Midwest
Environmental
Consulting, LLC

January 17, 2022

Ms. Jennifer Dorman
Wisconsin Department of Natural Resources
2300 N. Martin Luther King Dr.
Milwaukee, WI 53212

RE: Off-Site Liability Exemption and Liability Clarification Application
Heimes Garage - Former
3418 – 66th Street
Kenosha, WI
BRRTS#: 03-30-409382
FID#: 230058620

Dear Ms. Dorman:

Please find enclosed the Off-Site Liability Exemption and Liability Clarification Application for the above-referenced site. The $700.00 application fee will be submitted under separate cover.

Based on review of the Site Investigation Report, the Department stated in email correspondence that the site investigation was incomplete and that further information and an additional round of groundwater sampling was required. However, the email was very brief, with few specific details. It is MEC's opinion that investigation of the petroleum contamination is complete, pending the additional round of groundwater sampling, and that the chlorinated volatile organic compound contamination in the 66th Street right-of-way and adjacent portions of the Heimes and Yutka Storage sites originated from an off-site source, Industrial Pumping, Inc.

In light of the above, MEC is hereby providing the additional information requested, seeking clarification and additional information to ensure that all of the Department's concerns can be addressed efficiently and seeking a liability exemption for the CVOC contamination on behalf of Talman Venture, LLC, the Responsible Party (RP).

Please let me know if you have any questions.

Sincerely,
MIDWEST ENVIRONMENTAL CONSULTING

Sean Cranley, P.G.
Principal Hydrogeologist
(262) 237-4351

State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison, WI 53707-7921
dnr.wi.gov

Off-Site Liability Exemption and Liability Clarification Application

Form 4400-201 (R 05/19)

Notice: Pursuant to ss. 292.13 and 292.55, Wis. Stats., this application must be completed to request a written determination from the Department of Natural Resources (DNR) for the off-site liability exemption or for the liability clarification regarding property affected by an off-site discharge. The Department will not consider, or act upon your application unless all sections are completed on this form and the required fee of $700, required under ch. NR 749, Wis. Adm. Code is included. Personal information collected will be used for administrative purposes and may be provided to requester's to the extent required by Wisconsin's Open Records law [ss. 19.31 - 19.39, Wis. Stats.]

Definitions:

"Off-Site Exemption" refers to a statutory limit on liability available to a person with respect to the existence of a hazardous substance in the groundwater or soil, including sediments, on Property possessed or controlled by the person, as provided in s. 292.13, Wis. Stats. The off-site exemption is available only to persons who possess or control the affected property, who meet the requirements and criteria in the statutes. DNR provides a written determination regarding liability upon submittal of this application and the required fee.

"General Liability Clarification" refers to a written determination by the Department, as provided in s. 292.55, Wis. Stats., that clarifies the environmental liability of a person, business or another party for a specific situation. General liability clarifications can be provided in situations when the party requesting the clarification does not meet one of the requirements for the off-site exemption at the time of the application submittal, for example, does not yet own the off-site property. This application form should be used to request a written liability clarification **for property affected by an off-site discharge.**

"Property" refers to the subject property that has been impacted by hazardous substances that migrated there from a different property containing the original contamination source. The subject property is often referred to as an "off-site" or "off-source" property.

"Possession or control" refers to holding title to the property or exercising possession or control over the property by some other means, such as a lease.

[NOTE: a person with an easement doesn't have possession or control over the property; the property owner just allows the person to use part of the property for a limited purpose].

Instructions:

- Use this application to request a written determination from the Department for the off-site liability exemption or for the liability clarification regarding **property affected by an off-site discharge**. See DNR's Fact Sheet: "When Contamination Crosses a Property Line - Rights and Responsibilities of Property Owners Off-Site Limited Liability Exemption" (RR-589) for general information on eligibility requirements, liability clarification letters related to the off-site liability exemption, and property owner responsibilities. Information and these publications are available by contacting a DNR office or on the Internet at: http://dnr.wi.gov/topic/Brownfields.
- Complete the application and include the information that adequately shows that the required criteria are met. See Section 7 on page 4.
- Include a $700 fee payment with this application, in accordance with ch. NR 749, Wis. Adm. Code.
- Send the completed application, fee, and supporting materials to the DNR regional office where the Property is located, as listed on page 6. Contact the person listed with any questions.
- Department staff will make every attempt to provide timely written determinations. However, the time required for the determination varies depending on the complexity of the site, and the clarity and completeness of the application and supporting documentation.
  Do not use this application form to request liability clarifications for properties without off-site contamination. Contact one of the DNR regional offices or see the DNR website on the Internet for more information.

1. Applicant information for person requesting the determination.

Applicant Last Name Zacker	First Mike		MI
Address 4515 Washington Rd.	City Kenosha	State WI	ZIP Code 53144
Phone Number (include area code) (262) 308-3663	Fax Number (include area code)	E-Mail Address mike@coverealtyllc.com	
Contact for questions (if different than applicant) Last Name Cranley	First Sean		MI
Address N6395 E. Paradise Rd.	City Burlington	State WI	ZIP Code 53105
Phone Number (include area code) (262) 237-4351	Fax Number (include area code)	E-Mail Address mwenvirocon@gmail.com	

2. Applicant eligibility for off-site exemption or off-site liability clarification.

Request one determination based on whether the requirements for the off-site exemption are currently met. *See page 5 and sign the appropriate certification.*

☒ **Off-Site Discharge Exemption – I "possess or control" the Property and I believe I meet the criteria for an off-site exemption. I request an off-site exemption letter.**

☒ **I have completed Section 8a on page 5.**

As the applicant, I am:

● Current owner

○ Other* Explain your relationship to the Property or the nature of your possession or control of the Property:

*Additional documentation may be requested by the DNR to verify the applicant's possession or control of the Property. For example, if a lessee requests a determination, DNR would need a copy of the lease by which to assess whether the lessee possesses or controls the Property.

☐ **Off-site Liability Clarification – I lack one or more of the requirements for the off-site exemption as shown below. I request a liability clarification letter that explains which conditions must be met in order to qualify for the off-site liability exemption.**

☐ **I have completed Section 8b on page 5.**

Requirements for the off-site exemption that are missing:

☐ 1. Currently I do not possess or control the Property and

○ I plan to buy the Property on (Date) or

○ I plan to lease the Property on (Date) .

☐ 2. Currently no contamination has been detected on the Property but there is credible evidence that contamination has migrated onto the Property.

☐ 3. Multiple contiguous properties are believed to be affected by contamination from a known source.

☐ 4. Other: Explain the circumstances here or in an attachment.

3. Information on additional parties.

Check the appropriate box to have a copy of the determination letter sent to one or more of these parties:

☒ **Environmental Consultant** Cranley
First: Sean
MI:
Address: N6395 E. Paradise Rd.
City: Burlington
State: WI
ZIP Code: 53105
Phone Number (include area code): (262) 237-4351
Fax Number (include area code):
E-Mail Address: mwenvirocon@gmail.com

☐ **Attorney / Other Last Name**
First:
MI:
Address:
City:
State:
ZIP Code:
Phone Number (include area code):
Fax Number (include area code):
E-Mail Address:

4. Information on Property affected by off-site discharge.

Property / Facility Name Heimes Garage (Former)	County Kenosha

Address 3418 - 66th St.	City Kenosha	State WI	ZIP Code 53142

Public Land Survey Coordinates

Latitude	42	34	27.9336	Longitude -87	51	02.7792

Section 01	Range 22 ● E ○ W	Township 01 N	Datum (check only one): ● NAD27 ○ NAD83 ○ 1990 Adjustment	Method	Accuracy

(Attach a list of locations if this request is for multiple properties.)

☒ I request that DNR provide a copy of the Liability Clarification Letter to the current owner.

Current Owner (if different than applicant) Last Name	First	MI

Address	City	State	ZIP Code

Phone Number (include area code)	Fax Number (include area code)	E-Mail Address

5. Information about contamination on the impacted Property.

A. Have hazardous substances been detected on the Property or Properties?

○ No. If not, explain why contamination is suspected on the Property or Properties in an attachment or here:

● Yes. Check all that apply: ☒ Groundwater ☐ Soil ☐ Sediment ☐ Other, describe:

B. Has the presence of contamination been reported to any State or local governmental agency?

○ No.

● If yes, check all that apply:
☒ DNR
☐ Division of Emergency Government
☐ Commerce
☐ Department of Agriculture, Trade and Consumer Protection (DATCP)
☐ Other, describe:

Date Reported
02/10/2003

C. Is the source of the contamination known? Check only one.

○ No.

● Yes. If yes, what is the source of the contamination?
ASTs and USTs on the off-site property (petroleum). ASTs and drums on source property (petroleum and chlorinated solvents)

Provide the name and address of the owner of the contamination source or source property, if known.

Owner Name
Andrew R Peters & Daniela P Peters

Address 3502 66th St.	City Kenosha	State WI	ZIP Code 53142

○ Suspected. If suspected to be migrating from a nearby source, what is the source and its address?

Provide the name of the owner of the suspected contamination source or source property, if known.

Owner Name

Address	City	State	ZIP Code

6. Specific liability clarification questions relating to off-site contamination.

○ I have no additional liability clarification questions.

● I request a DNR response to the questions provided to clarify my liability for the cleanup of off-site contamination to be included in the written determination (questions should be provided here or in an attachment) :

Please see Section 6 of the Attachment

7. Property information needed for the determination of off-site exemption or off-site liability clarification.

DNR requires adequate information in order to make the determination requested in this application. Incomplete or inadequate information will delay the completion of the determination. DNR has the authority to request additional information, if needed. Include the following information with the application, if appropriate:

1. Map(s) showing Property location(s) and any suspected or known off-site contaminant source properties.
2. For any environmental data submitted, include:
   a) Property map(s) showing sampling locations for all data submitted;
   b) Interpretation of data signed by a qualified environmental professional, including data tables and figures that include data;
   c) Soil boring logs;
   d) Groundwater monitoring well construction, development and sampling logs;
   e) Laboratory-provided data reports;
   f) Survey information for groundwater elevations;
   g) Chain of custody forms for all samples; and
   h) Description of sample collection methods.

The submitted materials should document that the statutory criteria are satisfied regarding the contamination and its source as listed in A through C below.

A. Document that there is hazardous substance contamination present in soil, groundwater and/or sediment on the Property or Properties. Examples of information include: Analytical results and interpretations for samples collected from soil, groundwater, and/or sediment on the Property, or at or near the Property line, that conclusively document the presence of a hazardous substance in one or more of these media on the Property. This information could be documented in a Phase II Environmental Assessment report, or could refer to existing reports in DNR files related to the source property.

B. Document that the hazardous substance contamination, which is present in soil, groundwater, and/or sediment on the Property or Properties, is migrating onto the Property or Properties from an off-site source.

Examples of information include:

1. Information identifying known or suspected discharges of the hazardous substance on neighboring property(ies), e.g., a Phase I Environmental Assessment report, information in existing reports in DNR files related to the source property.
2. Soil, groundwater and/or sediment sample data and interpretations adequate to conclude that the hazardous substance is migrating onto the Property or Properties, such as:
   - Samples from monitoring wells located on the upgradient side of the Property or Properties (include information to establish upgradient direction), which show increasing contaminant concentrations toward the upgradient Property or Properties;
   - Off-site investigation results that provide information about groundwater flow direction and contaminant movement that convincingly document hazardous substances from a known or suspected off-site source have impacted the Property or Properties; or
   - A description of the event(s) that caused the deposit or accumulation of contaminated sediment on the affected Property or Properties and a map showing the location of the water body and elevations of the affected Property or Properties and water surface at normal flow and flood stage conditions.

C. Document that the discharge of a hazardous substance is not from a source on the Property or Properties.

Examples of information include:

1. Information related to historical activities, such as descriptions of chemicals used and handled, areas where chemicals were used and handled, and areas of potential discharges on the Property or Properties, e.g., a Phase I Environmental Assessment report.
2. Where the types of hazardous substances used, handled, or discharged on the Property or Properties are the same as the hazardous substances migrating onto the Property or Properties, provide environmental information, e.g., expanded Phase II environmental assessment data, including type and volume of hazardous substances handled, generated or stored on the applicant's Property during the period of ownership and/or length of lease, and analytical results and interpretation for soil and groundwater samples collected from potential discharge areas to demonstrate that the contamination migrating onto the Property is separate and distinct from the contamination that may be on the Property.

8. Sign one of the certifications below based on whether the requirements of the off-site exemption are currently met.

8a. Certification if the applicant currently meets all the requirements for the off-site liability exemption.

Applicant Certification for a Determination for the Off-Site Discharge Exemption, as provided in s. 292.13, Wis. Stats.

I certify that I possess or control the Property and have read and am familiar with the information on this application. The information on and included with this application is true, accurate and complete to the best of my knowledge.

I understand that I retain the responsibility for any hazardous substance discharges that I caused or cause, and for any discharges whose source I possess or control on the Property or on other properties.

I believe that I meet the criteria in s. 292.13, Wis. Stats., with respect to the fact that I never controlled or possessed either the source property itself, or the hazardous substances that have migrated onto the Property from the source property, nor did I cause the hazardous substance discharge for which I am seeking this written exemption.

I understand that if I fail to satisfy the statutory requirements in s. 292.13, Wis. Stats., such as failing to provide access to the Property, the DNR has the authority to revoke the off-site exemption for the Property.

Applicant Last Name Zacker	First Mike	MI
Signature	Date Signed 1-17-2022	

8b. Certification if applicant has not currently met all the conditions for the off-site exemption.

Applicant Certification for a Determination for Liability Clarification, as provided in s. 292.55, Wis. Stats.

I certify that I have read and am familiar with the information on this application and that the information on and included with this application is true, accurate and complete to the best of my knowledge.

I understand that I retain the responsibility for any hazardous substance discharges that I caused or cause, and for any discharges whose source I possess or control on the Property or Properties or on other properties.

It is my understanding that I have not met all the conditions for the off-site exemption at the time of this application, but I request a liability clarification determination that includes the conditions under which I or others would become eligible for the off-site discharge exemption for the Property or Properties, if I were to meet all the criteria under s. 292.13, Wis. Stats. I believe that I meet the criteria regarding the source of the contamination and the source property in s. 292.13, Wis. Stats., with respect to the fact that I never controlled or possessed either the source property itself, or the hazardous substances that have migrated onto the Property or Properties from the source property, nor did I cause the hazardous substance discharge for which I am seeking this written exemption.

I understand that if I meet the criteria in s. 292.13, Wis. Stats., and obtain the off-site liability exemption, but subsequently fail to satisfy the statutory requirements in s. 292.13, Wis. Stats., such as failing to provide access to the Property, the DNR has the authority to revoke the off-site exemption for the Property.

Applicant Last Name	First	MI
Signature	Date Signed	

9. DNR contacts and addresses for application submittals.

Send or deliver the completed request, supporting materials, and fee to the region where the property is located.
Contact a DNR Regional Brownfield Specialist with any questions about this form or a specific situation involving a contaminated property

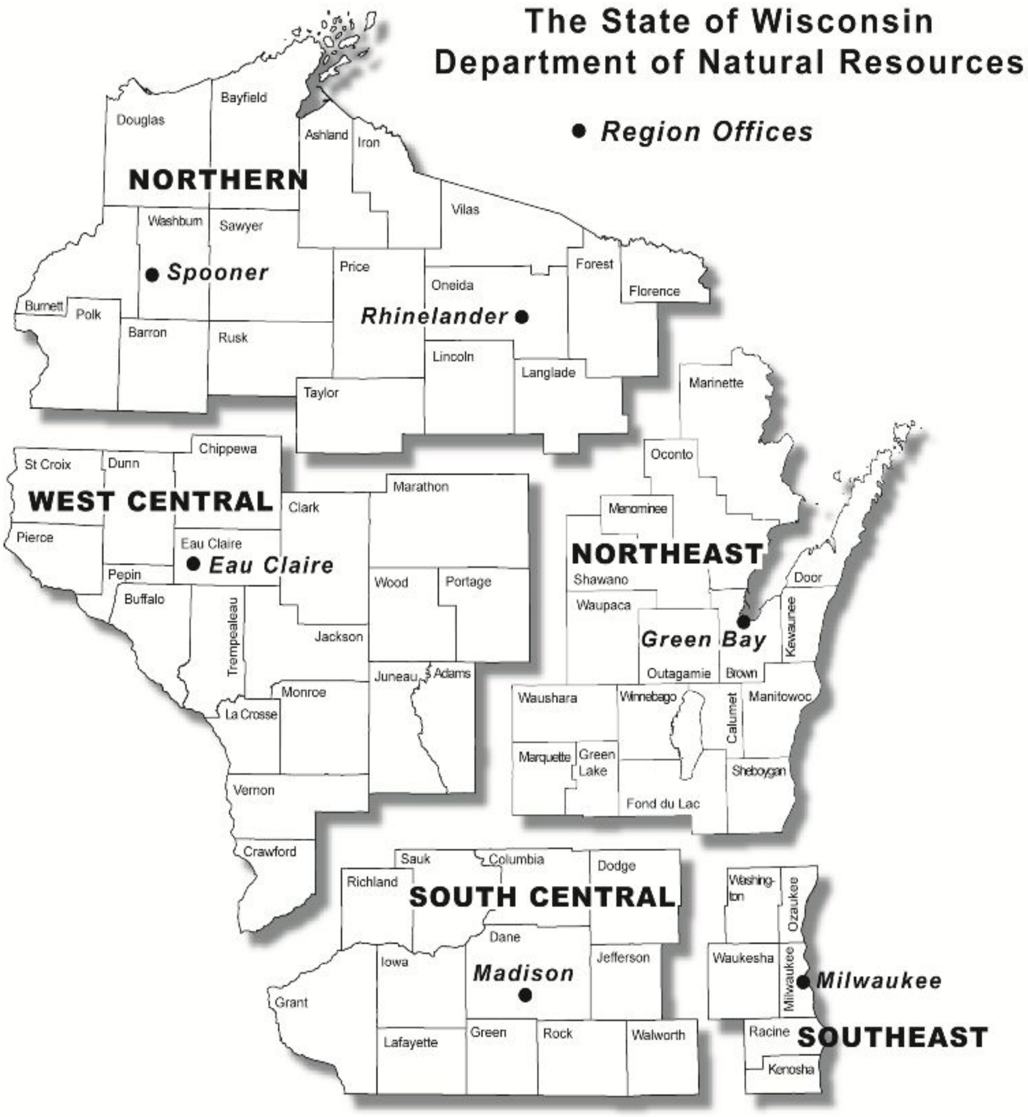
DNR NORTHERN REGION
Attn: RR Program Assistant
Department of Natural Resources
223 E Steinfest Rd Antigo, WI 54409

DNR NORTHEAST REGION
Attn: RR Program Assistant
Department of Natural Resources
2984 Shawano Avenue
Green Bay WI 54313

DNR SOUTH CENTRAL REGION
Attn: RR Program Assistant
Department of Natural Resources
3911 Fish Hatchery Road
Fitchburg WI 53711

DNR SOUTHEAST REGION
Attn: RR Program Assistant
Department of Natural Resources
2300 North Martin Luther King Drive
Milwaukee WI 53212

DNR WEST CENTRAL REGION
Attn: RR Program Assistant
Department of Natural Resources
1300 W Clairemont Avenue
Eau Claire WI 54702



Note: These are the Remediation and Redevelopment Program's designated regions. Other DNR program regional boundaries may be different.

For DNR Office Use Only

Date Received	BRRTS Activity Name		BRRTS Activity Code
Date Assigned	DNR Reviewer		BRRTS FID No. (if used)
Comments			Fee Enclosed ○ Yes ○ No
Date Approved	Date Additional Information Requested	Date Withdrawn	Date Denied

Off-Site Liability Exemption Application
Former Heimes Garage
3418 – 66th Street
Kenosha, WI

ATTACHMENT

Based on review of the Site Investigation Report (SIR) for the Former Heimes Garage site (Heimes), the Wisconsin Department of Natural Resources (WDNR) stated in email correspondence that the site investigation was incomplete and that further information and an additional round of groundwater sampling was required. However, the email was very brief, with few specific details. It is MEC's opinion that investigation of the petroleum contamination is complete, pending the additional round of groundwater sampling, and that the chlorinated volatile organic compound (CVOC) contamination in the 66th Street right-of-way and adjacent portions of the Heimes and Yutka Storage sites originated from an off-site source, Industrial Pumping, Inc. (IP), adjacent to the west side of Heimes.

In light of the above, MEC is hereby providing the additional information requested, seeking clarification and additional information to ensure that all of the Department's concerns can be addressed efficiently and seeking a liability exemption for the CVOC contamination on behalf of Talman Venture, LLC, the Responsible Party (RP).

This attachment is organized in general to conform to the enumerated items on form 4400-201, to provide additional information where needed.

4.0 Information on Property Affected by Off-Site Discharge

The latitude and longitude for the Former Heimes Garage site (Heimes) was obtained from Wisconsin Department of Natural Resources (WDNR) Bureau of Remediation and Redevelopment Tracking System (BRRTS) on the web listing for the site. The data was converted from decimal to degrees, minutes and seconds using the Federal Communication Commission website, which uses NSD27.

6.0 Specific Liability Questions Related to Off-Site Contamination

On June 9, 2020, MEC submitted the SIR for the Heimes site to the Department. The Remedial Action Options Report was submitted on June 12, 2020. The complete Closure Request Packet was submitted on June 17, 2020, and a July 6, 2020 email acknowledged receipt of the closure review fees by the Department. On June 25, 2020, MEC was notified by email that the Peer Review Committee recommended an additional round of groundwater sampling based on their review of the SIR and a phone call was scheduled for later that day. To MEC's recollection, no requirements beyond the additional round of groundwater sampling were specified by the Department. However, MEC anticipated that a formal written response to the Closure Request, for which the fees were paid, would be issued with the Department's findings and recommendations.

Due to the high volume of submittals to the Department as a result of the sunset of the PECFA program in June 2020, MEC anticipated that review of the Closure Request would likely take longer than usual. However, no written documentation of the review findings with any additional requirements was received. Beginning in early 2021 several attempts were made to contact the Department and determine what if any additional requirements beyond another round of groundwater sampling resulted from the Department's review of the SIR and Closure Request Packet.

MEC received an email on June 10, 2021 outlining the recommendations of the Peer Review Committee based on their review of the SIR. However, the email was very brief, with few specific details. Therefore MEC, is herein providing the additional information required, as well as seeking clarification and additional information on behalf of the Responsible Party to ensure that all of the Department's concerns can be addressed in the most efficient and economical means and with the fewest field mobilizations possible. In addition, MEC is seeking a liability exemption on behalf of the RP for the CVOC contamination on and in the immediate vicinity of the Heimes site, for which the former IP site at 3502 66th Street, adjacent to the west side of the Heimes site, is the source. The IP site is identified by BRRTS#: 02-30-000853. The June 10, 2021 email discussed above is provided for reference in Appendix A.

The items/recommendations outlined in the June 10, 2021 email are addressed point by point below.

1) **No soil figure has been prepared to illustrate the comprehensive soil delineation and conditions.**

MEC included Soil Contamination Maps in the SIR (Figure 3) and Closure Request (Figure B.2.a). Both figures illustrated the extent of petroleum and CVOC soil contamination exceeding residual contaminant levels (RCLs) based on the recent sampling results. The maps showed that the extent of petroleum soil contamination exceeding RCLs had been completely defined, while definition of the CVOC soil contamination adjacent to the Heimes site remained incomplete.

