Delphi Energy and Chassis Systems
P.O. Box 92700
Rochester, New York 14692

Dear Mr. Eisemann:

Focused Remedial Investigation Report
Delphi Thermal Site, Registry No. 932113

The New York State Departments of Health and Environmental Conservation have reviewed revised Table 12 and Appendix D submitted by Delphi Harrison Thermal Systems (Delphi) on July 9, 2002 and find it acceptable. This letter, therefore, transmits formal Department approval of the Focused Remedial Investigation Report dated April 2002. The July 9, 2002 letter of transmittal with attachments will be addended to the previously submitted Remedial Investigation Report.

In the past, Delphi has sent copies of important project documents directly to the document repository. We would greatly appreciate it if Delphi would again do the same by sending a copy of the final Focused Remedial Investigation Report to the document repository.

Should you have any questions, please feel free to call me at 716-851-7220.

Sincerely yours,

Glenn M. May

Glenn M. May, CPG
Engineering Geologist I

GMM/tml

cc: Mr. Daniel King, NYSDEC, Region 9
Mr. Jeff Konsella, NYSDEC, Albany
Mr. Matthew Forcucci, NYSDOH, Buffalo

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
270 Michigan Avenue, Buffalo, New York 14203-2999
Phone: (716) 851-7220 • FAX: (716) 851-7226
Website: www.dec.state.ny.us

Erin M. Crotty
Commissioner

December 17, 2002

Mr. Richard Eisemann
Delphi Energy and Chassis Systems
P.O. Box 92700
Rochester, New York 14692

Dear Mr. Eisemann:

Draft Focused Feasibility Study Report
Delphi Thermal Site, Registry No. 932113

The New York State Departments of Health (DOH) and Environmental Conservation (DEC) have reviewed the Focused Feasibility Study (FFS) Report prepared by GZA GeoEnvironmental (GZA) and submitted to the Departments in October 2002. While the report is a good "first cut" regarding the groundwater plume, additional information will be required regarding DNAPL source areas before the FFS Report can be approved. Approval of the final FFS Report is necessary prior to development of the Proposed Remedial Action Plan (PRAP).

The main concern we have is the presence of DNAPL in well MW-5, and, based upon groundwater concentrations in well MW-7, the suspected presence of DNAPL at the Area of Concern. This DNAPL will continue to act as a source of groundwater contamination that, if not addressed, will likely require long-term groundwater monitoring for a period much longer than the thirty years evaluated in the FFS Report.

The Departments, therefore, view the remediation of the Delphi Thermal Site as a two-phase project - remediation of the DNAPL source areas and remediation of the groundwater plume. The draft FFS Report adequately addresses the groundwater plume; however, it avoids addressing DNAPL by stating that "several Site factors, including the complex characteristics of the bedrock fracture system and limits of DNAPL, limit the potential remedial technologies that would be viable." The report further states that the use of in-situ chemical oxidation may be effective at reducing a portion of the DNAPL, but that this technology (1) would be unlikely to provide for complete DNAPL mass reduction without extensive effort and expense, (2) would cause the mobilization of DNAPL, and (3) may impact the naturally occurring attenuation. While the Departments are familiar with the inherent difficulties of addressing DNAPL within fractured bedrock, several factors suggest that a more serious evaluation of DNAPL remediation technologies is warranted. These factors include a relatively shallow bedrock groundwater zone, a relatively small source area, and the alternative of performing perpetual groundwater sampling and reporting. The Departments believe that a final remedy for the Site should combine a proposed DNAPL alternative with a proposed groundwater plume alternative.

General and specific comments regarding the FFS Report are summarized as follows:

GENERAL COMMENTS:

1. Monitored Natural Attenuation: The Departments disagree with this technology being linked to Alternatives 3 (Groundwater Extraction and Ex-Situ Treatment) and 4 (In-Situ Chemical Oxidation). Monitored Natural Attenuation should be a stand alone technology, and evaluated against Groundwater Extraction/Treatment and In-Situ Chemical Oxidation using the seven FS screening criteria. We suggest, therefore, that Alternatives 3 and 4 be renamed "*Groundwater Extraction and Ex-Situ Treatment with Groundwater Monitoring*" and "*In-Situ Chemical Oxidation with Groundwater Monitoring*", respectively. The Departments recognize, however, that natural attenuation will continue to occur under both Alternatives 3 and 4, and would be evaluated inherently during long term groundwater monitoring associated with these technologies. Many of the specific comments summarized below relate to this issue, and are included to aid revision of the FFS Report.

2. Analytical results from well sampling show that concentrations of 1,2-DCE in the source area are relatively constant. This is true even in wells that do not show a corresponding elevated TCE concentration (e.g., in well MW-3S there is very high concentrations of 1,2-DCE but very low to non-detect concentrations of TCE). Other wells (such as MW-4) show relatively constant concentrations of TCE, 1,2-DCE and VC. Persistent, stable concentrations of contaminants in some site areas may be indicative of the lack of natural biodegradation. In addition, it is possible that in the future biological conditions may not be as supportive of natural attenuation of site contaminants.

SPECIFIC COMMENTS:

1. Section 2.3.1, Contaminants of Concern and SCG Goals, Paragraph 1, Page 13: In Section 1.4.3 it is stated that BTEX compounds were detected in wells MW-3S and MW-4. This statement is consistent with the findings of the RI Report. In Section 2.3.1 of the FFS, however, it is stated that BTEX compounds were detected in only one well. Although BTEX compounds were only detected in well MW-4 on one occasion (the 8/27/97 DEC split sample), Section 2.3.1 should be modified for consistency with Section 1.4.3 of the FFS and the RI Report. As correctly stated, however, the important issue is the TCE contamination, not the presence of BTEX. See also Section 2.3.2.1, Paragraph 1.

2. Section 2.5.4.7, In-Situ Chemical Oxidation, Page 20: Several concerns regrading the use of chemical oxidation in areas containing DNAPL are given in this section. These concerns include (1) rebound of dissolved phase concentrations, (2) potential mobilization of DNAPL, and (3) the occurrence of 1,1-DCE. GZA should elaborate and justify these specific concerns. While the rebound of concentrations is a bonafide issue, the Departments do not believe that mobilization of DNAPL is a legitimate concern given the fact that chemical oxidation produces a destructive reaction.

Does GZA have any literature or documentation of NAPL mobilization as a result of an in-situ chemical oxidation application? In addition, it is mentioned that the occurrence of 1,1-DCE is a concern without actually stating why it is a concern. While 1,1-DCE has not been reported in the bedrock groundwater, it degrades much more rapidly than 1,2-DCE. Since the Site has an abundance of 1,2-DCE in groundwater, we are not sure why GZA has a concern over the appearance of 1,1-DCE.

3. Section 3.4, Alternative No. 3, Page 25: Consistent with the general MNA comment above, please delete the words "*with MNA*" in the second sentence of the first paragraph on page 25 and the last bullet on page 26. The general groundwater monitoring program that would be required under this alternative is included in Bullet 5.

4. Section 3.3, Alternative No. 2, Page 24: Although USEPA guidance specifies a 30-year duration as the benchmark for evaluating remedial alternatives, in reality, long-term groundwater monitoring under the MNA alternative would likely be for a much longer duration. This section, therefore, should include some discussion of the time over distance relationship of plume attenuation and the plumes potential continued migration.

5. Section 3.5, Alternative No. 4, Page 26:

   A. Paragraph 2, Page 26: It is stated that sodium permanganate would be the oxidant of choice. Is this correct? The Departments are not familiar with this oxidant, but have utilized potassium permanganate at several sites. Also, consistent with the general MNA comment above, please delete the last sentence of this paragraph and replace with the following: "*The untreated portion of the groundwater plume (with CVOC concentrations less than 100 ppm) would be allowed to attenuate naturally by current mechanisms.*"

   B. Groundwater Monitoring, Bullet 1, Page 29: It is the Departments belief that the purpose in evaluating in-situ chemical oxidation is to reduce the time required for long term groundwater monitoring. Therefore, the length of time proposed for groundwater monitoring under Alternative 4 should be less than the 30-year duration associated with Alternative 2. If GZA believes that 30 years of groundwater monitoring is required under Alternative 4 because of existing site conditions, it should be so stated when describing this technology. This issue is also important when evaluating this alternative against the seven screening criteria in Section 4.0.

6. Section 4.3, Detailed Analysis of Remedial Alternatives, Paragraph 1, Page 31: Descriptions of the alternatives are provided in *Section 3.0*, not Section 3.4 as stated.

7. Section 4.3.1, Alternative No. 1, Compliance with ARARs, Page 32: While groundwater SCGs are presently being met at wells near the property line, this section should also state that chemical specific SCGs ***will not*** be met in some areas of the groundwater plume in the foreseeable future due to the continuing presence of DNAPL.

8. Section 4.3.2, Alternative No. 2, Compliance with ARARs, Page 34: While groundwater SCGs are presently being met at wells near the property line, this section should also state that chemical specific SCGs ***will not*** be met in some areas of the groundwater plume in the foreseeable future due to the continuing presence of DNAPL.

9. Section 4.3.3, Alternative No. 3, Page 35: The screening criteria in this section are misnumbered.

   A. Short-Term Impacts and Effectiveness, Page 35: Consistent with the general MNA comment above, please delete Bullet 3 and the fourth sentence (Monitored Natural Attenuation procedures...) of the first full paragraph on this page.

      In the second paragraph that starts on this page, delete the first three full sentences on Page 36 that relate to natural attenuation as they focus more on the natural attenuation process than groundwater extraction.

   B. Long-Term Effectiveness and Performance, Page 36: Consistent with the general MNA comment above, please delete the words "*as part of MNA*" in the second sentence of this paragraph.

   C Compliance with ARARs, Page 37: While groundwater SCGs are presently being met at wells near the property line, this section should also state that chemical specific SCGs ***will not*** be met in some areas of the groundwater plume in the foreseeable future due to the continuing presence of DNAPL.

   D. Overall Protection of Human Health and the Environment, Page 37: The discussion under this section should focus more on the groundwater extraction alternative than natural attenuation. As a result, please delete the first sentence of the first paragraph on page 38. Also, the last sentence states that "this alternative would somewhat mitigate the environmental impacts..." In the same discussion for Alternative 3, however, it is stated that MNA "will mitigate the environmental impacts..." These statements should be modified for consistency and to take into account the fact that In-Situ Chemical Oxidation is probably more protective overall than MNA because it is a more aggressive remedial technology.

   E. Cost, Page 38: The first sentence of paragraph 1 should be modified to clarify its meaning.

10. Section 4.3.4, Alternative No. 4, Page 38: Several concerns regrading the use of chemical oxidation are given in this section. These concerns, however, have not been discussed or supported elsewhere in the FS. See Specific Comment #2 above.

A. Short-Term Impacts and Effectiveness, Page 38: Consistent with the general MNA comment above, please delete Bullet 4 and the second, third and fourth sentences of the last paragraph of this section. These sentences focus more on the natural attenuation process than in-situ chemical oxidation.

B. Long-Term Effectiveness and Performance, Page 39: Consistent with the general MNA comment above, please delete the words "*as part of MNA*" in the second sentence of this paragraph.

C Compliance with ARARs, Page 41: While groundwater SCGs are presently being met at wells near the property line, this section should also state that chemical specific SCGs ***will not*** be met in some areas of the groundwater plume in the foreseeable future due to the continuing presence of DNAPL.

D. Overall Protection of Human Health and the Environment, Page 41: The discussion under this section should focus more on the in-situ chemical oxidation alternative than natural attenuation. As a result, please delete the second sentence of this section.

E. Cost, Page 41: The first sentence of paragraph 1 should be modified to clarify its meaning.

11. Section 5.7, Cost, Page 43: For Alternatives 3 and 4, replace the words "*monitored natural attenuation*" with "*groundwater monitoring*".

12. Section 6.1, Summary and Conclusions, Page 44:

A. Alternative 3, Paragraph 1, Page 46: Consistent with the general MNA comment above, please replace the word "*MNA*" in the first sentence with "*groundwater monitoring*".

B. Alternative 4, Paragraph 3, Page 46: Please delete the second sentence in this paragraph as this sentence references the monitored natural attenuation parameters of Alternative 2.

Should you have any comments or questions regarding the above, or would like to schedule a meeting to discuss these issues in more detail, please feel free to contact me at (716) 851-7220.

Sincerely yours,

Glenn M May

Glenn M. May, CPG
Engineering Geologist I

cc: Mr. Daniel King, NYSDEC, Region 9
Mr. Jeff Konsella, NYSDEC, Albany
Mr. Matthew Forcucci, NYSDOH, Buffalo

GZA
GeoEnvironmental
of New York

*Engineers and
Scientists*

January 28, 2003
File No. 55039.20

Mr. Glenn M. May, CPG
New York State Department of Environmental Conservation
Region 9 – Division of Environmental Remediation
270 Michigan Avenue
Buffalo, New York 14203-2999

Re: Draft Focused Feasibility Study Report
Delphi Thermal Site
Registry No. 932113

Dear Glenn:

364 Nagel Drive
Buffalo
New York 14225
716-685-2300
FAX 716-685-3629
http://www.gza.net

As requested by Delphi Harrison Thermal Systems (Delphi Thermal) and on its behalf, GZA GeoEnvironmental of New York (GZA) prepared this response to comments provided in the New York State Department of Environmental Conservation (NYSDEC) December 17, 2002 letter regarding the referenced site. This letter was also discussed during a conference call with Delphi Thermal, NYSDEC and GZA on January 9, 2003.

In general, we understand the NYSDEC and New York State Department of Health's (NYSDOH) concern regarding the presence of dense non-aqueous phase liquid (DNAPL) in well MW-5 and a potential for the suspected presence of DNAPL at the Area of Concern (AOC), based upon groundwater concentration in well MW-7. As we discussed on January 9th, it would be advantageous to know the current concentration of the target chlorinated volatile organic compounds (CVOCs). To accomplish this, Delphi Thermal is initiating the process of sampling groundwater from existing monitoring wells MW-3s, MW-4, MW-5, MW-6, MW-7 and MW-8. Each groundwater sample shall be collected and analyzed for CVOCs via SW-846, Method 8260. Delphi Thermal plans to notify NYSDEC when the sampling is scheduled.

A Subsidiary of GZA
GeoEnvironmental
Technologies, Inc.

Following the receipt of the groundwater sample analytical report and its review/assessment by Delphi Thermal and GZA, we plan to schedule a meeting with NYSDEC to discuss the results and how to incorporate that information into the FFS report (either as letter addendum or revise draft FFS report). We will also further discuss additional information obtained from the literature related to chemical oxidation and monitored natural attenuation. This additional data shall also be incorporated into revisions to the draft FFS report.

Comments related to editorial and typographical issues shall be addressed. We plan on providing a strike-out/corrected version of the draft FFS so that the specific editorial and typographic modifications can be tracked.

When the additional well sampling is scheduled, we will submit a revised project schedule for you use. Thank you for you cooperation and assistance on this project. Please call if you have questions or concerns.

Very Truly Yours,

GZA GEOENVIRONMENTAL OF NEW YORK

GZA

Christopher Z. Boron
Project Geologist

Ernest R. Hanna, P.E.
Associate Principal

cc: R. Eisenman (Delphi Thermal)
D. King (NYSDEC – Buffalo)
J. Konsella (NYSDEC – Albany)

New York State Department of Environmental Conservation
Division of Environmental Remediation, Region 9
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Erin M. Crotty
Commissioner

July 22, 2003

Mr. Richard Eisemann
Delphi Energy and Chassis Systems
P.O. Box 92700
Rochester, New York 14692

Dear Mr. Eisemann:

Quarterly Progress Report - 1st Quarter 2003
Delphi Thermal Site, Registry No. 932113

The New York State Departments of Health and Environmental Conservation have completed review of the subject report submitted by Delphi Harrison Thermal Systems (Delphi) in May 2003. This report presents the analytical results of groundwater samples collected in April 2003 from selected on-site wells in and immediately downgradient of the source area. These results, along with previous RI data, should be utilized by Delphi in the Feasibility Study (FS) during the evaluation of proposed remedial alternatives for the site.

Based upon a review of the April 2003 analytical results, we agree with Delphi that natural attenuation appears to be ongoing at the site. While a significant decrease in the TCE concentration at the source area (well MW-7) was observed, the concentration of TCE in this well is still significantly above the 5 μg/l groundwater standard. The principle question that will have to be addressed in the FS, therefore, is how long natural attenuation will take to reduce groundwater concentrations to acceptable levels (i.e., below groundwater standards). As a result, evaluation of technologies designed to "speed up" the natural attenuation process (e.g. HRC or chemical oxidation) should be included and evaluated in the FS. The April 2003 groundwater data, however, may influence the selection of a proposed remedy.

Should you have any questions, please feel free to contact me at 716/851-7220.

Sincerely yours,

Glenn M. May, CPG
Engineering Geologist I

GMM/tml

cc: Mr. Daniel King, NYSDEC, Region 9
Mr. Ed Belmore, NYSDEC, Albany
Mr. Matthew Forcucci, NYSDOH, Buffalo

APPENDIX B

APRIL 2003 LABORATORY REPORT

DELPHI ENERGY & ENGINE

RI/FS

SAMPLE DATES
4/7/03

FREE-COL LABORATORIES

11618 COTTON ROAD
MEADVILLE, PENNSYLVANIA 16335
PHONE: (814) 724-6242
FAX: (814) 333-1466
EMAIL: service@free-col.com

Certificate Of Analysis

Delivery Group ID: 2003:0003767

6 Sample(s) are included in this Delivery Group.

Company Name: Delphi Energy & Engine
Contact Name: Mr. Rick Eisenmen

P.O. Box 92700
Rochester, NY 14692

Date Received 4/8/03
Time Received: 17:00
Delivered By: Field Services

P.O. RPB00999

Project Name: Delphi RI/FS

Printed on 04/22/2003 at 03:41PM

Sample ID: 2003:0003767-1 **Client's Sample ID:** MW-4
Date Sampled: 4/7/03 **Time Sampled:** **Date Received:** 4/8/03

Analyte	Result	Units	Date Analyzed	Start Time	Analyst	Method Source
Organics						
cis-1,2-Dichloroethylene	110	mg/L	04/10/03	11:49	Henry	SW-846 8260B
1,2-Dichloroethylene (Total)	110	mg/L	04/10/03	11:49	Henry	SW-846 8260B
trans-1,2-Dichloroethylene	0.32	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Tetrachloroethylene	0.08	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Trichloroethylene	39	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Vinyl chloride	26	mg/L	04/10/03	11:49	Henry	SW-846 8260B

Sample ID: 2003:0003767-2 **Client's Sample ID:** MW-5
Date Sampled: 4/7/03 **Time Sampled:** **Date Received:** 4/8/03

Analyte	Result	Units	Date Analyzed	Start Time	Analyst	Method Source
Organics						
cis-1,2-Dichloroethylene	1.5	mg/L	04/10/03	11:49	Henry	SW-846 8260B
1,2-Dichloroethylene (Total)	1.5	mg/L	04/10/03	11:49	Henry	SW-846 8260B
trans-1,2-Dichloroethylene	<0.2	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Tetrachloroethylene	64	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Trichloroethylene	96	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Vinyl chloride	<0.2	mg/L	04/10/03	11:49	Henry	SW-846 8260B

Volatile Compounds NOTE: All reported values with a less than sign (<) have detection limit changes due to a dilution.

Sample ID: 2003:0003767-3 **Client's Sample ID:** MW-6
Date Sampled: 4/7/03 **Time Sampled:** **Date Received:** 4/8/03

Analyte	Result	Units	Date Analyzed	Start Time	Analyst	Method Source

FREE-COL LABORATORIES

11618 COTTON ROAD
MEADVILLE, PENNSYLVANIA 16335
PHONE: (814) 724-6242
FAX: (814) 333-1466
EMAIL: service@free-col.com

Certificate Of Analysis

Delivery Group ID: 2003:0003767 6 Sample(s) are included in this Delivery Group.

Company Name: Delphi Energy & Engine
Contact Name: Mr. Rick Eisenmen

P.O. Box 92700
Rochester, NY 14692

Date Received 4/8/03
Time Received: 17:00
Delivered By: Field Services

P.O. RPB00999

Project Name: Delphi RI/FS

Printed on 04/22/2003 at 03:41PM

Sample ID: 2003:0003767-3 **Client's Sample ID:** MW-6
Date Sampled: 4/7/03 **Time Sampled:** **Date Received:** 4/8/03

Analyte	Result	Units	Date Analyzed	Start Time	Analyst	Method Source
Organics						
cis-1,2-Dichloroethylene	7.3	mg/L	04/10/03	11:49	Henry	SW-846 8260B
1,2-Dichloroethylene (Total)	7.3	mg/L	04/10/03	11:49	Henry	SW-846 8260B
trans-1,2-Dichloroethylene	<0.2	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Tetrachloroethylene	31	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Trichloroethylene	7.4	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Vinyl chloride	1.4	mg/L	04/10/03	11:49	Henry	SW-846 8260B

Volatile Compounds NOTE: All reported values with a less than sign (<) have detection limit changes due to a dilution.

Sample ID: 2003:0003767-4 **Client's Sample ID:** MW-7
Date Sampled: 4/7/03 **Time Sampled:** **Date Received:** 4/8/03

Analyte	Result	Units	Date Analyzed	Start Time	Analyst	Method Source
Organics						
cis-1,2-Dichloroethylene	45	mg/L	04/10/03	11:49	Henry	SW-846 8260B
1,2-Dichloroethylene (Total)	45	mg/L	04/10/03	11:49	Henry	SW-846 8260B
trans-1,2-Dichloroethylene	<0.2	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Tetrachloroethylene	<0.2	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Trichloroethylene	75	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Vinyl chloride	2.8	mg/L	04/10/03	11:49	Henry	SW-846 8260B

Volatile Compounds NOTE: All reported values with a less than sign (<) have detection limit changes due to a dilution.

Sample ID: 2003:0003767-5 **Client's Sample ID:** MW-3s
Date Sampled: 4/7/03 **Time Sampled:** **Date Received:** 4/8/03

Analyte	Result	Units	Date Analyzed	Start Time	Analyst	Method Source

FREE-COL LABORATORIES

11618 COTTON ROAD
MEADVILLE, PENNSYLVANIA 16335
PHONE: (814) 724-6242
FAX: (814) 333-1466
EMAIL: service@free-col.com

Certificate Of Analysis

Delivery Group ID: 2003:0003767

6 Sample(s) are included in this Delivery Group.

Company Name: Delphi Energy & Engine
Contact Name: Mr. Rick Eisenmen

P.O. Box 92700
Rochester, NY 14692

Date Received 4/8/03
Time Received: 17:00
Delivered By: Field Services

P.O. RPB00999

Project Name: Delphi RI/FS

Printed on 04/22/2003 at 03:41PM

Sample ID: 2003:0003767-5 **Client's Sample ID:** MW-3s

Date Sampled: 4/7/03 **Time Sampled:** **Date Received:** 4/8/03

Analyte	Result	Units	Date Analyzed	Start Time	Analyst	Method Source
Organics						
cis-1,2-Dichloroethylene	97	mg/L	04/10/03	11:49	Henry	SW-846 8260B
1,2-Dichloroethylene (Total)	97	mg/L	04/10/03	11:49	Henry	SW-846 8260B
trans-1,2-Dichloroethylene	<0.2	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Tetrachloroethylene	<0.2	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Trichloroethylene	1.5	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Vinyl chloride	1.8	mg/L	04/10/03	11:49	Henry	SW-846 8260B

Volatile Compounds NOTE: All reported values with a less than sign (<) have detection limit changes due to a dilution.