Historical soil sampling activities were conducted on and immediately adjacent to the Heimes property during the K. Singh and Associates (Singh) IP site investigation and remedial soil excavation in the early 1990s, as well as through a Phase II Environmental Site Assessment (ESA) conducted on the Heimes site by PEP Environmental (PEP) in 2002. In addition, MEC conducted soil sampling in the adjacent 66th Street right-of-way (ROW) in 2017 and 2018 as part of the environmental site investigation for the Yutka Storage site (BRRTS#: 02-30-578109) located on the south side of 66th Street at 6606 – 34th Avenue. These activities and results were documented in both the SIR and the Closure Request. However, while the Yutka sampling points were included on the Soil Contamination Map, those from Singh and PEP were excluded for purposes of clarity, legibility and for the presentation of the site conditions as they existed circa 2020, at the time of the closure request.

Maps including the Heimes site and two adjacent sites, (IP and Yutka Storage) have been developed, depicting all the soil sampling locations from 1992 to 2020 and the related site contaminant conditions. These maps are provided on Figures B.1.b.1, B.1.b.2, B.2.a.1, B.2.a.2, B.2.a.3 and B.2.b in Appendix B.

The Heimes environmental site investigation was conducted under the Petroleum Environmental Cleanup Fund (PECFA) program. The goal of the Heimes environmental site investigation was to characterize and define the petroleum contamination for which the Heimes site is the source property. It is MEC's opinion that the petroleum soil contamination at the Heimes site has been sufficiently investigated and is completely defined. It is also MEC's opinion that the RP for the Heimes site is not responsible for the CVOC soil contamination on and in the immediate vicinity of the Heimes site that has originated from offsite, specifically from the adjacent IP site. Therefore, the Heimes soil investigation should be considered complete. The CVOC soil contamination in the vicinity of the Heimes site is illustrated on Figure B.2.a.3 in Appendix B.

2) **Add B borings & discuss relevance of historic soil data to more recent sampling.**

The "B borings" refers to those advanced on the Heimes site by Singh as part of the 1992 to 1994 IP site investigation and by PEP as part of the 2002 Phase II ESA.

As part of the Heimes site investigation, MEC evaluated the historical soil data from the "B borings" as well as the results for the 1995 remedial soil excavation soil samples collected on, or adjacent to, the Heimes site using the most recent (December 2018) WDNR spreadsheet for determining RCL exceedances for both direct contact and groundwater protection. These activities and results were documented in both the SIR and the Closure Request. The PEP and IP soil boring locations and results were depicted on SIR Figures 11 and 24, respectively. The tables included in the Heimes SIR are provided for reference in Appendix C.

In 1992, four soil borings (B-11, B-13, B-14 and B-18) were drilled on the Heimes site as part of the IP site investigation. One soil sample was collected from each boring and analyzed for full VOCs, with two samples being collected from B-14. The exception was B-11, the soil sample from which was analyzed for diesel range organics (DRO) only, exhibiting a minor detection. Low level petroleum contamination was identified in the soil samples from these borings. Only benzene in the sample from B-13 exhibited a concentration above the current groundwater protection residual contaminant level (GWP RCL). However, the sample from B-13, like those from the other IP borings advanced on the Heimes site was collected from the saturated zone and therefore, the RCL is not applicable. The saturated zone at the Heimes site is present at approximately 6 feet below land surface (bls).

None of the IP soil samples were collected from the direct contact exposure zone. The low levels observed in these soil samples are consistent with those observed in samples collected in 2019 by MEC. Please refer to Figure B.2.a.1 in Appendix B. Table 7 summarizing the soil sample analytical results for borings B-11, B-13, B-14 and B-18 is provided in Appendix C.

In 2002 PEP advanced 6 soil borings (B-1 to B-6) on the Heimes site as part of a Phase II ESA. One soil sample was collected from each of the borings and analyzed for petroleum volatile organic compounds (PVOCs) and naphthalene. PVOCs and/or naphthalene were detected in all six of the PEP soil samples analyzed, with five of the samples exhibiting one or more compounds exceeding groundwater protection RCLs current as of December 2018. The PEP soil sample results are provided on Table 4 in Appendix C.

PEP soil boring B-6 was advanced directly through the underground storage tank (UST) cavity on the east side of the Heimes property. Soil sample B-6 exhibited the presence of significant petroleum contamination, with levels indicative of the presence of free product per WDNR guidance document RR 800, Addressing Vapor Intrusion at Remediation and Redevelopment Site in Wisconsin. However, it was collected from the saturated zone and therefore, represents groundwater contamination and the GWP RCLs are not applicable.

MEC soil boring DP-6 was advanced immediately adjacent to the downgradient (east) side of the UST cavity. The soil sample from DP-6 exhibited only minor detects of petroleum related contaminants, with no RCL exceedances. In addition, groundwater samples collected from DP-6 and co-located monitoring well MW-3 exhibited relatively low contaminant concentrations, with only benzene and methyl-tert-butyl-ether (MTBE) exceeding groundwater quality standards (GQSs). No free product was observed at DP-6 or at MW-3 during well development or two rounds of groundwater sampling. It is therefore apparent that the contaminant levels observed at B-6 were either confined to the tank cavity backfill, have degraded over the intervening decades or both.

The levels observed in the PEP borings were considerably higher than those observed in soil samples from both the Singh IP borings and the MEC borings located onsite. The reason for this anomaly is unknown however the preponderance of evidence for soil contaminant concentrations at the Heimes site lies with the historical K. Singh and recent MEC data. Although current industrial direct contact RCLs were exceeded in two of the PEP soil samples (B-2 and B-6), all of the samples were collected from below the upper four-foot direct contact zone and therefore, the direct contact RCLs are not applicable. The site is zoned G-2 Commercial. As a consequence, non-industrial direct contact RCLs apply at the site. None of the eight soil samples collected in 2019 by MEC from within the direct contact exposure zone (0 to 4 feet bls) exhibited contaminant concentrations exceeding direct contact RCLs.

Of the nine soil samples collected in 2019 by MEC from the unsaturated zone only three samples from two boring locations (DP-2 and DP-3) exhibited contaminant concentrations of exceeding RCLs protective of groundwater. Naphthalene exceeded the GWP RCL in all three samples and was the only compound to exceed a GWP RCL at the site in the MEC samples. The extent of petroleum soil contamination at the site exceeding RCLs has been defined. Definition of CVOC soil contamination exceeding RCLs adjacent to the site remained incomplete. The distribution of petroleum soil contamination exceeding groundwater protection RCLs is illustrated on Figures B.1.b.1, B.1.b.2, B.2.a.1, B.2.a.2, B.2.a.3 and B.2.b, in Appendix B.

No CVOCs have been detected in soil on the Heimes site with the exception of chlorobenzene, detected at low levels in saturated zone samples from IP borings B-14 and B-18. The distribution of CVOC soil contamination adjacent to the Heimes site is illustrated on Figure B.2.a.3 in Appendix B.

It is uncertain if, or the extent to which, petroleum soil contamination from the former Industrial pumping and Heimes site comingled. However, soil samples collected at the eastern extent of the Industrial Pumping remedial soil excavation appear to indicate that it was not substantial as illustrated on Figure B.2.b in Appendix B. The results for the remedial excavation samples collected on or immediately adjacent to the Heimes site are provided on Table 9 in Appendix C.

Whether due to the type of material released from the tank farm, the soil removal reportedly performed when the ASTs were removed from the Heimes site or the age and weathering of the release, there is a general absence of lighter end compounds, such as benzene and the prevalence of heavier end compounds, such as naphthalene and trimethylbenzenes, in the low levels of petroleum soil contamination remaining at the site, as documented by the samples collected by MEC. Petroleum soil contamination exceeding RCLs has been defined and does not extend offsite as illustrated on Figures B.1.b.1, B.1.b.2, B.2.a.1, B.2.a.2, B.2.a.3 and B.2.b.

3) **Use all relevant data to delineate soil contamination with isolines**

See discussion under items 1 and 2 above and Figures B.2.a.1, B.2.a.2, B.2.a.3 and B.2.b.

4) **Further groundwater sampling is needed to establish stable conditions. Two sampling events conducted 8 weeks apart are not adequate to make a decision.**

MEC will conduct the additional round of groundwater sampling once the scope of activities required to address any and all issues raised by the Peer Review Committee based on the SIR have been clarified and the parameters to be sampled for are determined. The Department has stated that the site investigation is incomplete. Therefore, MEC is attempting to determine what, if any field sampling activities are required prior to conducting the groundwater sampling to assure that any additional wells needed or other sampling required can be completed in as few field mobilizations as possible to minimize the costs and timeframe to achieve closure. In addition, it is MEC's contention that sampling the existing monitoring well network for the full list of

VOCs has been completed per DNR protocol and that the source of the CVOCs is offsite. Therefore, Talman Ventures is not responsible for additional sampling for the full list of VOCs or for addressing the consequences of the presence of CVOCs and the samples should be analyzed for petroleum volatile organic compounds (PVOCs) and naphthalene only.

5) Use groundwater data from area sites to define groundwater impacts.

Historical groundwater sampling activities were conducted on, and adjacent to the Heimes property as the result of the K. Singh IP site investigation in the early 1990s, as well as the PEP Phase II ESA conducted on the Heimes site in 2002. In addition, MEC conducted groundwater sampling in the adjacent 66th Street ROW as part of the Yutka Storage site (Yutka) investigation in 2017 and 2018. These activities and results were documented in both the SIR and the Closure Request. However, while the Yutka sampling points were included on the Groundwater Contamination Map, those from Singh and PEP were excluded for purposes of clarity, legibility and for the presentation of the site conditions as they existed circa 2020, at the time of the closure request.

Maps including the Heimes site and the IP and Yutka Storage sites have been developed, depicting all the groundwater sampling locations from 1992 to 2020 and the related site contaminant conditions. These maps are provided on Figure B.1.b.2, B.3.b.1, B.3.b.2 and B.3.b.3 in Appendix B. The PEP and IP groundwater sampling results on the Heimes site are provided on Tables 5 and 8, respectively in Appendix C. The Yutka groundwater sampling results adjacent to the Heimes site are provided on Table 11 in Appendix C.

The goal of the Heimes PECFA environmental site investigation was to characterize and define the petroleum contamination for which the Heimes site is the source property. It is MEC's opinion that the petroleum groundwater contamination has been sufficiently investigated, is completely defined and that the groundwater investigation should be considered complete. However, an additional round of sampling will be conducted to better evaluate concentration trends. It is also MEC's opinion that the RP for petroleum contamination that originated on the Heimes site is not responsible for the CVOC groundwater contamination in the 66th Street ROW or adjacent portions of the Heimes and Yutka sites that originated offsite. Therefore, the Heimes groundwater investigation should be considered complete, pending the additional round of groundwater sampling to be conducted for PVOCs and naphthalene. The CVOC groundwater contamination in the vicinity of the Heimes site is illustrated on Figure

B.3.b.3 in Appendix B.

Groundwater elevation data from the Heimes site investigation indicates that groundwater flow is to the south and southeast as illustrated on Figures B.3.c.1, B.3.c.2 and B.3.c.3 in Appendix B. Groundwater flow as established by the IP site investigation was consistently to the southeast over the period from 1992 to 1994. The southeasterly groundwater flow in the area is further corroborated by data from the Perrone site (BRRTS#: 03-30-553041) at 3604 67th Street, approximately 700 feet southwest of Heimes. See Figure B.1.c in Appendix B. Groundwater flow maps for the IP and Perrone sites are provided in Appendix D. The southward deviation in groundwater flow observed by the Heimes data, may be attributable the unusually wet conditions and related high groundwater elevations in 2020 as compared to historical data. Groundwater monitoring wells have yet to be installed as part of the Yutka site investigation. Consequently, groundwater elevation and flow data are not currently available for the Yutka site.

6) **Do not abandon the wells at this time.**

MEC will not abandon any groundwater monitoring wells without a commitment from the Department that a site has been granted closure.

7) **Vapor – further justification of screening results is needed using additional/comprehensive groundwater data.**

In April 2020, MEC completed vapor intrusion screening for the on-site buildings and the pole barn in the southwest corner of the Kenosha Steel Castings property, downgradient of the site. The screening considered both petroleum VOCs and CVOC contamination. However, the additional justification of the screening results discussed below is based solely on the Heimes petroleum contamination, as the CVOC contamination is from an off-site source, IP and not the responsibility of the Heimes RP.

All three buildings are of concrete slab-on-grade construction. The residence/office while heated, air conditioned and routinely occupied, is over 60 feet from locations where significant VOC concentrations were detected. As a consequence, the vapor intrusion screening primarily focused on the garage building on the Heimes site and the pattern storage pole barn on the adjacent Kenosha Steel Castings property. Both of these buildings are poorly sealed with overhead doors for vehicle access that make the potential for the migration and buildup of vapors inside the buildings highly unlikely.

The garage building has an overhead gas furnace for the cold weather months however, the building is only occupied for vehicle repair and maintenance on an intermittent basis and therefore, the duration of, and potential for, exposure is very limited. The pole barn is used for casting pattern storage, is unheated and occupied only briefly when casting patterns are stowed or retrieved consequently, the duration of exposure is extremely limited.

Existing petroleum soil and groundwater data were reviewed to assess the potential for VOC/PVOC vapor intrusion of the buildings. The petroleum contamination vapor intrusion screening was conducted in accordance with the January 2018 WDNR guidance document RR-800 Addressing Vapor Intrusion at Remediation and Redevelopment Sites in Wisconsin. The purpose of the screening was to determine if a vapor intrusion investigation of these buildings, to include sampling and analysis, was necessary, based on the petroleum contamination that originated onsite. The situations where a vapor investigation is recommended based on the presence of petroleum contamination according to the guidance document were evaluated, as discussed below.

Non-aqueous phase liquid (NAPL) indicators: NAPL also referred to as free product, has not been observed in any of the monitoring wells at the site. There are a number of NAPL indicators identified by the guidance. The NAPL indicators and Heimes sampling locations exhibiting those indicators are listed on the table below.

NAPL Indicators	Sampling Locations
Benzene > 10 mg/kg in soil	PEP B-2 (Unsat), B-6 (Sat)
Benzene > 5 mg/l in groundwater	None
Naphthalene >5 mg/kg in soil	PEP B-2 (Unsat), B-3 (Unsat), B-6 (Sat)
BTEX > 10 mg/kg in soil	PEP B-2 (Unsat), B-6 (Sat)
BTEX > 20 mg/l in groundwater	None
TPH > 250 mg/kg in soil	PEP B-1 (Unsat), B-2 (Unsat), B-3 (Unsat), B-6 (Sat)
TPH > 30 mg/l in groundwater	None
PID > 500 ppm in soil	DP-2, DP-3, PEP Borings Unknown

Notes:
BTEX = Benzene, Toluene, Ethylbenzene & Xylenes
TPH = Total Petroleum Hydrocarbons, equivalent to gasoline range organics (GRO) and/or diesel range organics (DRO).
PID = Photoionization Detector

PEP boring B-2 exhibited four soil NAPL indicators in 2002 and was located approximately 15 feet from MEC boring DP-2 and 20 feet from MEC boring DP-3 and monitoring well MW-1. While both borings DP-2 and DP-3 exhibited PID readings greater than 500 ppm, the soil and groundwater samples from those locations and MW-1 exhibited no analytical results even remotely approaching any of the NAPL indicators. Furthermore, no free product was observed during the development of MW-1 or two rounds of sampling the well. As a consequence, it is apparent that no free product in present in the area around B-2, DP-2, DP-3 and MW-1. B-2 is also greater than 30 feet from any building, beyond the threshold distance listed in the guidance. Furthermore, PEP boring B-5 is located between B-2 and the garage building and exhibited the absence of any NAPL indicators.

PEP boring B-3 exhibited two soil NAPL indicators in 2002 and was located approximately 10 feet from MEC boring DP-1. Boring DP-1 exhibited no NAPL indicators whatsoever and it is apparent that no free product is present in the area surrounding B-3 or DP-1. B-3 is also greater than 30 feet from any building and therefore, beyond the threshold distance listed in the guidance.

PEP boring B-6, advanced through the UST tank cavity, exhibited four soil NAPL indicators in 2002 and was located approximately 10 feet from boring MEC DP-6 and well MW-3. Boring DP-6 and well MW-3 exhibited no NAPL indicators whatsoever and it is apparent that no free product is present in the area surround B-6 or DP-6/MW-3. Furthermore, no free product was observed during the development of MW-3 or two rounds of sampling the well. As a consequence, it is apparent that no free product in present in the area around B-6, DP-6, and MW-3. B-6 is approximately 20 feet from the concrete slab-on-grade garage and therefore, within the threshold distance listed in the guidance. However, it is beyond the 30 foot threshold distance from the other buildings.

As a consequence of the above, the existence of NAPL at the site can be eliminated as an avenue for vapor intrusion.

Building has less than 5 feet of separation from groundwater with benzene exceeding 1,000 ug/l: At approximately 1.4 to 5.0 feet bls, the groundwater table is within the five-foot distance listed in the guidance as presenting a risk of intrusion. The buildings screened are all concrete slab-on-grade. However, the highest benzene concentration at the site from recent data is 169 ug/l at DP-6, well below the 1,000 ug/l screening threshold for groundwater beneath a building, as stipulated in the guidance document. Sample WB-6 collected from PEP boring B-6, located within the UST cavity in 2002 exhibited a benzene concentration of 184 ug/l. The groundwater well MW-3, located adjacent to both DP-6 and B-6 exhibited benzene concentrations of <0.25 ug/l and 4.7 ug/l. As a consequence, this potential pathway for vapor intrusion can be dismissed per the guidance.

Groundwater exceeding PALs in contact with foundation or entering the building: Based on the distribution of petroleum related groundwater contamination at the site, concentrations exceeding PALs may be present beneath the garage and pole barn buildings. However, at 1.4 to 5.0 feet bls, groundwater is below the slab-on-grade foundations and is not entering the buildings. Therefore, this avenue for vapor intrusion can be eliminated as a concern.

PVOC impacted soil with potential for off-gassing: No PVOCs were identified in recent soil data at concentrations exceeding RCLs. One relatively low-level PAH constituent (naphthalene) was present at concentrations exceeding the GWP RCL in soil at borings DP-2 and DP-3. These represent the only RCL exceedances at the site and do not pose a significant risk for lateral vapor migration or intrusion.

Significant PVOC concentrations were exhibited by the soil sample collected in 2002 from the PEP boring B-6. However, this sample was collected from the saturated zone within the UST cavity and therefore, represents dissolved phase groundwater contamination and not soil contamination subject to significant off-gassing. Furthermore, only minimal soil contamination was detected at the adjacent MEC boring DP-6. Therefore, this pathway for vapor intrusion can be eliminated as a concern.

Utilities with PVOC vapors: No PVOCs were identified in recent soil data at concentrations exceeding RCLs. Significant PVOC concentrations were exhibited by the soil sample collected in 2002 from the PEP boring B-6. However, this sample was collected from the saturated zone within the UST cavity and therefore, represents dissolved phase groundwater contamination and not soil contamination subject to significant off-gassing into utility trenches. Furthermore, only minimal soil contamination was detected at the adjacent MEC boring DP-6.

There is no evidence of vapors in utility trenches at the site. The sanitary sewer, municipal water lateral and natural gas utilities are shallow with little to no impermeable pavement above to prevent off-gassing to the atmosphere. With the relatively low level PVOC contamination and the long distance from contaminated areas to the concrete slab-on-grade office/residence building it is very unlikely that vapors would migrate to that building. The water and gas lines run to the garage from 66th Street and then to the office/residence, which is too distant from the contaminated areas to be at significant risk. The concrete slab-on-grade construction and occupancy of the garage makes the potential for vapor accumulation remote. The pole barn is not served by underground utilities. This avenue can be eliminated as a concern.

PVOC odors: No odors were evident during site visits and are not present within the buildings in question, according the owner and the occupant in 2020.

Based on the petroleum vapor intrusion screening discussed above, performance of a petroleum vapor intrusion investigation has been determined to be unwarranted per WDNR guidance. The Heimes RP is not responsible for the CVOC contamination that originated from an off-site source (IP) or for investigating potential CVOC vapor intrusion.

8) SI not considered complete.

MEC will conduct the additional round of groundwater sampling to further evaluate groundwater concentration trends once the scope of activities required to address all the issues raised by the Peer Review Committee based on the SIR have been clarified and the parameters to be sampled for are determined.

It is MECs opinion that petroleum soil and groundwater contamination at the Heimes site have been sufficiently characterized and the extents have been fully defined. In addition, petroleum vapor intrusion has been screened out as a concern. Therefore, MEC believes the petroleum site investigation is complete. However, the Department has stated that the site investigation is incomplete.

In light of the above, MEC is attempting to determine what, if any, field sampling activities are required prior to conducting the groundwater sampling to assure that any additional wells needed or other sampling required can be completed in as few field mobilizations as possible to minimize the costs and timeframe for achieving closure. In addition, it is MEC's contention that the first-round sampling of the existing monitoring wells for the full list of VOCs has been completed per DNR protocol and that the source of the CVOCs is from offsite, IP. Therefore, the RP (Talman Ventures) is not responsible for additional investigation of the CVOC contamination. Nor is Talman responsible for additional groundwater analysis for the full list of VOCs or for addressing the consequences of results identifying the presence the CVOCs.

7.0 Property Information to Determine Off-Site Exemption

The property at 3502 66th Street, immediately adjacent to the west side of the Former Heimes Garage (Heimes) site, previously operated as Industrial Pumping, Inc. (IP) a bulk petroleum recycling facility with numerous aboveground storage tanks (ASTs). It is the opinion of Midwest Environmental Consulting (MEC) that the former IP site is the source of the chlorinated volatile organic compound (CVOC) contamination on, and in the vicinity of, the Heimes site. As a consequence, Talman Ventures, LLC, the Responsible Party (RP) for the Heimes Garage site should only be responsible for the petroleum contamination that originated onsite and should not bear further responsibility for addressing the CVOC contamination that originated from the offsite source, IP.

MEC's opinion is based the IP site investigation and remediation data, which identified the presence of CVOCs on the IP site. In addition, MEC's opinion is based on the occurrence of improper storage issues and numerous historic waste/oil spills at the IP site, some of which were documented to contain CVOCs. The detailed evidence for these conclusions is discussed in the sections below.

7.1 Location Maps

The site locations are illustrated on Figures B.1.a, B.1.b.1, B.1.b.2 and B.1.c in Appendix B.

7.2a Property with Sampling Locations

Maps depicting the sampling locations on the IP, Yutka and Heimes sites are provided in Appendix B.

7.2b Data Interpretation Signed by a Qualified Environmental Professional

The recent and historical data regarding CVOC contamination at, and in the vicinity of, the IP, Yutka and Heimes sites is discussed in chronological order and by site in the sections that follow.

Spill Incidents – Former Industrial Pumping Facility 3502 66th Street: MEC reviewed the WDNR file regarding spill incidents related to the IP facility that occurred in the 66th Street ROW. The BRRTS numbers associated with the spills information are 04-30-042541 and 02-30-000853.

Kenosha Fire Department inspection records included in a May 10, 1994 K. Singh letter (Appendix L, discussed later) show that the IP site was occupied by Gabron-Girsh Oil, Inc. between 1964 and 1979 and that violations occurred in the 1970s. The site had six ASTs containing gasoline and number 1 and number 2 fuel oil. Please refer to Appendix E.

February 1988 Oil Spill: On February 8, 1988, the Kenosha Fire Department hazardous materials team responded to an oil spill in the 3500 block of 66th Street. Paul Hess of the Kenosha County Department of Emergency Government (DEG) reported the release to the WDNR. The location was listed as the alley (66th Street) adjacent to Industrial Pump, Inc. The Toxic and Hazardous Spill Report form identified the Industrial Pumping, Inc. facility at 3502 66th Street as the source property with the source of the spill listed as leaking storage tanks. The spilled material was described as approximately 100 gallons of an unknown liquid. The Spill Report form noted the possibility of prosecution as an unlicensed storage facility and waste hauler.