Sample ID: 2003:0003767-6 **Client's Sample ID:** MW-Dup

Date Sampled: 4/7/03 **Time Sampled:** **Date Received:** 4/8/03

Analyte	Result	Units	Date Analyzed	Start Time	Analyst	Method Source
Organics						
cis-1,2-Dichloroethylene	96	mg/L	04/10/03	11:49	Henry	SW-846 8260B
1,2-Dichloroethylene (Total)	96	mg/L	04/10/03	11:49	Henry	SW-846 8260B
trans-1,2-Dichloroethylene	0.28	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Tetrachloroethylene	0.07	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Trichloroethylene	34	mg/L	04/10/03	11:49	Henry	SW-846 8260B
Vinyl chloride	27	mg/L	04/10/03	11:49	Henry	SW-846 8260B

PC: GZA

John R Paraska

QUALITY ASSURANCE SUPER

WHITE COPY - Original YELLOW COPY - Lab Files PINK COPY - Project Manager

CHAIN-OF-CUSTODY RECORD

W.O. # _____ *(for lab use only)*

Sample I.D.	Date/Time Sampled (Very Important)	Matrix A=Air S=Soil GW=Ground W. SW=Surface W. WW=Waste W. DW=Drinking W. Other (specify)	WW ONLY: ☐pH ☐Cond.	GC Screen (VOA)	☐524.2 ☐502.2	624	☐601 ☐602	625	Formaldehyde	ANALYSIS REQUIRED: 8260	8021	8021 - "8010" List	8021 "8020" List	8270 ☐Full ☐PAH ☐BN	8082-PCBs Only	8081 - Pest Only	TPH-GC (Mod. 8100)	TPH-GC w/FING	EPH (MA DEP)	VPH (MA DEP)	TCLP (Spec. Below)	Filtering (✓ if requested)	Metals ☐PPM-13 ☐R-8	Metals (List Below)	8260 TARGET COMPOUNDS				Total # of Cont.	Note #
MW-4	4.7.03	GW																						X	X	TARGET COMPOUNDS				2	
MW-5	"	"																						X						2	
MW-6		"																						X						2	
MW-7	"																							X						2	
MW-35																								X						2	
MW-Dup	"	"																						X						2	
PRESERVATIVE (Cl - HCl, M=MeOH, N - HNO3, S - H2SO4, Na - NaOH, O - Other)*																															
CONTAINER TYPE (P-Plastic, G-Glass, V-Vial, O-Other)*																															

RELINQUISHED BY:	DATE/TIME	RECEIVED BY:
Chris Baron	3/8/03	[illegible] 4/8/03
RELINQUISHED BY:	DATE/TIME	RECEIVED BY:
RELINQUISHED BY:	DATE/TIME	RECEIVED BY:

NOTES: Preservatives, special reporting limits, known contamination, additional testing parameters, etc.:

TARGET COMPOUNDS: Trichloroethylene, Vinyl Chloride
Tetrachloroethylene
Total 1,2-Dichloroethene
trans-1,2-Dichloroethene
cis-1,2-Dichloroethene

PROJECT MANAGER: Chris Baron EXT: _____

DATA REPORT ☑ PDF (Adobe) ☐ ASCII ☐ EXCEL Specify State _____

TURNAROUND TIME: ~~Standard~~ Rush ___ Days, Approved by: _____ LAB USE: TEMP. OF COOLER _____ °C

GZA FILE NO: 21.0731 P.O. NO. _____

PROJECT Delhi RI/FS

LOCATION Delhi NY

COLLECTOR(S) Chris Baron SHEET 1 OF 1

GZA GeoEnvironmental, Inc.
ENGINEERS AND SCIENTISTS
106 South Street
Hopkinton, MA 01748
(508) 435-9244
FAX (508) 435-9912

ACCREDITED IN ACCORDANCE WITH nelac

P003

APPENDIX C

COST ESTIMATE AND BACKUP CALCULATIONS

Table C-1
Cost Estimate Summary
Alternative No.1: No Further Action

Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport New York

Item No.	Description	Capital Costs	Present Worth of O&M Costs
1	No Further Action	$ -	$ -
Subtotal		$ -	$ -
Engineering (15%)		$ -	
Contingency/Administration (10%)		$ -	
TOTAL		$ -	$ -

Net Present Worth

Capital Costs	$ -
Present Worth of Annual O&M Costs	$ -
TOTAL NET PRESENT WORTH =	$ -

Notes:
1.) Refer to the attached pages for descriptions of the cost estimate assumptions.

Cost Estimate Assumptions
Alternative 1: No Further Action

Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Item No. 1: No Further Action

Assumes No Further Action would be conducted at the Site.

GZA GeoEnvironmental of New York

Table C-2
Cost Estimate Summary
Alternative No.2: Monitored Natural Attenuation with Groundwater Monitoring

Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport New York

Item No	Description	Capital Costs	Present Worth of O&M Costs
1	Monitiored Natural Attenuation with Groundwater Monitoring	$ -	$ 178,000
2	Institutional Controls	$ -	$ 77,000
Subtotal		$ -	$ 255,000
Engineering (15%)		$ -	$ -
Contingency/Administration (10%)		$ -	$ -
TOTAL		$ -	$ 255,000

Net Present Worth

Capital Costs	$ -
Present Worth of Annual O&M Costs	$ 255,000
TOTAL NET PRESENT WORTH =	$ 255,000

Notes:
1.) Refer to the attached pages for descriptions of the cost estimate assumptions.
2.) Present Worth of O&M costs were calculated for a 30-year duration, using a 5% discount rate (i.e., interest rate = 9%, inflation rate = 4%).
3.) Total costs are rounded to the nearest $1,000.
4.) 10% Contingency/Administration for Delphi Thermal included in initial cost.

DRAFT

Cost Estimate Assumptions
Alternative 2: Monitored Natural Attenuation with Groundwater Monitoring

Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Item No. 1: Monitored Natural Attenuation with Groundwater Monitoring

Assume monitoring conducted on an annual basis for 30 years.

Assume includes well redevelopment (purge 3 - 5 well volumes) and sampling of 8 existing on-site monitoring wells (see Figure 5).

Estimated cost of each sampling effort includes field labor, equipment, and expenses: $5,200.

Estimated cost of analytical testing includes:

- Laboratory Analysis of 8 groundwater samples plus QA/QC samples (1 duplicate, 2 MS/MSDs, 1 rinsate blank, 1 trip blank) for CVOCs.
- Validation of the laboratory data.
- Estimated cost: $1,700.

Assume preparation of a MNA report. Estimated cost for report preparation and time for project coordination: $2,400.

Above costs are based on standard engineering rates, U.S. Environmental Rental Corp., PSC Environmental Services, and Dataval Inc.

Assume 15% Engineering Cost = $1,400

Assume 10% Contingency/Administrative (Delphi Thermal) Cost = $930

Annual Groundwater Monitoring Cost = $11,600

Item No. 2: Institutional Controls

Assume Institutional Controls will be maintained through out the duration of the project.

- Institutional controls currently in place (i.e., subsurface work permit, confined space permit) will be continued.
- New institutional controls for project specifics (i.e., Hazwoper training for employees that might encounter contaminated groundwater, yearly refesher course) would be implemented.

Assume a cost of $5000 per year to maintain current and implement new institutional controls.

NOTE:
See backup calculations following this description page.

GZA GeoEnvironmental of New York

Project DELPHI HARRISON THERMAL SYSTEMS — File No. 55039.2
Location WEST LOCKPORT COMPLEX, LOCKPORT NY — Date 9/7/02 — By D. TROY
Subject FFS - COST ESTIMATE — Checked 9/11/02 — By CZB
~~Based on~~ ALTERNATIVE 2 — Revised 11.20.03 — By CZB

Monitored Natural Attenuation w/ Groundwater Monitoring

PERFORMED ANNUALLY

- Assume ground water monitoring performed at 8 existing monitoring wells. Wells include MW-4, -5, -7, -9, -10, -13, -14, -15.
- Assume wells are purged of 3-5 well volumes and sampled by two field geologists.
- Assumed duration = 3 - 10hour days (including travel time)
- Assume sample and collect unfiltered samples. Analysis to include CVOCs
- Field measurements of MNA include pH, Conductivity, temperature, Oxidation Reduction potential (ORP) and dissolved oxygen (DO). To be measured w/ a down-hole water quality meter during purging.
- Assume sampling will be completed by low flow pumping and dissolved inorganic samples will not be collected.

Labor: (3)(20 hr/day)($20/hour)(3.0 mark-up) = $3,600
std. rates + practices
(Field)

EQUIPMENT: (U.S Environmental Rental Corp.)

- Hnu Organic Vapor Meter (OVM)	(3days)($75/day)	= $225
- Water Level Indicator	(3days)($20/day)	= $60
- Water Quality (ph, D.O, ORP, Temp, Cond, Turbidity)	(3days)($125/day)	= $375
- Disposable Bailers	(1case)($130/case)	= 130
- HDPE Tubing ($30/100ft)	(300 feet)	= $90
- Low flow pump (ISCO 150 peristaltic)	(3days)($40/day)	= $120
- Generator	(3days)($50/day)	= $150
		$1,150

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Project DELPHI HARRISON THERMAL SYSTEMS — File No. 55039.2
Location WEST LOCKPORT COMPLEX, LOCKPORT N.Y — Date 9/7/02 — By D.TROY
Subject FFS - COST ESTIMATE — Checked 9/11/02 — By CZB
Based on ALTERNATIVE 2 — Revised 11.20.03 — By CZB

Expenses

- Milage, Fed Ex shipping, office expences (photocopies, phone, overnight mail) ≈ $ 400 (std. rates)

Consumables

- Latex gloves, paper towels, D.I water, Ice, Ziplock baggies, garbage bags ≈ $ 75 (std. rates)

OFFICE LABOR (to coordinate field work and produce MNA monitoring report)

- Project Manager (4hr)($100/hr) ≈ $ 400
- Staff Engineer (8hr)($80/hr) ≈ $ 640
- Geologist (20hr)($65/hr) ≈ $ 1300

≈ $ 2,350

Analytical Testing (based on PSC Environmental Services and Data Val)

Eight (8) samples + 1 (duplicate) + 2 (ms/msd) + 1 (rinsate blank) + 1 (trip blank-VOCs only) = 13 samples

- Lab Testing VOCs $100/sample (13) ≈ $ 1,300
- Validation $26/sample (on VOCs only)(13) $ 340

$1,640

TOTAL COSTS FOR GROUNDWATER MONITORING w/ MNA: $ 9,200 (rounded to nearest $100) / sample event

- Assume 10% Additional cost for Administrative/Contingency costs ~ $920
- Assume 15% additional cost for engineering ~ $ 1,400

∴ Annual Sampling ≈ $11,600/YEAR

Institutional Controls:

Assume that Delphi employees will be trained due to possible encounter w/ contaminated groundwater.

Training would include: OSHA Standards 29 CFR 1910.120 Hazwhopper

8 employees * $500 for training = $4,000

Miscellaneous Items: Signs, paperwork $1,000

Assumes no costs for permitting such as confined space or subsurface work.

Total Institutional Control ~ $5,000/yr

Table C-3A
Cost Estimate Summary
Alternative No.3A: Source Area DNAPL Extraction
with Groundwater Monitoring
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Item No.	Description	Capital Costs	Present Worth of O&M Costs
1	Source Area DNAPL Extraction		$ 69,000
2	DNAPL Drum Disposal		$ 15,000
3	Groundwater Monitoring	$ -	$ 143,000
4	Institutional Controls	$ -	$ 77,000
Subtotal			$ 304,000
Engineering (15%)			$ -
Contingency/Administration (10%)			$ -
TOTAL		$ -	$ 304,000

Net Present Worth

Capital Costs	$ -
Present Worth of Annual O&M Costs	$ 304,000
TOTAL NET PRESENT WORTH =	$ 304,000

Notes:
1.) Refer to the attached pages for descriptions of the cost estimate assumptions.
2.) Present Worth of O&M costs were calculated for a 30-year duration, using a 5% discount rate (i.e., interest rate = 9%, inflation rate = 4%).
3.) Total costs are rounded to the nearest $1,000.
4.) The above estimate provides the cost estimate for the conceptual design presented in the Figure 6. Additional information regarding the effectiveness of the systems would be evaluated during remedial design.

DRAFT

Cost Estimate Assumptions
Alternative 3A: Source Area DNAPL Extraction with Groundwater Monitoring

Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Item No. 1: Source Area Extraction

Assumes Source Area DNAPL extraction will be done at existing monitoring well MW-5.

Assumes extraction event will be done monthly for the first three months, quarterly for 2 years, and semi-annualy for the remainder (30 yrs.)

Assumes extraction event can be completed in one 8-hour day.
Assumes flow rate for extraction to be approximately 0.2 gpm.
Estimated cost of each extraction event includes field labor, equipment, and expenses: $700.
Assumes maintanance or refurbishment on well every 5 years: $1,000 (every 5 years)
Assume $1,500 engineering costs per year.
Assume $1,000 contingency/administrative costs per year.

Total Annual Extraction Event Cost(years 1) = $6,700/year
Total Annual Extraction Event Cost(years 2 - 3) = $5,300/year
Total Annual Extraction Event Cost(years 4 - 30) = $4,300/year

Item No. 2: DNAPL and Groundwater Disposal

Assumes approximately 50 gallons, or one (1) 55-gallon drum, of DNAPL and groundwaterflow will be generated for disposal per event.

Estimated costs to dispose of DNAPL and groundwater drum as hazardous waste: $ 400.
Total Annual Drum Disposal Cost (years 1) = $2,400/year
Total Annual Drum Disposal Cost (years 2 - 3) = $1,600/year
Total Annual Drum Disposal Cost (years 4 - 30) = $800/year

Item No. 3: Groundwater Monitoring

Assume monitoring on an annual basis for years 1 through 30.

Assume includes well redevelopment (purge 3 - 5 well volumes) and sampling of 8 existing on-site monitoring wells (see Figure 6). Also, assume water level measurements performed in site wells.

Estimated cost of each sampling effort includes field labor, equipment, and expenses: $5,200

Estimated cost of analytical testing includes:
- Laboratory Analysis of 8 groundwater samples plus QA/QC samples (1 duplicate, 2 MS/MSDs, 1 rinsate blank, 1 trip blank) for CVOCs.
- Validation of the laboratory data.
- Estimated cost: $1,700.

Assume preparation of a brief data summary report. Estimated cost for report preparation and time for project coordination: $2,400.

Total Annual Groundwater Monitoring Cost (years 3 - 30) = $9,300/year

Item No. 4: Institutional Controls

Assume Institutional Controls will be maintained through out the duration of the project.
- Institutional controls currently in place (i.e., subsurface work permit, confined space permit) will be continued.
- New institutional controls for project specifics (i.e., Hazwoper training for employees that might encountered contaminated groundwater, yearly refesher course) would be implemented.

Assume a cost of $5,000 per year to maintain current and implement new institutional controls.

NOTE:
See backup calculations following this description page.

GZA GeoEnvironmental of New York

Project Delphi Harrison Thermal Systems FFS — File No. 55731.55089.2
Location Lockport NY — Date 11/19/03 — By CZB
Subject Source Area DNAPL Extraction — Checked 11/21/03 — By ERH
Based on Alternative 3A — Revised — By

Source Area DNAPL Extraction

Assumes:

- Source Area DNAPL Extraction will be done at existing monitoring well, MW-5.
- Extraction will be done via low-flow peristaltic pump w/ flow rates of approx. 0.2 gal/min
- DNAPL extraction will be done monthly for first 3 months, then quarterly for 2 years, and semi annually for remainder (30 yrs). Extract approx. 50 gals of groundwater and DNAPL per event. would be extracted
- Extracted fluids will be placed in a steel 55-gallon drum to be disposed off-site.
- Extraction event can be completed in one, 8 hour day.
- Flow rates (approx. 0.2 gal/min) will not purge well dry.

Associated Costs per Event

Peristaltic Pump Rental (includes shipping):	$50/day	(Pine Env.)
Tubing (approx. 50 ft) 50 ft × 0.30/ft =	$15	(Pine Env.)
55-gal steel NYS DOT approved drum =	$75/drum	(Lab Safety Supply)
Field Geologist ($20/hr.)(8 hrs)(3.0 markup) =	$480	
Field Expenses (latex gloves, DI water, etc.)	$25	(Eng. Assumpt.)
Mileage: 75 miles at $0.36/mile.	$30	(Eng. Assumpt.)
Drum Disposal (Hazardous Waste)	$400/drum	(Eng. Assumpt.)
	$1,075 Say $1,100	

GZA GeoEnvironmental of New York
Engineers and Scientists

Project Delphi Harrison Thermal Systems FFS — File No. 55731.55058.2
Location Lockport NY — Date 11/18/03 — By CZB
Subject Source Area DNAPL Extraction — Checked — By
Based on Alternative 3A — Revised 11/24/03 — By CZB

Operation + Maintenance Costs

Repairs to well every 5 yrs. $1,000 (Eng. Assumpt.)

Assume 15% for engineering
Assume 10% for contingency + administration

Groundwater Monitoring Program

Assumes and Costs associated w/ groundwater monitoring are same as Alternative #2 with the exception that sampling and water quality readings will be conducted quarterly for years 1 and 2 and then annually for years 3 through 30.

Institutional Controls.

Assumes that Delphi employees will be trained due to the possible encounter w/ contaminated groundwater and DNAPL. Training would include OSHA Standard 29 CFR 1910.120 Hazwhopper. No costs assumed for required permitting such as confined space of subsurface work.

8 employees x $500 per employee for training = $4,000
Misc. Items (Signs, paperwork, etc) = $1,000
$5,000

Table C-3B
Cost Estimate Summary
Alternative No.3B: Groundwater Extraction and Treatment with Monitored Natural Attenuation
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Item No.	Description	Capital Costs	Present Worth of O&M Costs
1	Groundwater Extraction System	$ 136,000	$ 607,000
2	Ex-Situ Groundwater Treatment System	$ 92,000	$ 505,000
3	Groundwater Monitoring	$ -	$ 195,000
4	Institutional Controls	$ -	$ 77,000
Subtotal		$ 228,000	$ 1,384,000
Engineering (15%)		$ 34,000	
Contingency/Administration (10%)		$ 23,000	
TOTAL		$ 285,000	$ 1,384,000

Net Present Worth

Capital Costs	$ 285,000
Present Worth of Annual O&M Costs	$ 1,384,000
TOTAL NET PRESENT WORTH =	$ 1,669,000

Notes:
1.) Refer to the attached pages for descriptions of the cost estimate assumptions.
2.) Present Worth of O&M costs were calculated for a 30-year duration, using a 5% discount rate (i.e., interest rate = 9%, inflation rate = 4%).
3.) Total costs are rounded to the nearest $1,000.
4.) The above estimate provides the cost estimate for the conceptual design presented in the Figure 7. Additional information regarding the effectiveness of the systems would be evaluated during remedial design.

DRAFT

Cost Estimate Assumptions
Alternative 3B: Groundwater Extraction and Treatment with Groundwater Monitoring

Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Item No. 1: Groundwater Extraction

Assume geophysical study of the Site would be completed to better define fractures in bedrock: $10,000

Assume Groundwater Extraction System Pilot Study is conducted which includes:
- installation and materials for one, 6-inch stainless steel extraction well to approximately 25 feet BGS with 20 feet of screen section using traditional well design: $13,100
- installation and materials for six, 2-inch PVC piezometers installed to approximately 20 feet BGS with 15 feet of screen section using traditional well design: $7,800
- performing 48-hour pump test (cost includes labor and equipment rental): $7,200
- assumes pump water discharge to be containerized and managed by Delphi, management and disposal costs are not included.

Assumes five additional extraction wells are installed to complete the Groundwater Extraction System which includes.
- installation and materials for five, 6-inch stainless steel extraction wells to approximately 25 feet BGS with 20 feet of screen section using traditional well design (includes vaults, pumps and assessories): $67,500
- extraction trenches (cost includes piping and trenching, etc.). $30,800

Assumes flow rate from each of six extraction wells to be approximately 2 gpm.

Assumes annual cost for Operation and Maintenance of Groundwater Extraction System: $36,500/year
- costs include monitoring of system, labor, parts and repair, etc.

Assumes groundwater extraction pumps and accessories to be replaced every 5 years: $12,000 (every 5 years)

Assumes groundwater extraction wells to be refurbished every 5 years: $5,000 (every 5 years)

Refer to Figure 7 for locations of extraction wells and piping.

Item No. 2: Ex-Situ Groundwater Treatment and Discharge

Assumes flow rate from extraction wells to the treatment system to range from approximately 10 to 15 gpm.

Assumes average initial influent concentration of total VOCs to be approximately 30 ppm; TDS is low such that filtration is not required.

Assumes Treatability Study is conducted for system design: $10,000

Assumes Pretreatment Building (20 ft X 20 ft) is fabricated and constructed which includes:
- prefabricated metal structure with epoxy-coated paint, a concrete foundation with secondary containment, and insulation: $30,000
- instrumentation and controls, electrical and plumbing systems: $7,500

Assumes 3 pumps (in addition to one backup pump) required to move groundwater from extraction wells through the GAC vessels: $ 4,000

Assumes pretreatment system will not be required

Assumes electrical utilities will have to be connected to the Treatment Building: $5,000

(continued on page 2)

Cost Estimate Assumptions
Alternative 3B: Groundwater Extraction and Treatment with Groundwater Monitoring

Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Item No. 2: Ex-Situ Groundwater Treatment and Discharge (continued from page 1)

Assumes granular activated carbon treatment system installation and start up: $10,000

Assumes effluent discharge limit (PCE, TCE, DCE) is to be 5 ppb, and VC is to be 2 ppb (by Best Available Treatment Technology).

Carbon treatment system will consist of two units (2,500 lbs of carbon per unit) in series. A third unit would be available for "swing" usage (e.g., containing fresh carbon for changeout or as spent carbon being transported off site for disposal).
Total cost for three carbon vessels = $25,000

Analysis on the effluent of both carbon vessel units conducted 4 times a month to monitor for breakout of VOCs from the lead unit and for discharge compliance from the polish unit effluent: $7,200/year

Assumes carbon changeout five times a year at $1.65 per pound of carbon. Assumes approx. 33-34 lbs of carbon used per day. Carbon change out = $20,625 per year.

Assumes cost for SPEDES permit and discharge quantity of 12 gpm to storm sewer: $1,000 (every 5 years).

Assumes annual Operation and Maintenance cost for Groundwater Treatment System: $5,000/year (years 1 through 30)
Includes site supervision, remote monitoring, repair labor, emergency repair, parts and supplies).

Refer to Figure 7 for location pretreatment building.

Item No. 3: Groundwater Monitoring with MNA

Assume monitoring on a quarterly basis (i.e., four times per year) for years 1 and 2; and annually for years 3 through 30.

Assume includes well redevelopment (purge 3 - 5 well volumes) and sampling of 8 existing on-site monitoring wells (see Figure 7). Also, assume water level measurements performed in site wells.

Estimated cost of each sampling effort includes field labor, equipment, analysis, and expenses: $ 5,200

Estimated cost of analytical testing includes:
- Laboratory Analysis of 8 groundwater samples plus QA/QC samples (1 duplicate, 2 MS/MSDs, 1 rinsate blank, 1 trip blank) for CVOCs.
- Validation of the laboratory data.
- Estimated cost: $1,700.

Assume preparation of a brief data summary report. Estimated cost for report preparation and time for project coordination: $2,400.

Total Annual Groundwater Monitoring Cost (years 1 - 2) = $37,000/year
Total Annual Groundwater Monitoring Cost (years 3 - 30) = $9,300/year

Item No. 4: Institutional Controls

Assume Institutional Controls will be maintained through out the duration of the project.
- Institutional controls currently in place (i.e., subsurface work permit, confined space permit) will be continued.
- New institutional controls for project specifics (i.e., Hazwoper training for employees that might encountered contaminated groundwater, yearly refesher course) would be implemented.

Assume a cost of $5,000 per year to maintain current and implement new institutional controls.

NOTE:
See backup calculations following this description page.

GZA GeoEnvironmental of New York

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Project DELPHI HARRISON THERMAL SYSTEMS FFS — File No. 55039.2
Location LOCKPORT, NY — Date 7/10/02 — By D TROY
Subject GROUNDWATER EXTRACTION & TREATMENT — Checked 9/15/02 — By CZB
Based on SYSTEMS. AH.3 — Revised — By

GROUNDWATER EXTRACTION SYSTEM: PILOT STUDY

- Assume a geophysical study will be completed to identify fractures in bedrock. Mapping of major fractures in subsurface will assist in groundwater extraction well locations — $10,000 Engineering assumptions

- Assume one extraction well will be installed to approx. 25 feet bgs for 48-hr pump test.

- Groundwater extracted will be placed in drums for offsite disposal. In addition to soil spoils of well installation.

Installation and Materials (Costs based on Engineering Assumptions and Earthdimensions Cost unless otherwise noted)

- assume cost of mob/demob — ≈ $500

- Drilling to be completed with 8 1/4 inch HSA and split spoon sampling to depth of approximately 20 feet bgs. Assume $36/foot — ≈ $360

- Rock Core drilling with casing - Assume 15 feet Appox $52.00/LF — ≈ $780 ECHOS 33-23-1175

- Assumes 20 feet of stainless steel screen 6" ∅ ≈ $203/L.F x 20 feet = — ≈ $4060 ECHOS 33-23-0224

- Stainless steel plug for 6" ∅ well. $335 ea — $335 ECHOS 33-23-0313

Sand Pack, Bentonite, Grout:
Sand Pack @ $25/L.F x 15' — $375 ECHOS 33-23-1403
Bentonite chip/seal @ $144/CF/2CF — $300 ECHOS 33-23-2103

4 foot by 4 foot Heavy duty steel frame, hatch door Vault with concrete to house well and head — $2510 each + $1000 for add'l Hand — $3510 Echos 33-23-2208

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Project DELPHI HARRISON THERMAL SYSTEMS FFS — File No. 55039.2
Location LOCKPORT, NEW YORK — Date 9/10/02 By P. TROY
Subject GROUNDWATER EXTRACTION AND TREATMENT — Checked 9/15/02 By CZB
Based on SYSTEMS Alt. 3 — Revised — By

- Flow meter (digital) $500 each — $500

- Submersible Pump 4" 0.3 to 7 GPM — $1750 ECHOS
  Head ≤ 140 feet, 1½ hp with controls $1750 ea. — ECHOS 37-23-0521

Accessories for pump (i.e., Level detection float etc.) $500 — $500 Engineering Assumption

Downwell piping from pump to ground surface vault
25 ft 2" ∅ PVC @ $5/LF — $125 ECHOS p. 3-10

Assume six 2" ∅ PVC piezometers installed to approximately 20 feet bgs for purpose of monitoring groundwater during pump test.

- Well installation using 6¼ HSA to 10'
  10 ft × $20/ft — $200/piezo

- 5 7/8 inch Rollbit Rock Coring and Casing Assume 10'
  $40/LF — $400/piezo

- Well materials including 2-inch PVC screen and riser bentonite
  Grout, concrete, $28/LF @ 20 LF ea. — $560/piezo

- Road Box Protective Casing $130 ea. — $130/piezo

FACTORS INCLUDED IN COSTS

Total unit cost of Installation Groundwater monitoring piezometers = — $1290/piezometer

Six piezometer installations ≈ $7750

- Assume $150/hr to perform 48-hour Pump test
  ($150/hr)(48 hr.) — ≈ $7200 Engineering Assumption

PILOT STUDY COST : $38,100 ✓

GROUNDWATER EXTRACTION SYSTEM TREATABILITY STUDY
- assumes cost to include the collection of samples, laboratory analysis and evaluation of Lab results with report

$10,000 ← COST TO BE INCLUDED WITH TREATMENT

Project DELPHI HARRISON THERMAL SYSTEMS FFS — File No. 55039.2
Location LOCKPORT, NEW YORK — Date 9/10/02 — By D.TROY
Subject GROUNDWATER EXTRACTION SYSTEM — Checked 9/15/02 — By CZB
Based on Alt.3 — Revised — By

GROUNDWATER EXTRACTION SYSTEM.

- Assume a total of 6 six groundwater extraction wells installed to 25' BGS. One well would be previously installed during pilot study.
- Assumes all equipment, materials, and supplies prior to entering treatment building/trailer.
- Assumes Cost of field oversight of Extraction System will be included with Engineering costs.
- Assumes flow rate to be approx 2 gpm per extraction well or 12 gpm for entire system.
- Assumes cost for treating and discharging of groundwater are included in the Treatment System
- Assumes approx. 1350 feet of trenching/bedding/backfill would be included in Extraction System and 50 feet would be included in Treatment System

Installation And Materials:

- Mobilization/Demobilization to site ≈ $1,000 ✓
- 8 1/4 inch HSA & Soil sampling: $36/foot — $360 / WELL ✓
  Assume 10 feet of overburden
- Rock core drilling with Casing: $52.00/LF — ≈ $780/well ✓
  Assume 15 feet of rock core
  ECHOS - 33-23-1175
- Assumes 20 feet of stainless steel screen 6" ø — ≈ $4050/well ✓
  $202.58 per Linear foot x 20 feet
  ECHOS 2001 33-28-0204

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Project DELPHI HARRISON THERMAL SYSTEMS FFS — File No. 55039.2
Location LOCKPORT, NEW YORK — Date 9/10/02 — By D. TROY
Subject GROUNDWATER EXTRACTION SYSTEM — Checked 9/15/02 — By CZB
Based on Alt. 3 — Revised — By

- Stainless steel well plugs for 6" ϕ well ≈ $335/well
  $334.84 each
- SAND pack, Bentonite Grout bentonite chips
  SAND ~ $25/LF @ 15' ≈ $ 375/well ECHOS p. 9
  Bentonite chip $44/CF x 2 CF ≈ $ 300/well 33-23 1403
  And 33-23-210
- 4 foot x 4 foot Heavy Duty steel frame Hatch door vault with concrete to house well pump head
  ($2,510 each) ≈ $2500 ECHOS 2001 33-23-2
  + $1000 for concrete + 1. $1000 Engineering Assumption
- Flowmeter (digital)
  $500 each $500
- Submersible Pump for 4" Submersible pump, 0.3-7 GPM, Head <= 140 feet, 1/3 hp with controls $1732 ≈ $1750 Echos 33-23-05
  Assessories for Pump ≈ $420/well $420 Engineering Assumption
- Down well piping to pump in well ≈ 25 ft. 2" ϕ PVC
  (25 Ft)($5/Ft) ~ $125 $125 ECHOS p. 3-10

TOTAL UNIT COST FOR ONE GROUNDWATER EXTRACTION WELL ≈ → $ 13,500

Installation of Five Groundwater extraction well → $ 67,500

Assume 1400 L.F of 4" ϕ HDPE piping to connect treatment building and Extraction wells. Cost includes extra for Fittings.
1400 LF ($3/FF) = $ 4200 ECHOS 33-26-25

- assume cost for 1400 L.F of clean bedding stone for HDPE piping and trenching from wells to treatment system. ≈ $26,600
  (1400 Ft)($3/Ft + $16/Ft) =

ALT.

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Project DELPHI HARRISON THERMAL SYSTEMS FFS — File No. 55039.2
Location LOCKPORT, NY — Date 9/10/02 — By D-TROY
Subject GROUNDWATER EXTRACTION & TREATMENT — Checked 9/15/02 — By CJS
Based on SYSTEMS Alt.3 — Revised — By

GROUND WATER EXTRACTION SYSTEM ≃ #98,300

GROUNDWATER TREATMENT SYSTEM

- Assume influent groundwater concentrations to range from approximately 1 to 900 ppm for total VOCs. Assumed Average of total VOC is 300ppm. Average concentrations of 4 main chlorinated compounds are:
  - PCE ~ 9.780ppm
  - TCE ~ 220 ppm
  - DCE ~ 50 ppm
  - V.C. ~ 6ppm
- Assume effluent groundwater concentration must be <5ppb for PCE, TCE and DCE and <2ppb for vinyl chloride.
- Assume no other contaminants will be addressed for this groundwater treatment system (i.e., BTEX)
- Assumes a total flow rate of 12gpm to the treatment system from 6 extraction wells each pumping approx. 2gpm.
- Assume permanent structure to house treatment system. Foundation will be slab on grade and will include 2nd day containment.
- Assumes all treatment equipment will be run on electricity.
- Assumes system startup and installation costs in addition to individual equipment installation and startup to encompass all equipment into a single system.
- Assumes treatment effluent will be discharged to storm drainage channel.
- Assumes total dissolved solids will be low (and total suspended solids) such that filtration is not required. These will be evaluated during treatability study.
- Assumes 3 carbon vessels used. Two in continuous operation with third vessel as "swing" or alternate. During changeout system can be changed to new vessel and spent vessel can be removed from site for disposal and brought back with fresh carbon before next changeout. Units can be moved with typical forklifts from treatment building.

Project DELPHI HARRISON THERMAL SYSTEMS FFS File No. 55039.2

Location LOCKPORT, NEW YORK Date 9/10/02 By

Subject GROUNDWATER EXTRACTION AND TREATMENT Checked 9/15/02 By CZR

Based on SYSTEM Revised By

Assumes a 20x20 foot x 15' prefabricated metal building with dual containment foundation, epoxy coated paint internal plumbing and an instrumentation and control room.

$30,000 building and foundation $30,000

25% of cost for control room, electrical connections etc. $7500

TOTAL BUILDING COST $37,500

Engineering Assumption

Assume 3 pumps will be required to move groundwater through the treatment system + assessories.

(3 pumps) ($1,000 each) $3,000

Engineering Assumption

one spare backup pump $1000 $1000

Assumes three GAC carbon Vessels in Series one vessel will be "living" vessel with Lead and Lag (Polish) Units include hose connections, vent assembly, delivery to site.

Assume Vessels will contain 2500 lbs of Carbon each

(Tigg-C-75) Three C-75 vessels delivered to site. $25,000 Vendor Quot

- Assume Groundwater Treatment System installation and startup cost.

$10,000 Engineering Assumption $10,000

- Assume electrical utilities will need to be connected to the Site Treatment Facility building.

$5000 Engineering Assumption $5,000

TOTAL COST FOR TREATMENT SYSTEM = $81,500

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Project Delphi Harrison Thermal Systems FFS | File No. 55039.2
Location LOCKPORT, NEW YORK | Date 9/10/02 | By DTROY
Subject GROUNDWATER Extraction and Treatment | Checked 9/15/02 | By CZB
Based on SYSTEM Alt.3 | Revised | By

OPERATIONS AND MAINTENANCE COSTS

- Assumes O+M costs will be included in first year total costs.
- Assume Site Personell will be used to monitor and maintain Groundwater Extraction and Treatment System. (GWE+T)
  - Assume on-site supervision for 1 week (40 hrs) per month @ $45/hr
    (40 hr)($45/hr)(12 months) = $21,600 PER YEAR
  - Assumes GWE+T will contain remote monitoring for 24 hr/day surveillance
    $5000 per year Engineering Assumption.
- Assumes electrical costs for the year $15,000/year
  Engineering Assumption
- Assumes GAC vessel will require changeout approximately 5 times/year
  Assumes 34 lbs carbon used/day @ 12 GPM flowrate
  changeout costs: $1.65/lb carbon x 2500 lbs carbon x 5 times/year = $20,625/year
- Assumes additional labor costs for repairs per year.

Electrician	$3,000/yr	(100 hrs @ $35/hr)	Echos p-2-37 = $3500
Mechanic	$3,000/yr	(100 hrs @ $24/hr)	Echos p-2-63 = $2400
Laborer	$1500/yr	(100 hrs @ $15/hr)	Echos p-2-37 = $1500

$7400/year

- Assume new extraction pumps and assessories needed every 5 years (years 5, 10, 15, 20, 25) $12,000 (see page 4)
- Assumes cost for emergency repairs $1000/yr
  Engineering Assumption
- Assumes a cost for parts and supplies $1500/yr
  Engineering Assumption

Assume Permit modifications for SPDES PERMIT

Assume $1000 Cost every 5 years (yrs 5, 10, 15, 20, 25)

26,675 (?)

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Project DELPHI HARRISON THERMAL SYSTEMS FFS File No.
Location LOCKPORT, NY Date 9/10/02 By D. TROY
Subject GROUNDWATER EXTRACTION AND TREATMENT Checked 9/15/02 By CZB
Based on SYSTEM Revised 11.20.03 By CZB

- Assumes cost for effluent groundwater sampling between Lead and Polish GAC vessels, after Polish vessel and effluent compliance.
  Assume Testing 4 samples every month for VOCs (monitor VOC breakout).

  12 mo/yr x 4 samples/month x ($150/sample) = $7200/yr

  Assume Groundwater Extraction wells to be refurbished every 5 years

  Assume $5,000 Engineering Assumption $5,000 (MRS 5, 10, 15, 20, 25)

- Groundwater Monitoring

  Assumes and Costs associated w/ groundwater monitoring are the same as Alternative 2 w/ exception that sampling will be conducted quarterly for years 1 and 2 following the start up of the groundwater extraction and treatment system and then annually for years 3 to 30.

- Institutional Controls: Assumes that Delphi employees will be trained due to possible encounter w/ contaminated groundwater. Training would include OSHA Standard 29 CFR 1910.120 Hazwhopper

  8 employees * $500 for training = $4,000
  Misc. Items: Signs, paperwork, other $1,000
  $5,000

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Table C-4A
Cost Estimate Summary
Alternative No.4A: Source Area DNAPL In-Situ Chemical Oxidation with Groundwater Monitoring
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Item No.	Description	Capital Costs	Present Worth of O&M Costs
1	In-Situ Chemical Oxidation	$ 36,000	
2	Institutional Controls		$ 77,000
3	Groundwater Monitoring		$ 195,000
Subtotal		$ 36,000	$ 272,000
Engineering (15%)		$ 5,000	
Contingency/Administration (10%)		$ 3,600	
TOTAL		$ 44,600	$ 272,000

Net Present Worth

Capital Costs	$ 45,000
Present Worth of Annual O&M Costs	$ 272,000
TOTAL NET PRESENT WORTH =	$ 317,000

Notes:

1.) Refer to the attached pages for descriptions of the cost estimate assumptions.
2.) Present Worth of O&M costs were calculated for a 30-year duration using a 5% discount rate (i.e., interest rate = 9%, inflation rate = 4%).
3.) Total costs are rounded to the nearest $1,000.
4.) The above estimate provides the cost estimate for the conceptual design presented in the Figure 8.
5.) The above cost estimate does not include costs for groundwater extraction and treatment contingency plan. Costs associated with contingency plan will be on the order of cost estimate described in Alternative No. 3B.

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Cost Estimate Assumptions
Alternative 4A: Source Area In-Situ Chemical Oxidation with Groundwater Monitoring

Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Item No. 1: Source Area DNAPL In-Situ Chemical Oxidation

In-Situ Chemical Oxidation (Sodium Permanganate) technology would be applied via a step-wise approach:
First a pilot study would be performed, then if the pilot study yields favorable results, perform source area application.

Assumes a Pilot Study (1 injection event in MW-5) will be conducted to asses the feasibility of In-Situ Chemical Oxidation process.

-Assumes 5 groundwater monitoring wells within the vicinity of MW-5 will be sampled three times, once immediately following injection, again after one month, and then six-months later.
Total cost for Pilot Study: $8,400

Assumes a phase approach for injections will be utilized into existing monitoring wells MW-3s, MW-4, MW-5, and MW-7.
Total cost for 2 injection events, including oxidant, labor, groundwater sampling of 13 wells for Chlorinated VOCs and equipment: $26,000

Refer to Figure 8 for locations.

Item No. 2: Institutional Controls

Assume Institutional Controls will be maintained through out the duration of the project.
- Institutional controls currently in place (i.e., subsurface work permit, confined space permit) will be continued.
- New institutional controls for project specifics (i.e., Hazwoper training for employees that might encountered contaminated groundwater, yearly refesher course) would be implemented.

Assume a cost of $5000 per year to maintain current and implement new institutional controls

Item No. 3: Groundwater Monitoring

Assume monitoring on a quarterly basis (i.e., four times per year) for years 1 and 2; and annually for years 3 through 30.

Assume includes well redevelopment (purge 3 - 5 well volumes) and sampling of 8 existing on-site monitoring wells (see Figure 8). Also, assume water level measurements performed in site wells.

Estimated cost of each sampling effort includes field labor, equipment, analysis and expenses: $5,200

Estimated cost of analytical testing includes:
- Laboratory Analysis of 8 groundwater samples plus QA/QC samples (1 duplicate, 2 MS/MSDs, 1 rinsate blank, 1 trip blank) for CVOCs.
- Validation of the laboratory data.
- Estimated cost: $1,700.

Assume preparation of a brief data summary report. Estimated cost for report preparation and time for project coordination: $2,400.

Total Annual Groundwater Monitoring Cost (years 1 - 2) = $37,000/year
Total Annual Groundwater Monitoring Cost (years 3 - 30) = $9,300/year

NOTE:
See backup calculations following this description page.

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ALTERNATIVE 4A
Source Area

Page No. 1/4

Project Delphi Thermal FFS — File No. 55039.2
Location Lockport, New York — Date 9/13/02 — By CZB
Subject Alt. 4A Cost Est. ISCO w/ Groundwater Monitoring — Checked 9/19/02 — By DTROY
Based on — Revised 11-24-03 — By CZB

In-Situ Chemical Oxidation (ISCO)

Assumes:

- Source Area application of Sodium Permanganate using a step-wise and phased approach following favorable results pilot study.
- Sodium permanganate will be oxidant used to address...

- Carus Chemical (Supplier) would require a Demand Test of a soil and groundwater sample to verify oxidant will be properly selected and have an understanding of Site chemistry. Cost includes collection of groundwater sample, analysis of soil and groundwater samples. Assuming rock core samples already collected from previous well installations to be used. $ 1,000

- Pilot Study would be conducted to gather information on the effectiveness of ISCO at the Site. Assume pilot study would be completed at MW-5. Pilot Study would include injection at MW-5. After the injection, 2 rounds of sampling at MW-5, -4, -8, -9, -10 would be completed for Chlorinated VOCs.
Costs for Pilot Study include:

Sodium Permanganate Material: 4 @ $2,000 (Carus Chem info + Eng. Assump.)
5 Analytical Samples (2 rounds of Sampling: (5 samp x 2 rds) x 100 each = $1,500
Labor for Injection and Sampling: 2 days x 2 man crew x 8 hr x 45/hr. = $2,880 (Eng. Assump.)
(equip., supplies, tech support) Equipment: $ 2,000 (Eng Assump.)

Engineering Costs are included as 15% of Alternative Cost

COST FOR PILOT STUDY: $9,400
includes Demand Test

Project Delphi Thermal FFS File No. 55731
Location Lockport NY Date 11.21.03 By CZB
Subject Alt. 4A Cost Est. Checked 11-21-03 By ERH
Based on Revised By

Source Area Application

Assume:

- Source area application would be completed in existing monitoring wells w/ 2 application events MW-3s, MW-4, MW-5, and MW-7.
- Each well has an approx. Total CVOC concentration of 100 ppm.
- Approx 1,000 lbs of product would be mixed w/ water and injected into each of the 4 wells. Injected solution would be an approx 5% solution therefore approx. 700 gals would be injected. However, application will done in 2 events.

700 gals ÷ 2 applications = 350 gals per well or 1,400 gals per injection event.

Costs:

Material: 1000 lbs per well × 4 wells = 4,000 × 2.96 = $11,840 (Carus)

Labor: Assume 2-person crew could inject 1,800 gal per day for 1 day of injections

Assume 1 day of prep. for 2 man crew

(2 applications)(2 days)(1 2 man crew)($1,500 per day per crew) = $6,000 (SLC)

Sampling: $3000 per event × 2 events = $6,000 (Eng. Assmpt.)

Mob/Demob: $2,000 (Eng Assmpt) $1,000 × 2 events

Cost for 2 injection applications

$26,000

Groundwater Monitoring:

Assumptions and Costs for groundwater monitoring are same as Alternative 2 w/ exception that groundwater sampling will be done quarterly for years 1 and 2 following ISCO and then annually for years 3 to 30

Institutional Controls:

Assumes that Delphi employees will be trained due to possible encounter w/ contaminated groundwater.

Training would include: OSHA Standard 29 CFR 1910.120 Hazwhopper.

8 employees * $500 for training = $4,000

Miscellaneous Items: Signs, paperwork, & others $1,000

$5,000 per year

Assumes no costs for permitting such as confined space, or subsurface work.

CONTINGENCY PLAN:

Groundwater Extraction System: Preventive measures if ISCO does not work effectively and if DNAPL begins to migrate.

Assume: - Groundwater Ext. System will be installed approx 100' downgradient of eastern portion of ISCO injection area. See Figure 7 for approx. locations

- Six (6) extraction wells will be installed as described in Alt. 3.

- Geophysical study would need to be completed prior to the well location selection.

- Pump test to be completed as stated in Alt. 3B.

- Extraction System Treatability Study will be completed

- Treatment System similar to Alt. 3 but will be able to remove + handle DNAPL

Assumed Costs:

(PILOT STUDY)
- Geophysical Study: $10,000 (Eng. Assumption) ✓
- 48 hr Pump Test: $28,100 (See Alt. 3B) ✓

5 Additional extraction wells at $13,500 each = $67,500 (See Alt. 3B) ✓

Extraction System Treatability Study = $10,000 (See Alt 3B) ✓

Trenching, Piping, + Backfill for Treatment System = $30,800 (See Alt 3B) ✓

Treatment System w/ Building, Equip., Control Panel, etc = $81,500 (See Alt 3B)

O + M Costs (Same as Alt. 3B) = $32,825

Table C-4B
Cost Estimate Summary
Alternative No.4B: Full-Scale In-Situ Chemical Oxidation
with Groundwater Monitoring
Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Item No.	Description	Capital Costs	Present Worth of O&M Costs
1	Full-Scale In-Situ Chemical Oxidation	$ 655,000	
2	Institutional Controls		$ 77,000
3	Groundwater Monitoring	$ -	$ 195,000
Subtotal		$ 655,000	$ 272,000
Engineering (15%)		$ 98,000	
Contingency/Administration (10%)		$ 66,000	
TOTAL		$ 819,000	$ 272,000

Net Present Worth

Capital Costs	$ 819,000
Present Worth of Annual O&M Costs	$ 272,000
TOTAL NET PRESENT WORTH =	$ 1,091,000

Notes:

1.) Refer to the attached pages for descriptions of the cost estimate assumptions.
2.) Present Worth of O&M costs were calculated for a 30-year duration using a 5% discount rate (i.e., interest rate = 9%, inflation rate = 4%).
3.) Total costs are rounded to the nearest $1,000.
4.) The above estimate provides the cost estimate for the conceptual design presented in the Figures 9 and 10.
5.) The above cost estimate does not include costs for groundwater extraction and treatment contingency plan. Costs associated with contingency plan will be on the order of cost estimate described in Alternative No. 3B.

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Cost Estimate Assumptions
Alternative 4B: Full-Scale In-Situ Chemical Oxidation with Monitored Natural Attenuation

Focused Feasibility Study
Delphi Harrison Thermal Systems
West Lockport Complex
Lockport, New York

Item No. 1: Full-Scale In-Situ Chemical Oxidation

In-Situ Chemical Oxidation (Sodium Permanganate) technology would be applied via a step-wise approach:
First a pilot study would be performed, then if the pilot study yields favorable results, perform full-scale application.
Assume full-scale application for purposes of cost estimate.

Assumes a Pilot Study (1 injection event in 9 injection wells) will be conducted to asses the feasibility of In-Situ Chemical Oxidation process. Pilot study will be in vicinity of MW-5.
- Injection well installation costs are included.
- Assumes 5 groundwater monitoring wells with in the vicinity of MW-5 will be sampled twice, once immediately following injection and again after one month.
- Assumes five days to inject oxidant for pilot study.
Total cost for Pilot Study: $23,000

Assumes an additional 168, 2-inch diameter PVC injection wells will be installed: $139,000

Assumes a phase approach for injections will be utilized. Total cost for 2 injection events, including oxidant, labor, groundwater sampling of 13 wells for Target VOCs and equipment: $488,000

Refer to Figure 7 and 8 for location of injection wells.

Item No. 2: Institutional Controls

Assume Institutional Controls will be maintained through out the duration of the project.
- Institutional controls currently in place (i.e., subsurface work permit, confined space permit) will be continued.
- New institutional controls for project specifics (i.e., Hazwoper training for employees that might encountered contaminated groundwater, yearly refesher course) would be implemented.

Assume a cost of $5000 per year to maintain current and implement new institutional controls

Item No. 3: Groundwater Monitoring

Assume monitoring on a quarterly basis (i.e., four times per year) for years 1 and 2; and annually for years 3 through 30.

Assume includes well redevelopment (purge 3 - 5 well volumes) and sampling of 8 existing on-site monitoring wells (see Figure 8). Also, assume water level measurements performed in site wells.

Estimated cost of each sampling effort includes field labor, equipment, and expenses: $5,200

Estimated cost of analytical testing includes:
- Laboratory Analysis of 8 groundwater samples plus QA/QC samples (1 duplicate, 2 MS/MSDs, 1 rinsate blank, 1 trip blank) for CVOCs.
- Validation of the laboratory data.
- Estimated cost: $1,700.

Assume preparation of a brief data summary report. Estimated cost for report preparation and time for project coordination: $2,400.

Total Annual Groundwater Monitoring Cost (years 1 - 2) = $37,000/year
Total Annual Groundwater Monitoring Cost (years 3 - 30) = $9,300/year

NOTE:
See backup calculations following this description page.

GZA GeoEnvironmental of New York

In-Situ Chemical Oxidation (ISCO)

Assumes:

- Full scale application of Sodium Permanganate using a step-wise and phased approach following favorable results pilot study.
- Sodium permanganate will be oxidant used to address Total VOC concentrations > 100 ppm. Area assumed for injections is ~ 48750 sq ft.
- Injections would be completed on grid system on w/ injection wells completed approx 30' apart, using an air rotary drill rig.
- Carus Chemical (Supplier) would require a Demand Test of a soil and groundwater sample, to verify oxidant will be properly selected and have an understanding of Site chemistry. Cost includes collection of groundwater sample, analysis of soil and groundwater samples. Assuming rock core sample already collected from previous well installations to be used. $ 1,000
- Pilot Study would be conducted to gather information on the effectiveness of ISCO at the Site. Assume pilot study would be completed around MW-5. Pilot Study would include 9 injection points on 30' spacing up gradient of MW-5. After injections, 2 rounds of sampling at MW-5, -4, -8, -9, -10 would be completed for Target VOCs.

Costs for Pilot Study include:

9 injection wells Installed w/ oversight: $ 9,000 (Earth Dimension Est. + Eng. Assumption)
Sodium Permanganate Material: $ 5,000 (Carus Chem info + Eng. Assumption)
5 Analytical Samples (2 rounds of Sampling: (5 samp x 2 rds) x 100 each = $1,000
Labor for Injection and Sampling: 5 days x 2 man crew * 8 hrs x 45/hr. = $3,600 (Eng. Assumption)
(equip., supplies, tech support) Equipment: $ 4,000 (Eng Assumption)

Injection points will consist of air rotary borings w/ 2" ϕ PVC piping w/ a 10' screen section. One crew will complete boring and second crew will install injection wells.

- Additional monitoring well would be installed in injection area, approx. ½ distance from MW-5 to former location of MW-2.

* Engineering Costs are included as 15% of Alternative cost.

Total For Pilot Study NY: $24,000

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ALT 4B

Project: Delphi Thermal FFS — File No. 55039.2
Location: Lockport New York — Date: 9/13/02 — By: CZB
Subject: Alt. 4 Cost Est ISCO w/ Groundwater Mon. — Checked: 9/19/02 — By: D. TROY
Based on — Revised — By

Assumes:

- Full Scale Injection would be completed in area shown on Figure 7. Based on assumption of 30' spacing for injection points. Approx 177 injection points would be needed for area coverage. Injection points will be completed to a depth of 15 to 25' bgs pending proximity to AOC w/ average depth considered to be ~20' bgs.

- Phased Approach would be used for injection process. Based on conversations w/ Carus Chemical and calculation spreadsheets provide by Carus Chemical, the volumes and quantities for the injections were determined. The following are some of assumptions that used to determine injection quantities.

  Area: 49,500 sq. ft
  Thickness of contaminant area: 15' } Site Specific Info.
  Porosity: 20%
  Contaminant Conc.: 300 ppm
  Cost of oxidant: $2.96 } Carus Chemical determinations
  SWAG Factor for uncertainties: 5
  5% injection solution (product to water)

- Two sample rounds would be conducted between injection phases. One immediately following injections, second sample round one month later. All site wells would be sampled (13 wells) for VOCs only

- Based on above mentioned assumes ~ 129,500 lbs of product will be needed. The solution would have a volume of 90,700 gals. at 5%.
  90,700 gal ÷ 177 inj. wells = 512 gal ÷ 2 inj. events = ~ 260 gals per inj. well per event.