A sample of the spilled material was collected by the City of Kenosha Fire Department Hazmat Team and submitted by the WDNR for metals analysis, The Water Chemistry – Law Enforcement form indicated the presence of lead at 590 mg/kg and the absence of the other metals tested. The form identified the spilled material as cutting oil and a field test indicated polychlorinated biphenyls (PCBs) were less than 50 ppm. The chain of custody form described the spilled material as oil from a leaking tanker. The BRRTS site (04-30-042541) listed the cause as a hole poked in a tank car. The material was not tested for CVOCs and therefore, it is not known if they were present or not.

In a March 7, 1988, letter the WDNR requested information on the IP facility including, storage tanks, stored materials, destination of the materials and security measures. Industrial Pumping responded to the request on March 14, 1988, indicating the facility primarily stored waste oil, with some coolant and fuel oil, all destined for recycling. No information on security measures was provided.

It should be noted that the Heimes Garage bulk storage site stored virgin products for sale in six 15,000-gallon ASTs and one 20,000-gallon AST, including gasoline, kerosene, fuel oil and an unidentified solvent, possibly the non-CVOC containing Stoddard solvent. Based on aerial photographs the ASTs were still present in 1970 and were removed by 1975. The Heimes AST volumes, contents, locations and select aerial photographs are included in Appendix F. In addition, the Heimes Garage site had two 500-gallon USTs, one gasoline and one diesel for vehicle fueling, see Figures B.1.b.1 and B.1.b.2 in Appendix B.

Collocated soil boring and monitoring well B-14/MW-7 was installed as part of the IP site investigation at the former location of the Heimes solvent AST. Chlorobenzene at 0.75 mg/kg, above the current GWP RCL was the only CVOC detected in soil. However, the soil sample was collected from the saturated zone and therefore, the GWP RCL is not applicable.

According to the United States Geological Survey (USGS), chlorobenzene is both a solvent produced for industry and the breakdown product of both 1,2-dichlorobenzene (DCB) and 1,4-dichlorobenzene. Please refer to Description, Properties and Degradation of Selected VOCs Detected in Ground Water in Appendix G. The sources of Chlorobenzenes are discussed on Page 9 of the USGS report. The degradation of chlorobenzenes is discussed beginning on page 24, with Table 16 on page 27 showing degradation of 1,2-DCB and 1,4-DCB to chlorobenzene under aerobic and anaerobic conditions. Chlorobenzene has been detected in soil samples collected from the saturated zone on both the Heimes site and the upgradient IP site. 1,2-DCB, 1,3-DCB and 1,4-DCB were all present in the 1990 oil spill sample at concentrations of 16, 12 and 7 mg/kg, respectively, documenting the IP site as a source for a release of these CVOCs.

An April 6, 1988 follow up letter from the WDNR made recommendations regarding security of the oil storage and transfer system at the IP site and noted the presence of an area of leaked oil where hoses are coupled/uncoupled that required soil removal and disposal, as well as the use of a portable catch basin to contain future dripping from the hoses. A memo noted that the U.S. EPA Emergency Response Team visited the facility in November 1988. WDNR file documents pertaining to the February 1988 spill are provided as Appendix H.

According to the April 7, 1995 K. Singh letter (Appendix L, discussed later), an oil sample and a sludge sample were collected by Ken Smith of IP in September 1989 to be analyzed for waste characterization purposes. The oil sample was not analyzed for CVOCs however, the sludge sample was, revealing the presence of methylene chloride, trichloroethene (TCE), tetrachloroethene (PCE), 1,1,1-Trichloroethane (1,1,1-TCA), 1,1-dichloroethene (1,1-DCE) and the gasoline additive 1,1-dichloroethane (1,1-DCA). The total CVOC concentration was 22.586 mg/kg with a total chlorine content of 6,000 ppm. An additional oil sample was collected on October 24, 1989, and analyzed for VOCs, revealing the presence of TCE, 1,1,1-TCA and carbon tetrachloride with a total CVOC concentration of 315 mg/kg. The individual CVOC concentrations are provided on Figure B.4.c in Appendix B. Please refer to the documentation provided as Appendix I.

<u>August 1990 Oil Spill:</u> On August 7, 1990, the Kenosha County DEG responded to another oil spill in the 3500 block of 66th Street, also emanating from the IP facility. The spill volume was estimated at 100 gallons and was cleaned up by IP. Sampling and analysis of the spilled material revealed the presence of PCBs and VOCs, including CVOCs. The eight CVOCs present included various dichlorobenzenes, methylene chloride, chloroform and dichloroethenes. The material was deemed by the WDNR not to constitute a hazardous waste. An August 20, 1990 file note referenced a conference call with Ken Smith of IP discussing site security, soil cleanup, waste oil activities, a Bureau of Petroleum Inspection and a semi-trailer adjacent to the property. The individual CVOC concentrations are provided on Figure B.4.c in Appendix B. WDNR file documents pertaining to the August 1990 spill are provided as Appendix J.

<u>September 1991 Oil Spill:</u> In September 1991 an incident occurred involving material leaking from oil drums located inside a truck at the IP site. The Kenosha County DEG contacted the WDNR with concerns that the material may be hazardous waste, that it should be identified as soon as possible and that it may not be handled properly. No information was available regarding cleanup and disposal of the spilled materials or if analysis for CVOCs was conducted.

A WDNR hazardous waste field inspection was conducted in August 1993. The form, signed in September 1993 indicated that a notice of noncompliance or a notice of violation would be sent. MEC was not able to locate a copy of such a letter.

A WDNR hazardous waste field inspection of the IP facility was conducted in March 1994. Approximately 75 drums of waste oil and PCBs were observed on site. Waste profiles were submitted to Chemical Waste Management (CWM) based on samples collected in September 1993, prior to clean out and removal of the IP oil recycling and processing facility. The estimated volume was 50 drums and 12.5 tons of oily liquids, as well as 50 drums of oily solids. The oily solids were indicated to have a PCB concentration of 533 ppm. The copies were faxed by CWM to the DNR Waste Management Bureau, noting that as of April 1994, the materials had not been received. It is not known if the waste profile samples were analyzed for VOCs however, waste oils containing impurities such as PCBs are likely to also contain CVOCs. WDNR file documents pertaining to the September 1991 spill and follow up activities through 1994 are provided as Appendix K.

An April 1994 WDNR letter regarding the K. Singh Remedial Investigation and Remedial Action Plan stated that additional site investigation activities were required and additional information regarding the history of the site, including the storage and handling of parts cleaning solvents was needed. The letter also stated that, based on the products and wastes handled at the facility, additional parameters, including full VOCs needed to be analyzed and the presence of CVOCs needed to be determined.

In their May 1994 response, K. Singh stated that the Gabron-Girsh bulk plant operated until 1979. In 1980/1981 IP purchased the site and the use of the tanks changed from virgin fuel oil and gasoline to waste oil. Ken Smith of IP stated that no solvents were stored onsite but, that solvents may have been present in the waste oil that came from a number of local facilities, which included American Motors. The letter also included a description of the delivery of waste oil to the site in tankers and the storage, reclamation and disposal of the waste oil. Coolant from a die casting facility was also stored at the site. The letter included plans for additional investigation activities to include sampling of soil and groundwater for full VOCs. The April 1994 WDNR letter and May 1994 K. Singh response are provided as Appendix L.

It should be noted that 66th Street is paved with gravel. The gravel pavement provides a porous surface into which petroleum and other liquids could easily infiltrate, and then potentially migrate through permeable fill in the near subsurface and possibly through the native clay layer to the underlying silt and fine sand layer at depth.

Municipal water and sanitary sewer lines running north-south are present beneath 66th Street in the vicinity of the historic spills. The sanitary sewer and municipal water lines traverse the Heimes Garage site, the Industrial Pumping site, 66th Street and the Yutka Storage site on the south side of 66th Street. These subsurface utilities present a potential preferred conduit for contaminant migration. See Figures B.1.b.1 and B.1.b.2 in Appendix B.

In summary, several waste oil spills were documented to have occurred on the IP site and/or in the adjacent 66th Street ROW. Some of the waste oil spilled and stored at the facility is documented to have contained significant concentrations of CVOCs and the waste oil spilled but not tested for VOCs likely also contained CVOCs, which is common for waste oil, especially from industrial sources. The IP site surface was unpaved, the 66th Street ROW was paved with gravel and therefore, the surfaces on to which the spills and dripping occurred were pervious to infiltration by the waste oil. In addition, sanitary sewer and municipal water utility are present beneath 66th street, constituting potential preferred contaminant migration pathways as illustrated on the Figures B.1.b.1 and B.1.b.2 in Appendix B. Consequently, the waste oil releases from IP constitute a known source of CVOCs available to contaminate soil and groundwater in and adjacent to the 66th Street ROW.

Site Investigation and Remediation – Former Industrial Pumping 3502 66th Street: In May 1992, the WDNR issued a responsible party letter to Mr. Kenneth Smith, the owner of IP, requiring an environmental site investigation and cleanup. K. Singh conducted investigation activities from June 1992 through July 1997. Twenty-three soil borings (B-1 to B-23) were advanced on and adjacent to the IP site, seven of which were completed as groundwater monitoring wells (MW-1 to MW-7) and five of which were completed as post-remedial soil excavation replacement wells (MW-1R, MW-2R, MW-4R, MW-5R and MW-6R).

Soil samples were collected from borings B-1 to B-18 and analyzed for some combination of the following; Gasoline range organics (GRO), DRO, VOCs, PVOCs, total recoverable petroleum hydrocarbons (TRPH) and the eight Resource Conservation and Recovery Act (RCRA) metals. Groundwater samples collected from the wells were analyzed for some combination of the following; GRO, DRO, VOCs/PVOCs, polynuclear aromatic hydrocarbons (PAHs), PCBs and the eight RCRA metals during several rounds of sampling.

Soil and groundwater contamination was identified both on the IP site and offsite to the east on the Heimes Garage property. Based on the contaminant distribution, it appears likely that contamination was also present beneath 66th Street, however this was never investigated by K. Singh. The former IP AST system configuration, soil boring and monitoring well locations, along with the distribution of soil and groundwater contamination are illustrated on the Figures in Appendix B.

CVOCs in Soil - Industrial Pumping Property

Soil borings B-1 to B-8 were all advanced in June 1992 on the IP site. The soil samples collected were not analyzed for the full list of VOCs therefore, the presence or absence of CVOCs at these locations is undocumented.

Soil borings B-9 to B-11 were all advanced off the IP site in October 1992. Borings B-9 and B-10 were advanced on the south side of 66th Street, adjacent to the future Yutka Storage site. Boring B-11 was advanced on the Heimes site, just across the property line from IP. The soil samples collected were not analyzed for the full list of VOCs therefore, the presence or absence of CVOCs at these locations is unknown.

Soil borings B-12 to B-18 were advanced in July 1994 on the IP site (B-16 & B-17), on the Heimes site (B-13, B-14 and B-18) and on the southside of 66th Street, adjacent to the future Yutka site (B-12). All the soil samples collected were analyzed for full VOCs. Soil samples from borings B-14, B16, B-17 and B-18 exhibited the presence of CVOCs. The soil sample results from the IP borings advanced on and adjacent to the Heimes site are summarized on Tables 6 and 7 in Appendix C. Excerpts of laboratory reports from the IP site investigation and remediation activities exhibiting the presence of CVOCs in soil and groundwater samples are provided in Appendix M.

CVOCs identified on the IP site were TCE at B-16 and chlorobenzene at B-17, both located in the northwestern (upgradient) portion of the site. The TCE concentration was two orders of magnitude above the current GWP RCL. Chlorobenzene was detected on the Heimes site at both B-14 and B-18, both above the GWP RCL. However, all of these soil samples were collected from the saturated zone and therefore, represent groundwater contamination and therefore, GWP RCLs do not apply. Only the shallower of the two soil samples collected from B-14 exhibited chlorobenzene. According to the USGS, chlorobenzene is both a solvent produced for industry and the breakdown product of 1,2-DCB and 1,4-DCB through aerobic and anaerobic decomposition, as well as abiotic dechlorinization. Please refer to Appendix G.

In March 1995, K. Singh directed the excavation and disposal of 5,338 tons of contaminated soil from the IP site and from the northwest portion of the Heimes site onto which the excavation was extended based on elevated PID readings and strong gasoline odors. In addition, 24,000 gallons of contaminated groundwater were pumped out of the excavation and transported offsite for treatment/disposal. The area of excavation is illustrated on Figures B.1.b.1, B.1.b.2, B.2.a.3 and B.2.b in Appendix B.

Forty-two soil samples were collected from the final limits (base and walls) of the excavation, all of which were analyzed for full VOCs. Soil wall sample A-7W, collected from the unsaturated zone in the southwest corner of the site, exhibited the presence of both cis-1,2-DCE and trans-1,2-DCE, with cis-1,2-DCE exceeding the GWP RCL. Base sample E-3B collected from the saturated zone near the property line with Heimes Garage exhibited the presence of 1,2-DCA, a CVOC, which is however, a common gasoline additive and is therefore, related to petroleum, not solvent contamination. The analytical results for the soil samples collected from the excavation on and immediately adjacent to the Heimes site are summarized on Table 9 in Appendix C.

One of the soil stockpile samples collected during the remedial soil excavation (SP#2) exhibited a significant PCE concentration of 1.430 mg/kg, three orders of magnitude higher than the current GWP RCL.

Soil borings B-19 to B-23 were all advanced in June 1995 on the Industrial Pumping site, except B-21, which was advanced on the future Yutka property, to the south of 66th Street. No soil samples were collected as the borings were advanced to install monitoring wells MW-1R, MW-2R, MW-4R, MW-5R and MW-6R to replace the monitoring well network removed as part of the remedial soil excavation.

CVOCs in Groundwater – Industrial Pumping

Six groundwater monitoring wells (MW-1 to MW-6) were installed on the IP site as part of the K. Singh site investigation. Three rounds of groundwater monitoring were conducted for monitoring wells MW-1 to MW-6 from June 1992 through June 1994. The wells were sampled for full VOCs all three rounds. The CVOC 1,1-DCE was present in MW-6, located in the northwest (upgradient) portion of the site during the July 1992 sampling round, which exceeded the preventive action limit (PAL), indicating an upgradient source. Excerpts of laboratory reports from the IP site investigation and remediation activities exhibiting the presence of CVOCs in soil and groundwater samples are provided in Appendix M.

No monitoring well was installed in the southeast corner of the IP property or the 66th Street ROW where the historic oil spills occurred, some documented to contain CVOCs. The nearest well, MW-4 was located approximately 40 feet north (upgradient) from the southeastern corner property lines. Therefore, the presence of CVOC contamination in the area of the historic oil spills was not adequately investigated. Soil boring HP-1, advanced adjacent to the southeast corner of the IP site as part of the Yutka investigation exhibited both soil and groundwater CVOC contamination, with PCE exceeding the GWP RCL. The PCE in soil at this location represents a source for the CVOC groundwater contamination in, and adjacent to, the 66th Street ROW, which includes PCE and its breakdown products.

Monitoring well MW-4, located in the southeast portion of the site, exhibited petroleum related groundwater quality standard (GQS) exceedances with contaminant concentrations increasing over time. As a consequence, monitoring well MW-7 was installed by K. Singh on the Heimes site, down-gradient (east) from MW-4. Monitoring well MW-7 was sampled for full VOCs in July 1992 and July 1994. Similar to MW-4, MW-7 also exhibited benzene exceeding the enforcement standard (ES), however, no CVOCs were detected. It should be noted that MW-7 was installed at the former location of the solvent AST on the Heimes site, providing strong evidence that the Heimes solvent AST was not a source for CVOC contamination. The analytical results for the seven groundwater samples collected from MW-7 are summarized on Table 8 in Appendix C.

Replacement wells MW-1R, MW-2R, MW-4R, MW-5R and MW-6R, installed outside the main zone of contamination after the remedial soil excavation were sampled for full VOCs in July 1995. No CVOCs were detected. However, MW-4R was installed on the future Yutka site, in a hydraulically side-gradient direction. As a consequence, MW-7 was the only down-gradient well for the IP site. However, MW-7 was not located directly down-gradient from the historic spills area, but rather side/up-gradient.

As previously discussed, multiple releases of petroleum from the IP site occurred in, and immediately adjacent to, 66th Street, some of which were documented to contain CVOCs. However, investigation of soil and groundwater contamination within the right-of-way, including underground utilities which may have provided preferred contaminant migration pathways was never conducted during the IP site investigation. As discussed below, site investigation activities for the adjacent Yutka Storage site have identified petroleum and non-petroleum soil and groundwater contamination within the 66th Street ROW, with CVOCs exceeding both soil RCLs and GQSs. The CVOC contamination has impacted the 66th Street ROW and adjacent portions of the Heimes and Yutka sites.

CVOC Soil Investigation – Yutka Storage: As of the date of this Liability Exemption Request, MEC is conducting an environmental site investigation at the Yutka Storage site, across 66th Street to the south of Heimes. The initial investigation activities included advancing four direct-push soil borings (HP-1 to HP-4), in December 2017, within the 66th Street ROW adjacent to the Yutka, Heimes and IP sites to facilitate the collection and analysis of soil samples and groundwater grab samples. The soil boring locations within the 66th Street ROW, adjacent to the Heimes site are illustrated on Figure B.1.b.1, B.1.b.2, B.2.a.1, B.2.,a.2 and B.2.a.3 in Appendix B.

One soil sample was collected from each of the soil borings within the 66th Street ROW and analyzed for VOCs. One CVOC, PCE, was detected in the soil sample from HP-1. The PCE concentration exceeded the groundwater protection RCL. Soil boring HP-1 was advanced immediately adjacent to the southern property line of the former IP site where historical spills occurred, and which is deemed to be the source of the soil contamination. The Yutka site 66th Street ROW soil sample CVOC results are summarized on Figure B.2.a.3 in Appendix B and Table 10 in Appendix C.

The three remaining soil borings in the 66th Street ROW were advanced further to the east of HP-1, to the south of the Heimes and Kenosha Steel Castings property lines. No VOCs were detected in the three remaining soil samples collected within the 66th Street ROW, further indicating the former IP property as the source of the CVOC contamination.

CVOC Groundwater Investigation – Yutka Storage

Groundwater grab samples were collected from all four of the borings (HP-1 to HP-4) advanced within the 66th Street ROW and analyzed for VOCs. CVOCs were detected in both HP-1W and HP-3W, with vinyl chloride exceeding the ES in sample HP-3W. The CVOCs detected are all breakdown products of PCE, which was present in the soil sample from boring HP-1 exceeding the GWP RCL at the IP source.

Due to a laboratory error, the groundwater samples discussed above were left unrefrigerated for several days, requiring the analytical results to be flagged. As a consequence, four additional soil borings (HP-1R to HP-4R) were advanced in the same locations as HP-1 to HP-4 in January 2018, to collect additional groundwater grab samples for VOC analysis. CVOCs were detected in all four of the groundwater samples, with vinyl chloride exceeding the ES in samples HP-3WR and HP-4WR. Once again, the CVOCs present were all breakdown products of PCE, which exceeded the GWP RCL in the soil sample from boring HP-1 located adjacent to the Industrial Pumping site. The Yutka groundwater sampling locations within the 66th Street right-of-way are illustrated on Figures B.3.b.1 and B3.b.2 in Appendix B. The Yutka site 66th

Street ROW groundwater sample results are summarized on Table 11 in Appendix C.

The Yutka site investigation results demonstrate that CVOC contamination from the IP site has impacted the 66th Street ROW, adjacent portions of the Heimes and Yutka sites.

The Yutka Storage site investigation observations confirm the prevalence of near-surface historical filling in the general area around the Heimes, Yutka and IP sites, predominated by permeable foundry sand fill that, in conjunction with the unpaved surfaces in the area of the historic oil spills, present conditions favorable for the infiltration and migration of oil and CVOCs in the subsurface.

CVOC Soil Investigation – Heimes

In 1992, four soil borings (B-11, B-13, B-14 and B-18) were advanced on the Heimes site as part of the IP site investigation. One soil sample was collected from each boring and analyzed for full VOCs, with two samples being collected from B-14.The exception was B-11, the soil sample from which was analyzed for DRO only. Low level chlorobenzene contamination was identified in saturated soil in one sample each from borings B-14 and B-18. Please refer to the IP CVOC section for the detailed discussion. The low levels of chlorobenzene at borings B-14 and B-18 are not indicative of a CVOC source on the Heimes property. Rather, these levels are in keeping with residual groundwater contamination from a more distant source, further upgradient.

In March 1995, K. Singh conducted a remedial soil excavation up to the western Heimes property line and across the property line onto northwest corner of the Heimes property. One excavation wall soil sample (F-2W) was collected on the Heimes site and analyzed for full VOCs. In addition, 14 excavation wall and floor soil samples were collected immediately adjacent to the western Heimes property line, along which the Heimes ASTs and in particular the solvent AST were located. The samples were analyzed for full VOCs. The only CVOC detected in any of these samples was the gasoline additive 1,2-DCA, in base soil sample E-3B, collected from the saturated zone. These results do not indicate the presence of a source of CVOCs from the ASTs, drum storage building or pump house on the Heimes site. The excavation soil sample locations and CVOC results are illustrated on Figure B.2.a.3 in Appendix B. Please refer to the IP CVOC section for the detailed discussion of the K. Singh investigation and remediation activities and results on, and immediately adjacent to, the Heimes site.

In 2002, six soil borings (B-1 to B-6) were advanced on the Heimes site as part of the PEP Phase II ESA. The soil samples collected were not analyzed for the full list of VOCs therefore, the presence or absence of CVOCs at these locations is undocumented.

In September 2019, MEC advanced 8 direct-push soil borings (DP-1 through DP-8) on the Heimes property and the adjacent Kenosha Steel Castings property to the east. The soil samples collected were not analyzed for the full list of VOCs as part of the PECFA investigation therefore, the presence or absence of CVOCs at these locations is undocumented.

In January 2020, five hollow-stem auger (HSA) soil borings (MW-1 to MW-5) were advanced on the Heimes and Kenosha Steel Castings properties for the purpose of installing groundwater monitoring wells. No elevated PID readings were observed at any of the borings. Due to the proximity of these borings to previously advanced direct push borings, no soil samples were collected for laboratory analysis as definition of petroleum soil contamination was considered to be complete.

In March 2020, three HSA borings (MW-6 to MW-8) were advanced further down-gradient (southeast) from the site on the Kenosha Steel Castings property and Yutka Storage site to install additional groundwater monitoring wells to complete definition of the extent of petroleum groundwater contamination, specifically MTBE contamination. No elevated PID readings were observed and no soil samples were collected for laboratory analysis as the extent of petroleum soil contamination was considered to be completely defined.

A total of nine soil samples were submitted to a state-certified laboratory for analysis. Because the investigation of the Heimes Garage site was conducted as part of the PECFA program, the soil samples were not analyzed for full VOCs as the IP site was deemed to be the source of CVOCs in the area and these costs were ineligible for reimbursement. Therefore, the presence or absence of CVOCs at these locations is undocumented by the MEC soil samples.