- Assume no cost for water

- Assume two, 2-person crews would inject 3,600 gal per day or 13 pts per day. 15 field days would be needed. (2 extra days were added for problems)

- Cost for installation of additional 168 injection wells: 825 each * 168 = 138,600 ✓
  Approx. 75 drums will be generated for cuttings 75 x $60 = $4,500 (Earth Dim)

Rnd 1 Inj. costs: Chemical: $191,500 (½ of total cost based on Carus Chem. spreadsheet)
Labor + Equip: 15 days x 2 crews x 1,500 per crew = $45,000 ($6K estimate) ✓
Sampling: $3,000 per event * 2 = $6,000 (Eng Assumpt) ✓
Well Demob: $1,000 (Eng Assumpt)

Assume 5 gal/min pumping rate.
5 gal/min x 60 min/hr x 6 pump hr/day = 1,800 gal/day x 2 crews = 3,600 gal/day
Assume approx 15 days for one injection event.

Cost For Rd 1 ≈ $244,000 * 2 rds. = $488,000

Groundwater Monitoring

Assumptions and Costs for groundwater sampling are the same as Alternative 2 w/ exception that groundwater sampling will be done quarterly for years 1 and 2 following ISCO and the annually for years 3 to RD

Institutional Controls:

Assumes that Delphi employees will be trained due to possible encounter w/ contaminated groundwater.

Training would include: OSHA Standard 29 CFR 1910.120 HAZWHOPER.

8 employees * $500 for training = $4,000

Miscellaneous Items: Signs, paperwork, & others $1,000

$5,000 per year

Assumes no costs for permitting such as confined space, or subsurface work.

CONTINGENCY PLAN:

Groundwater Extraction System: Preventive measures if ISCO does not work effectively and if DNAPL begins to migrate.

Assume: - Groundwater Ext. System will be installed approx 100' downgradient of eastern portion of ISCO injection area. See Figure 7 for approx. locations

- Six (6) extraction wells will be installed as described in Alt. 3.

- Geophysical study would need to be completed prior to the well location selection.

- Pump test to be completed as stated in Alt. 3B

- Extraction System Treatability Study will be completed

- Treatment System similar to Alt. 3B but will be able to remove + handle DNAPL

Assumed Costs:

PILOT STUDY

Geophysical Study: $10,000 (Eng. Assumption) ✓

48 hr Pump Test: $28,100 (See Alt. 3B) ✓

5 Additional extraction wells at $13,500 each = $67,500 (See Alt. 3B) ✓

Extraction System Treatability Study = $10,000 (See Alt 3B) ✓

Trenching, Piping, + Backfill for Treatment System = $30,800 (See Alt 3B) ✓

Treatment System w/ Building, Equip., Control Panel, etc = $81,500 (See Alt. 3B)

O + M Costs (Same as Alt. 3) = $32,825

APPENDIX D

BIOCHLOR AND BIOSCREEN MODELS

METHODS

GZA's evaluation for the Delphi Thermal Site included computer modeling using the computer code BIOCHLOR – Natural Attenuation Decision Support System (BIOCHLOR, Version 1.1) and BIOSCREEN – Natural Attenuation Decision Support System (BIOSCREEN, Version 1.4). The purpose of this modeling was two fold:

- Use BIOCHLOR to assess the relative stability of the contaminant plume (*i.e.,* assess whether the plume has reached steady state conditions, or is expected to advance or retreat from its current position); and
- Use BIOSCREEN to estimate time to closure assuming the presence of a contaminant source and two remedial scenarios: 1) An engineered remedial approach achieving 50% removal of contaminant mass, which conservatively assumes a successful remedial program; and 2) A monitored natural attenuation (MNA) approach, which assumes no engineered removal of contaminant mass.

Both computer codes, which were developed by Groundwater Services, Inc. of Houston, Texas for the United States Air Force Center for Environmental Excellence, are analytical computer models that operate in the Microsoft Excel® environment. The models are based on the Domenico analytical solute transport model, and have the ability to simulate advection, dispersion, adsorption, and biological transformation. Requisite model input parameters include the following:

- Hydrogeology;
- Dispersion;
- Adsorption;
- First order decay coefficients;
- Plume morphology;
- Simulation time;
- Source data (BIOSCREEN only); and
- Field contaminant concentration data.

Please note that first order decay rates for chlorinated aliphatic hydrocarbons (CAHs) were calculated based on analytical data for groundwater samples collected from certain monitoring wells generally located along the plume centerline (see attached Figures). The time axis is based on travel time for the CAH plume between monitoring locations assuming a seepage velocity of about 200 feet/year. The y-axis represents the normalized decrease for each CAH at each downgradient monitoring location. The slopes of the best-fit lines for each CAH were the decay rates used for the modeling work.

RESULTS

BIOCHLOR RUNS

GZA ran the model using simulation time steps of 1, 10, and 100 years for tetrachloroethene (PCE), trichloroethene (TCE), total 1,2-dichlorothenes (1,2-DCEs), and vinyl chloride (VC),

assuming a 1,000-foot modeled area length. The output plots for the 1-year time step run showed the plume advancing less than about 500 feet; however, both the 10- and 100-year time steps runs showed the plume advancing beyond 1,000 feet. Therefore, GZA increased the modeled area length from 1,000 to 2,000 feet and re-ran the model for the 10- and 100-year time steps. The 10-year time step run showed the plume advancing up to about 1,500 feet, whereas the 100-year time step run showed the plume advancing up to about 2,000 feet. Modeling results suggests that the CAH plume will continue to advance, with PCE generally at the leading edge followed by VC, 1,2-DCEs, and TCE.

GZA performed a sensitivity analysis by varying one selected model input parameter. (refer to the BIOCHLOR Sensitive Analyses Input Data/Output Plots for additional information). GZA's sensitivity analysis consisted of varying the fraction of organic carbon (foc) for the 10-year time step because, in our experience, foc can vary widely. The input parameters and output results for the two foc sensitivity analyses are included herein. Foc was varied by one order of magnitude above and below the model input value data (0.001). Results of these sensitivity runs were that foc does not effect first order kinetics, but it effects the migration pattern of the CAH plume. With a smaller foc value (0.0001), no significant change in plume migration patterns is apparent, in comparison to the original model. Conversely, with a larger foc value (0.01), the velocity at which the plume travels decreases. In effect, the plume length is decreased by about 1,000 feet. These results are consistent with the fact that formation matrices with larger foc values tend to adsorb more CAHs than matrices with smaller values.

BIOSCREEN RUNS

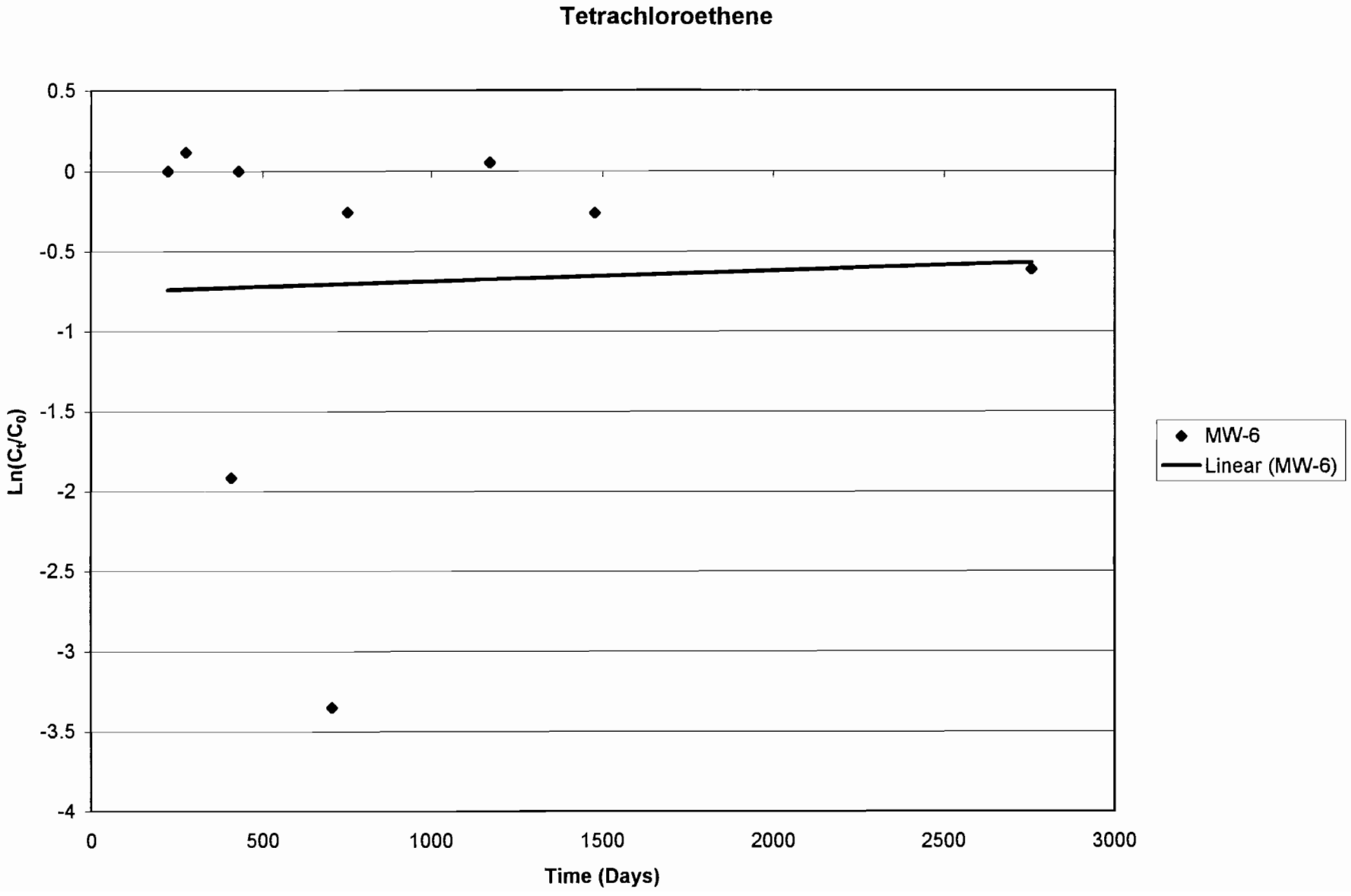
GZA ran the model using simulation time steps of 1, 10, 25, 50, 100, and 1,000 years for the following two remedial approaches, assuming the CAH with the highest detected concentration (TCE):

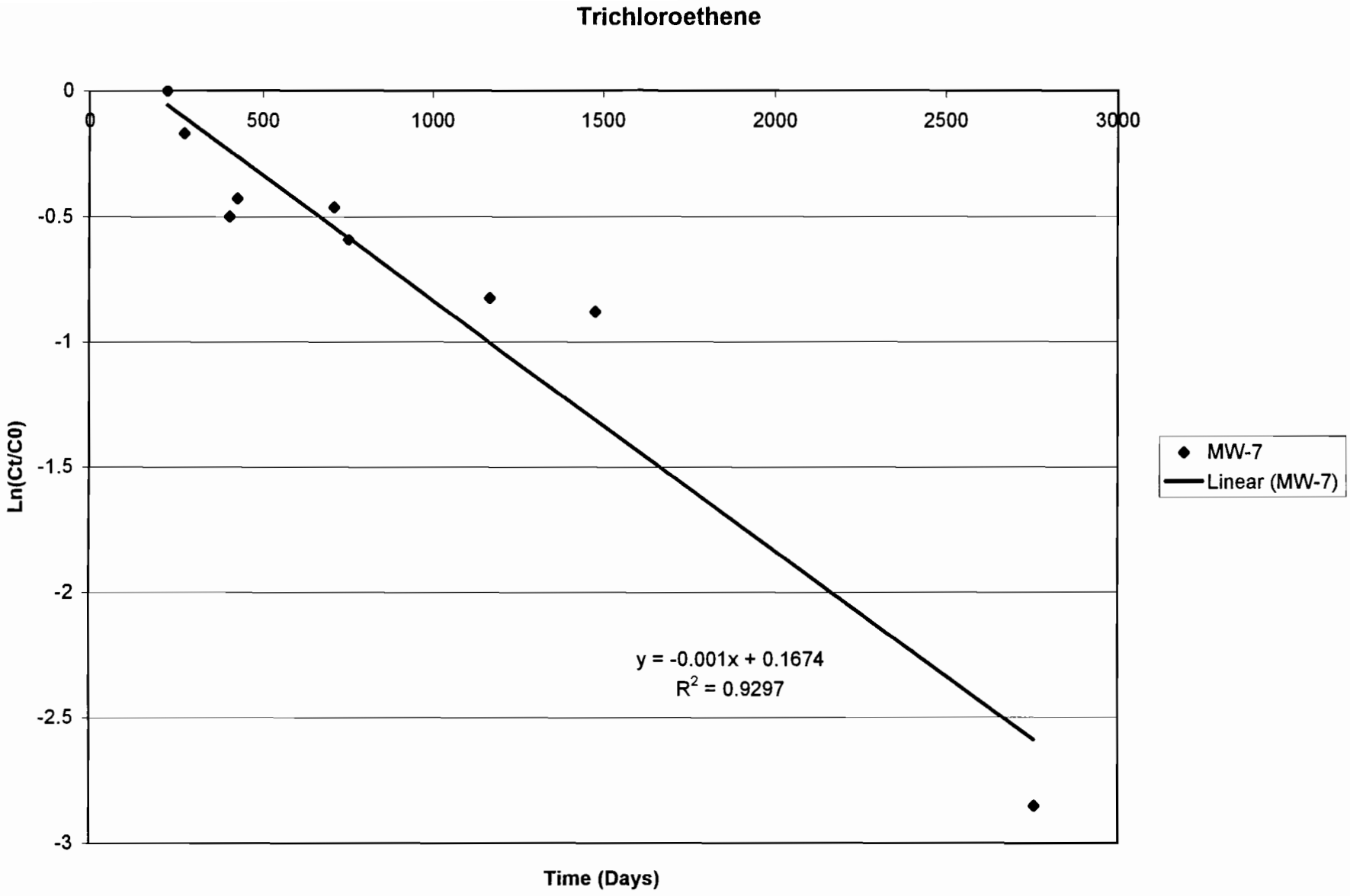
- A generally successful engineered remedial approach (*i.e.,* achieving 50% removal of contaminant mass); and
- An MNA approach, with no engineered source removal (*i.e.,*, 0% engineered removal of contaminant mass).

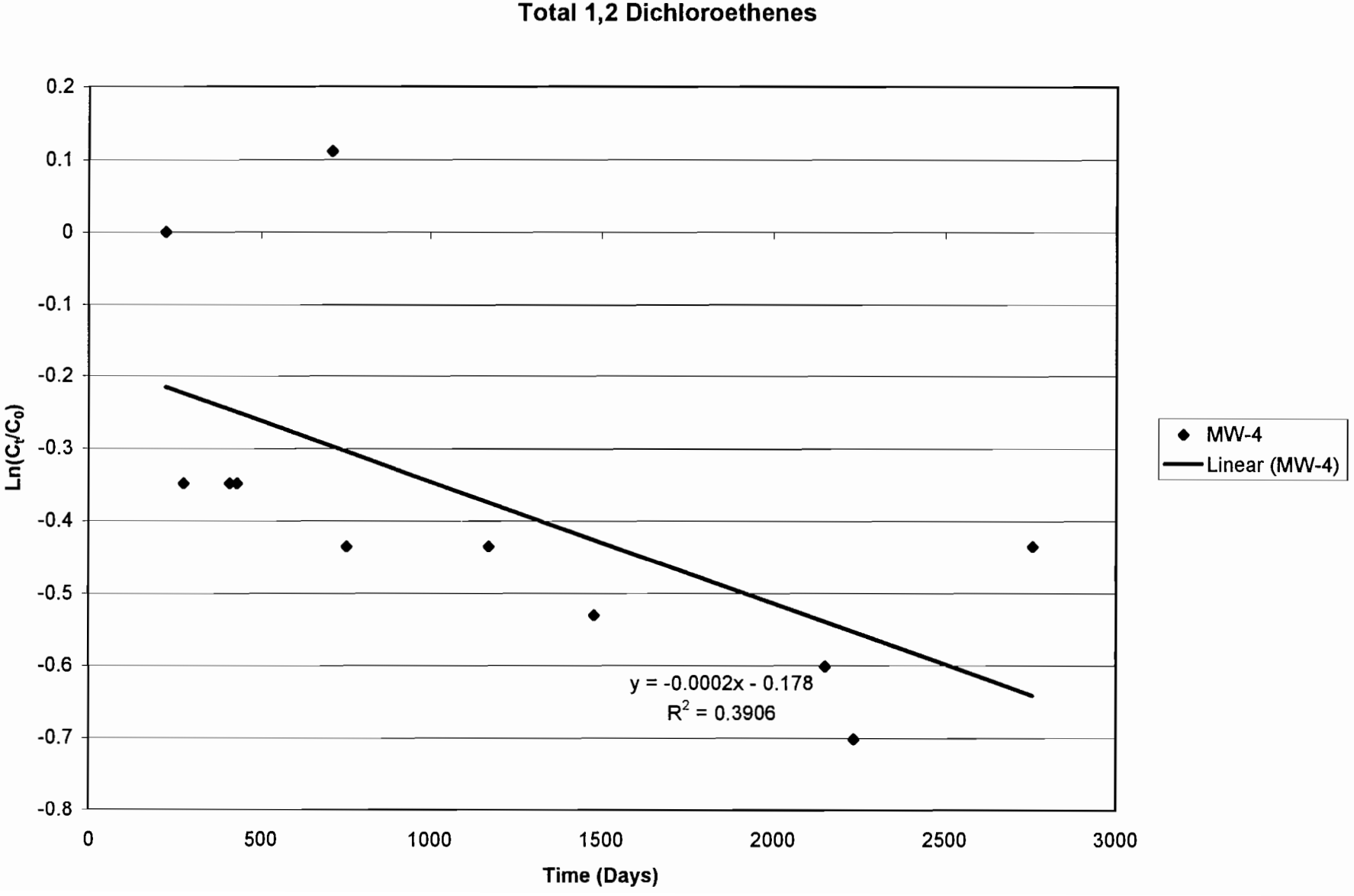
The output plots for both the MNA and engineered remedial approach were similar. Both scenarios show the plume advancing over about 1,500 feet for the 50-year time step, but not beyond that time step, suggesting that an engineered approach of source removal would not be a necessary remedial action and that both remedial options may achieve closure in about 50-years.

GZA performed a sensitivity analysis by varying one selected model input parameter. (refer to the BIOCHLOR Sensitive Analyses Input Data/Output Plots for additional information). GZA's sensitivity analysis consisted of varying the fraction of organic carbon (foc) for the 10-year time step (assuming engineered remediation achieving a 50% removal of TCE mass) because, in our experience, foc can vary widely. The input parameters and output results for the two foc sensitivity analyses are included herein. Foc was varied by one order of magnitude above and below the model input value data (0.001). Results of these sensitivity runs were that foc effects the migration pattern of the CAH plume. With a smaller foc value (0.0001), the 10-year time step shows the plume advancing over about 1,200 feet. Conversely, with a larger foc

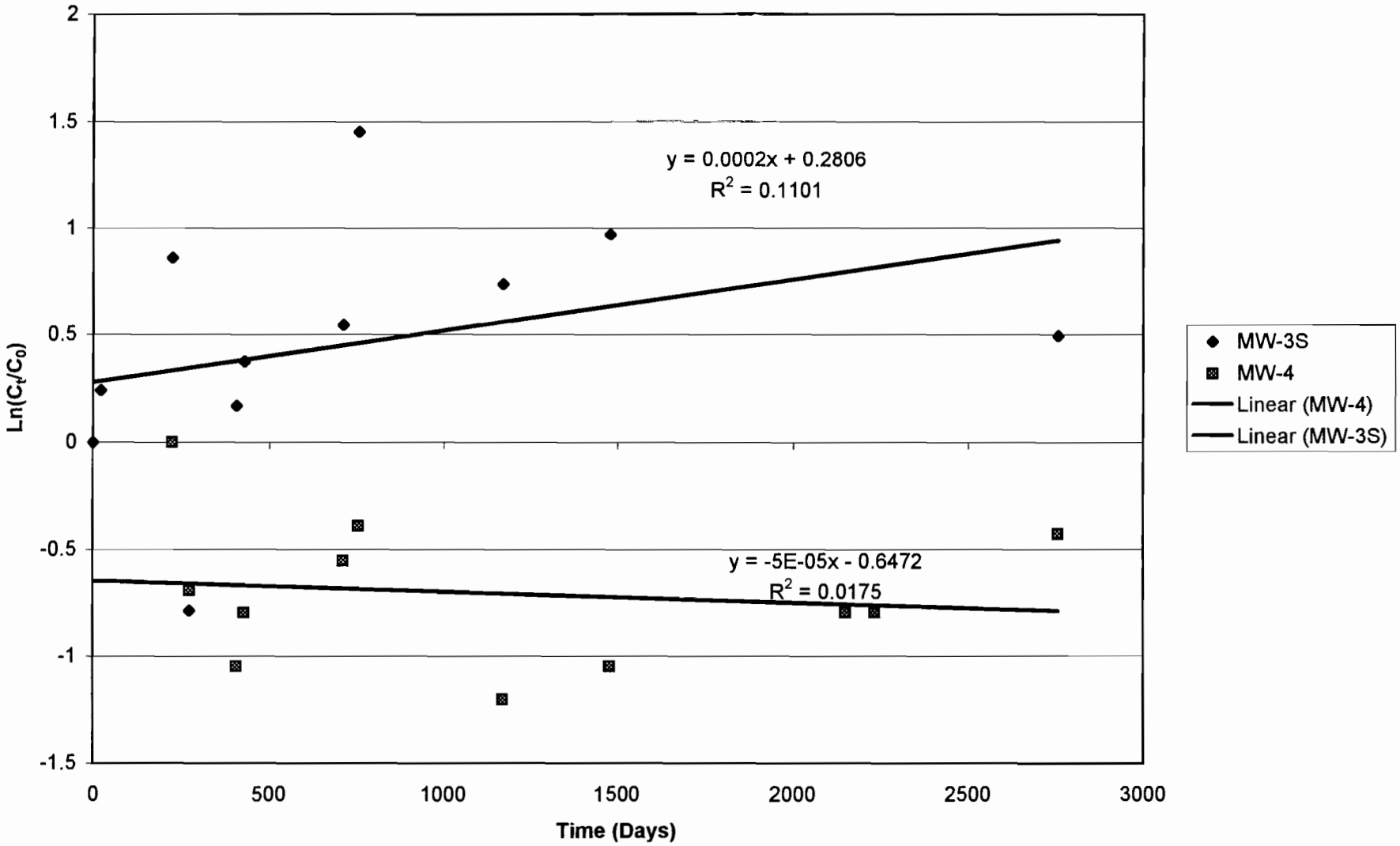
value (0.01), the velocity at which the plume travels decreases. In effect, the plume length is decreased by about 300 feet. These results are consistent with the fact that formation matrices with larger foc values tend to adsorb more CAHs than matrices with smaller values.


Tetrachloroethene
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
-4
Ln(Ct/C0)
0
500
1000
1500
2000
2500
3000
Time (Days)
MW-6
Linear (MW-6)


Trichloroethene
0
-0.5
-1
-1.5
-2
-2.5
-3
0
500
1000
1500
2000
2500
3000
Ln(Ct/C0)
Time (Days)
y = -0.001x + 0.1674
R2 = 0.9297
MW-7
Linear (MW-7)


Total 1,2 Dichloroethenes
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.5
-0.6
-0.7
-0.8
Ln(Ct/C0)
0
500
1000
1500
2000
2500
3000
Time (Days)
y = -0.0002x - 0.178
R2 = 0.3906
MW-4
Linear (MW-4)

Vinyl Chloride



BIOCHLOR RUNS
INPUT/OUTPUT PLOTS

1-Year Time Step

BIOCHLOR Natural Attenuation Decision Support System

Version 1.1
for Excel 7.0/ '95

Delphi Thermal System
Lockport, NY
Run Name

Data Input Instructions:

115
or
0.02

1. Enter value directly....or
2. Calculate by filling in gray cells. Press Enter, then C

(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x Calc. Method	100	(ft)
(Alpha y) / (Alpha x)	10	(-)
(Alpha z) / (Alpha x)	5.E+00	(-)

Change Alpha x Calc. Method

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho		2.25	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.8	(-)
TCE	130	(L/kg)	2.5	(-)
DCE	125	(L/kg)	2.4	(-)
VC	30	(L/kg)	1.3	(-)
ETH	302	(L/kg)	4.4	(-)
Common R (used in model)* =			**2.5**	

4. BIOTRANSFORMATION

	-1st Order Decay Coef* λ (1/yr)	half-life (yrs)	Yield*
Zone 1			
PCE → TCE	0.37		0.79
TCE → DCE	2.91		0.74
DCE → VC	1.67		0.64
VC → ETH	1.47		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.00		
TCE → DCE	0.00		
DCE → VC	0.00		
VC → ETH	0.00		
ETH → Ethane	0.00		

5. GENERAL

Simulation Time*	1	(yr)
Modeled Area Width*	500	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

Zone 2= L - Zone 1

6. SOURCE DATA

Source Options

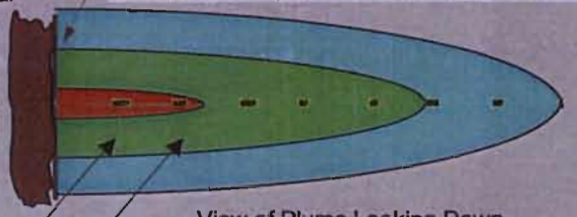
TYPE: Single Planar

Source Thickness in Sat. Zone* 20 (ft)

Width* (ft) 150

Conc. (mg/L)*	C1
PCE	64.0
TCE	75.0
DCE	45.0
VC	3.0
ETH	

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

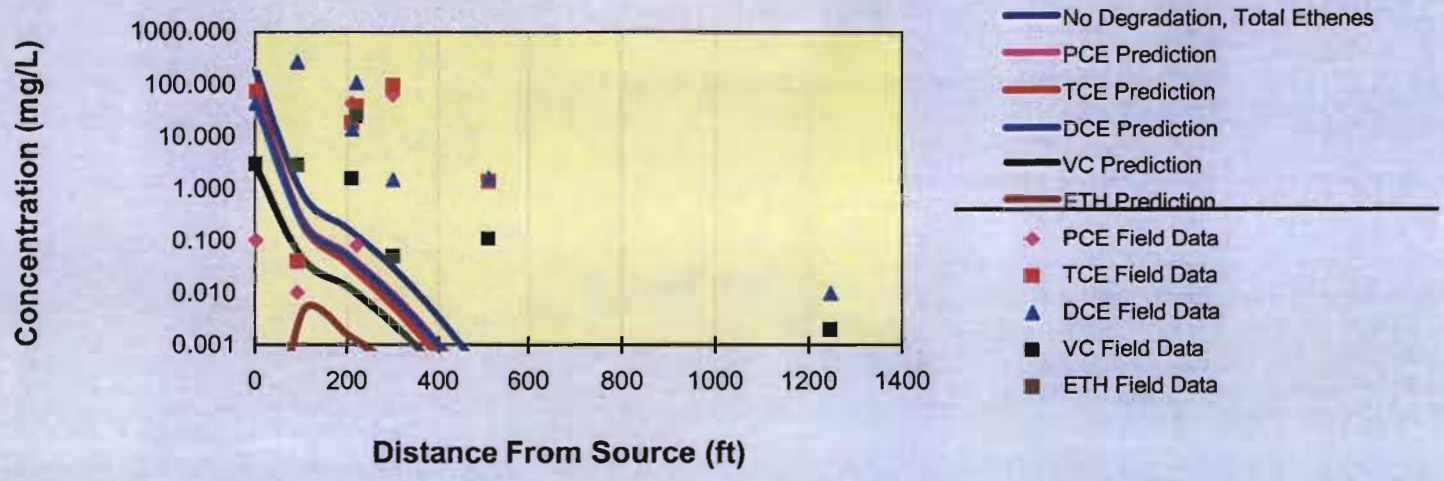
7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.1	.01	44.0	.08	64.0						
TCE Conc. (mg/L)	75.0	.04	19.0	39.0	96.0	1.4	.25				
DCE Conc. (mg/L)	45.0	270.0	14.0	110.0	1.5	1.6	.473	.01			
VC Conc. (mg/L)	3.0	2.9	1.6	26.0	.05	.11	.053	.002			
ETH Conc. (mg/L)											
Dist. from Source (ft)	0	90	210	220	300	510	650	1245			

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE



Log ⟺ Linear

Time:

1 Years

To Input

To Individual Compounds

10-Year Time Step

BIOCHLOR Natural Attenuation Decision Support System

Version 1.1
for Excel 7.0/ '95

Delphi Thermal System
Lockport, NY
Run Name

Data Input Instructions:

115 or 0.02

1. Enter value directly....or
2. Calculate by filling in gray cells. Press Enter, then C

(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x Calc. Method	100	(ft)
(Alpha y) / (Alpha x)	10	(-)
(Alpha z) / (Alpha x)	5.E+00	(-)

Change Alpha x Calc. Method

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	2.25	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.8	(-)
TCE	130	(L/kg)	2.5	(-)
DCE	125	(L/kg)	2.4	(-)
VC	30	(L/kg)	1.3	(-)
ETH	302	(L/kg)	4.4	(-)
Common R (used in model)* =			2.5	

4. BIOTRANSFORMATION

Zone 1	λ (1/yr)	half-life (yrs)	Yield*
PCE → TCE	0.37		0.79
TCE → DCE	2.91		0.74
DCE → VC	1.67		0.64
VC → ETH	1.47		0.45

Zone 2	λ (1/yr)	half-life (yrs)
PCE → TCE	0.00	
TCE → DCE	0.00	
DCE → VC	0.00	
VC → ETH	0.00	
ETH → Ethane	0.00	

5. GENERAL

Simulation Time*	10	(yr)
Modeled Area Width*	500	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

Zone 2= L - Zone 1

6. SOURCE DATA

Source Options

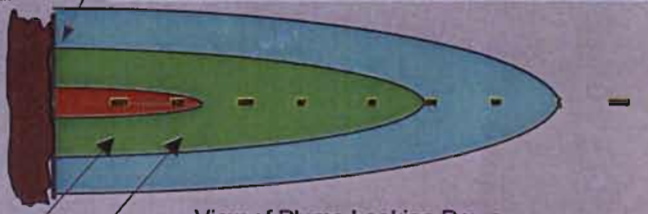
TYPE: Single Planar

Source Thickness in Sat. Zone* 20 (ft)

Width* (ft) 150

Conc. (mg/L)*	C1
PCE	64.0
TCE	75.0
DCE	45.0
VC	3.0
ETH	

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

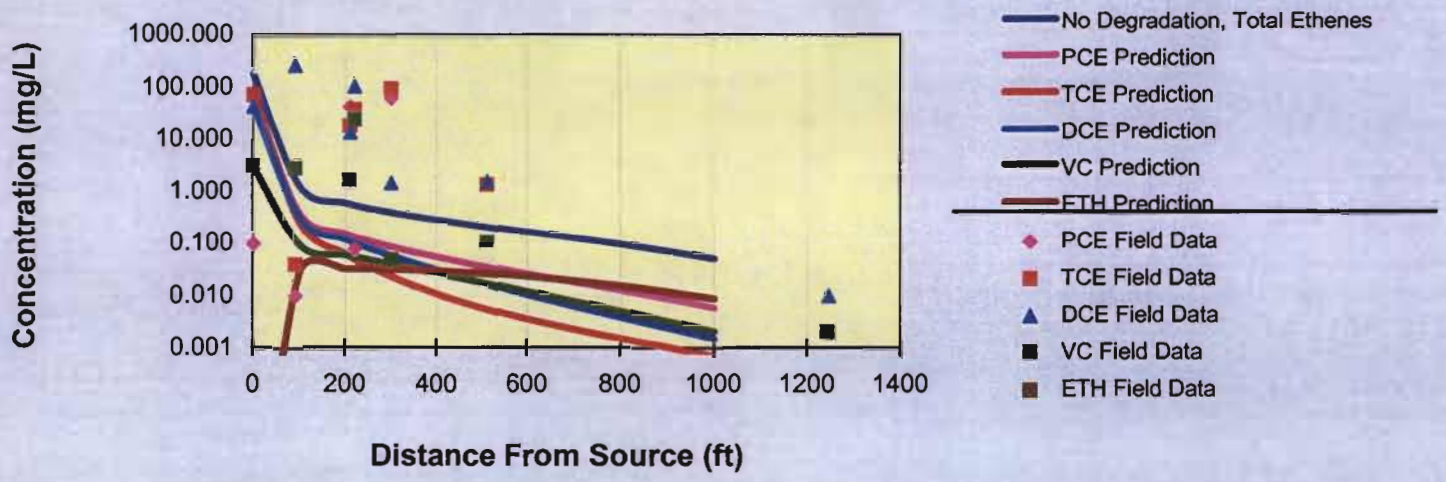
7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.1	.01	44.0	.08	64.0						
TCE Conc. (mg/L)	75.0	.04	19.0	39.0	96.0	1.4	.25				
DCE Conc. (mg/L)	45.0	270.0	14.0	110.0	1.5	1.6	.473	.01			
VC Conc. (mg/L)	3.0	2.9	1.6	26.0	.05	.11	.053	.002			
ETH Conc. (mg/L)											
Dist. from Source (ft)	0	90	210	220	300	510	650	1245			

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE



Log ⟺ Linear

Time:

10 Years

To Input

To Individual Compounds

10-Year Time Step
2,000-Foot Modeled Length

BIOCHLOR Natural Attenuation Decision Support System

Version 1.1
for Excel 7.0/ '95

Delphi Thermal Systems
Lockport, NY
Run Name

Data Input Instructions:

115 ← 1. Enter value directly....or
or
0.02 2. Calculate by filling in gray cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ● Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x Calc. Method	100	(ft)	Change Alpha x Calc. Method
(Alpha y) / (Alpha x)	10	(-)	
(Alpha z) / (Alpha x)	5.E+00	(-)	

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	2.25	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.8	(-)
TCE	130	(L/kg)	2.5	(-)
DCE	125	(L/kg)	2.4	(-)
VC	30	(L/kg)	1.3	(-)
ETH	302	(L/kg)	4.4	(-)
Common R (used in model)* =			2.5	

4. BIOTRANSFORMATION

Zone 1	λ (1/yr)	-1st Order Decay Coef*	half-life (yrs)	Yield*
PCE → TCE	0.37	←		0.79
TCE → DCE	2.91	←		0.74
DCE → VC	1.67	←		0.64
VC → ETH	1.47	←		0.45

Zone 2	λ (1/yr)		half-life (yrs)
PCE → TCE	0.00	←	
TCE → DCE	0.00	←	
DCE → VC	0.00	←	
VC → ETH	0.00	←	
ETH → Ethane	0.00	←	

5. GENERAL

Simulation Time*	10	(yr)	
Modeled Area Width*	500	(ft)	W
Modeled Area Length*	2000	(ft)	L
Zone 1 Length*	2000	(ft)	
Zone 2 Length*	0	(ft)	Zone 2= L - Zone 1

6. SOURCE DATA

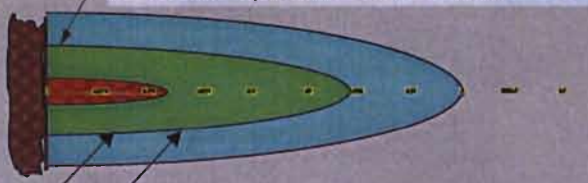
Source Options — TYPE: Single Planar

Source Thickness in Sat. Zone* 20 (ft)

Width* (ft) 150

Conc. (mg/L)*	C1
PCE	64.0
TCE	75.0
DCE	45.0
VC	3.0
ETH	

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

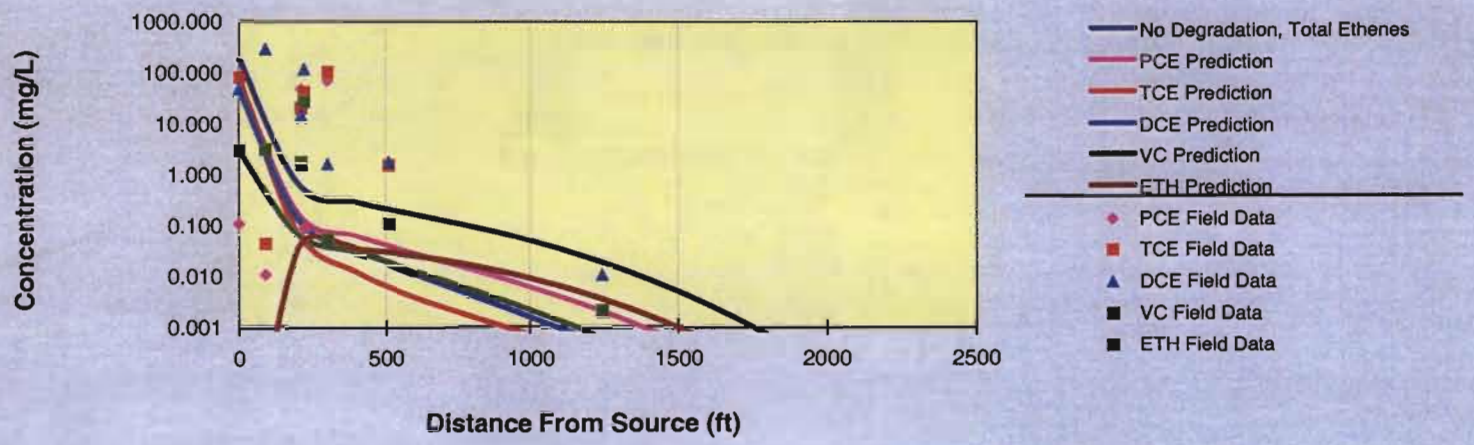
7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.1	.01	44.0	.08	64.0						
TCE Conc. (mg/L)	75.0	.04	19.0	39.0	96.0	1.4	.25				
DCE Conc. (mg/L)	45.0	270.0	14.0	110.0	1.5	1.6	.473	.01			
VC Conc. (mg/L)	3.0	2.9	1.6	26.0	.05	.11	.053	.002			
ETH Conc. (mg/L)											
Dist. from Source (ft)	0	90	210	220	300	510	650	1245			

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example Dataset

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE



Log ⟺ Linear

Time:

10 Years

To Input

To Individual Compounds

100-Year Time Step

BIOCHLOR Natural Attenuation Decision Support System

Version 1.1
for Excel 7.0/ '95

Delphi Thermal System
Lockport, NY
Run Name

Data Input Instructions:

115
or
0.02

1. Enter value directly....or
2. Calculate by filling in gray cells. Press Enter, then C

(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ◉ Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	I	0.0012	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x Calc. Method	100	(ft)
(Alpha y) / (Alpha x)	10	(-)
(Alpha z) / (Alpha x)	5.E+00	(-)

Change Alpha x Calc. Method

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho		2.25	(kg/L)	
FractionOrganicCarbon, foc		1.0E-3	(-)	
Partition Coefficient	Koc			
PCE	426	(L/kg)	5.8	(-)
TCE	130	(L/kg)	2.5	(-)
DCE	125	(L/kg)	2.4	(-)
VC	30	(L/kg)	1.3	(-)
ETH	302	(L/kg)	4.4	(-)
Common R (used in model)* =			**2.5**	

4. BIOTRANSFORMATION -1st Order Decay Coef*

	λ (1/yr)	half-life (yrs)	Yield*
Zone 1			
PCE → TCE	0.37		0.79
TCE → DCE	2.91		0.74
DCE → VC	1.67		0.64
VC → ETH	1.47		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.00		
TCE → DCE	0.00		
DCE → VC	0.00		
VC → ETH	0.00		
ETH → Ethane	0.00		

5. GENERAL

Simulation Time*	100	(yr)
Modeled Area Width*	500	(ft)
Modeled Area Length*	1000	(ft)
Zone 1 Length*	1000	(ft)
Zone 2 Length*	0	(ft)

Zone 2= L - Zone 1

6. SOURCE DATA

Source Options

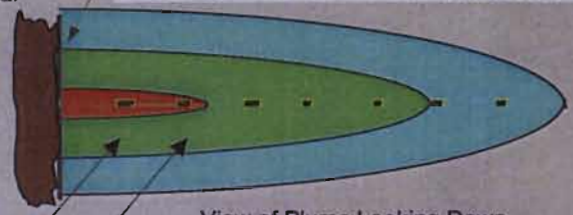
TYPE: Single Planar

Source Thickness in Sat. Zone* 20 (ft)

Width* (ft) 150

Conc. (mg/L)*	C1
PCE	64.0
TCE	75.0
DCE	45.0
VC	3.0
ETH	

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

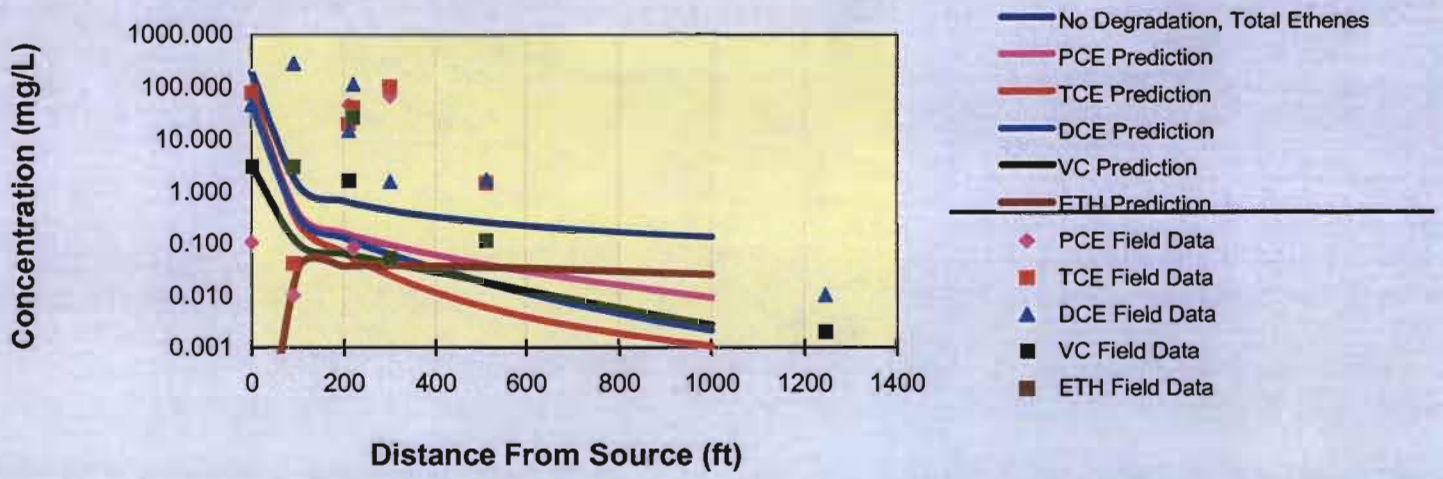
7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.1	.01	44.0	.08	64.0						
TCE Conc. (mg/L)	75.0	.04	19.0	39.0	96.0	1.4	.25				
DCE Conc. (mg/L)	45.0	270.0	14.0	110.0	1.5	1.6	.473	.01			
VC Conc. (mg/L)	3.0	2.9	1.6	26.0	.05	.11	.053	.002			
ETH Conc. (mg/L)											
Dist. from Source (ft)	0	90	210	220	300	510	650	1245			

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE



Log ⟺ Linear

Time:

100 Years

To Input

To Individual Compounds

100-Year Time Step
2,000-Foot Modeled Length

BIOCHLOR Natural Attenuation Decision Support System

Version 1.1
for Excel 7.0/ '95

Delphi Thermal Systems
Lockport, NY
Run Name

Data Input Instructions:

115 ← 1. Enter value directly....or
or
0.02 2. Calculate by filling in gray cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ● Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x Calc. Method	100	(ft)
(Alpha y) / (Alpha x)	10	(-)
(Alpha z) / (Alpha x)	5.E+00	(-)

Change Alpha x Calc. Method

3. ADSORPTION

Retardation Factor* → R
or

	Koc			R
Soil Bulk Density, rho	2.25	(kg/L)		
FractionOrganicCarbon, foc	1.0E-3	(-)		
Partition Coefficient				
PCE	426	(L/kg)		5.8 (-)
TCE	130	(L/kg)		2.5 (-)
DCE	125	(L/kg)		2.4 (-)
VC	30	(L/kg)		1.3 (-)
ETH	302	(L/kg)		4.4 (-)

Common R (used in model)* = 2.5

4. BIOTRANSFORMATION

	-1st Order Decay Coef* λ (1/yr)	half-life (yrs)	Yield*
Zone 1			
PCE → TCE	0.37		0.79
TCE → DCE	2.91		0.74
DCE → VC	1.67		0.64
VC → ETH	1.47		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.00		
TCE → DCE	0.00		
DCE → VC	0.00		
VC → ETH	0.00		
ETH → Ethane	0.00		

5. GENERAL

Simulation Time*	100	(yr)
Modeled Area Width*	500	(ft)
Modeled Area Length*	2000	(ft)
Zone 1 Length*	2000	(ft)
Zone 2 Length*	0	(ft)

Zone 2= L - Zone 1

6. SOURCE DATA

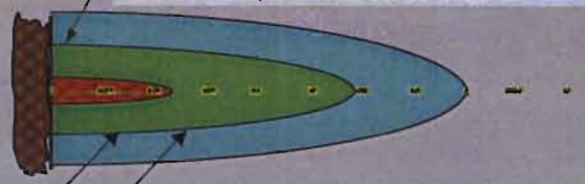
Source Options TYPE: Single Planar

Source Thickness in Sat. Zone* 20 (ft)

Width* (ft) 150

Conc. (mg/L)*	C1
PCE	64.0
TCE	75.0
DCE	45.0
VC	3.0
ETH	

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

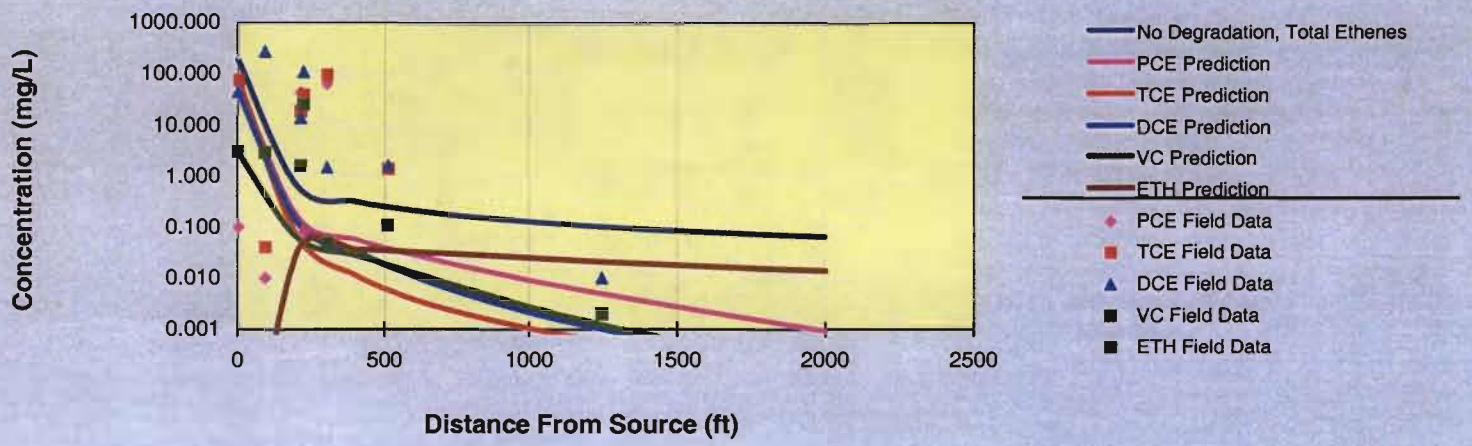
7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.1	.01	44.0	.08	64.0						
TCE Conc. (mg/L)	75.0	.04	19.0	39.0	96.0	1.4	.25				
DCE Conc. (mg/L)	45.0	270.0	14.0	110.0	1.5	1.6	.473	.01			
VC Conc. (mg/L)	3.0	2.9	1.6	26.0	.05	.11	.053	.002			
ETH Conc. (mg/L)											
Dist. from Source (ft)	0	90	210	220	300	510	650	1245			

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example Dataset

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE



Log ⟺ Linear

Time:

100 Years

To Input

To Individual Compounds

BIOCHLOR Sensitivity Runs

BIOCHLOR Natural Attenuation Decision Support System

Version 1.1
for Excel 7.0/ '95

Delphi Thermal Systems
Lockport, NY
Run Name

Data Input Instructions:

115 → 1. Enter value directly....or
0.02 ← 2. Calculate by filling in gray cells. Press Enter, then C

(To restore formulas, hit "Restore Formulas" button)

Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ● Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x Calc. Method	100	(ft)
(Alpha y) / (Alpha x)	10	(-)
(Alpha z) / (Alpha x)	5.E+00	(-)

Change Alpha x Calc. Method

3. ADSORPTION

Retardation Factor* → R

or

Soil Bulk Density, rho	2.25	(kg/L)		
FractionOrganicCarbon, foc	1.0E-4	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	1.5	(-)
TCE	130	(L/kg)	1.1	(-)
DCE	125	(L/kg)	1.1	(-)
VC	30	(L/kg)	1.0	(-)
ETH	302	(L/kg)	1.3	(-)

Common R (used in model)* = 1.1

4. BIOTRANSFORMATION

-1st Order Decay Coef*

		λ (1/yr)	half-life (yrs)	Yield*
Zone 1				
PCE →	TCE	0.37		0.79
TCE →	DCE	2.91		0.74
DCE →	VC	1.67		0.64
VC →	ETH	1.47		0.45
Zone 2		λ (1/yr)	half-life (yrs)	
PCE →	TCE	0.00		
TCE →	DCE	0.00		
DCE →	VC	0.00		
VC →	ETH	0.00		
ETH →	Ethane	0.00		

5. GENERAL

Simulation Time*	10	(yr)
Modeled Area Width*	500	(ft)
Modeled Area Length*	2000	(ft)
Zone 1 Length*	2000	(ft)
Zone 2 Length*	0	(ft)

Zone 2 = L - Zone 1

6. SOURCE DATA

Source Options

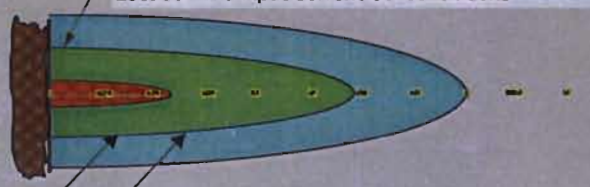
TYPE: Single Planar

Source Thickness in Sat. Zone* 20 (ft)

Width* (ft) 150

Conc. (mg/L)*	C1
PCE	64.0
TCE	75.0
DCE	45.0
VC	3.0
ETH	

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

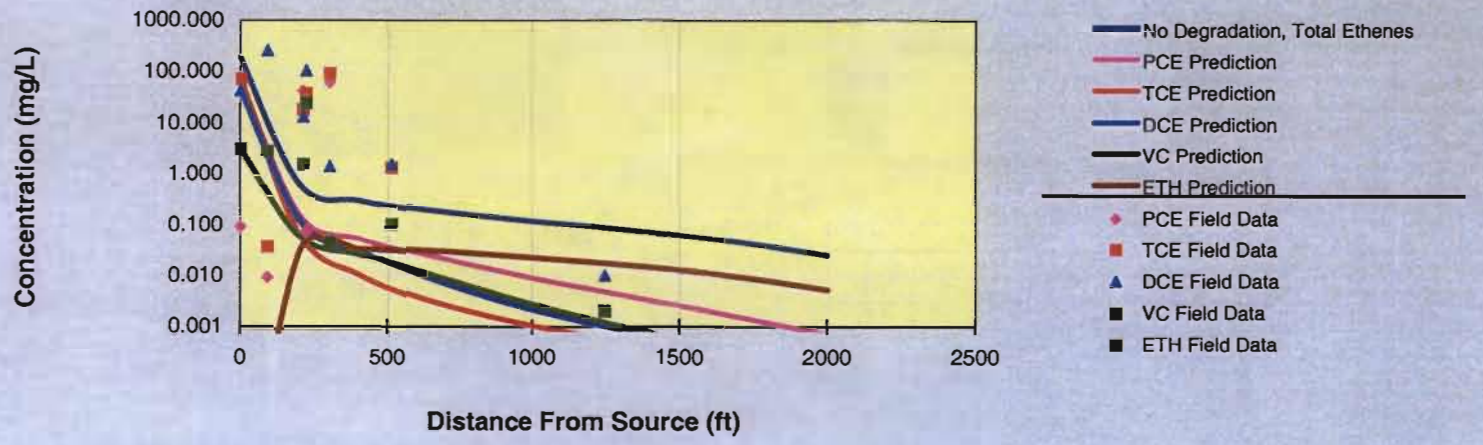
7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.1	.01	44.0	.08	64.0						
TCE Conc. (mg/L)	75.0	.04	19.0	39.0	96.0	1.4	.25				
DCE Conc. (mg/L)	45.0	270.0	14.0	110.0	1.5	1.6	.473	.01			
VC Conc. (mg/L)	3.0	2.9	1.6	26.0	.05	.11	.053	.002			
ETH Conc. (mg/L)											
Dist. from Source (ft)	0	90	210	220	300	510	650	1245			

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example Dataset

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE



Log ⟺ Linear

Time:

10 Years

To Input

To Individual Compounds

BIOCHLOR Natural Attenuation Decision Support System

Version 1.1
for Excel 7.0/ '95

Delphi Thermal Systems
Lockport, NY
Run Name

Data Input Instructions:
115 ← 1. Enter value directly....or
0.02 ← or 2. Calculate by filling in gray cells. Press Enter, then C
(To restore formulas, hit "Restore Formulas" button)
Variable* → Data used directly in model.