In summary, full VOCs were analyzed in five K. Singh soil samples collected from three onsite locations (B-13, B-14, B-18 and F-2W). No CVOCs have been detected in soil onsite with the exception of chlorobenzene at low levels in saturated zone samples from former IP borings B-14 and B-18. See Table 7 in Appendix C. In addition, 13 soil excavation samples were collected immediately adjacent to the western Heimes property line and one sample on the Heimes property with no CVOCs detected, except the gasoline additive 1,2-DCA in sample E-3B. See Table 9 in Appendix C. Based on these results, there is no evidence of an onsite source for non-petroleum related CVOC soil contamination at the Heimes site.

CVOC Groundwater Contamination – Heimes

Monitoring well MW-7 was installed on the Heimes site in 1992 as part of the IP site investigation and was samples twice for full VOCs with none detected. IP well MW-7 was installed at the former location of the solvent AST on the Heimes site, providing strong evidence that the Heimes solvent AST was not a source for CVOC contamination. The location of MW-7 is illustrated on Figures B.1.b.1, B1.b.2, B.3.b.1 and B.3.b.2 in Appendix B. The analytical results for the seven groundwater samples collected from MW-7 are summarized on Table 8 in Appendix C.

In September 2019, Midwest advanced eight direct-push soil borings (DP-1 through DP-8) at the site and on the Kenosha Steel Castings property adjacent to the east. Temporary groundwater grab sampling points (DP-1W through DP-8W) were inserted into all of the direct-push soil borings and a groundwater grab sample was collected from each of these locations for analysis of VOCs. CVOCs were identified in groundwater at one location (DP-4), adjacent to the 66th Street ROW, with vinyl chloride exceeding the ES. The two CVOCS detected at DP-4 are both breakdown products of PCE, identified in spilled material at the former IP site, upgradient and adjacent to the west, as well as HP-1. The groundwater grab sampling locations and groundwater CVOC results are illustrated on Figure B.3.b.3 in Appendix B.

In January 2020, MEC installed and sampled the five NR141 compliant groundwater monitoring wells (MW-1 to MW-5) on the Heimes and Kenosha Steel properties. The samples were analyzed for full VOCs. Based on the sample results, petroleum groundwater contamination was defined with the exception of MTBE, which exceeded the ES at two downgradient locations (MW-5 and DP-4). As a consequence, three additional down-gradient monitoring wells (MW-6 to MW-8) were installed on the Kenosha Steel property and Yutka site and sampled in March 2020. The samples were analyzed for full VOCs. The five previously installed wells were also resampled at this time and analyzed for PVOCs and naphthalene. The sample results confirmed that the extent of petroleum groundwater contamination exceeding GQSs had been defined. Groundwater flow in the vicinity of the site is toward the south and southeast. The monitoring well locations are illustrated on Figure B.3.b.1 in Appendix B. The monitoring well sample results are summarized on Table 2 in Appendix C.

CVOCs were identified in samples from groundwater grab sampling point DP-4W and monitoring wells MW-2, MW-7 and MW-8, all located adjacent to the 66th Street ROW. Vinyl chloride exceeded the ES at DP-4W/MW-2 with PCE exceeding the PAL at MW-7 and MW-8 and cis-1,2-DCE exceeding the PAL at DP-4W. All of these CVOCs are breakdown products of PCE, identified at Yutka soil boring HP-1, advanced within the 66th Street ROW and immediately adjacent to the IP site at a concentration exceeding the GWP RCL.

The only non-petroleum related CVOC identified on the Heimes site was chlorobenzene at low levels in the saturated zone of IP borings B-14 and B-18, which therefore, represents groundwater contamination.

Based on the above, the CVOC groundwater contamination is not attributable to the Heimes site and the great preponderance of evidence documents the IP site as the source. Definition of CVOC groundwater contamination in the immediate vicinity of the Heimes site is substantially, but not completely, defined.

This Off-Site Liability Exemption and Liability Clarification Application and Attachment was prepared by Midwest Environmental Consulting, LLC

I, Sean Cranley, hereby certify that I am a hydrogeologist as that term is defined in chapter NR 712.03(1), Wis. Adm. Code, am registered in accordance with the requirements of Ch. GHSS 3. Wis. Adm. Code, and that, to the best of my knowledge, all of the information contained in this document is correct and the document was prepared in compliance with all applicable requirements in Chapters NR 700 to 726, Wis. Adm. Code.

Signature ______________________

Title Professional Geologist

Date: 1/17/2022

APPENDIX A
June 10, 2021 WDNR Email

Gmail **Sean Cranley <mwenvirocon@gmail.com>**

Heimes Garage File Review & Path to Closure

Delcore, Lee R - DNR <Lee.Delcore@wisconsin.gov> Thu, Jun 10, 2021 at 3:13 PM
To: "Sean Cranley <mwenvirocon@gmail.com> (mwenvirocon@gmail.com)" <mwenvirocon@gmail.com>
Cc: "mike@coverealtyllc.com" <mike@coverealtyllc.com>

Sean,

After locating the Heimes Garage case file and correspondence, the following is the status of the site:

On June 25, 2020, a peer review session was held reviewing the site investigation completeness for the site. The site investigation report was received on June 9, 2020 and a substantial portion of the case closure request was compiled prior to the sunset of the PECFA Program. The review was scheduled to evaluate the completeness of the Site Investigation in order to determine if the wells could be abandoned prior to the PECFA claim deadline. In an email that same day after the review, I indicated that I presented the Site Investigation information to a peer review group and that the decisions was that a additional round of sampling from the wells was appropriate. I had indicated that I would call you later that afternoon to discuss. Based on our conversation, the decision was made not to abandon the wells and sampling of the wells utilizing PECFA-funding was determined impractical, based on time restraints. For this site, it is unclear if the other Site Investigation Completeness comments were communicated. I do not have record that they were communicated in writing. The complete peer review group comments are as follows:

- No soil figure has been prepared to illustrate the comprehensive soil delineation and conditions.
- Add B borings & discuss relevance of historic soil data to more recent sampling.
- Use all relevant data to delineate soil contamination with isolines
- Further groundwater sampling is needed to establish stable conditions. The two sampling events conducted 8 weeks apart are not adequate to make a decision.
- Use groundwater data from area sites to define the groundwater impacts.
- Do not abandon the wells at this time
- Vapor – further justification of screening results is needed using additional/comprehensive groundwater data.
- SI not considered complete.

So, based on these notes and file information, the path to closure is to first provide the results of 1 additional round of groundwater sampling along with the information identified above to support SI completeness. If that information results in SI completeness concurrence, then the closure packet submitted can be updated with any new data adjustments and moved through the process.

Thank you for your time and follow-up effort to move this case to closure,

Lee

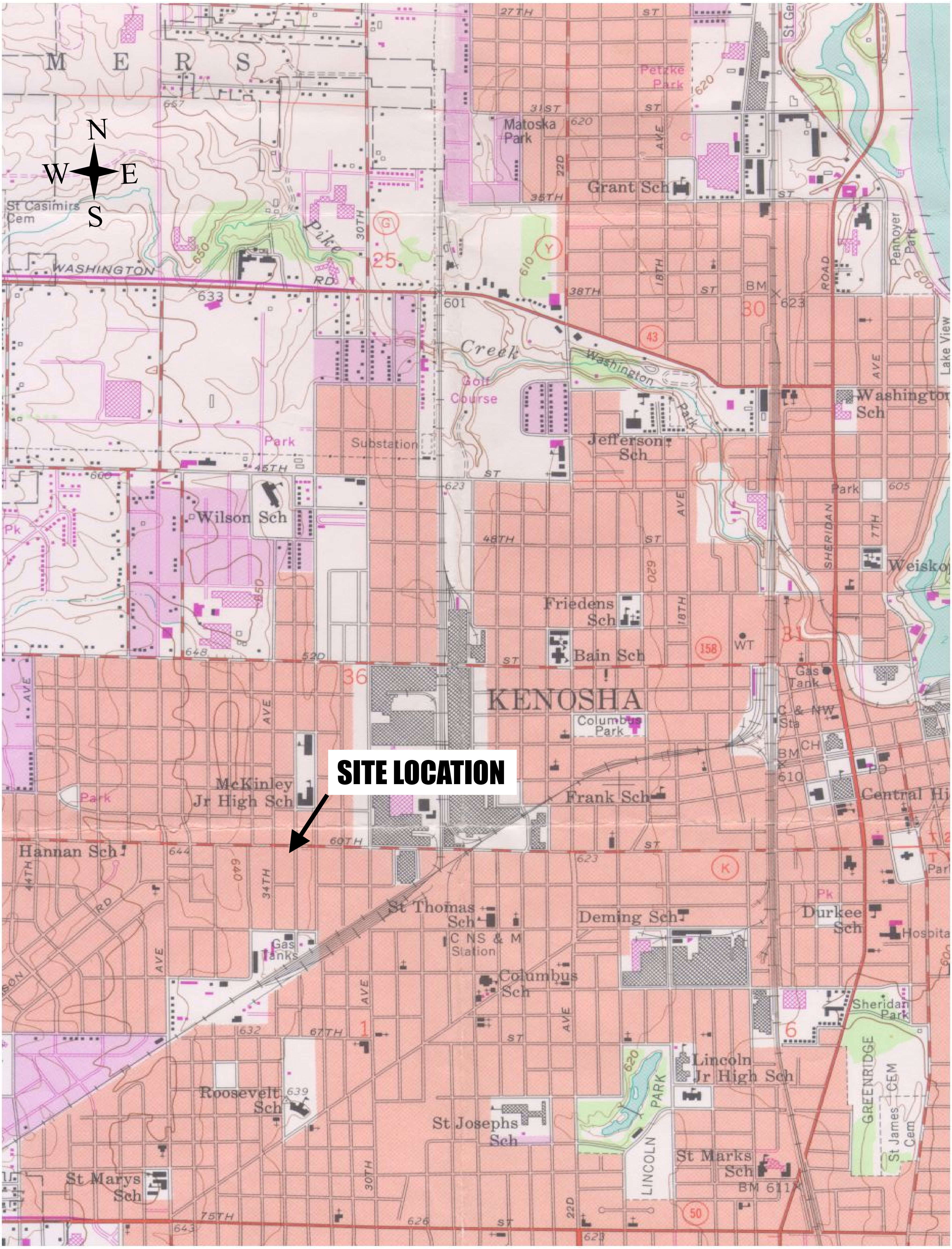
We are committed to service excellence.

Visit our survey at http://dnr.wi.gov/customersurvey to evaluate how I did.

Lee Delcore
Hydrogeologist - Remediation and Redevelopment Program
Wisconsin Department of Natural Resources
1155 Pilgrim Road, Plymouth, WI 53073
Phone: (262) 202-3838
Lee.Delcore@wisconsin.gov

dnr.wi.gov

APPENDIX B
Heimes Figures



Site Location Map

Date Approved:

Figure

3/5/20

Date Drawn:

3/5/20

Scale:

Not Scaled

Drawn By:

S. Cranley

B.1.a

Project Title and Address

FIGURE B.1.a
SITE LOCATION MAP

Suggar Property
3301 60th Street
Kenosha, WI 53144

MEC LLC
Midwest
Environmental
Consulting, LLC

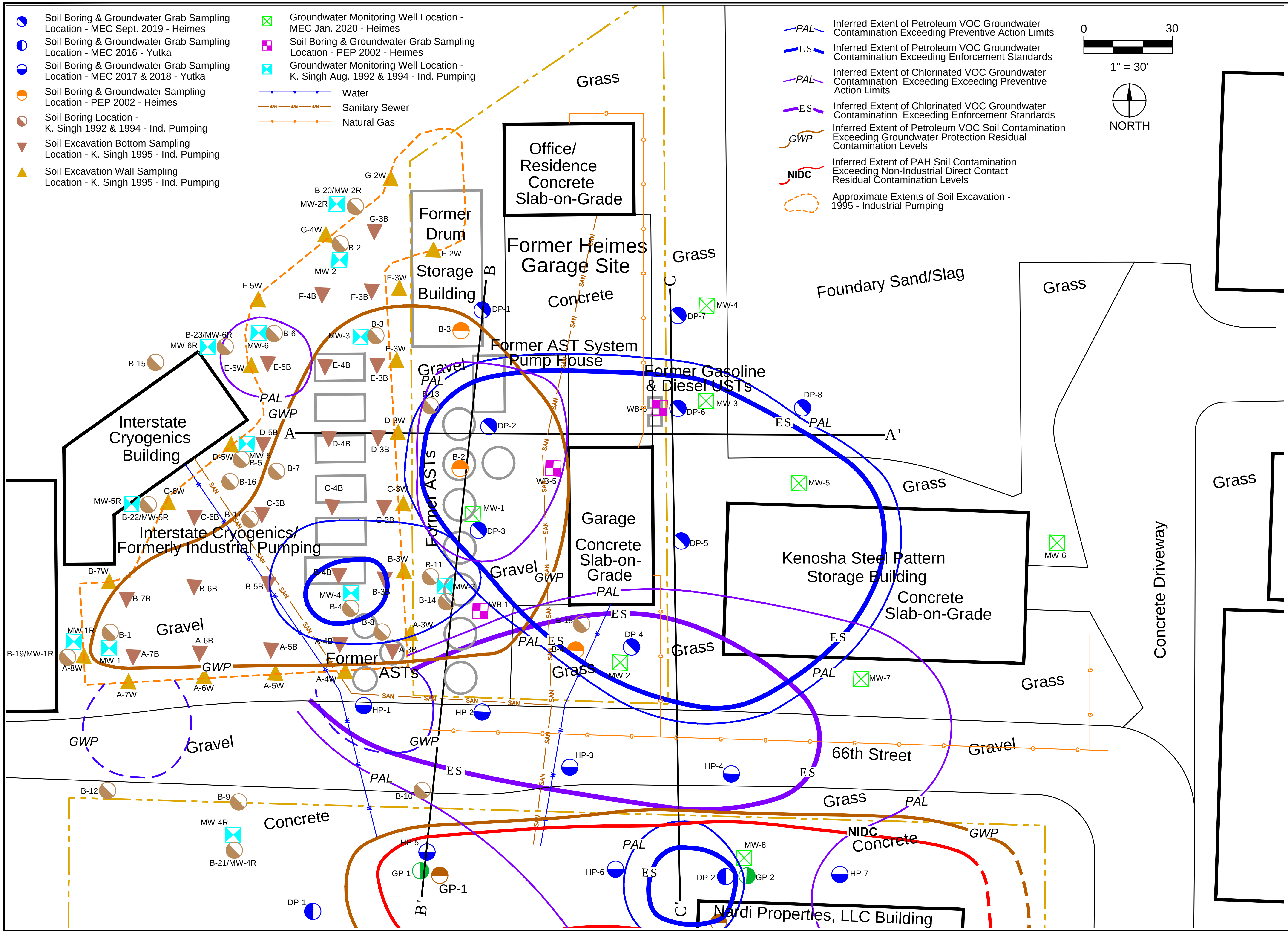


FIGURE B.1.b.1
DETAILED SITE MAP
HEIMES GARAGE
66TH STREET
KENOSHA, WI

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262-237-4351

Approved By: S. CRANLEY
Date Approved: 1/13/2022
Date Drawn: 1/13/2022
Drawn by: R. SCHWARTZ
Figure B.1.b.1

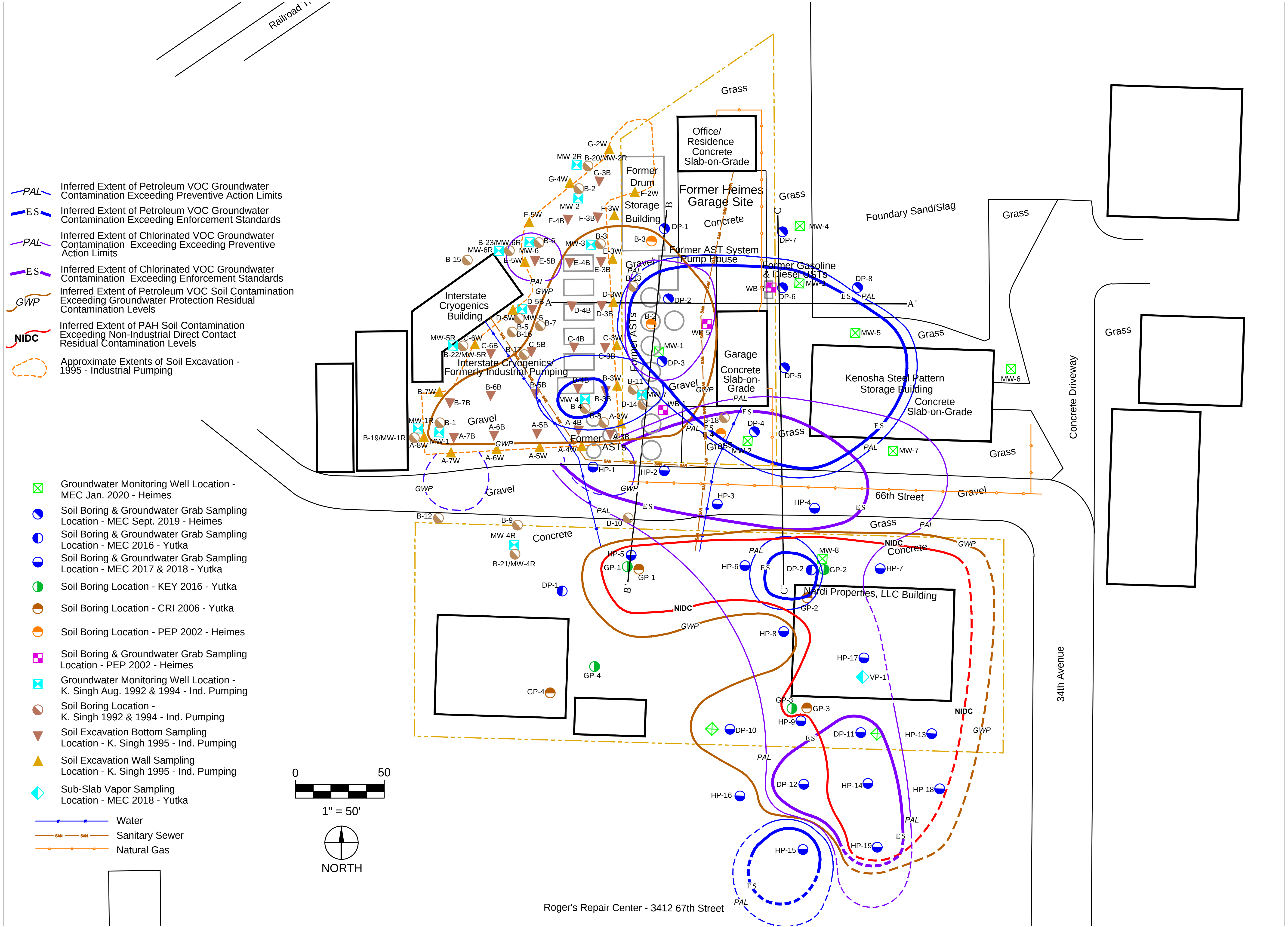

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FIGURE B.1.b.2 DETAILED SITE MAP

HEIMES GARAGE

66TH STREET
KENOSHA, WI

Approved By: S. Cranley	Figure B.1.b.2 of
Date Approved: 1/13/2022	
Date Drawn: 1/13/2022	
Drawn by: R. Schwartz	

RR Sites Map

Legend

- ● Open Site
- ● Closed Site
- ○ Continuing Obligations Apply

FIGURE B.1.c

WDNR RR SITES MAP

Former Heimes Garage SIWP
3218 – 66th Street
Kenosha, WI

0.1 0 0.03 0.1 Miles

NAD_1983_HARN_Wisconsin_TM

1: 1,980

© Latitude Geographics Group Ltd.

Note: Not all sites are mapped.

Notes

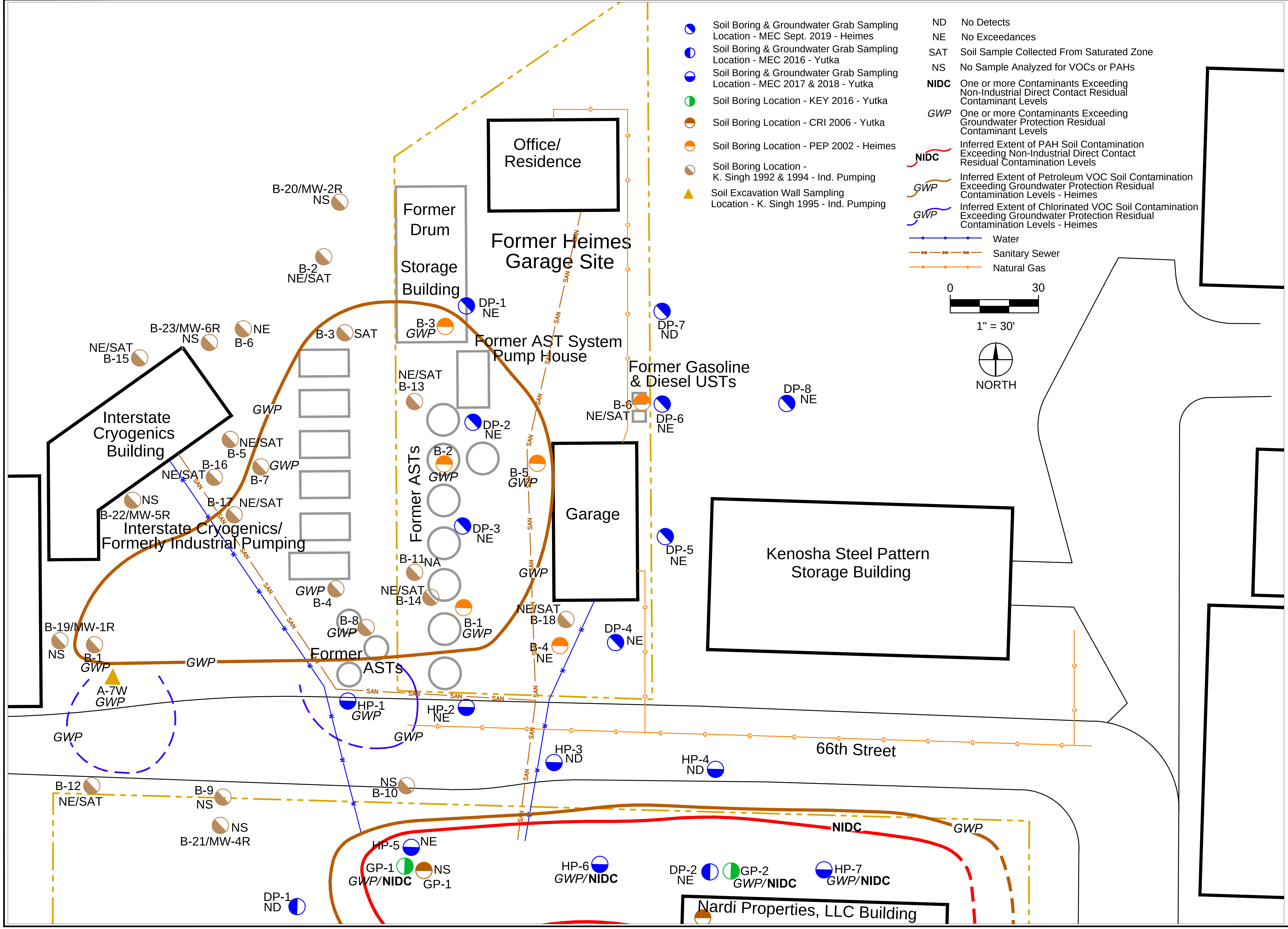

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FIGURE B.2.a.1
SOIL CONTAMINATION
HEIMES GARAGE
66TH STREET
KENOSHA, WI

Approved By: S. CRANLEY	Figure B.2.a.1
Date Approved: 1/13/2022	
Date Drawn: 1/13/2022	
Drawn by: R. SCHWARTZ	