Test if Biotransformation is Occurring → Natural Attenuation Screening Protocol

TYPE OF CHLORINATED SOLVENT: Ethenes ● Ethanes ○

1. ADVECTION

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Effective Porosity	n	0.2	(-)

2. DISPERSION

Alpha x Calc. Method	100	(ft)
(Alpha y) / (Alpha x)	10	(-)
(Alpha z) / (Alpha x)	5.E+00	(-)

Change Alpha x Calc. Method

3. ADSORPTION

Retardation Factor* → R
or

Soil Bulk Density, rho	2.25	(kg/L)		
FractionOrganicCarbon, foc	1.0E-2	(-)		
Partition Coefficient	Koc			
PCE	426	(L/kg)	48.9	(-)
TCE	130	(L/kg)	15.6	(-)
DCE	125	(L/kg)	15.1	(-)
VC	30	(L/kg)	4.3	(-)
ETH	302	(L/kg)	35.0	(-)

Common R (used in model)* = 15.6

4. BIOTRANSFORMATION

	λ (1/yr)	half-life (yrs)	Yield*
Zone 1	-1st Order Decay Coef*		
PCE → TCE	0.37		0.79
TCE → DCE	2.91		0.74
DCE → VC	1.67		0.64
VC → ETH	1.47		0.45
Zone 2	λ (1/yr)	half-life (yrs)	
PCE → TCE	0.00		
TCE → DCE	0.00		
DCE → VC	0.00		
VC → ETH	0.00		
ETH → Ethane	0.00		

5. GENERAL

Simulation Time*	10	(yr)
Modeled Area Width*	500	(ft)
Modeled Area Length*	2000	(ft)
Zone 1 Length*	2000	(ft)
Zone 2 Length*	0	(ft)

Zone 2 = L - Zone 1

6. SOURCE DATA

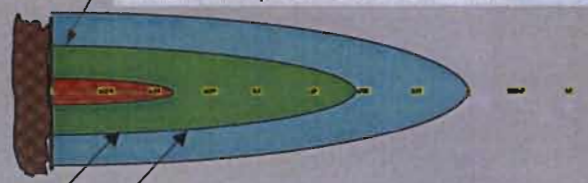
Source Options TYPE: Single Planar

Source Thickness in Sat. Zone* 20 (ft)

Width* (ft) 150

Conc. (mg/L)*	C1
PCE	64.0
TCE	75.0
DCE	45.0
VC	3.0
ETH	

Vertical Plane Source: Determine Source Well Location and Input Solvent Concentrations



View of Plume Looking Down

Observed Centerline Conc. at Monitoring Wells

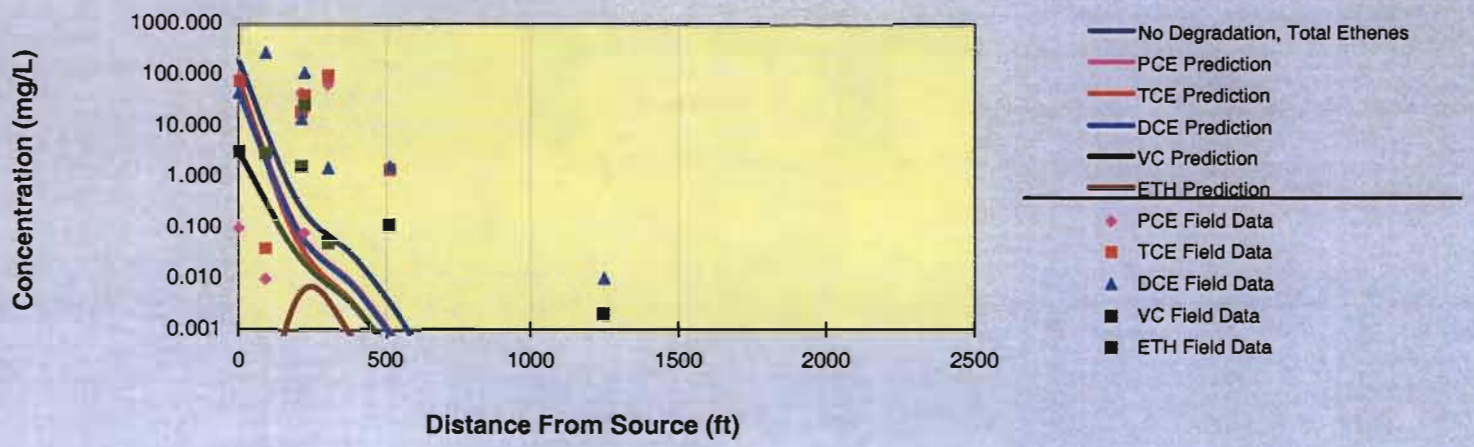
7. FIELD DATA FOR COMPARISON

PCE Conc. (mg/L)	.1	.01	44.0	.08	64.0						
TCE Conc. (mg/L)	75.0	.04	19.0	39.0	96.0	1.4	.25				
DCE Conc. (mg/L)	45.0	270.0	14.0	110.0	1.5	1.6	.473	.01			
VC Conc. (mg/L)	3.0	2.9	1.6	26.0	.05	.11	.053	.002			
ETH Conc. (mg/L)											
Dist. from Source (ft)	0	90	210	220	300	510	650	1245			

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE | RUN ARRAY | Help | Restore Formulas | RESET | SEE OUTPUT | Paste Example Dataset

DISSOLVED CHLORINATED SOLVENT CONCENTRATIONS ALONG PLUME CENTERLINE



Log ⟺ Linear

Time:

10 Years

To Input

To Individual Compounds

BIOSCREEN RUNS
INPUT/OUTPUT PLOTS

Engineered Remediation Approach
(Assuming 50% Reduction in Source Mass)

1-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

115 or 0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

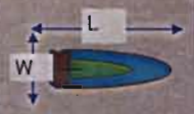
Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	1	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

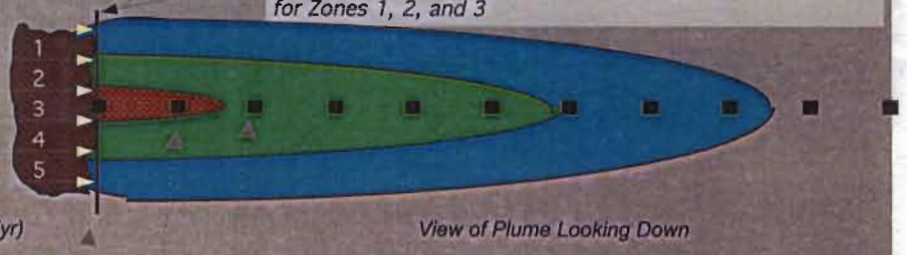
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass 57 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

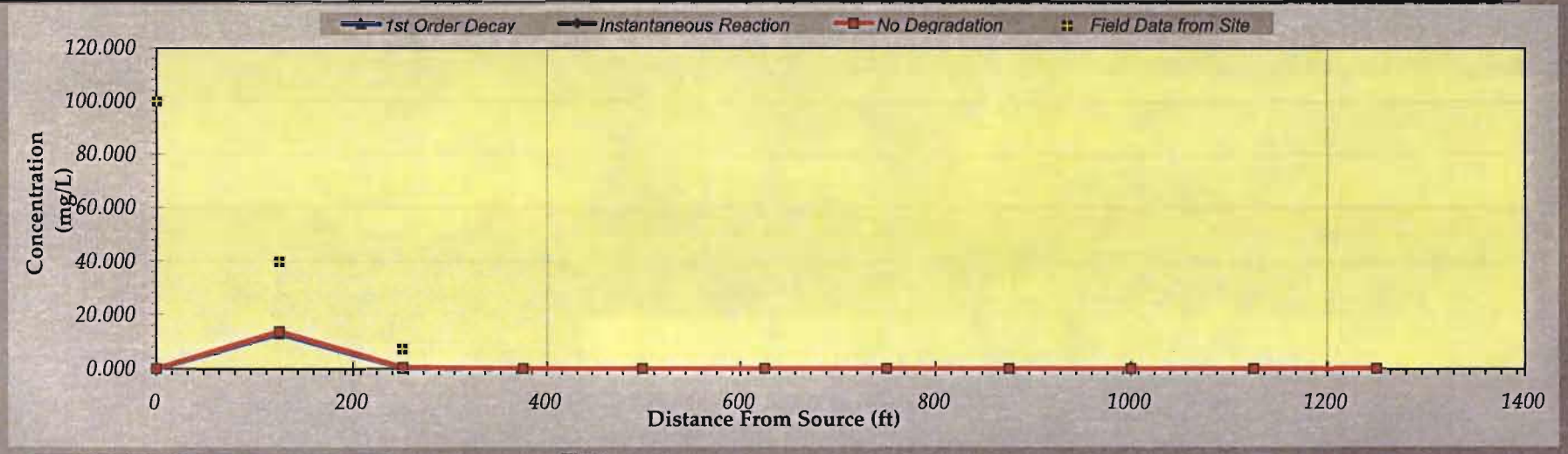
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	13.583	0.441	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.000	12.727	0.366	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	13.583	0.441	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time:

1 Years

Return to Input

Recalculate This Sheet

10-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

115
or
0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	I	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	10	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

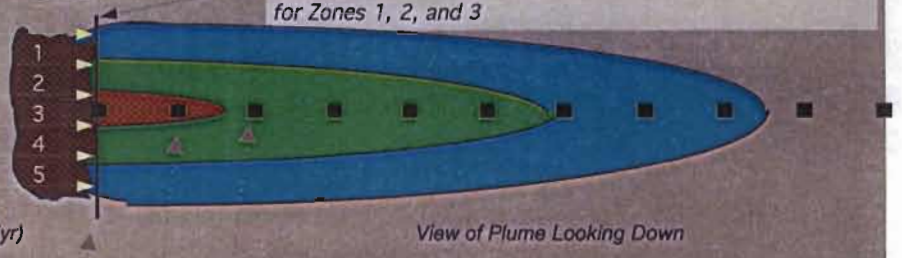
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass 57 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

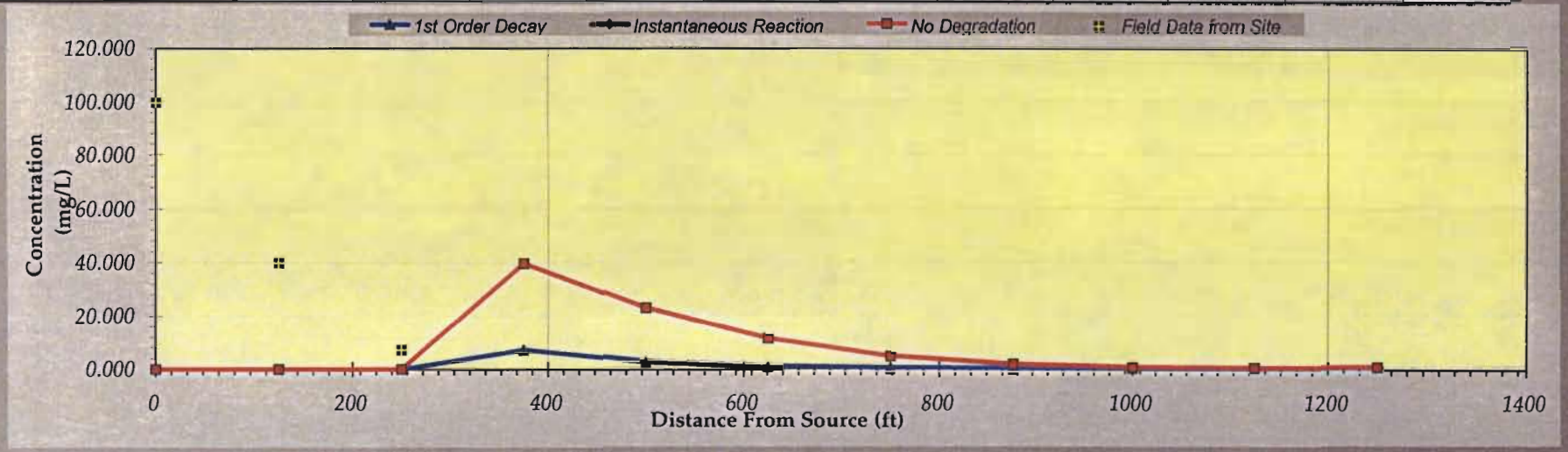
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	0.000	0.000	39.604	22.836	11.183	4.583	1.555	0.433	0.098	0.018
1st Order Decay	0.000	0.000	0.000	7.195	2.771	0.994	0.322	0.091	0.022	0.005	0.001
Inst. Reaction	0.000	0.000	0.000	39.604	22.836	11.183	4.583	1.555	0.433	0.098	0.018
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time:

10 Years

Return to Input

Recalculate This Sheet

25-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

*Variable** ▸ *Data used directly in model.*
▸ *Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	25	(yr)

115
or
0.02

Variable*
20

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

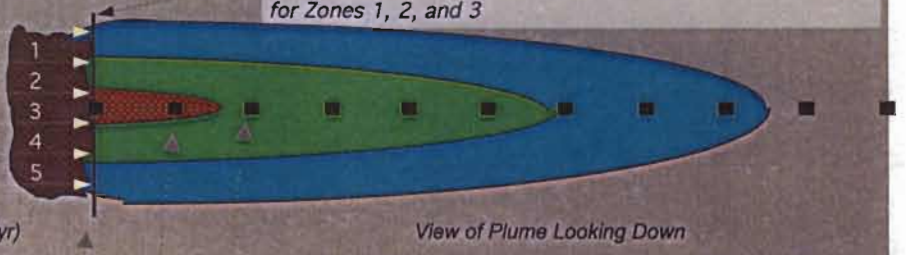
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass 57 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

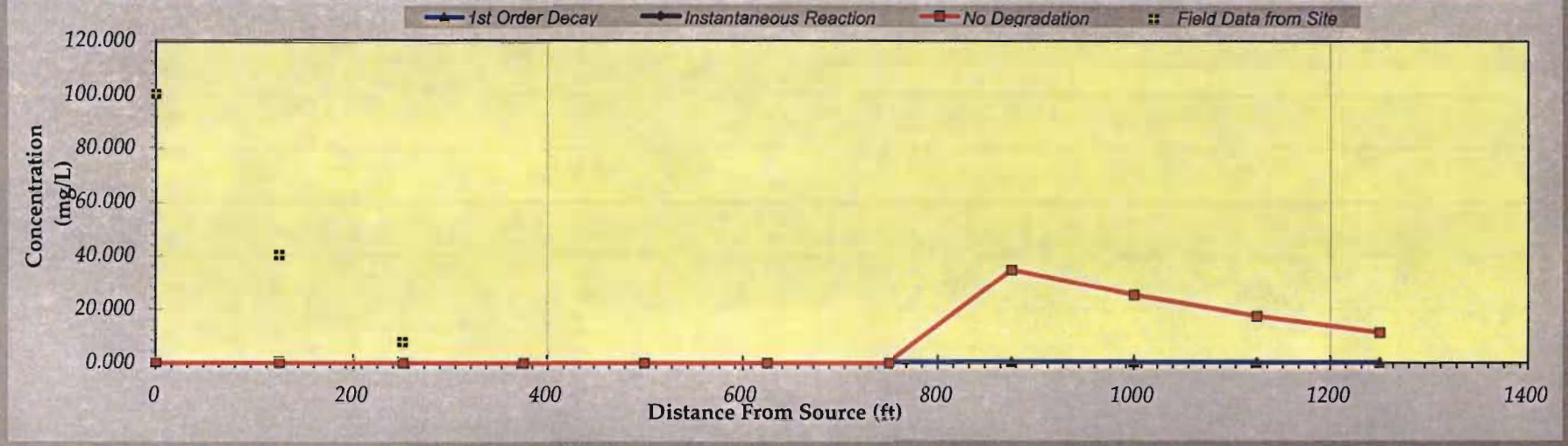
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	34.679	25.264	17.324	11.128
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.240	0.102	0.043	0.018
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	34.679	25.264	17.324	11.128
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time: 25 Years

Return to Input

Recalculate This Sheet

25-Year Time Step, 2000 ft

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

115 or 0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	2000	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	25	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

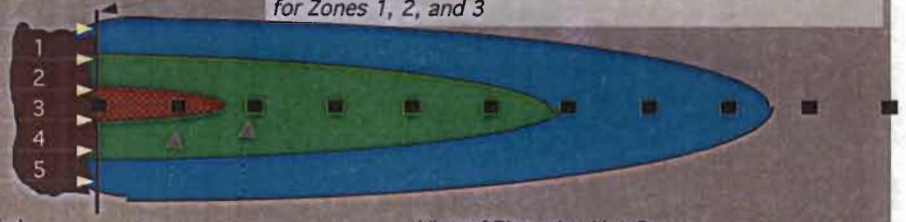
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass 57 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

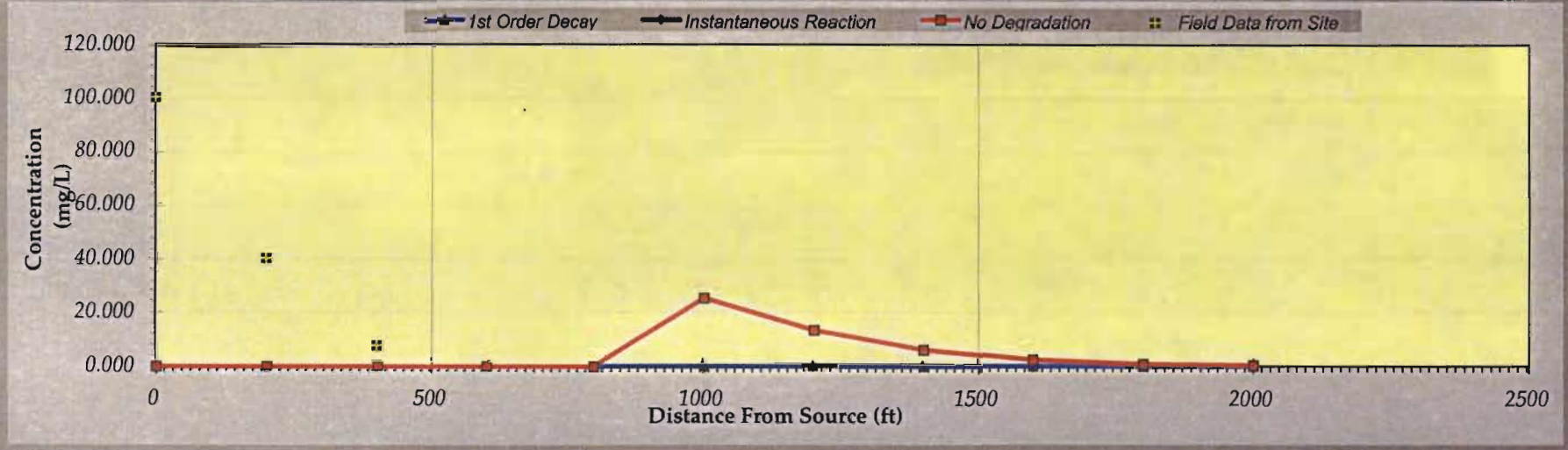
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	200	400	600	800	1000	1200	1400	1600	1800	2000
No Degradation	0.000	0.000	0.000	0.000	0.000	25.264	13.391	5.967	2.205	0.669	0.165
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.102	0.026	0.006	0.001	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	25.264	13.391	5.967	2.205	0.669	0.165
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time:
25 Years

Return to Input

Recalculate This Sheet

50-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

115 or 0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	50	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

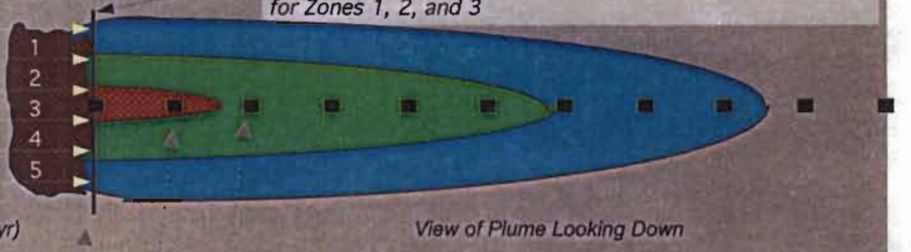
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass in Source NAPL, Soil: 57 (Kg)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

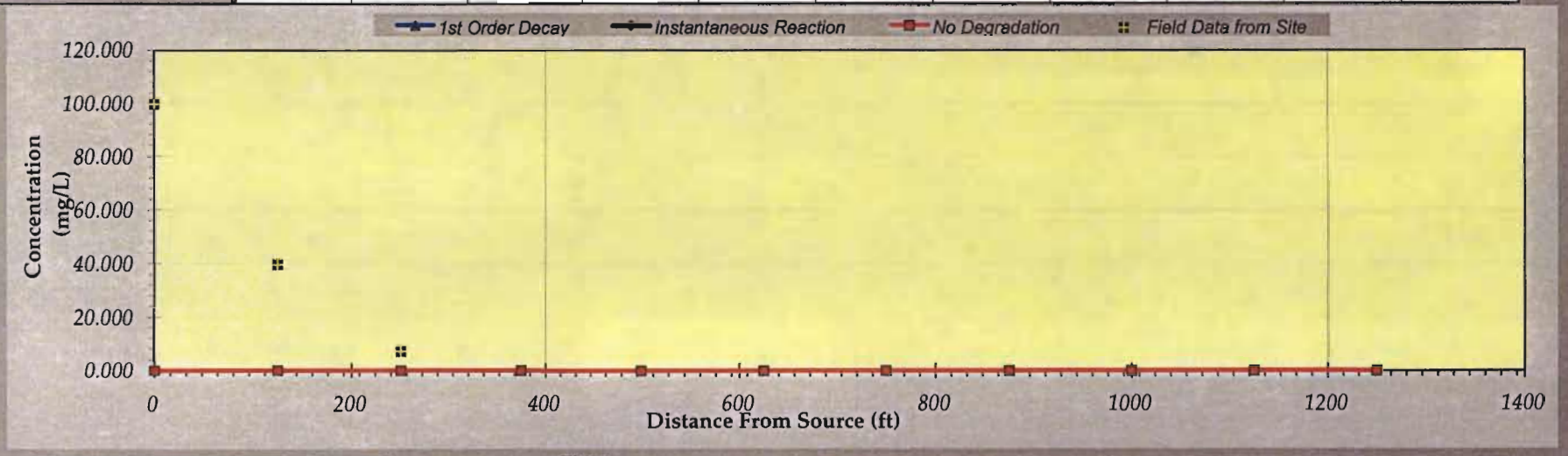
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#DIV/0!	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time: 50 Years