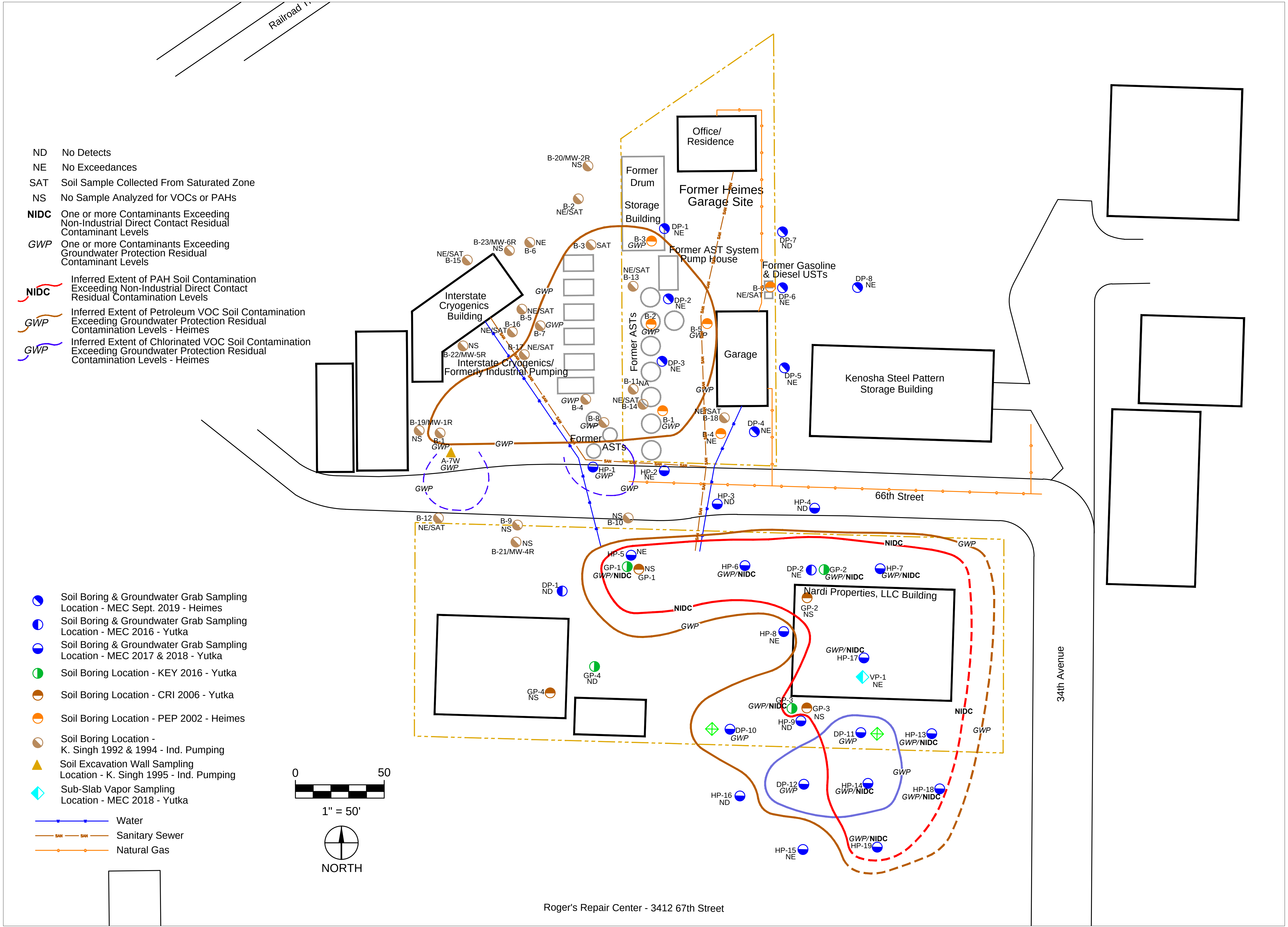

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FIGURE B.2.a.2
SOIL CONTAMINATION MAP
HEIMES GARAGE
66TH STREET
KENOSHA, WI

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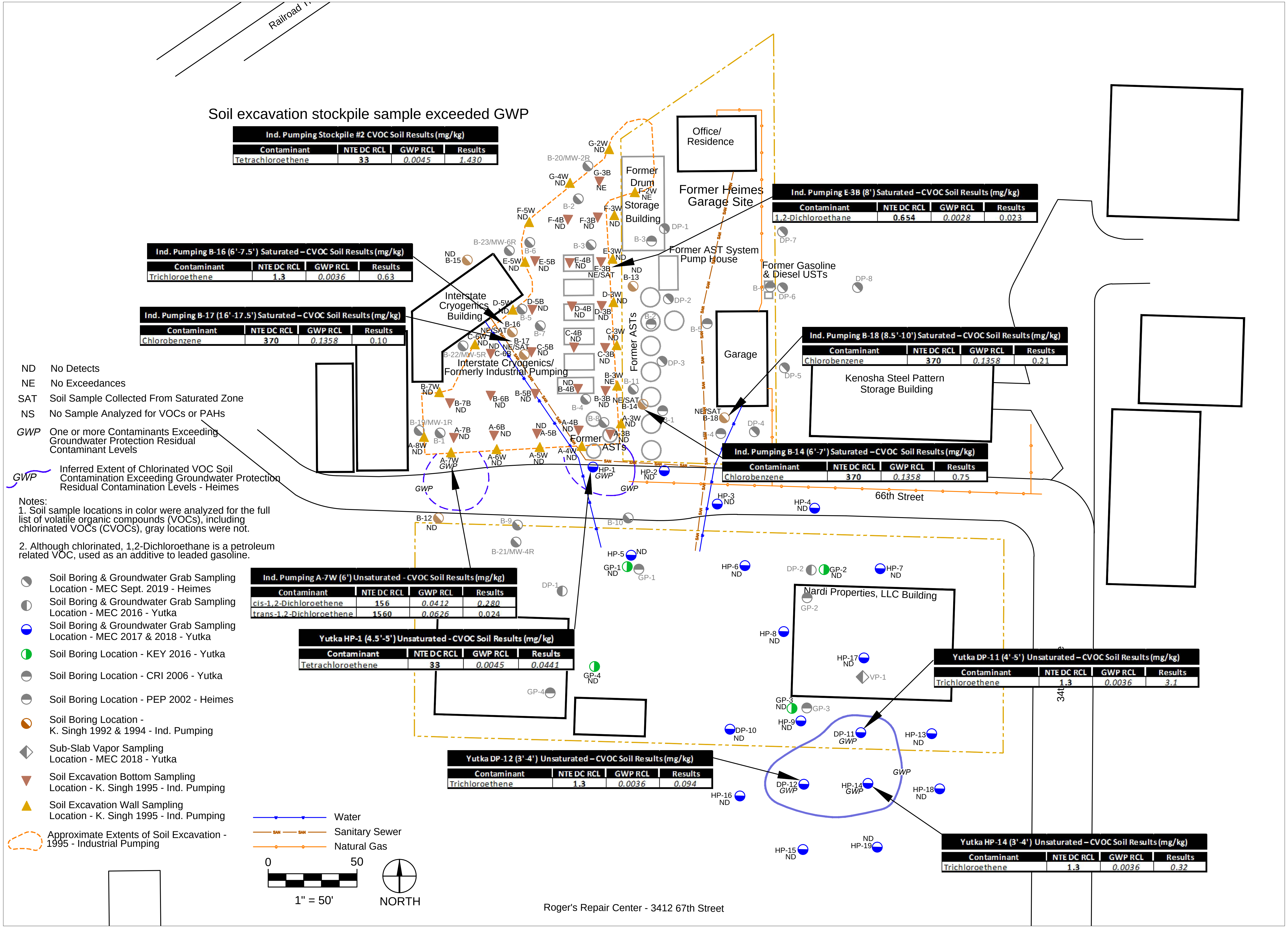
Date Approved: 1/13/2022	
Date Drawn: 1/13/2022	
Drawn by: R. Schwartz	



Soil excavation stockpile sample exceeded GWP

Ind. Pumping Stockpile #2 CVOC Soil Results (mg/kg)

Contaminant	NTE DC RCL	GWP RCL	Results
Tetrachloroethene	33	0.0045	1.430

Ind. Pumping E-3B (8') Saturated – CVOC Soil Results (mg/kg)

Contaminant	NTE DC RCL	GWP RCL	Results
1,2-Dichloroethane	0.654	0.0028	0.023

Ind. Pumping B-16 (6'-7.5') Saturated – CVOC Soil Results (mg/kg)

Contaminant	NTE DC RCL	GWP RCL	Results
Trichloroethene	1.3	0.0036	0.63

Ind. Pumping B-17 (16'-17.5') Saturated – CVOC Soil Results (mg/kg)

Contaminant	NTE DC RCL	GWP RCL	Results
Chlorobenzene	370	0.1358	0.10

Ind. Pumping B-18 (8.5'-10') Saturated – CVOC Soil Results (mg/kg)

Contaminant	NTE DC RCL	GWP RCL	Results
Chlorobenzene	370	0.1358	0.21

Ind. Pumping B-14 (6'-7') Saturated – CVOC Soil Results (mg/kg)

Contaminant	NTE DC RCL	GWP RCL	Results
Chlorobenzene	370	0.1358	0.75

Ind. Pumping A-7W (6') Unsaturated - CVOC Soil Results (mg/kg)

Contaminant	NTE DC RCL	GWP RCL	Results
cis-1,2-Dichloroethene	156	0.0412	0.280
trans-1,2-Dichloroethene	1560	0.0626	0.024

Yutka HP-1 (4.5'-5') Unsaturated - CVOC Soil Results (mg/kg)

Contaminant	NTE DC RCL	GWP RCL	Results
Tetrachloroethene	33	0.0045	0.0441

Yutka DP-11 (4'-5') Unsaturated – CVOC Soil Results (mg/kg)

Contaminant	NTE DC RCL	GWP RCL	Results
Trichloroethene	1.3	0.0036	3.1

Yutka DP-12 (3'-4') Unsaturated – CVOC Soil Results (mg/kg)

Contaminant	NTE DC RCL	GWP RCL	Results
Trichloroethene	1.3	0.0036	0.094

Yutka HP-14 (3'-4') Unsaturated – CVOC Soil Results (mg/kg)

Contaminant	NTE DC RCL	GWP RCL	Results
Trichloroethene	1.3	0.0036	0.32

ND	No Detects
NE	No Exceedances
SAT	Soil Sample Collected From Saturated Zone
NS	No Sample Analyzed for VOCs or PAHs
GWP	One or more Contaminants Exceeding Groundwater Protection Residual Contaminant Levels
GWP	Inferred Extent of Chlorinated VOC Soil Contamination Exceeding Groundwater Protection Residual Contamination Levels - Heimes

Notes:
1. Soil sample locations in color were analyzed for the full list of volatile organic compounds (VOCs), including chlorinated VOCs (CVOCs), gray locations were not.

2. Although chlorinated, 1,2-Dichloroethane is a petroleum related VOC, used as an additive to leaded gasoline.

◐	Soil Boring & Groundwater Grab Sampling Location - MEC Sept. 2019 - Heimes
◐	Soil Boring & Groundwater Grab Sampling Location - MEC 2016 - Yutka
◒	Soil Boring & Groundwater Grab Sampling Location - MEC 2017 & 2018 - Yutka
◑	Soil Boring Location - KEY 2016 - Yutka
◒	Soil Boring Location - CRI 2006 - Yutka
◒	Soil Boring Location - PEP 2002 - Heimes
◐	Soil Boring Location - K. Singh 1992 & 1994 - Ind. Pumping
◆	Sub-Slab Vapor Sampling Location - MEC 2018 - Yutka
▼	Soil Excavation Bottom Sampling Location - K. Singh 1995 - Ind. Pumping
▲	Soil Excavation Wall Sampling Location - K. Singh 1995 - Ind. Pumping
	Approximate Extents of Soil Excavation - 1995 - Industrial Pumping
	Water
	Sanitary Sewer
	Natural Gas

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FIGURE B.2.a.3
SOIL CVOC CONTAMINATION MAP
HEIMES GARAGE
66TH STREET
KENOSHA, WI

Approved By: S. Cranley	Figure B.2.a.3
Date Approved: 1/13/2022	
Date Drawn: 1/13/2022	of
Drawn by: R. Schwartz	

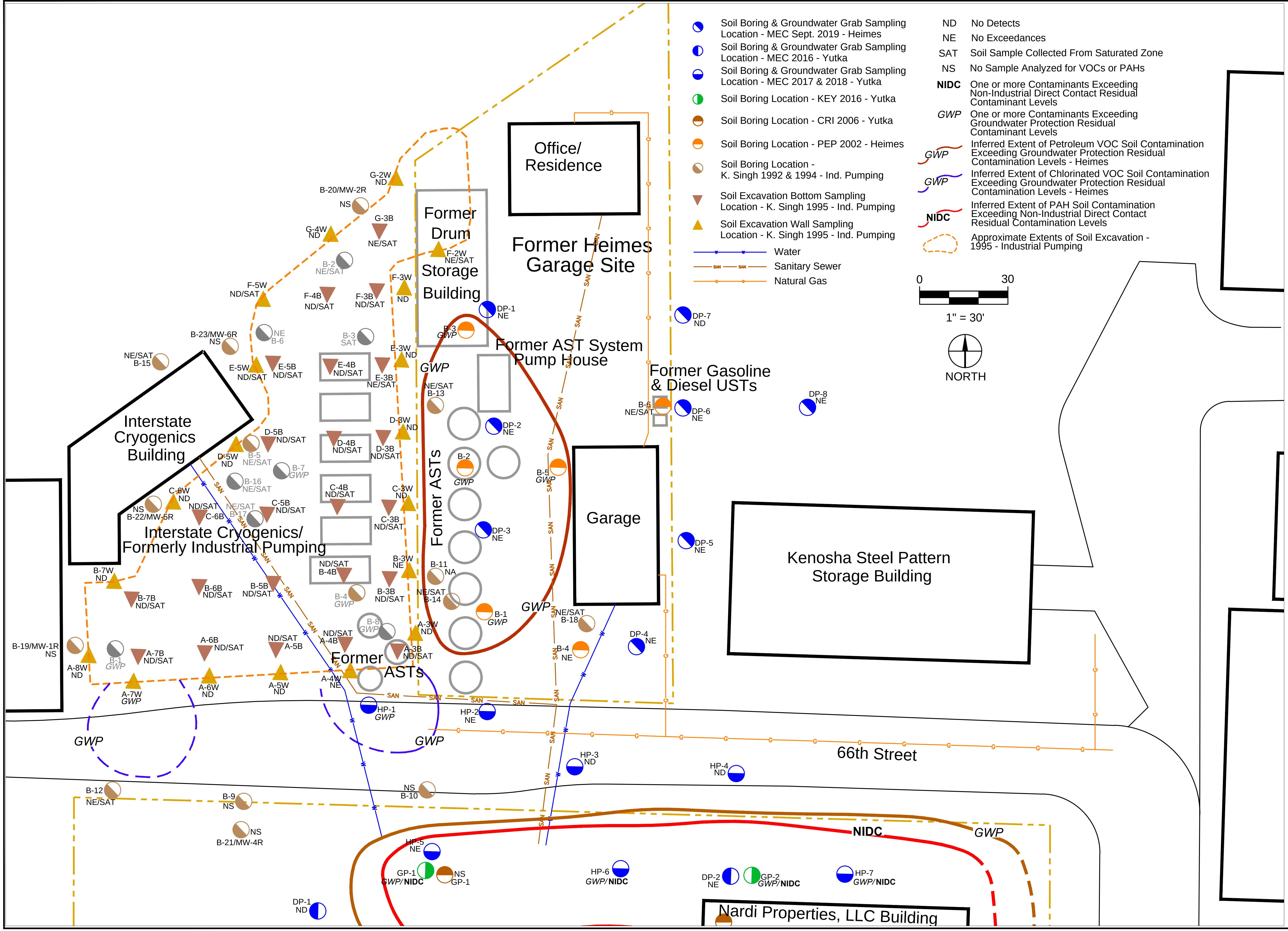

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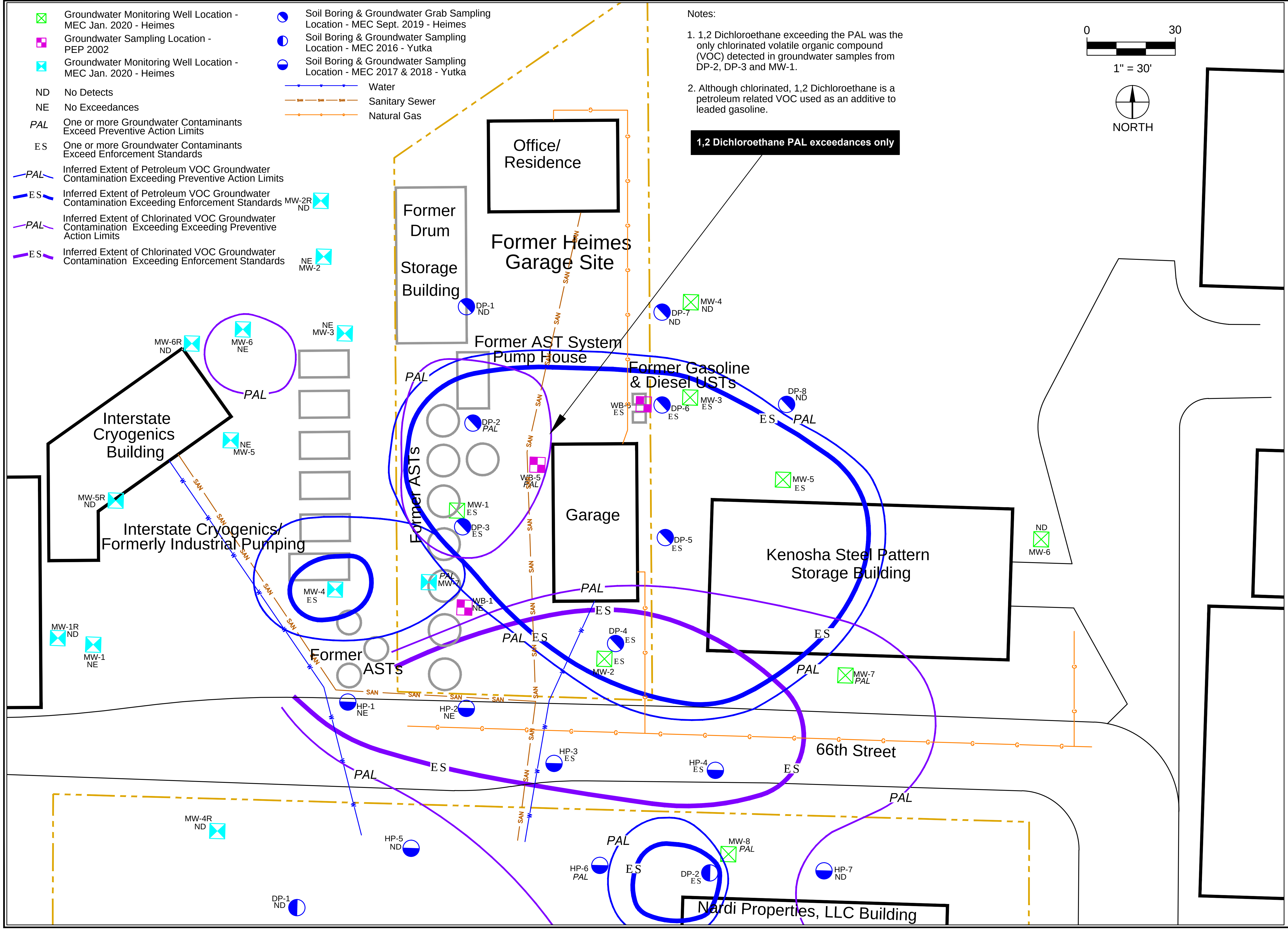
FIGURE B.2.b
POST INDUSTRIAL PUMPING REMEDIATION SOIL CONTAMINATION MAP
HEIMES GARAGE
66TH STREET
KENOSHA, WI

Approved By: S. CRANLEY
Date Approved: 1/13/2022
Date Drawn: 1/13/2022
Drawn by: R. SCHWARTZ
Figure B.2.b



Notes:

1. 1,2 Dichloroethane exceeding the PAL was the only chlorinated volatile organic compound (VOC) detected in groundwater samples from DP-2, DP-3 and MW-1.

2. Although chlorinated, 1,2 Dichloroethane is a petroleum related VOC used as an additive to leaded gasoline.

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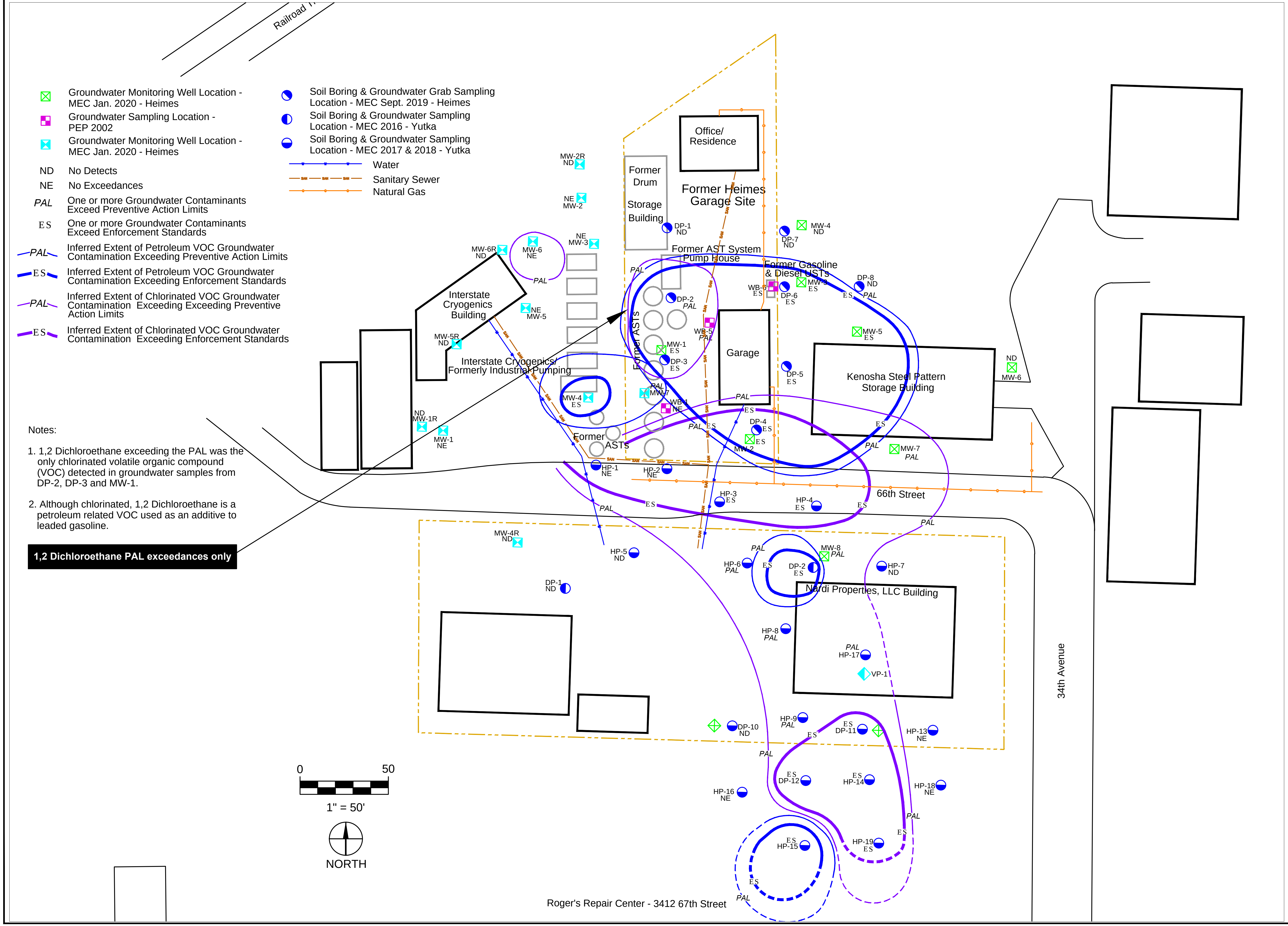
FIGURE B.3.b.1
GROUNDWATER CONTAMINATION
HEIMES GARAGE
66TH STREET
KENOSHA, WI

Approved By: S. CRANLEY	Figure B.3.b.1
Date Approved: 1/13/2022	
Date Drawn: 1/13/2022	
Drawn by: R. SCHWARTZ	

FIGURE B.3.b.2
GROUNDWATER CONTAMINATION MAP
HEIMES GARAGE
66TH STREET
KENOSHA, WI



☒ Groundwater Monitoring Well Location - MEC Jan. 2020 - Heimes

▨ Groundwater Sampling Location - PEP 2002

☒ Groundwater Monitoring Well Location - MEC Jan. 2020 - Heimes

● Soil Boring & Groundwater Grab Sampling Location - MEC Sept. 2019 - Heimes

◐ Soil Boring & Groundwater Sampling Location - MEC 2016 - Yutka

◒ Soil Boring & Groundwater Sampling Location - MEC 2017 & 2018 - Yutka

ND	No Detects
NE	No Exceedances
PAL	One or more Groundwater Contaminants Exceed Preventive Action Limits
ES	One or more Groundwater Contaminants Exceed Enforcement Standards
PAL	Inferred Extent of Petroleum VOC Groundwater Contamination Exceeding Preventive Action Limits
ES	Inferred Extent of Petroleum VOC Groundwater Contamination Exceeding Enforcement Standards
PAL	Inferred Extent of Chlorinated VOC Groundwater Contamination Exceeding Exceeding Preventive Action Limits
ES	Inferred Extent of Chlorinated VOC Groundwater Contamination Exceeding Enforcement Standards

Water
Sanitary Sewer
Natural Gas

Notes:

1. 1,2 Dichloroethane exceeding the PAL was the only chlorinated volatile organic compound (VOC) detected in groundwater samples from DP-2, DP-3 and MW-1.
2. Although chlorinated, 1,2 Dichloroethane is a petroleum related VOC used as an additive to leaded gasoline.

1,2 Dichloroethane PAL exceedances only

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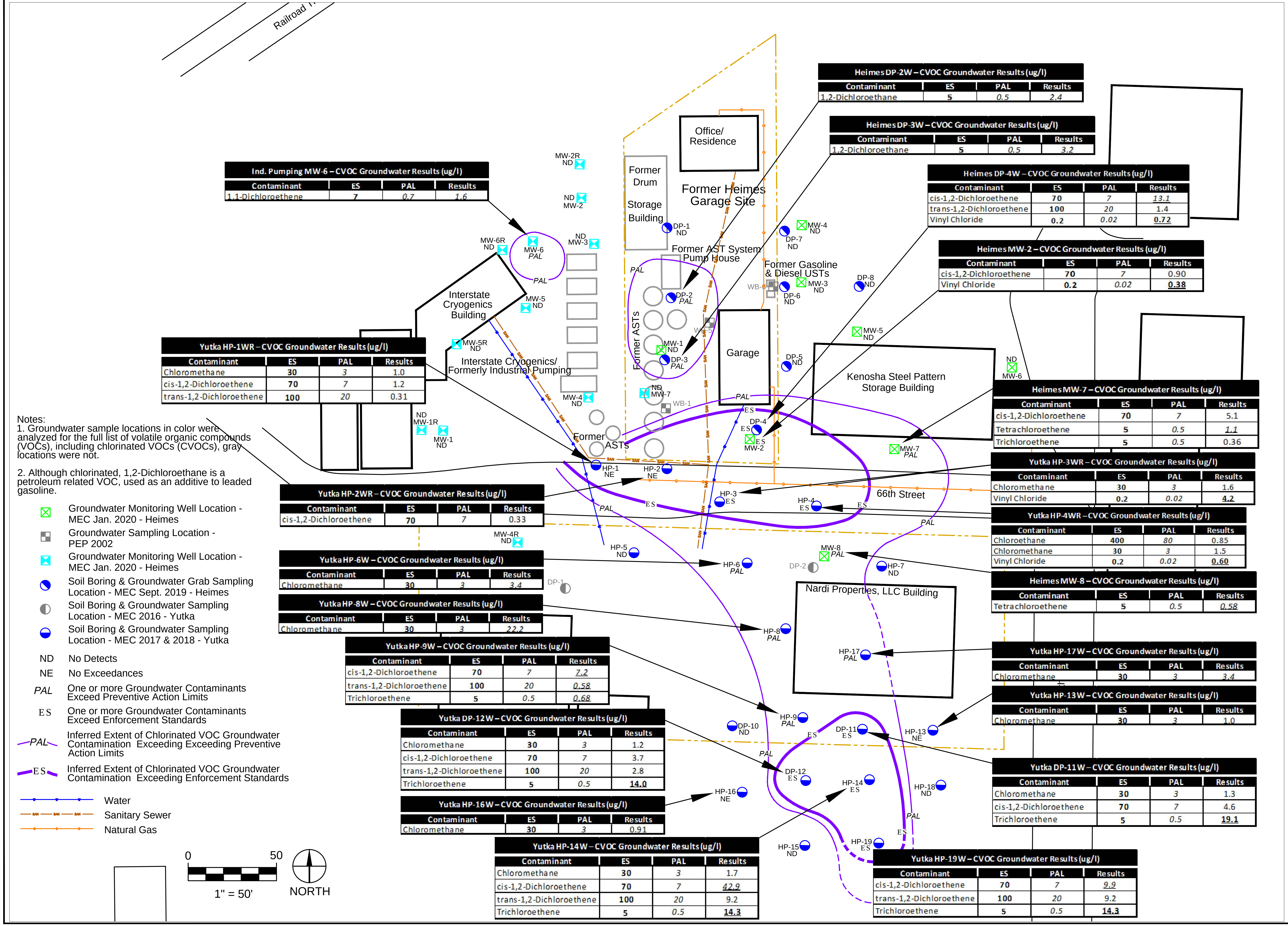
Date Approved: 1/13/2022
Date Drawn: 1/13/2022
Drawn by: R. Schwartz
Figure B.3.b.2 of



Ind. Pumping MW-6 – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
1,1-Dichloroethene	7	0.7	*1.6*

Heimes DP-2W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
1,2-Dichloroethane	5	0.5	*2.4*

Heimes DP-3W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
1,2-Dichloroethane	5	0.5	*3.2*

Heimes DP-4W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
cis-1,2-Dichloroethene	70	7	*13.1*
trans-1,2-Dichloroethene	100	20	1.4
Vinyl Chloride	0.2	0.02	**0.72**

Heimes MW-2 – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
cis-1,2-Dichloroethene	70	7	0.90
Vinyl Chloride	0.2	0.02	**0.38**

Yutka HP-1WR – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Chloromethane	30	3	1.0
cis-1,2-Dichloroethene	70	7	1.2
trans-1,2-Dichloroethene	100	20	0.31

Heimes MW-7 – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
cis-1,2-Dichloroethene	70	7	5.1
Tetrachloroethene	5	0.5	*1.1*
Trichloroethene	5	0.5	0.36

Yutka HP-3WR – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Chloromethane	30	3	1.6
Vinyl Chloride	0.2	0.02	**4.2**

Yutka HP-2WR – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
cis-1,2-Dichloroethene	70	7	0.33

Yutka HP-4WR – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Chloroethane	400	80	0.85
Chloromethane	30	3	1.5
Vinyl Chloride	0.2	0.02	**0.60**

Yutka HP-6W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Chloromethane	30	3	*3.4*

Heimes MW-8 – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Tetrachloroethene	5	0.5	*0.58*

Yutka HP-8W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Chloromethane	30	3	*22.2*

Yutka HP-9W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
cis-1,2-Dichloroethene	70	7	*7.2*
trans-1,2-Dichloroethene	100	20	*0.58*
Trichloroethene	5	0.5	*0.68*

Yutka HP-17W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Chloromethane	30	3	*3.4*

Yutka HP-13W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Chloromethane	30	3	1.0

Yutka DP-12W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Chloromethane	30	3	1.2
cis-1,2-Dichloroethene	70	7	3.7
trans-1,2-Dichloroethene	100	20	2.8
Trichloroethene	5	0.5	**14.0**

Yutka DP-11W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Chloromethane	30	3	1.3
cis-1,2-Dichloroethene	70	7	4.6
Trichloroethene	5	0.5	**19.1**

Yutka HP-16W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Chloromethane	30	3	0.91

Yutka HP-14W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
Chloromethane	30	3	1.7
cis-1,2-Dichloroethene	70	7	*42.9*
trans-1,2-Dichloroethene	100	20	9.2
Trichloroethene	5	0.5	**14.3**

Yutka HP-19W – CVOC Groundwater Results (ug/l)

Contaminant	ES	PAL	Results
cis-1,2-Dichloroethene	70	7	*9.9*
trans-1,2-Dichloroethene	100	20	9.2
Trichloroethene	5	0.5	**14.3**

Notes:
1. Groundwater sample locations in color were analyzed for the full list of volatile organic compounds (VOCs), including chlorinated VOCs (CVOCs), gray locations were not.

2. Although chlorinated, 1,2-Dichloroethane is a petroleum related VOC, used as an additive to leaded gasoline.

☒	Groundwater Monitoring Well Location - MEC Jan. 2020 - Heimes
▨	Groundwater Sampling Location - PEP 2002
☒	Groundwater Monitoring Well Location - MEC Jan. 2020 - Heimes
◒	Soil Boring & Groundwater Grab Sampling Location - MEC Sept. 2019 - Heimes
◐	Soil Boring & Groundwater Sampling Location - MEC 2016 - Yutka
◒	Soil Boring & Groundwater Sampling Location - MEC 2017 & 2018 - Yutka
ND	No Detects
NE	No Exceedances
PAL	One or more Groundwater Contaminants Exceed Preventive Action Limits
ES	One or more Groundwater Contaminants Exceed Enforcement Standards
—*PAL*—	Inferred Extent of Chlorinated VOC Groundwater Contamination Exceeding Exceeding Preventive Action Limits
—ES—	Inferred Extent of Chlorinated VOC Groundwater Contamination Exceeding Enforcement Standards
—•—•—	Water
—SAN—SAN—	Sanitary Sewer
—•—•—	Natural Gas

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FIGURE B.3.b.3
GROUNDWATER CVOC CONTAMINATION MAP
HEIMES GARAGE
66TH STREET
KENOSHA, WI

Approved By: S. Cranley	Figure B.3.b.3
Date Approved: 1/13/2022	
Date Drawn: 1/13/2022	
Drawn by: R. Schwartz	

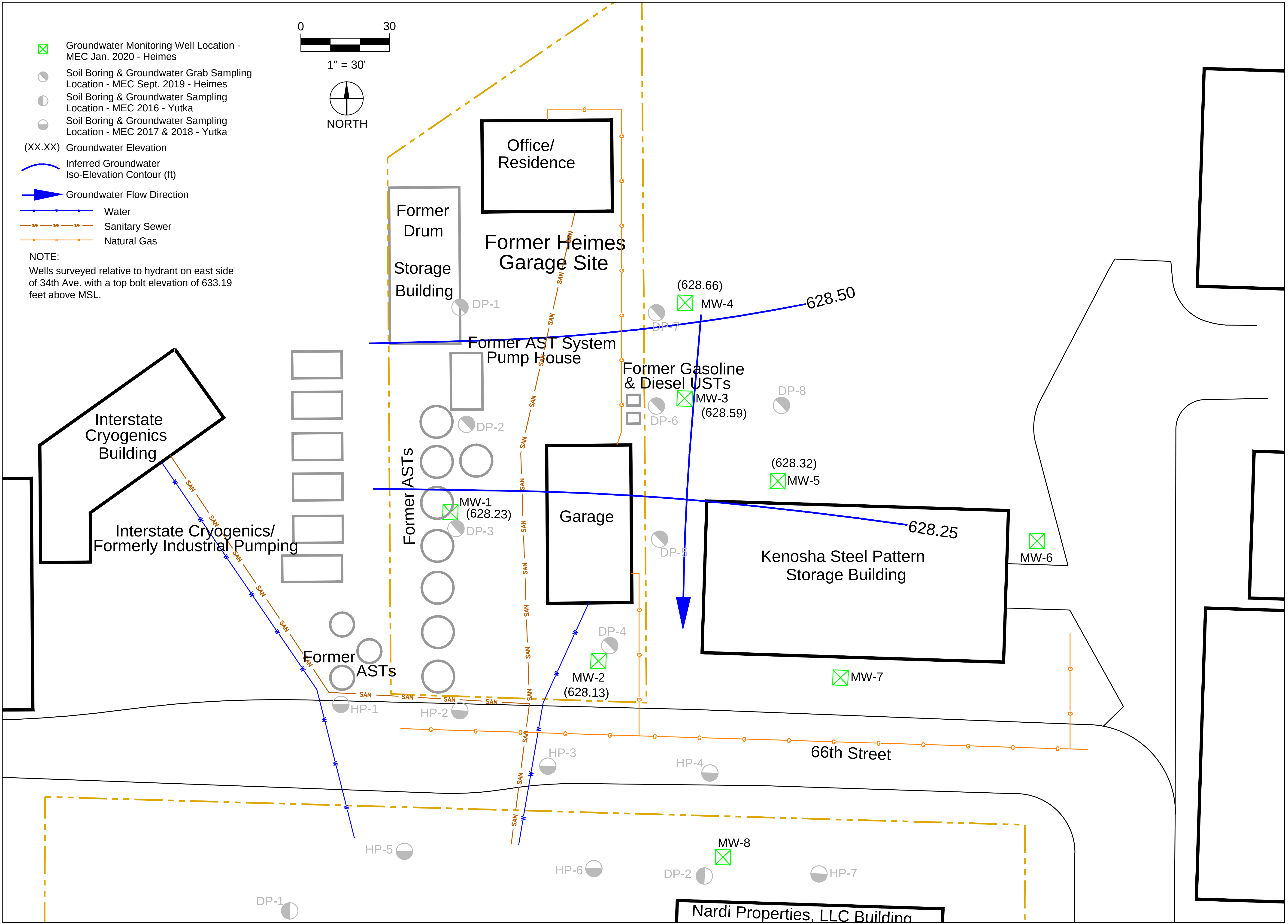

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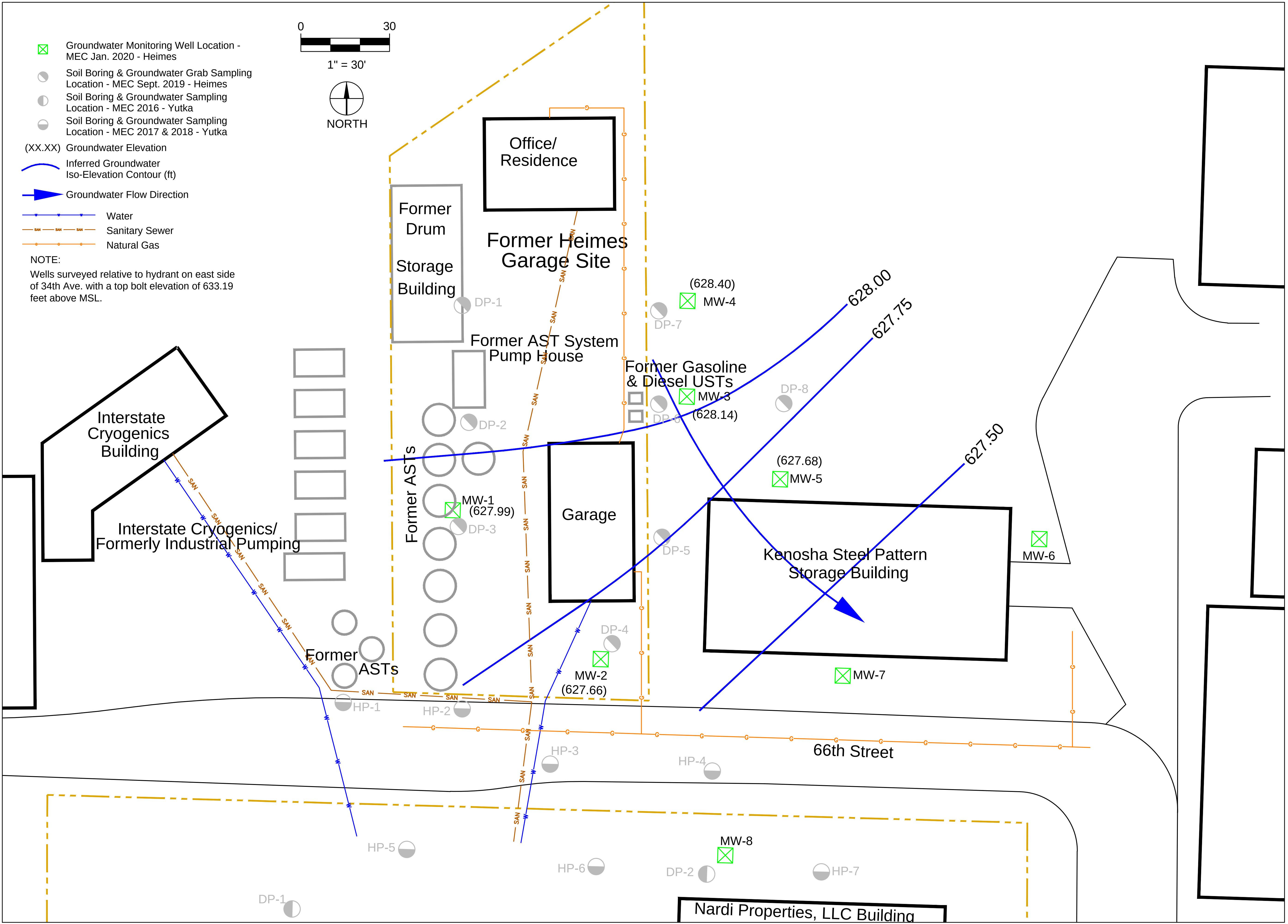
FIGURE B.3.c.1
GROUNDWATER FLOW
1/29/20

HEIMES GARAGE
66TH STREET
KENOSHA, WI

Approved By: S. CRANLEY	Figure
Date Approved: 1/13/2022	B.3.c.1
Date Drawn: 1/13/2022	
Drawn by: R. SCHWARTZ	



NOTE:
Wells surveyed relative to hydrant on east side of 34th Ave. with a top bolt elevation of 633.19 feet above MSL.

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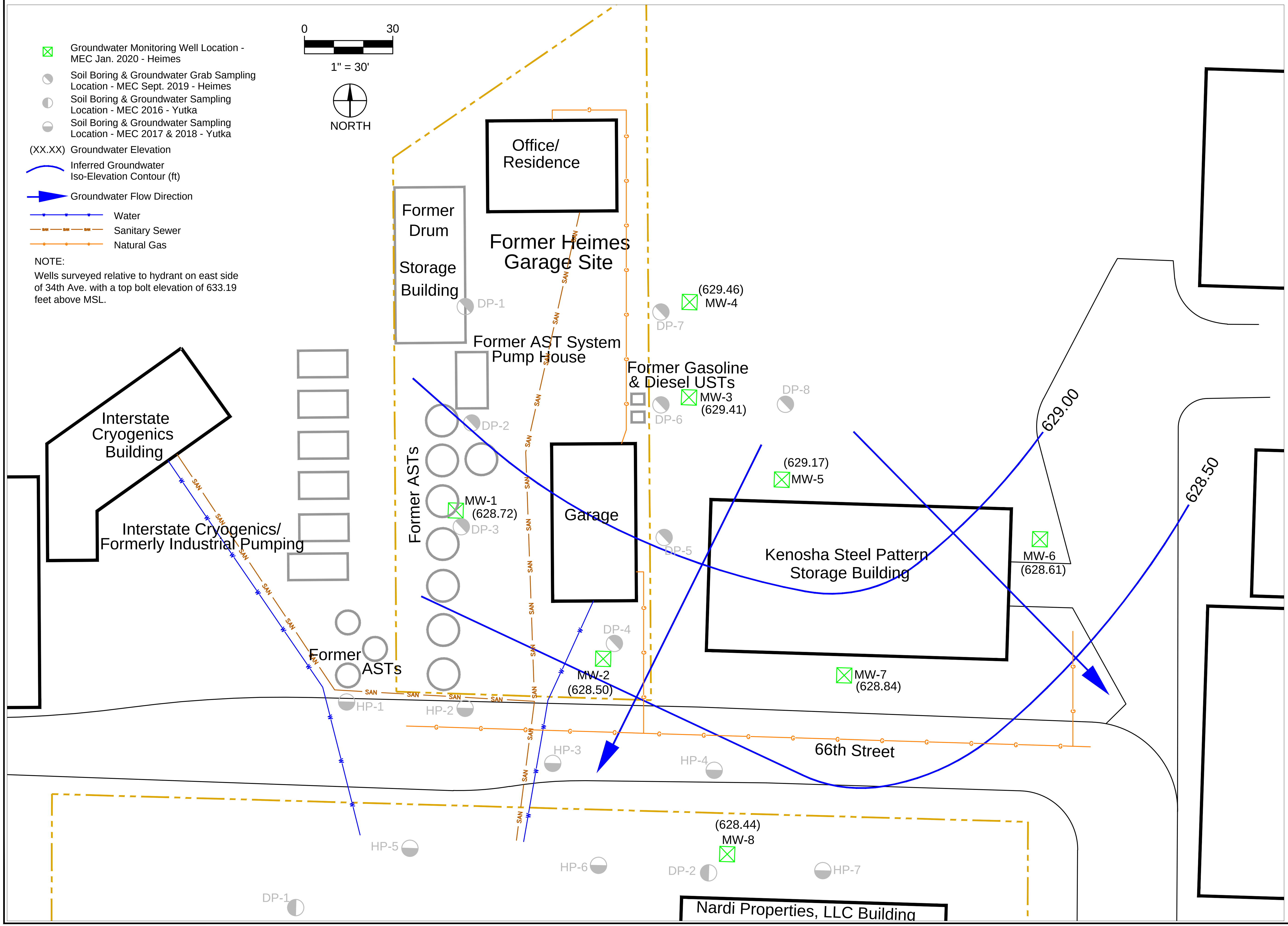
FIGURE B.3.c.2
GROUNDWATER FLOW
2/17/20

HEIMES GARAGE
66TH STREET
KENOSHA, WI

Approved By: S. CRANLEY	Figure B.3.c.2
Date Approved: 1/13/2022	
Date Drawn: 1/13/2022	
Drawn by: R. SCHWARTZ	



NOTE:
Wells surveyed relative to hydrant on east side of 34th Ave. with a top bolt elevation of 633.19 feet above MSL.