Return to Input

Recalculate This Sheet

50-Year Time Step, 2000 ft

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* ▸ Data used directly in model.
▸ Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		↑ or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

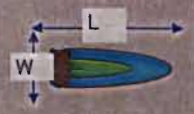
Retardation Factor*	R	5.8	(-)
or		↑ or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		↑ or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	2000	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	50	(yr)



115
↑ or
0.02

Variable*
20

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

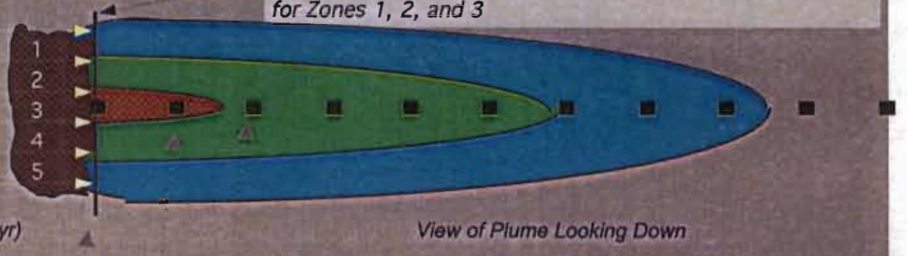
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass 57 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

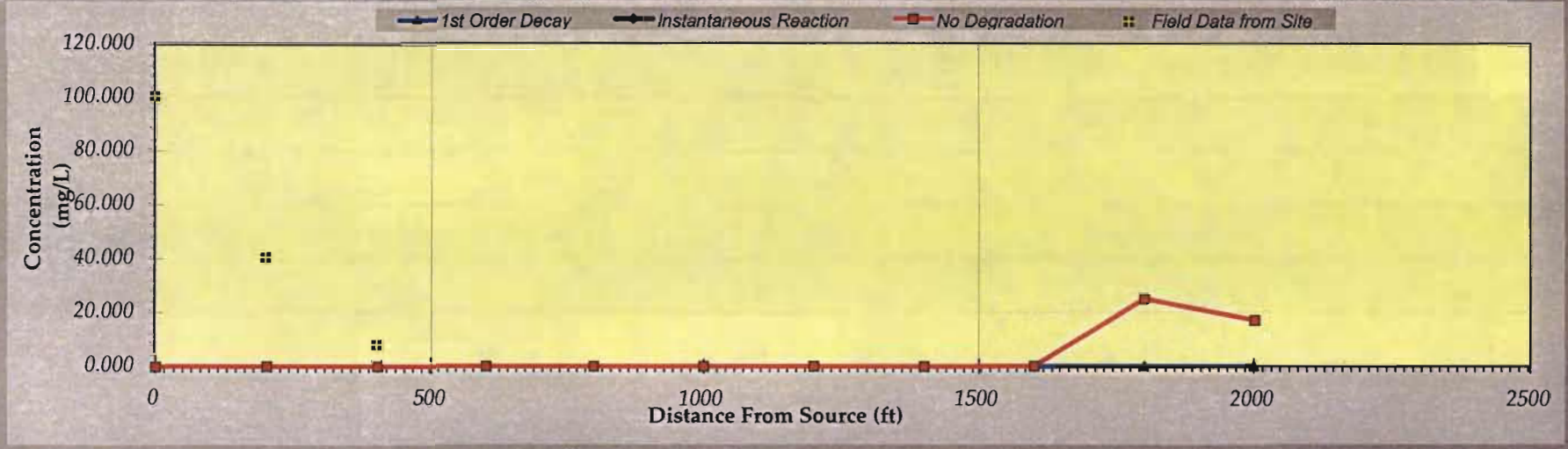
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	200	400	600	800	1000	1200	1400	1600	1800	2000
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	24.925	17.047
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#DIV/0!	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	24.925	17.047
Field Data from Site	100.000	40.000	7.400								



Time:

50 Years

Calculate Animation

Return to Input

Recalculate This Sheet

100-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

115
or
0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	100	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

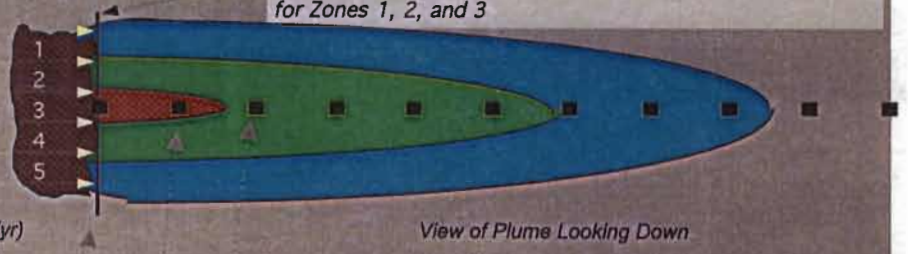
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass 57 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4									
Dist. from Source (ft)	0	300	390									

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

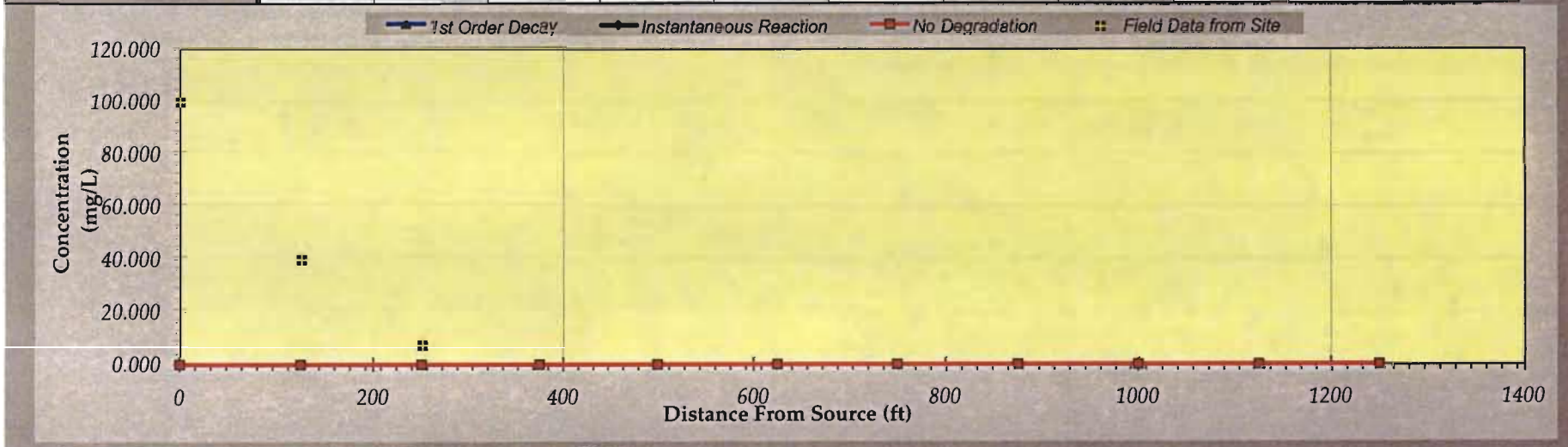
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time:

100 Years

Return to Input

Recalculate This Sheet

1,000-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

115
or
0.02

1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

Variable* — *Data used directly in model.*
20 — *Value calculated by model. (Don't enter any data).*

1. HYDROGEOLOGY

Seepage Velocity*	*Vs*	200.0	*(ft/yr)*
or		or	
Hydraulic Conductivity	*K*	1.8E-02	*(cm/sec)*
Hydraulic Gradient	*i*	0.0012	*(ft/ft)*
Porosity	*n*	0.2	*(-)*

2. DISPERSION

Longitudinal Dispersivity*	*alpha x*	100.0	*(ft)*
Transverse Dispersivity*	*alpha y*	10.0	*(ft)*
Vertical Dispersivity*	*alpha z*	0.0	*(ft)*
or		or	
Estimated Plume Length	*Lp*	1250	*(ft)*

3. ADSORPTION

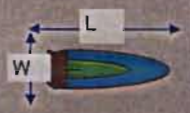
Retardation Factor*	*R*	5.8	*(-)*
or		or	
Soil Bulk Density	*rho*	2.25	*(kg/l)*
Partition Coefficient	*Koc*	426	*(L/kg)*
FractionOrganicCarbon	*foc*	1.0E-3	*(-)*

4. BIODEGRADATION

1st Order Decay Coeff*	*lambda*	3.7E-1	*(per yr)*
or		or	
Solute Half-Life	*t-half*	0.15	*(year)*
or Instantaneous Reaction Model			
Delta Oxygen*	*DO*	0	*(mg/L)*
Delta Nitrate*	*NO3*	0	*(mg/L)*
Observed Ferrous Iron*	*Fe2+*	0	*(mg/L)*
Delta Sulfate*	*SO4*	0	*(mg/L)*
Observed Methane*	*CH4*	0	*(mg/L)*

5. GENERAL

Modeled Area Length*	1250	*(ft)*
Modeled Area Width*	800	*(ft)*
Simulation Time*	1000	*(yr)*



6. SOURCE DATA

Source Thickness in Sat.Zone* 25 *(ft)*

Source Zones:

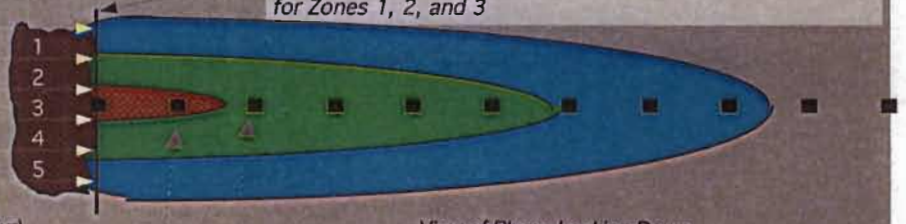
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	*(yr)*
Inst. React.	1st Order	

Soluble Mass 57 *(Kg)*
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

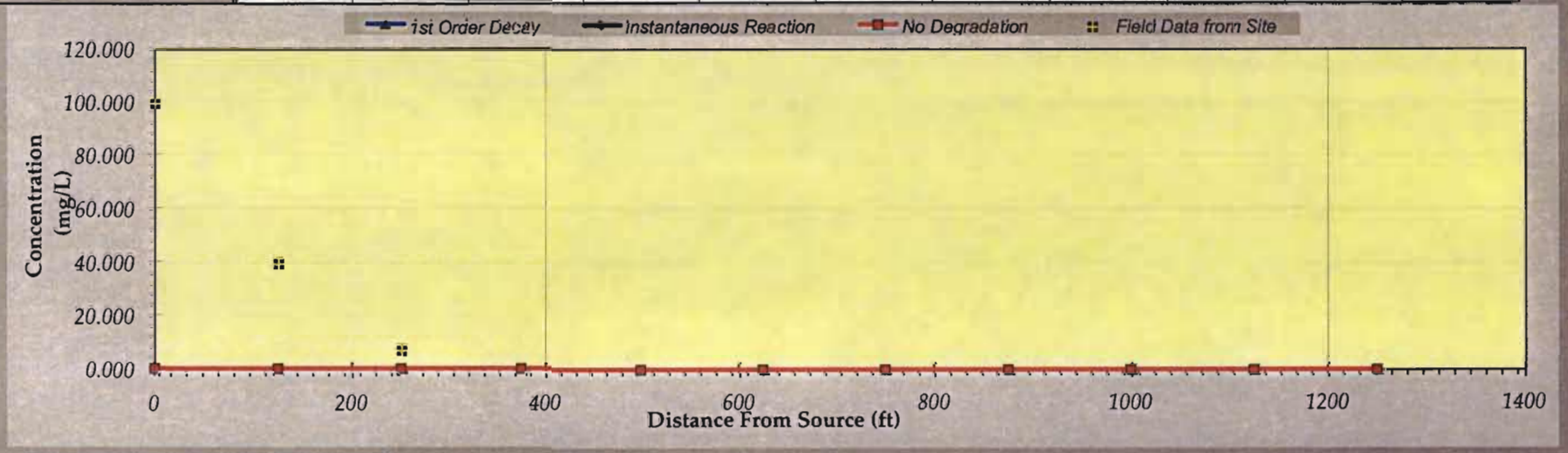
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time:

1,000 Years

Return to Input

Recalculate This Sheet

MNA Approach
(Assuming No Engineered Reduction in Source Mass)

1-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* ▸ Data used directly in model.
▸ Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

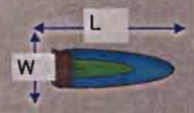
Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	1	(yr)



115 or 0.02

Variable* 20

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

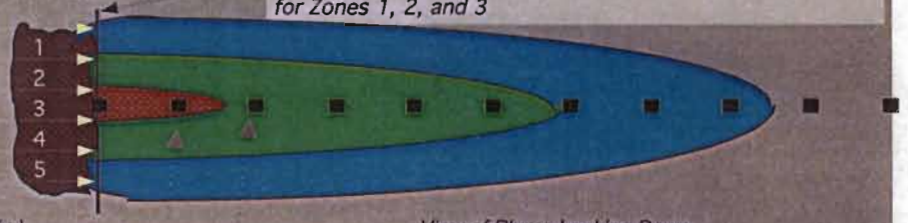
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass in Source NAPL, Soil: 113 (Kg)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

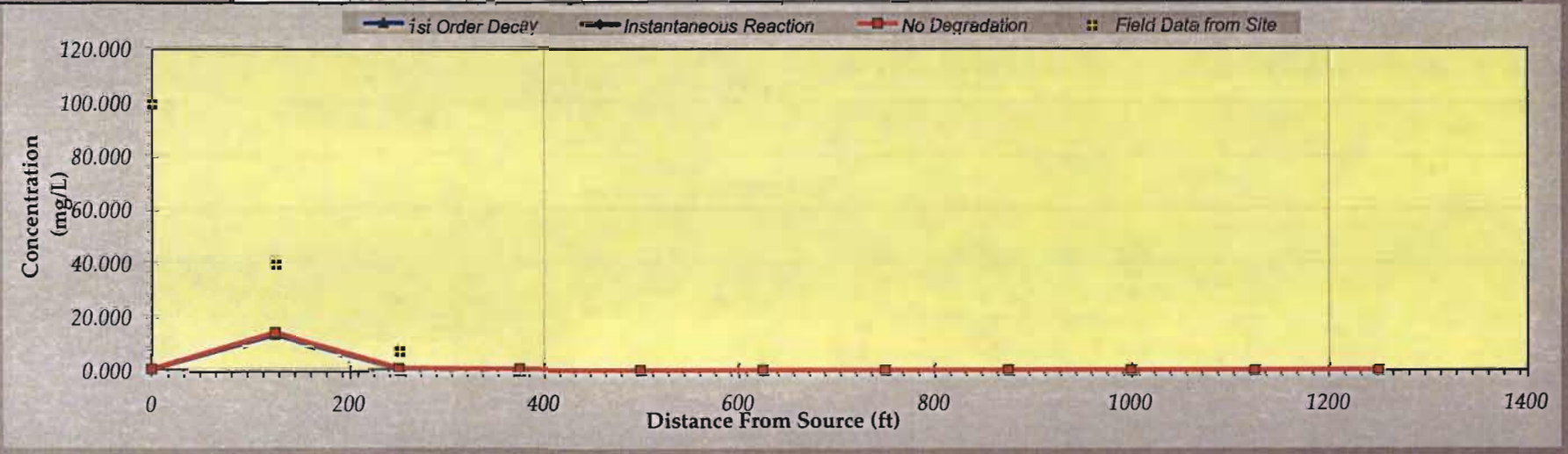
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.056	13.583	0.441	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.056	12.727	0.366	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.056	13.583	0.441	0.002	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time:
1 Years

Return to Input

Recalculate This Sheet

10-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

*Variable** ▸ *Data used directly in model.*
▸Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

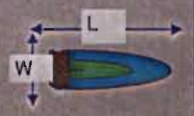
Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	10	(yr)



115 or 0.02

Variable* 20

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

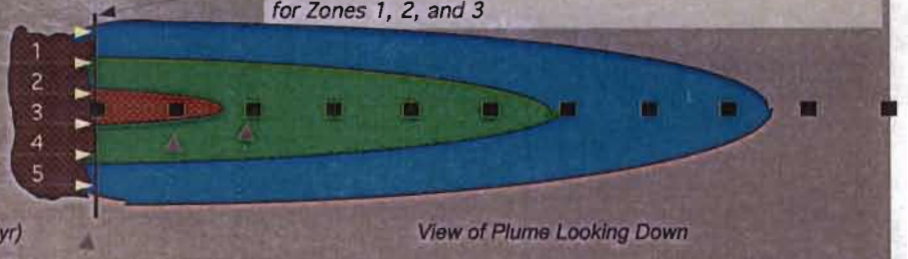
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass 113 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4									
Dist. from Source (ft)	0	300	390									

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

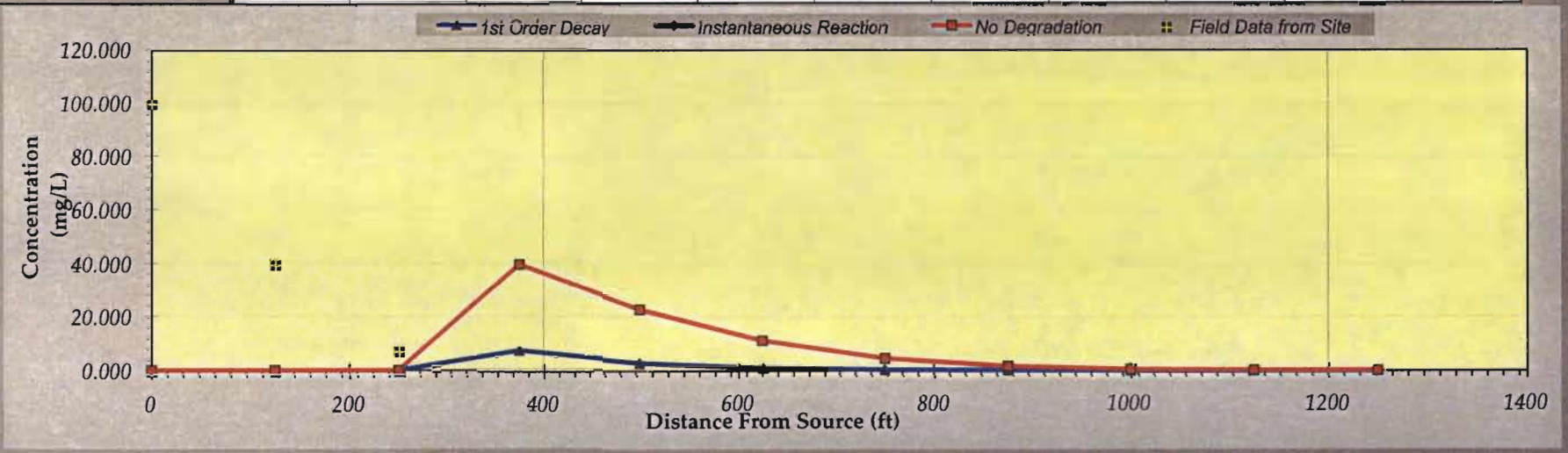
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	0.000	0.000	39.604	22.836	11.183	4.583	1.555	0.433	0.098	0.018
1st Order Decay	0.000	0.000	0.000	7.195	2.771	0.994	0.322	0.091	0.022	0.005	0.001
Inst. Reaction	0.000	0.000	0.000	39.604	22.836	11.183	4.583	1.555	0.433	0.098	0.018
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time:
10 Years

Return to Input

Recalculate This Sheet

25-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

115 or 0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	25	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

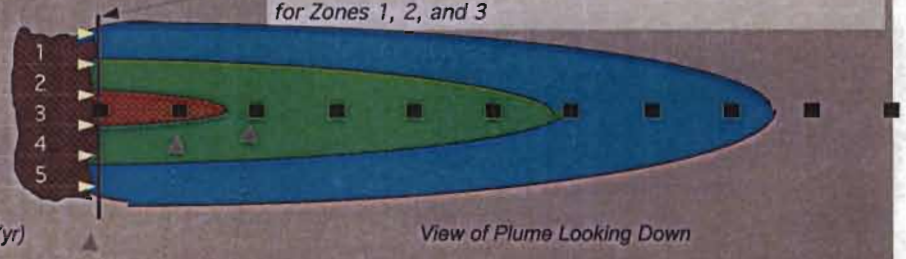
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass 113 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4									
Dist. from Source (ft)	0	300	390									

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

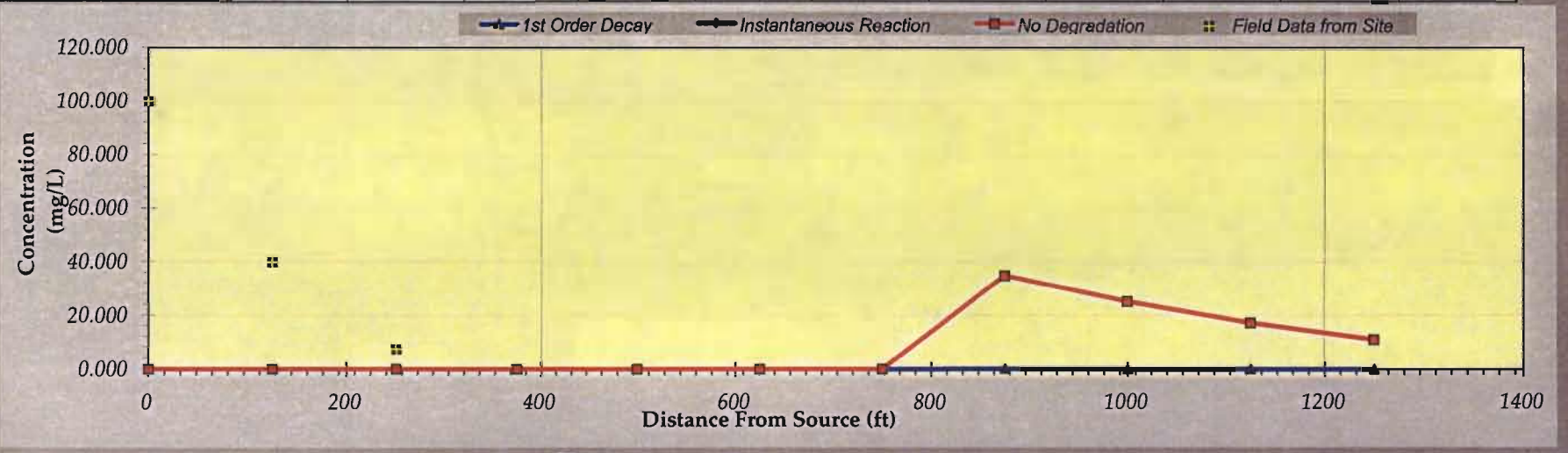
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	34.679	25.264	17.324	11.128
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.240	0.102	0.043	0.018
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	34.679	25.264	17.324	11.128
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time: 25 Years

Return to Input

Recalculate This Sheet

25-Year Time Step, 2000 ft

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

*Variable** ▸ *Data used directly in model.*
Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		↑ or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		↑ or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

Retardation Factor*	R	5.8	(-)
or		↑ or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		↑ or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	2000	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	25	(yr)

115
↑ or
0.02

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

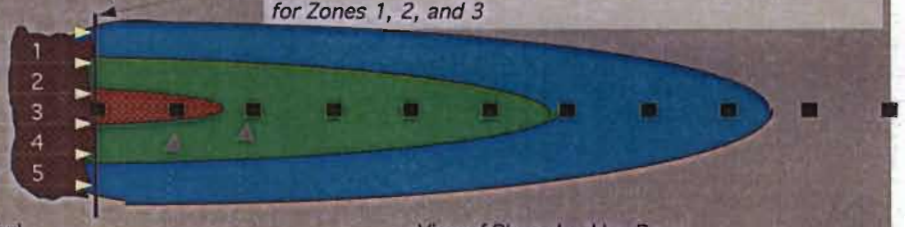
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React. ↑	↑ 1st Order	