262-237-4351

FIGURE B.3.c.3
GROUNDWATER FLOW
3/31/2020
HEIMES GARAGE
66TH STREET
KENOSHA, WI

Approved By: S. CRANLEY	Figure
Date Approved: 1/13/2022	B.3.c.3
Date Drawn: 1/13/2022	
Drawn by: R. SCHWARTZ	

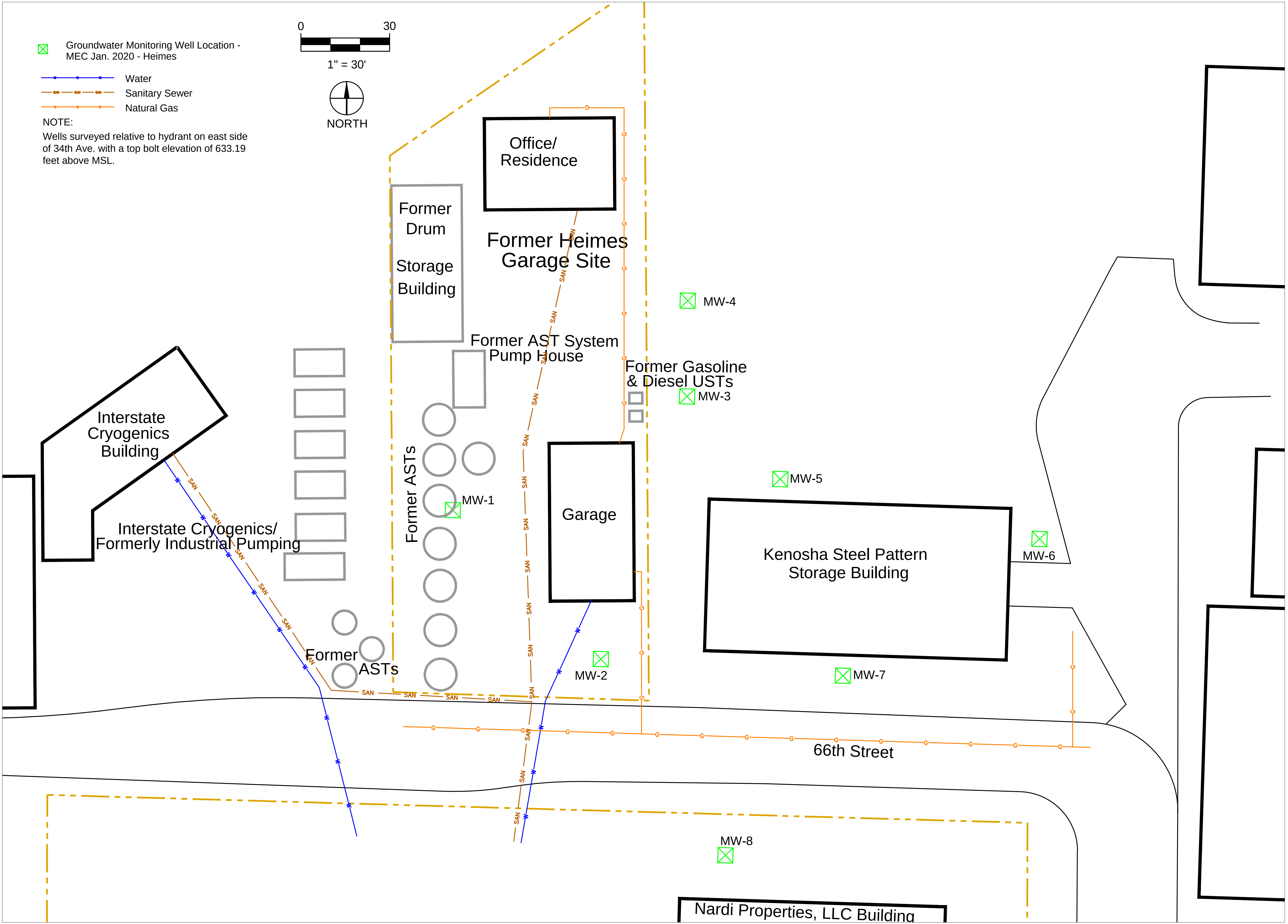


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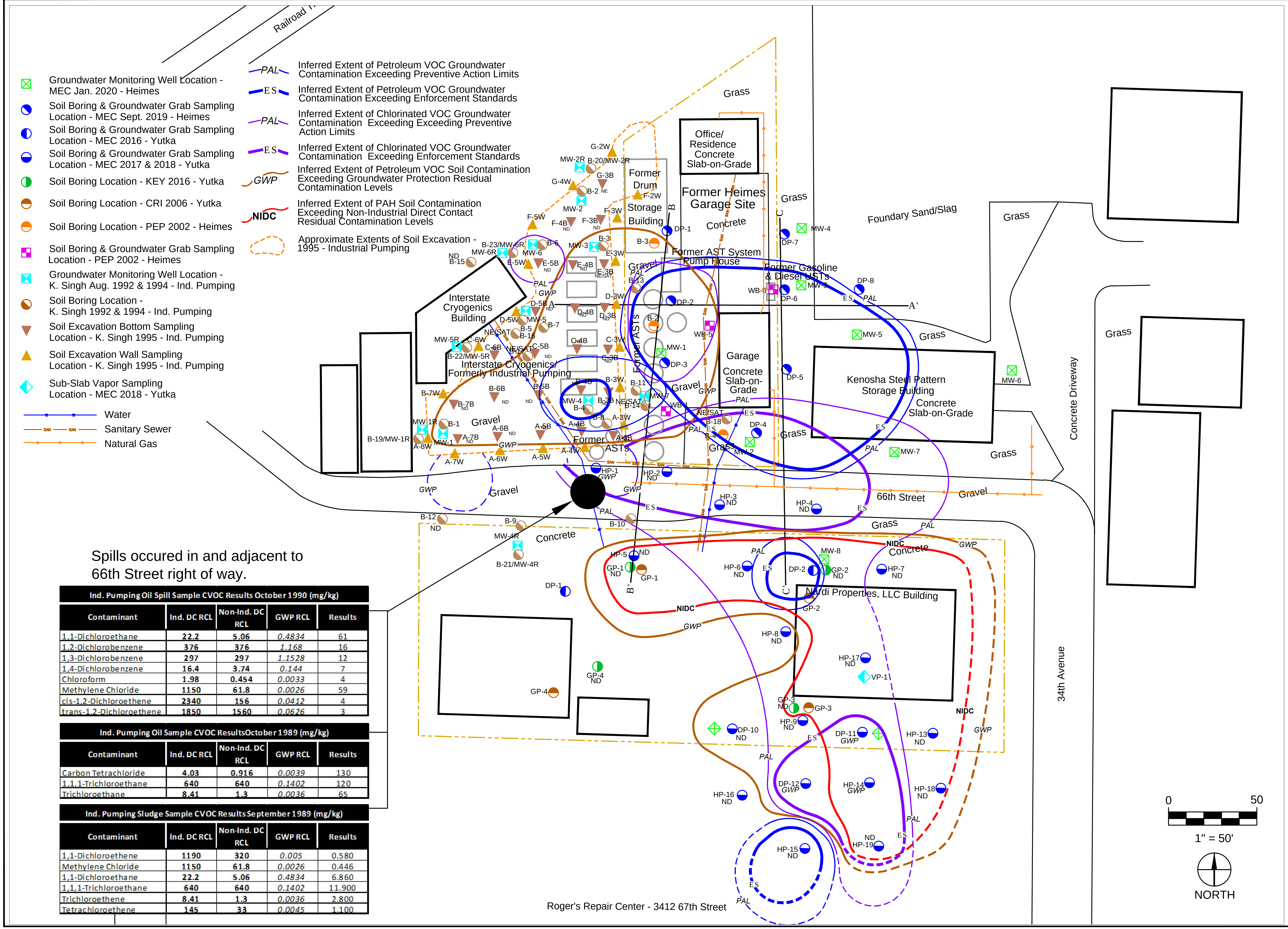
FIGURE B.3.d MONITORING WELLS

HEIMES GARAGE

66TH STREET
KENOSHA, WI

Approved By: S. CRANLEY
Date Approved: 1/13/2022
Date Drawn: 1/13/2022
Drawn by: R. SCHWARTZ
Figure B.3.d



Spills occured in and adjacent to 66th Street right of way.

Ind. Pumping Oil Spill Sample CVOC Results October 1990 (mg/kg)

Contaminant	Ind. DC RCL	Non-Ind. DC RCL	GWP RCL	Results
1,1-Dichloroethane	22.2	5.06	0.4834	61
1,2-Dichlorobenzene	376	376	1.168	16
1,3-Dichlorobenzene	297	297	1.1528	12
1,4-Dichlorobenzene	16.4	3.74	0.144	7
Chloroform	1.98	0.454	0.0033	4
Methylene Chloride	1150	61.8	0.0026	59
cis-1,2-Dichloroethene	2340	156	0.0412	4
trans-1,2-Dichloroethene	1850	1560	0.0626	3

Ind. Pumping Oil Sample CVOC ResultsOctober 1989 (mg/kg)

Contaminant	Ind. DC RCL	Non-Ind. DC RCL	GWP RCL	Results
Carbon Tetrachloride	4.03	0.916	0.0039	130
1,1,1-Trichloroethane	640	640	0.1402	120
Trichloroethane	8.41	1.3	0.0036	65

Ind. Pumping Sludge Sample CVOC Results September 1989 (mg/kg)

Contaminant	Ind. DC RCL	Non-Ind. DC RCL	GWP RCL	Results
1,1-Dichloroethene	1190	320	0.005	0.580
Methylene Chloride	1150	61.8	0.0026	0.446
1,1-Dichloroethane	22.2	5.06	0.4834	6.860
1,1,1-Trichloroethane	640	640	0.1402	11.900
Trichloroethene	8.41	1.3	0.0036	2.800
Tetrachloroethene	145	33	0.0045	1.100

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262-237-4351

FIGURE B.4.c
OIL SPILL CVOC MAP
HEIMES GARAGE
66TH STREET
KENOSHA, WI

Approved By: S. Cranley
Date Approved: 1/13/2022
Date Drawn: 1/13/2022
Drawn by: R. Schwartz
Figure B.4.c
of

APPENDIX C
Heimes SIR Tables

Table 1 (Page 1 of 2)
Soil Analytical Results Table
Heimes Garage
3418 66th Street
Kenosha, WI

Parameters	Sample Information / Results					Residual Contaminant Levels		
Sample ID	**DP-1**	**DP-2**	**DP-2**	**DP-3**	**DP-4**	**Groundwater Protection**	**Not to Exceed Non-Industrial Direct Contact**	**Not to Exceed Industrial Direct Contact Protection**
Sample Depth (ft/bls)	**5-7**	**2-3**	**3-4**	**3-4**	**2-2.5**			
Saturation Depth (ft/bls)	**7**	**5**	**5**	**8**	**5**			
Saturated / Unsaturated	**Unsaturated**	**Unsaturated**	**Unsaturated**	**Unsaturated**	**Unsaturated**			
Sample Date	**9/16/19**	**9/16/19**	**9/16/19**	**9/16/19**	**9/16/19**			
PVOCs (mg/kg)						mg/kg	mg/kg	mg/kg
1,2,4-Trimethylbenzene	<0.025	<0.20	<0.12	<0.12	<0.025	1.3787*	219	219
Ethylbenzene	<0.025	0.32	0.17	<0.12	<0.025	1.57	8.02	35.4
PAHs (mg/kg)						mg/kg	mg/kg	mg/kg
Acenaphthene	<0.0049	0.21	0.67	0.15	<0.0051	NS	3,590	45,200
Acenaphthylene	<0.0042	0.047	0.15	0.048	<0.0043	NS	NS	NS
Anthracene	<0.0072	0.076	0.22	0.039	<0.0075	196.9492	17,900	100,000
Benzo(a)anthracene	0.0047	<0.027	<0.11	0.032	0.0042	NS	1.14	20.8
Benzo(b)fluoranthene	0.0038	<0.029	<0.11	<0.028	<0.0037	0.4781	1.15	21.1
Fluoranthene	<0.0066	<0.025	<0.098	<0.024	<0.0068	88.8778	2,390	30,100
Fluorene	<0.0052	0.24	0.75	0.15	<0.0054	14.8299	2,390	30,100
1-Methylnaphthalene	<0.0051	2.1	6.7	2.2	0.011	NS	17.6	72.7
2-Methylnaphthalene	<0.0063	3.6	12.1	3.4	0.027	NS	239	3,010
Naphthalene	<0.011	*1.3*	*4.2*	*1.6*	0.011	0.6582	5.52	24.1
Phenanthrene	<0.015	0.69	2.1	0.26	<0.015	NS	NS	NS
Pyrene	<0.0057	<0.031	<0.12	0.046	<0.0059	54.5455	1,790	22,600

Notes:

Table includes detected analytes only.

Bold type indicates concentration within the upper 4 feet of the subsurface exceeds the non-industrial direct contact RCL and, if applicable, the background level, thus constituting a soil standard exceedance.

Italic type indicates a concentration exceeds the groundwater protection RCL and, if applicable the background level, thus constituting a soil standard exceedance.

RCL - Residual Contaminant Level

PVOCs - Petroleum Volatile Organic Compounds

PAHs - Polynuclear Aromatic Hydrocarbons

NS - No Standard

Table 1 (Page 2 of 2)
Soil Analytical Results Table
Heimes Garage
3418 66th Street
Kenosha, WI

Parameters	Sample Information / Results				Residual Contaminant Levels		
Sample ID	**DP-5**	**DP-6**	**DP-7**	**DP-8**			
Sample Depth (ft/bls)	**2-2.5**	**2-2.5**	**2-3**	**2.5-3**	**Groundwater Protection**	**Not to Exceed Non-Industrial Direct Contact**	**Not to Exceed Industrial Direct Contact Protection**
Saturation Depth (ft/bls)	**7**	**5**	**5**	**5.5**			
Saturated / Unsaturated	**Unsaturated**	**Unsaturated**	**Unsaturated**	**Unsaturated**			
Sample Date	**9/16/19**	**9/16/19**	**9/16/19**	**9/16/19**			
PVOCs (mg/kg)					mg/kg	mg/kg	mg/kg
1,2,4-Trimethylbenzene	<0.025	0.060	<0.025	<0.025	1.3787*	219	219
Ethylbenzene	<0.025	<0.025	<0.025	<0.025	1.57	8.02	35.4
PAHs (mg/kg)					mg/kg	mg/kg	mg/kg
Acenaphthene	<0.0028	<0.0047	<0.0050	<0.0030	NS	3,590	45,200
Acenaphthylene	<0.0027	<0.0040	<0.0043	<0.0029	NS	NS	NS
Anthracene	<0.0027	<0.0069	<0.0074	<0.0028	196.9492	17,900	100,000
Benzo(a)anthracene	0.0045	<0.0038	<0.0041	<0.0029	NS	1.14	20.8
Benzo(b)fluoranthene	0.0042	<0.0034	<0.0037	<0.0032	0.4781	1.15	21.1
Fluoranthene	0.0041	<0.0063	<0.0068	<0.0027	88.8778	2,390	30,100
Fluorene	<0.0026	<0.0050	<0.0054	<0.0027	14.8299	2,390	30,100
1-Methylnaphthalene	0.013	0.022	<0.0052	0.0037	NS	17.6	72.7
2-Methylnaphthalene	0.021	0.042	<0.0065	0.0080	NS	239	3,010
Naphthalene	0.0084	0.086	<0.011	0.012	0.6582	5.52	24.1
Phenanthrene	0.0086	<0.014	<0.015	<0.0026	NS	NS	NS
Pyrene	<0.0032	<0.0054	<0.0059	<0.0033	54.5455	1,790	22,600

Notes:

Table includes detected analytes only.

Bold type indicates concentration within the upper 4 feet of the subsurface exceeds the non-industrial direct contact RCL and, if applicable, the background level, thus constituting a soil standard exceedance.

Italic type indicates a concentration exceeds the groundwater protection RCL and, if applicable the background level, thus constituting a soil standard exceedance.

RCL - Residual Contaminant Level

PVOCs - Petroleum Volatile Organic Compounds

PAHs - Polynuclear Aromatic Hydrocarbons

NS - No Standard

Table 2 (Page 1 of 3)
Groundwater Analytical Results Table
Heimes Garage
3418 66th Street
Kenosha, WI

Parameters	Sample ID, Collection Date, Results								Groundwater Quality Standards	
	DP-1W	DP-2W	DP-3W	DP-4W	DP-5W	DP-6W	DP-7W	DP-8W	PAL	ES
	9/16/19	9/16/19	9/16/19	9/16/19	9/16/19	9/16/19	9/16/19	9/16/19		
VOCs (ug/l)									ug/l	ug/l
Benzene	<0.25	*3.7*	**11.6**	*1.4*	<0.50	**169**	<0.50	<0.50	0.5	5
n-Butylbenzene	<0.71	5.5	7.9	<0.71	<0.71	<2.8	<0.71	<0.71	NS	NS
sec-Butylbenzene	<0.85	3.6	9.3	<0.85	<0.85	<3.4	<0.85	<0.85	NS	NS
tert-Butylbenzene	<0.30	<0.61	0.91	<0.30	<0.30	<1.2	<0.30	<0.30	NS	NS
1,2-Dichloroethane	<0.28	*2.4*	*3.2*	<0.28	<0.28	<1.1	<0.28	<0.28	0.5	5
cis-1,2-Dichloroethene	<0.27	<0.54	<0.27	*13.1*	<0.27	<1.1	<0.27	<0.27	7	70
trans-1,2-Dichloroethene	<1.1	<2.2	<1.1	1.4	<1.1	<4.4	<1.1	<1.1	20	100
Diisopropyl ether	<1.9	7.6	3.1	<1.9	<1.9	<7.6	<1.9	<1.9	NS	NS
Ethylbenzene	<0.22	1.8	1.7	<0.22	<0.22	1.3J	<0.22	<0.22	140	700
Isopropylbenzene (Cumene)	<0.39	15.4	24.6	<0.39	<0.39	<1.6	<0.39	<0.39	NS	NS
p-Isopropyltoluene	<0.80	<1.6	0.98	<0.80	<0.80	<3.2	<0.80	<0.80	NS	NS
Methyl-tert-butyl-ether	<1.2	<2.5	*13.4*	**86.6**	**178**	**233**	<1.2	<1.2	12	60
Naphthalene	<1.2	*83.6*	*92.6*	<1.2	<1.2	<4.7	<1.2	<1.2	10	100
n-Propylbenzene	<0.81	43.9	35.3	<0.81	<0.81	<3.2	<0.81	<0.81	NS	NS
Tetrachloroethene	<0.33	<0.65	<0.33	<0.33	<0.33	<1.3	<0.33	<0.33	0.5	5
Toluene	<0.17	0.55	2.5	<0.17	<0.17	1.1	<0.17	<0.17	160	800
Trichloroethene	<0.26	<0.51	<0.26	<0.26	<0.26	<1.0	<0.26	<0.26	0.5	5
Vinyl Chloride	<0.17	<0.35	<0.17	**0.72**	<0.17	<0.70	<0.17	<0.17	0.02	0.2
Xylenes	<1.5	<3.0	2.5	<1.5	<1.5	14.6	<1.5	<1.5	400	2000

Notes:

Table includes detected analytes only, which are right justified in the columns.

Italic type indicates concentration exceeds PAL.

Bold type indicates concentration exceeds ES.

VOCs - Volatile Organic Compounds

PAL - NR 140 Preventive Action Limit

ES - NR 140 Enforcement Standard

NS - No Standard

Table 2 (Page 2 of 3)
Groundwater Analytical Results Table
Heimes Garage
3418 66th Street
Kenosha, WI

Parameters											Groundwater Quality Standards	
	MW-1		MW-2		MW-3		MW-4		MW-5		PAL	ES
	1/29/20	3/31/20	1/29/20	3/31/20	1/29/20	3/31/20	1/29/20	3/31/20	1/29/20	3/31/20		
VOCs (ug/l)											ug/l	ug/l
Benzene	**7.6**	**27.6**	0.42	<0.25	<0.25	*4.7*	<0.25	<0.25	<0.25	<0.25	0.5	5
n-Butylbenzene	0.74	NA	<0.71	NA	<0.71	NA	<0.71	NA	<0.71	NA	NS	NS
sec-Butylbenzene	0.93	NA	<0.85	NA	<0.85	NA	<0.85	NA	<0.85	NA	NS	NS
tert-Butylbenzene	1.2	NA	<0.30	NA	<0.30	NA	<0.30	NA	<0.30	NA	NS	NS
1,2-Dichloroethane	*3.4*	NA	<0.28	NA	<0.28	NA	<0.28	NA	<0.28	NA	0.5	5
cis-1,2-Dichloroethene	<0.27	NA	0.90	NA	<0.27	NA	<0.27	NA	<0.27	NA	7	70
trans-1,2-Dichloroethene	<1.1	NA	<1.1	NA	<1.1	NA	<1.1	NA	<1.1	NA	20	100
Diisopropyl ether	3.4	NA	<1.9	NA	<1.9	NA	<1.9	NA	<1.9	NA	NS	NS
Ethylbenzene	0.29	0.94	<0.22	<0.32	<0.22	0.38	<0.22	<0.32	<0.22	<0.32	140	700
Isopropylbenzene (Cumene)	3.0	NA	0.93	NA	<0.39	NA	<0.39	NA	<0.39	NA	NS	NS
p-Isopropyltoluene	<0.80	NA	<0.80	NA	<0.80	NA	<0.80	NA	<0.80	NA	NS	NS
Methyl-tert-butyl-ether	3.6	2.2	**95.8**	9.3	*33.3*	**123**	<1.2	<1.2	**167**	**94.4**	12	60
Naphthalene	7.5	*44.2*	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	<1.2	10	100
n-Propylbenzene	3.9	NA	<0.81	NA	<0.81	NA	<0.81	NA	<0.81	NA	NS	NS
Toluene	0.25	0.72	<0.17	<0.27	<0.17	<0.27	<0.17	<0.27	<0.17	<0.27	160	800
Trichloroethene	<0.26	NA	<0.26	NA	<0.26	NA	<0.26	NA	<0.26	NA	0.5	5
Vinyl Chloride	<0.17	NA	**0.38**	NA	<0.17	NA	<0.17	NA	<0.17	NA	0.02	0.2
Xylenes	1.0	1.4	<0.73	<0.73	<0.73	<0.73	<0.73	<0.73	<0.73	<0.73	400	2000

Notes:

Table includes detected analytes only, which are right justified in the columns.

Italic type indicates concentration exceeds PAL.

Bold type indicates concentration exceeds ES.

VOCs - Volatile Organic Compounds

PAL - NR 140 Preventive Action Limit

ES - NR 140 Enforcement Standard

NS - No Standard

Table 2 (Page 3 of 3)
Groundwater Analytical Results Table
Heimes Garage
3418 66th Street
Kenosha, WI

Parameters				Groundwater Quality Standards	
	MW-6	MW-7	MW-8	PAL	ES
	3/31/20	3/31/20	3/31/20		
VOCs (ug/l)				ug/l	ug/l
Benzene	<0.25	<0.25	<0.25	0.5	5
n-Butylbenzene	<0.71	<0.71	<0.71	NS	NS
sec-Butylbenzene	<0.85	<0.85	<0.85	NS	NS
tert-Butylbenzene	<0.30	<0.30	<0.30	NS	NS
1,2-Dichloroethane	<0.28	<0.28	<0.28	0.5	5
cis-1,2-Dichloroethene	<0.27	5.1	<0.27	7	70
trans-1,2-Dichloroethene	<0.46	<0.46	<0.46	20	100
Diisopropyl ether	<1.9	<1.9	<1.9	NS	NS
Ethylbenzene	<0.32	<0.32	<0.32	140	700
Isopropylbenzene (Cumene)	<1.7	<1.7	<1.7	NS	NS
p-Isopropyltoluene	<0.80	<0.80	<0.80	NS	NS
Methyl-tert-butyl-ether	<1.2	<1.2	<1.2	12	60
Naphthalene	<1.2	<1.2	<1.2	10	100
n-Propylbenzene	<0.81	<0.81	<0.81	NS	NS
Tetrachloroethene	<0.33	*1.1*	*0.58*	0.5	5
Toluene	<0.27	<0.27	<0.27	160	800
Trichloroethene	<0.26	0.36	<0.26	0.5	5
Vinyl Chloride	<0.17	<0.17	<0.17	0.02	0.2
Xylenes	<0.73	<0.73	<0.73	400	2000

Notes:

Table includes detected analytes only, which are right justified in the columns.