Soluble Mass 113 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

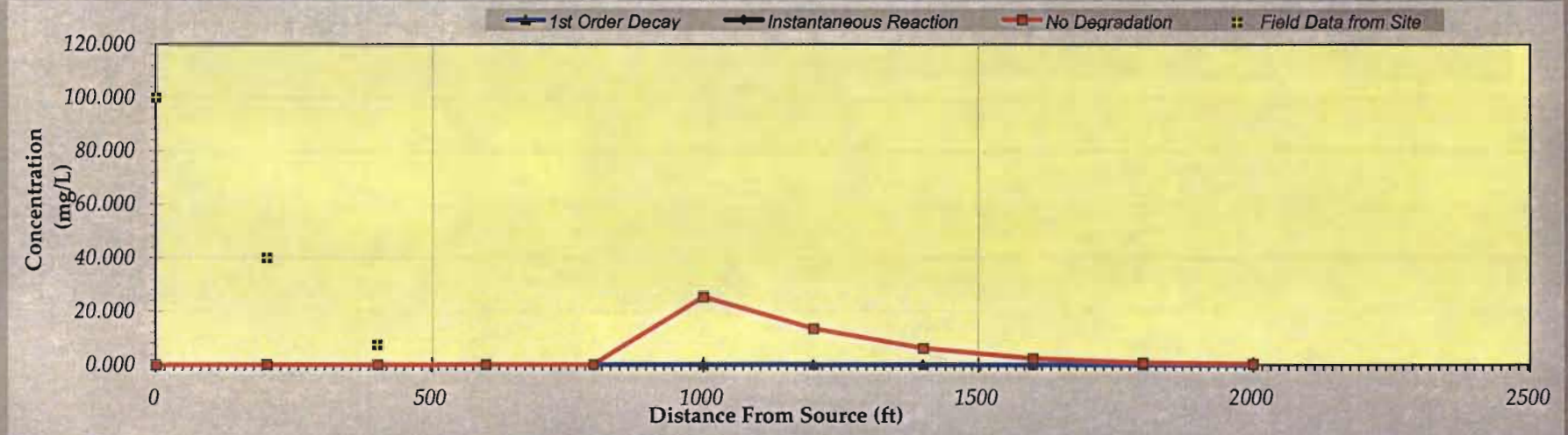
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	200	400	600	800	1000	1200	1400	1600	1800	2000
No Degradation	0.000	0.000	0.000	0.000	0.000	25.264	13.391	5.967	2.205	0.669	0.165
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.102	0.026	0.006	0.001	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	25.264	13.391	5.967	2.205	0.669	0.165
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time: 25 Years

Return to Input

Recalculate This Sheet

50-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

115 or 0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	I	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	50	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

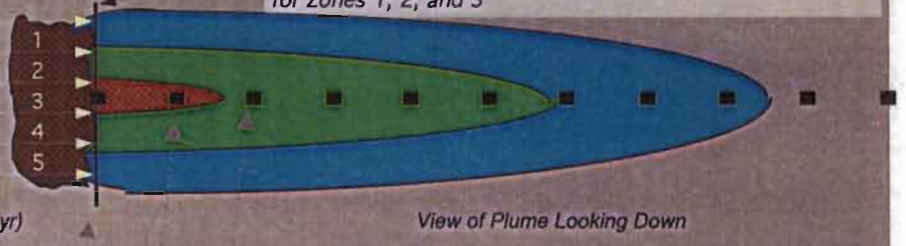
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass in Source NAPL, Soil: 113 (Kg)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

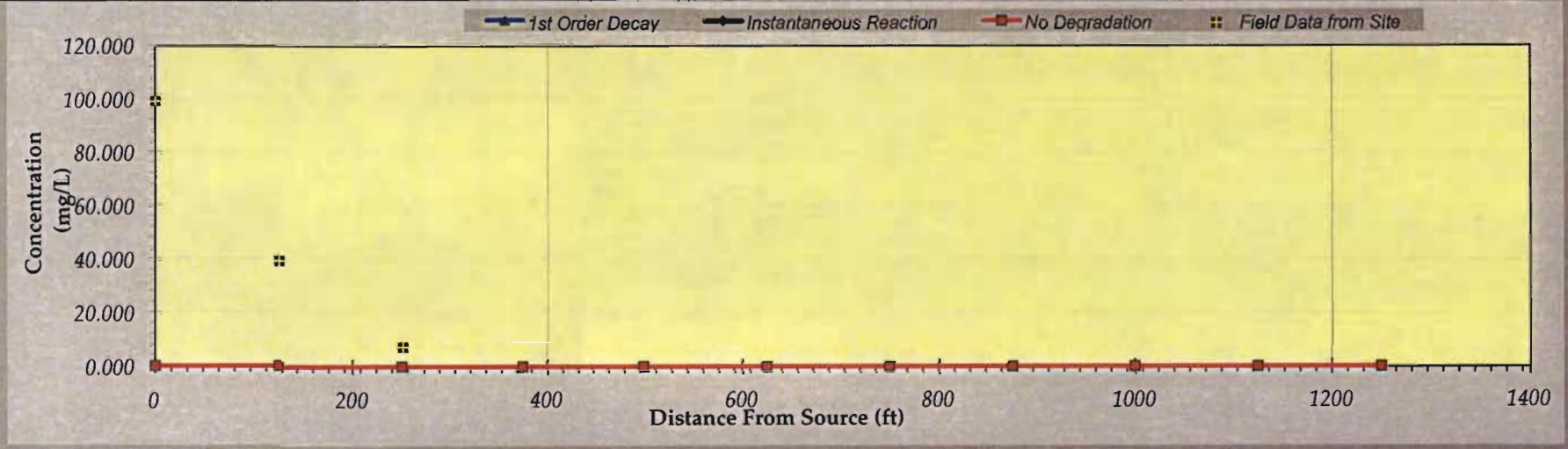
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	100.000	40.000	7.400								



Time:

50 Years

Calculate Animation

Return to Input

Recalculate This Sheet

50-Year Time Step, 2000 ft

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

115 / or / 0.02

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	2000	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	50	(yr)

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

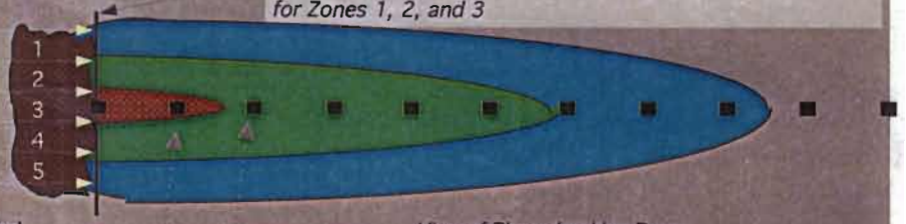
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass in Source NAPL, Soil: 113 (Kg)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

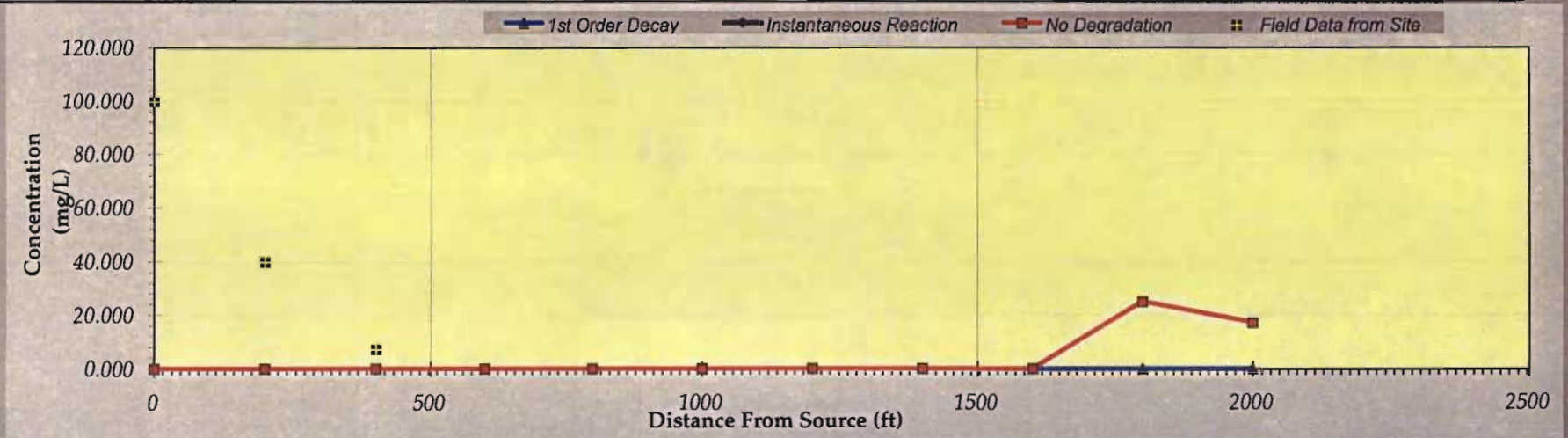
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	200	400	600	800	1000	1200	1400	1600	1800	2000
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	24.925	17.047
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	24.925	17.047
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time: 50 Years

Return to Input

Recalculate This Sheet

100-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

115 or 0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

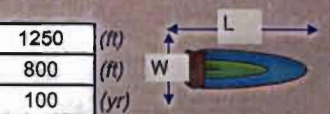
Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	100	(yr)



6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

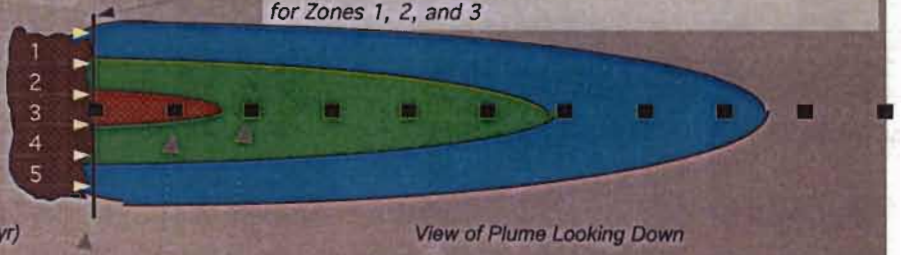
Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass 113 (Kg)
In Source NAPL, Soil

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — View Output

RUN ARRAY — View Output

Help

Recalculate This Sheet

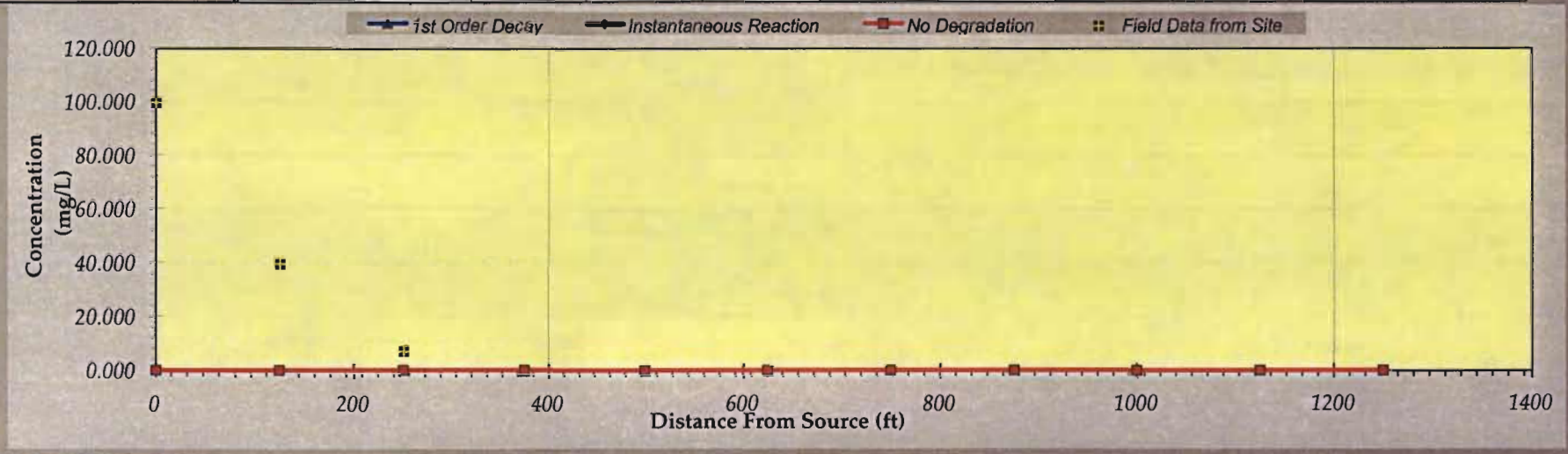
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#DIV/0!	#DIV/0!	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time:

100 Years

Return to Input

Recalculate This Sheet

1,000-Year Time Step

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence — *Version 1.4*

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* ▸ Data used directly in model.
▸ Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

Retardation Factor*	R	5.8	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-3	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	1000	(yr)

Variable*
20

6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

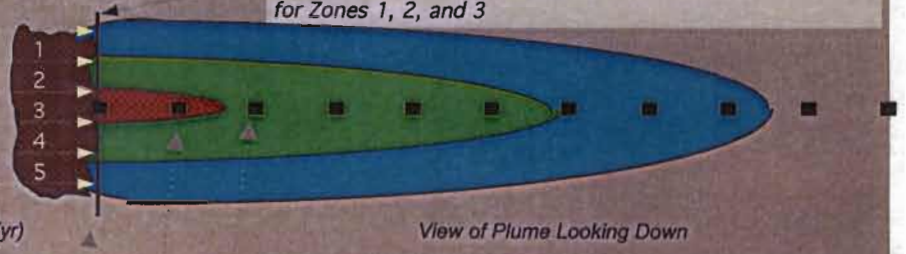
Source Zones:

Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
50	40
60	7.4

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	
Soluble Mass In Source NAPL, Soil	113	(Kg)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

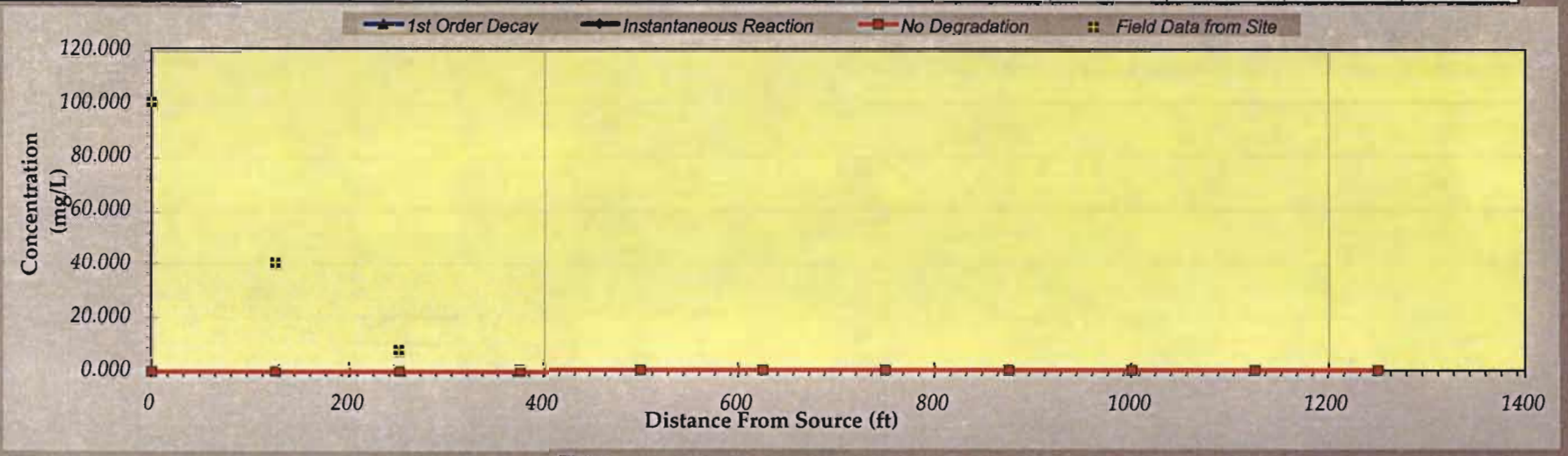
8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE	RUN ARRAY	Help	Recalculate This Sheet
View Output	View Output	Paste Example Dataset	
		Restore Formulas for Vs, Dispersivities, R, lambda, other	

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time:

1,000 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Sensitivity Runs

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

PCE-Delphi Harrison
Lockport, NY
Run Name

Data Input Instructions:

115 or 0.02

1. Enter value directly....or
2. Calculate by filling in grey cells below. (To restore formulas, hit button below).

Variable* — Data used directly in model.
20 — Value calculated by model. (Don't enter any data).

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

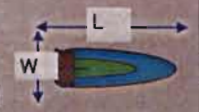
Retardation Factor*	R	48.9	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-2	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	10	(yr)



6. SOURCE DATA

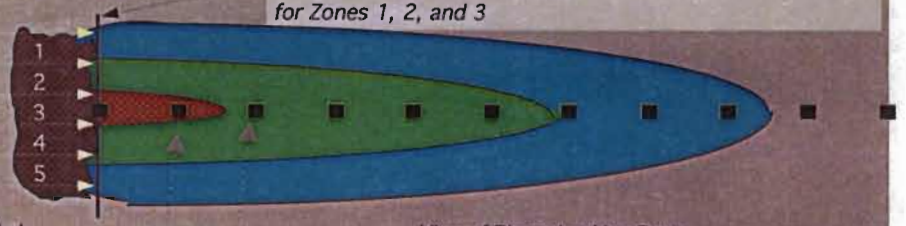
Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
90	40
50	7.4

Source Halflife (see Help):		
<1	<1	(yr)
Inst. React.	1st Order	
Soluble Mass In Source NAPL, Soil	57	(Kg)

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

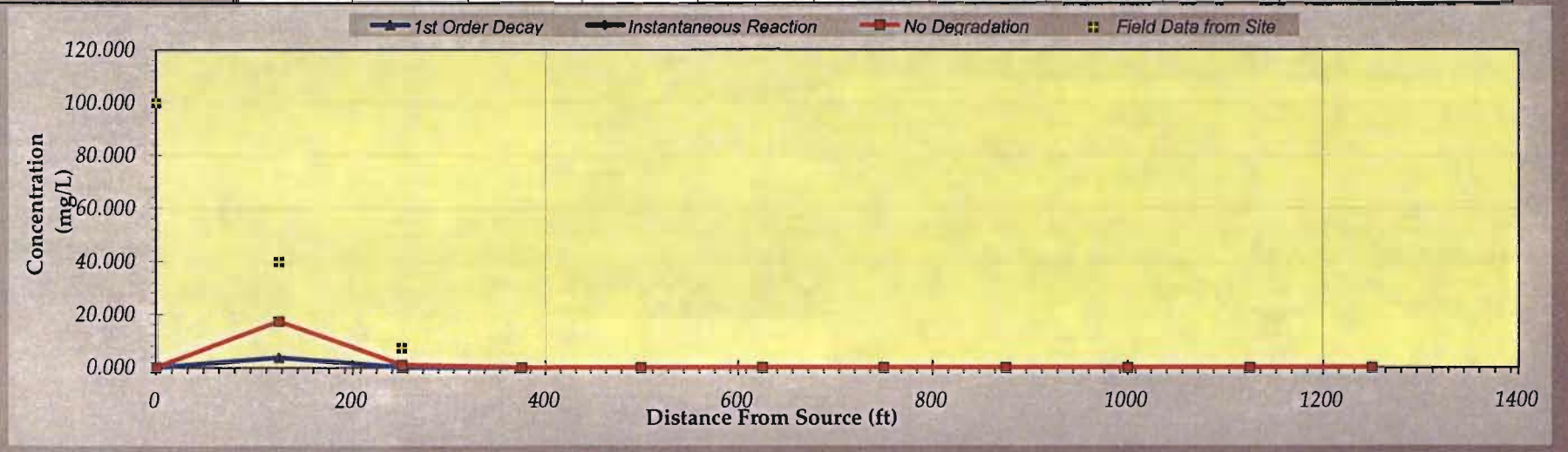
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	17.316	0.961	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.000	3.716	0.079	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	17.316	0.961	0.010	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time: 10 Years

Return to Input

Recalculate This Sheet

BIOSCREEN Natural Attenuation Decision Support System

Air Force Center for Environmental Excellence

Version 1.4

PCE-Delphi Harrison
Lockport, NY
Run Name

1. HYDROGEOLOGY

Seepage Velocity*	Vs	200.0	(ft/yr)
or		or	
Hydraulic Conductivity	K	1.8E-02	(cm/sec)
Hydraulic Gradient	i	0.0012	(ft/ft)
Porosity	n	0.2	(-)

2. DISPERSION

Longitudinal Dispersivity*	alpha x	100.0	(ft)
Transverse Dispersivity*	alpha y	10.0	(ft)
Vertical Dispersivity*	alpha z	0.0	(ft)
or		or	
Estimated Plume Length	Lp	1250	(ft)

3. ADSORPTION

Retardation Factor*	R	1.5	(-)
or		or	
Soil Bulk Density	rho	2.25	(kg/l)
Partition Coefficient	Koc	426	(L/kg)
FractionOrganicCarbon	foc	1.0E-4	(-)

4. BIODEGRADATION

1st Order Decay Coeff*	lambda	3.7E-1	(per yr)
or		or	
Solute Half-Life	t-half	0.15	(year)
or Instantaneous Reaction Model			
Delta Oxygen*	DO	0	(mg/L)
Delta Nitrate*	NO3	0	(mg/L)
Observed Ferrous Iron*	Fe2+	0	(mg/L)
Delta Sulfate*	SO4	0	(mg/L)
Observed Methane*	CH4	0	(mg/L)

5. GENERAL

Modeled Area Length*	1250	(ft)
Modeled Area Width*	800	(ft)
Simulation Time*	10	(yr)

Data Input Instructions:

115
or
0.02

1. *Enter value directly....or*
2. *Calculate by filling in grey cells below. (To restore formulas, hit button below).*

Variable* — *Data used directly in model.*
20 — *Value calculated by model. (Don't enter any data).*

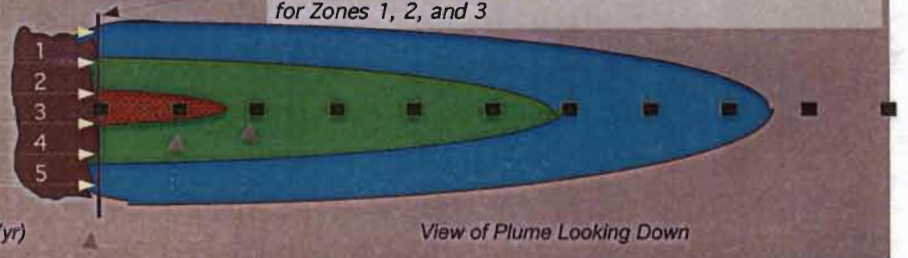
6. SOURCE DATA

Source Thickness in Sat.Zone* 25 (ft)

Source Zones:

Width* (ft)	Conc. (mg/L)*
50	7.4
90	40
220	100
90	40
50	7.4

Vertical Plane Source: Look at Plume Cross-Section and Input Concentrations & Widths for Zones 1, 2, and 3



View of Plume Looking Down

Source Halflife (see Help):

<1	<1	(yr)
Inst. React.	1st Order	

Soluble Mass 57 (Kg)
In Source NAPL, Soil

Observed Centerline Concentrations at Monitoring Wells
If No Data Leave Blank or Enter "0"

7. FIELD DATA FOR COMPARISON

Concentration (mg/L)	100.0	40.0	7.4								
Dist. from Source (ft)	0	300	390								

8. CHOOSE TYPE OF OUTPUT TO SEE:

RUN CENTERLINE — **View Output**

RUN ARRAY — **View Output**

Help

Recalculate This Sheet

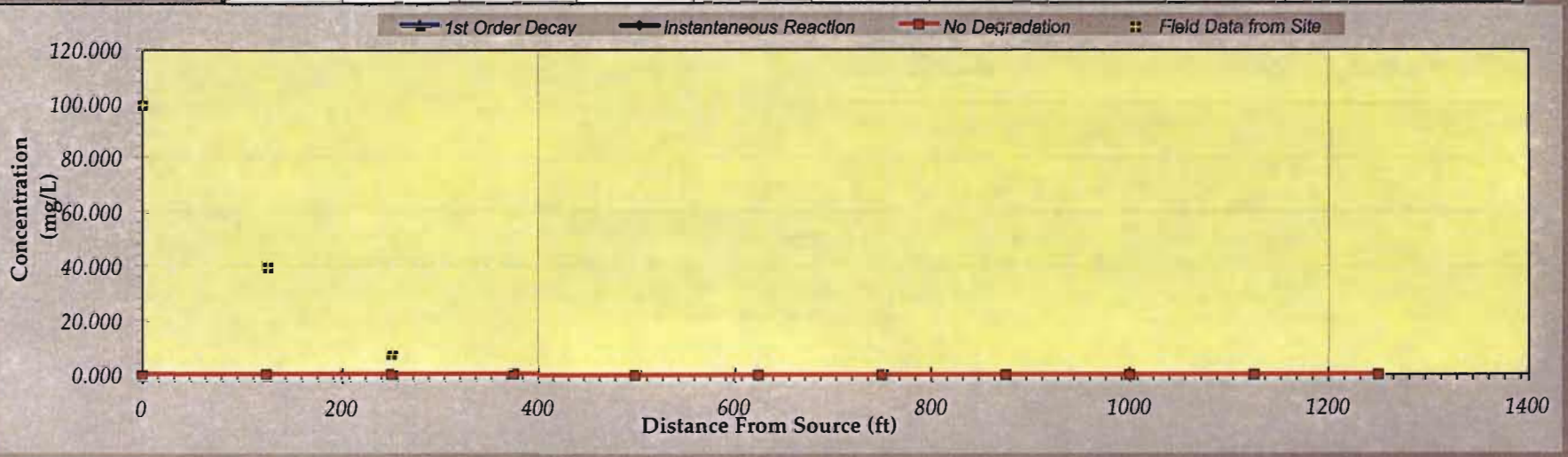
Paste Example Dataset

Restore Formulas for Vs, Dispersivities, R, lambda, other

DISSOLVED HYDROCARBON CONCENTRATION ALONG PLUME CENTERLINE (mg/L at Z=0)

Distance from Source (ft)

TYPE OF MODEL	0	125	250	375	500	625	750	875	1000	1125	1250
No Degradation	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1st Order Decay	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Inst. Reaction	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Field Data from Site	100.000	40.000	7.400								



Calculate Animation

Time:

10 Years

Return to Input

Recalculate This Sheet