Italic type indicates concentration exceeds PAL.

Bold type indicates concentration exceeds ES.

VOCs - Volatile Organic Compounds
PAL - NR 140 Preventive Action Limit
ES - NR 140 Enforcement Standard
NS - No Standard

Table 3A (Page 1 of 3)
Monitoring Well Data
Heimes Garage

Measurement	Well ID, Survey Date							
	MW-1 2/17/2020	MW-2 2/17/2020	MW-3 2/17/2020	MW-4 2/17/2020	MW-5 2/17/2020	MW-6 4/14/2020	MW-7 4/14/2020	MW-8 4/14/2020
TOC Elevation (ft)	634.68	634.09	634.01	634.28	633.20	632.56	633.03	631.20
Ground Surface Elevation (ft)	632.18	630.99	631.21	631.18	630.90	629.96	630.23	631.80
TOS Elevation (ft)	629.2	629.1	627.4	628.9	626.5	627.7	627.7	629.4
Screened Length (ft)	10	10	10	10	10	10	10	10
Total Well Depth (ft)	15.5	15.0	16.6	15.4	16.7	14.9	15.3	11.8
Stickup	2.5	3.1	2.8	3.1	2.3	2.6	2.8	-0.6

Notes:

The reference point is the top bolt on the fire hydrant located on the east side 34th Avenue, approximately 50 feet south of the intersection with 66th Street with an elevation of 633.45 feet above mean sea level.

TOC = Top of casing
TOS = Top of screen
NA = Not Applicable
MSL = Mean sea level

Table 3B (Page 2 of 3)
Groundwater Elevation Measurements
Heimes Garage

Measurement	Well ID, Date															
	MW-1				**MW-2**				**MW-3**				**MW-4**			
	1/22/20	**1/29/20**	**2/17/20**	**03/31/20**	**1/22/20**	**1/29/20**	**2/17/20**	**03/31/20**	**1/22/20**	**1/29/20**	**2/17/20**	**03/31/20**	**1/22/20**	**1/29/20**	**2/17/20**	**03/31/20**
Depth to Groundwater Below TOC (ft)	6.80	6.45	6.69	5.96	8.07	5.96	6.43	5.59	5.85	5.42	5.87	4.60	5.90	5.62	5.88	4.82
Groundwater Elevation (ft)	627.88	628.23	627.99	628.72	626.02	628.13	627.66	628.50	628.16	628.59	628.14	629.41	628.38	628.66	628.40	629.46
Groundwater Depth Below Ground Surface (ft)	4.3	4.0	4.2	3.5	5.0	2.9	3.3	2.5	3.1	2.6	3.1	1.8	2.8	2.5	2.8	1.7
Water Column Height (ft)	8.7	9.1	8.8	9.5	6.9	9.0	8.6	9.4	10.8	11.2	10.7	12.0	9.5	9.8	9.5	10.6
Well Volume (gal)	5.9	6.2	NA	6.6	5.8	8.2	NA	7.7	7.9	7.9	NA	8.1	7.9	7.9	NA	8.1
Volume Removed (gal)	18	20	NA	20	8 (1)	10 (1)	NA	9 (1)	10 (1)	10 (1)	NA	10 (1)	25	25	NA	25

Notes:
(1) = Well was purged dry
NA = Not Applicable

Table 3B (Page 2 of 3)
Groundwater Elevation Measurements
Heimes Garage

Measurement	Well ID, Date															
	MW-1				MW-2				MW-3				MW-4			
	1/22/20	**1/29/20**	**2/17/20**	**03/31/20**	**1/22/20**	**1/29/20**	**2/17/20**	**03/31/20**	**1/22/20**	**1/29/20**	**2/17/20**	**03/31/20**	**1/22/20**	**1/29/20**	**2/17/20**	**03/31/20**
Depth to Groundwater Below TOC (ft)	6.80	6.45	6.69	5.96	8.07	5.96	6.43	5.59	5.85	5.42	5.87	4.60	5.90	5.62	5.88	4.82
Groundwater Elevation (ft)	627.88	628.23	627.99	628.72	626.02	628.13	627.66	628.50	628.16	628.59	628.14	629.41	628.38	628.66	628.40	629.46
Groundwater Depth Below Ground Surface (ft)	4.3	4.0	4.2	3.5	5.0	2.9	3.3	2.5	3.1	2.6	3.1	1.8	2.8	2.5	2.8	1.7
Water Column Height (ft)	8.7	9.1	8.8	9.5	6.9	9.0	8.6	9.4	10.8	11.2	10.7	12.0	9.5	9.8	9.5	10.6
Well Volume (gal)	5.9	6.2	NA	6.6	5.8	8.2	NA	7.7	7.9	7.9	NA	8.1	7.9	7.9	NA	8.1
Volume Removed (gal)	18	20	NA	20	8 (1)	10 (1)	NA	9 (1)	10 (1)	10 (1)	NA	10 (1)	25	25	NA	25

Notes:
(1) = Well was purged dry
NA = Not Applicable

Table 3B (Page 3 of 3)
Groundwater Elevation Measurements
Heimes Garage

Measurement	Well ID, Date									
	MW-5				MW-6		MW-7		MW-8	
	1/22/20	1/29/20	2/17/20	03/31/20	03/26/20	03/31/20	03/26/20	03/31/20	3/26/20	03/31/20
Depth to Groundwater Below TOC (ft)	5.46	4.88	5.52	4.03	5.56	3.95	5.40	4.19	4.05	2.76
Groundwater Elevation (ft)	627.74	628.32	627.68	629.17	627.00	628.61	627.63	628.84	627.15	628.44
Groundwater Depth Below Ground Surface (ft)	3.2	2.6	3.2	1.7	3.0	1.4	2.6	1.4	4.6	3.4
Water Column Height (ft)	11.2	11.8	11.2	12.7	9.3	11.4	9.9	11.1	7.8	9.0
Well Volume (gal)	7.9	8.0	NA	8.2	7.1	7.7	7.5	7.8	5.9	6.8
Volume Removed (gal)	15 (1)	15 (1)	NA	15 (1)	22	24	24	24	7 (1)	8 (1)

Notes:
(1) = Well was purged dry
NA = Not Applicable

TABLE 4 (Page 1 of 1)
Heimes PEP Environmental Phase II Soil Sample Analytical Results Summary
Heimes Garage
PEP Environmental - December 2002

Sampling Location	**B-1**	**B-2**	**B-3**	**B-4**	**B-5**	**B-6**				
Sample Depth (ft-bls)	**4-6**	**4-6**	**4-6**	**4-6**	**4-6**	**6-8**				
Saturation Depth (ft-bls)	**6**	**6**	**6**	**6**	**6**	**6**				
Saturated/Unsaturated	**Unsat**	**Unsat**	**Unsat**	**Unsat**	**Unsat**	**Sat**		**NR 720 RCLs**		
Collection Date	**12/9/02**	**12/9/02**	**12/9/02**	**12/9/02**	**12/9/02**	**12/9/02**	**Industrial Direct Contact**	**Non-Industrial Direct Contact**	**Groundwater Protection**	
Parameter										
PVOCs (mg/kg)							mg/kg	mg/kg	mg/kg	
Benzene	<0.025	*3.060*	<0.025	<0.025	*0.0596*	7.130	7.07	1.6	0.0051	
Ethylbenzene	1.020	*6.510*	*4.170*	<0.025	0.368	89.200	35.4	8.02	1.57	
Naphthalene	*3.920*	*73.600*	*6.060*	0.0397	*2.280*	57.100	24.1	5.52	0.6582	
Toluene	0.374	*2.880*	*2.330*	<0.025	0.085	6.730	818	818	1.1072	
1,2,4-Trimethylbenzene	*1.690*	*14.500*	*1.910*	<0.025	0.456	191.000	219	219	1.3787 (1)	
1,3,5-Trimethylbenzene	*3.650*	*4.410*	*5.000*	<0.025	0.806	63.700	182	182	1.3787 (1)	
Xylenes	2.020	*14.100*	2.460	0.0423	1.780	375.000	260	260	3.96	
GRO/DRO (mg/kg)							mg/kg	mg/kg	mg/kg	
GRO	426	2250	651	<6.14	113	4250	NS	NS	NS	
DRO	46.9	7080	46.8	<6.14	106	2660	NS	NS	NS	
Metals (mg/kg)							mg/kg	mg/kg	mg/kg	**Background Threshold Value mg/kg**
Lead	NA	NA	NA	NA	NA	7.25	800	400	27	52

Notes:

Table includes detected analytes only.

Italicized Type indicates a contaminant concentration above the groundwater protection RCL, which may result in exceedance of groundwater quality standards.

Bold Type indicates contaminant a concentration exceeding the industrial direct contact exposure RCL in the upper four feet of the subsurface, which may pose a risk to human health through direct contact exposure. The property is zoned M-2 Heavy Manufacturing.

(1) The groundwater protection RCL applies to combined trimethylbenzenes.

RCL = Residual Contaminant Level

VOCs = Volatile Organic Compounds

GRO = Gasoline Range Organics

DRO = Diesel Range Organics

NA = Not Analyzed

NS = No Standard

TABLE 5 (Page 1 of 1)
Heimes PEP Environmental Phase II Groundwater Sample Analytical Results Summary
Heimes Garage
PEP Environmental - December 2002

Sampling Location	**B-1 (WB-1)**	**B-5 (WB-5)**	**B-6 (WB-6)**	**Groundwater Quality Standards**	
Collection Date	**12/9/02**	**12/9/02**	**12/9/02**	**Enforcement Standards**	**Preventive Action Limits**
Parameter PVOCs, Napthalene (ug/l)				ug/l	ug/l
Benzene	<0.50	<0.50	**184**	5	0.5
Ethylbenzene	<0.50	4.22	**2,340**	700	140
Methyl-tert-butyl-ether	5.02	1.11	**325**	60	12
Naphthalene	<2	*50.4*	**891**	100	10
Toluene	<0.50	1.47	**839**	800	160
1,2,4-Trimethylbenzene	<1	6.84	**2,620**	480 (1)	96 (1)
1,3,5-Trimethylbenzene	<1	4.73	**901**	480 (1)	96 (1)
Xylenes	1.02	10.50	**9,760**	2,000	400
GRO (ug/l)				ug/l	ug/l
GRO	<50	1,180	27,600	NS	NS

Notes:

Table includes detected analytes only.

Italicized Type indicates a contaminant concentration exceeding the preventive action limit.

Bold Type indicates contaminant a concentration exceeding the enforcement standard

(1) The groundwater quality standards apply to combined trimethylbenzenes.

PVOCs = Petroleum Volatile Organic Compounds

GRO = Gasoline Range Organics

NS = No Standard

TABLE 6 (Page 1 of 1)
Industrial Pumping Investigative Soil Sample Analytical Results Summary
Locations Adjacent to Heimes Site
K. Singh & Associates 1992

Sampling Location	**B-2**	**B-3**	**B-4**	**B-4**	**B-8**				
Sample Depth (ft-bls)	**6-7.5**	**6-7.5**	**3.5-5**	**8.5-10**	**3.5-5**				
Saturation Depth (ft-bls)	**6**	**6**	**6**	**6**	**6**				
Saturated/Unsaturated	**Sat**	**Sat**	**Unsat**	**Sat**	**Unsat**		**NR 720 RCLs**		
Collection Date	**6/17/92**	**6/17/92**	**6/17/92**	**6/17/92**	**6/17/92**	**Industrial Direct Contact**	**Non-Industrial Direct Contact**	**Groundwater Protection**	
Parameter									
VOCs (mg/kg)						mg/kg	mg/kg	mg/kg	
Benzene	<0.058	0.890	<0.050	NA	<0.050	7.07	1.6	0.0051	
n-Butylbenzene	NA	NA	NA	NA	NA	108	108	NS	
Chlorobenzene	NA	NA	NA	NA	NA	761	370	0.1358	
Ethylbenzene	<0.058	0.760	0.100	NA	0.980	35.4	8.02	1.57	
Methyl-tert-butyl-ether	<0.058	1.000	<0.050	NA	<0.050	282	63.8	0.027	
Isopropylbenzene	NA	NA	NA	NA	NA	268	268	NS	
Naphthalene	NA	NA	NA	NA	NA	24.1	5.52	0.6582	
Toluene	0.100	4.400	<0.050	NA	<0.050	818	818	1.1072	
1,2,4-Trimethylbenzene	0.079	1.400	*1.900*	NA	*4.300*	219	219	1.3787	
1,3,5-Trimethylbenzene	<0.058	0.790	*0.800*	NA	*3.400*	182	182	1.3787	
Xylenes	0.130	5.300	0.130	NA	1.100	260	260	3.96	
GRO/DRO (mg/kg)						mg/kg	mg/kg	mg/kg	
GRO	7.6	65	66	NA	250	NS	NS	NS	
DRO	90	23	970	26	1100	NS	NS	NS	
PAHs (ug/kg)						ug/kg	ug/kg	ug/kg	
Naphthalene	NA	NA	NA	NA	NA	24.1	5.52	0.6582	
PCBs (mg/kg)						mg/kg	mg/kg	mg/kg	
PCBs	NA	NA	NA	NA	NA	NS (2)	NS (2)	NS (2)	
RCRA Metals (mg/kg)						mg/kg	mg/kg	mg/kg	**Background Threshold Value mg/kg**
Arsenic	NA	NA	NA	NA	NA	3	0.677	0.584	8
Barium	NA	NA	NA	NA	NA	100,000	15,300	164.8	364
Chromium	NA	NA	NA	NA	NA	100,000	100,000	360,000	44
Lead	10	4.5	5.3	NA	4.7	800	400	27	52
Selenium	NA	NA	NA	NA	NA	5,840	391	0.52	NA

Notes:

Table includes detected analytes only.

Italicized Type indicates a contaminant concentration above the groundwater protection RCL, which may result in exceedance of groundwater quality standards.

Bold Type indicates contaminant a concentration exceeding the industrial direct contact exposure RCL in the upper four feet of the subsurface, which may pose a risk to human health through direct contact exposure. The property is zoned M-2 Heavy Manufacturing.

(1) The groundwater protection RCL applies to combined trimethylbenzenes.
(2) RCLs apply to individual PCB compounds
RCL = Residual Contaminant Level
VOCs = Volatile Organic Compounds
GRO = Gasoline Range Organics
DRO = Diesel Range Organics
PCBs = Polychlorinated Biphenyls
PAHs = Polynuclear Organic Hydrocarbons
RCRA = Resource Conservation and Recovery Act
NA = Not Analyzed
NS = No Standard

TABLE 7 (Page 1 of 1)
Industrial Pumping Investigative Soil Sample Analytical Results Summary Locations on Heimes Site
K. Singh & Associates 1992 - 1994

Sampling Location	**B-11**	**B-13**	**B-14**	**B-14**	**B-18**				
Sample Depth (ft-bls)	**8.5-10**	**8.5-10**	**6-7**	**8.5-10**	**8.5-10**				
Saturation Depth (ft-bls)	**6**	**6**	**6**	**6**	**6**				
Saturated/Unsaturated	**Sat**	**Sat**	**Sat**	**Sat**	**Sat**		**NR 720 RCLs**		
Collection Date	**10/29/92**	**7/22/94**	**7/22/94**	**7/22/94**	**7/25/94**	**Industrial Direct Contact**	**Non-Industrial Direct Contact**	**Groundwater Protection**	
Parameter									
VOCs (mg/kg)						mg/kg	mg/kg	mg/kg	
Benzene	NA	0.91	<0.50	<1.1	<0.10	7.07	1.6	0.0051	
n-Butylbenzene	NA	<0.20	0.98	<1.1	0.24	108	108	NS	
Chlorobenzene	NA	<0.20	0.75	<1.1	0.21	761	370	0.1358	
Ethylbenzene	NA	1.4	<0.50	<1.1	<0.025	35.4	8.02	1.57	
Isopropylbenzene	NA	<0.20	<0.50	<1.1	0.82	268	268	NS	
Naphthalene	NA	<0.20	0.94	<1.1	0.22	24.1	5.52	0.6582	
Toluene	NA	0.48	<0.50	<1.1	0.12	818	818	1.1072	
1,2,4-Trimethylbenzene	NA	0.57	4.2	4.1	0.19	219	219	1.3787	
1,3,5-Trimethylbenzene	NA	0.20	1.2	2.1	<0.10	182	182	1.3787	
Xylenes	NA	1.8	3.3	5.4	0.32	260	260	3.96	
GRO/DRO (mg/kg)						mg/kg	mg/kg	mg/kg	
GRO	NA	21	80	120	5.7	NS	NS	NS	
DRO	0.75	<5.0	12	8.1	<5.0	NS	NS	NS	
PAHs (ug/kg)						ug/kg	ug/kg	ug/kg	
Naphthalene	NA	<40	0.130	<40	<40	24.1	5.52	0.6582	
PCBs (mg/kg)						mg/kg	mg/kg	mg/kg	
PCBs	NA	ND	ND	ND	ND	NS (2)	NS (2)	NS (2)	
RCRA Metals (mg/kg)						mg/kg	mg/kg	mg/kg	**Background Threshold Value mg/kg**
Arsenic	NA	6.6	2.4	5.4	2.6	3	0.677	0.584	8
Barium	NA	31	24	44	23	100,000	15,300	164.8	364
Chromium	NA	4.4	5.5	9.9	7.0	100,000	100,000	360,000	44
Lead	NA	8.0	7.6	7.0	7.6	800	400	27	52
Selenium	NA	0.58	0.67	0.69	0.62	5,840	391	0.52	NA

Notes:

Table includes detected analytes only.

Italicized Type indicates a contaminant concentration above the groundwater protection RCL, which may result in exceedance of groundwater quality standards.

Bold Type indicates contaminant a concentration exceeding the industrial direct contact exposure RCL in the upper four feet of the subsurface, which may pose a risk to human health through direct contact exposure. The property is zoned M-2 Heavy Manufacturing.

(1) The groundwater protection RCL applies to combined trimethylbenzenes.

(2) RCLs apply to individual PCB compounds

RCL = Residual Contaminant Level

VOCs = Volatile Organic Compounds

GRO = Gasoline Range Organics

DRO = Diesel Range Organics

PCBs = Polychlorinated Biphenyls

PAHs = Polynuclear Organic Hydrocarbons

RCRA = Resource Conservation and Recovery Act

NA = Not Analyzed

NS = No Standard

TABLE 8 (Page 1 of 1)
Industrial Pumping Investigative Groundwater Sample Analytical Results Summary
Location MW-7 on Heimes Site
K. Singh & Associates July 1992 through February 1997

Sampling Location				**MW-7**				**Groundwater Quality Standards**	
Collection Date	**7/1/92**	**7/26/94**	**8/2/95**	**1/25/96**	**5/24/96**	**10/2/96**	**2/19/97**	**Enforcement Standards**	**Preventive Action Limits**
Parameter **VOCs (ug/l)**								ug/l	ug/
Benzene	<0.04	**20**	**19**	*4.3*	*4.4*	*1.1*	*2.0*	5	0.5
n-Butylbenzene	<0.20	1.1	NA	NA	NA	NA	NA	NS	NS
Ethylbenzene	0.2	<1.0	<0.50	<1.0	<0.50	<0.50	0.75	700	140
Isopropylbenzene	<0.20	1.5	NA	NA	NA	NA	NA	NS	NS
Methyl-tert-butyl-ether	<0.02	2.6	<5.0	2.3	*44*	*40*	*19*	60	12
Naphthalene	<0.02	<1.0	NA	NA	NA	NA	NA	100	10
Toluene	1.2	<1.0	<0.50	<1.0	<0.50	<0.50	<0.50	800	160
1,2,4-Trimethylbenzene	<0.2	6.4	<1.0	<1.0	1.1	<1.0	2.8	480 (1)	96 (1)
1,3,5-Trimethylbenzene	<0.2	2.0	<1.0	<1.0	<1.0	<1.0	<1.0	480 (1)	96 (1)
Xylenes	<0.4	5.0	<0.50	<3.0	1.6	<0.50	11	2,000	400
GRO/DRO (ug/l)								ug/l	ug/
GRO	<0.1	160	69	<50	<50	84	150	NS	NS
DRO	<0.1	0.14	<100	340	<100	NA	NA	NS	NS
PAHs (ug/l)								ug/l	ug/
PAHs	ND	ND	ND	NA	NA	NA	NA	NS (2)	NS (2)
PCBs (ug/l)								ug/l	ug/
PCBs	ND	ND	NA	NA	NA	NA	NA	NS (2)	NS (2)
Dissolved RCRA Metals (ug/l)								ug/l	ug/
Arsenic	NA	3.1	NA	NA	NA	NA	NA	1	10
Cadmium	4	<0.5	<0.5	NA	NA	NA	NA	0.5	5

Notes:
Table includes detected analytes only.
Italicized Type indicates a contaminant concentration exceeding the preventive action limit.
Bold Type indicates contaminant a concentration exceeding the enforcement standard
(1) The groundwater quality standards apply to combined trimethylbenzenes.
(2) The groundwater quality standards apply to individual compounds
VOCs = Volatile Organic Compounds
GRO = Gasoline Range Organics
DRO = Diesel Range Organics
PAHs = Polynuclear Aromatic Hydrocarbons
PCBs = Polychlorinated Biphenyls
RCRA = Resource Conservation and Recovery Act
NS = No Standard
NA = Not Analyzed

TABLE 9 (Page 1 of 3)
Industrial Pumping Excavation Soil Sample analytical Results Summary
On & Adjacent to Heimes Site
K. Singh - March 1995

Sampling Location	**A-3B**	**A-3W**	**B-3B**	**B-3W**	**C-3B**				
Sample Depth (ft-bls)	**9.5**	**5.5**	**10.0**	**5.0**	**8.0**				
Saturation Depth (ft-bls)	**6**	**6**	**6**	**6**	**6**				
Saturated/Unsaturated	**Sat**	**Unsat**	**Sat**	**Unsat**	**Sat**		**NR 720 RCLs**		
Collection Date	**3/15/95**	**3/17/95**	**3/14/95**	**3/17/95**	**3/9/95**	**Industrial Direct Contact**	**Non-Industrial Direct Contact**	**Groundwater Protection**	
Parameter									
PVOCs & 1,2-DCA (mg/kg)						mg/kg	mg/kg	mg/kg	
Benzene	<0.005	<0.0083	<0.005	<0.0055	<0.005	7.07	1.6	0.0051	
Ethylbenzene	<0.005	<0.029	<0.005	0.150	<0.005	35.4	8.02	1.57	
Methyl-tert-butyl-ether	<0.005	<0.029	<0.005	<0.025	<0.005	282	63.8	0.027	
Toluene	<0.005	<0.029	<0.005	0.074	<0.005	818	818	1.1072	
1,2,4-Trimethylbenzene	<0.005	<0.029	<0.005	0.160	<0.005	219	219	1.3787 (1)	
1,3,5-Trimethylbenzene	<0.005	<0.029	<0.005	0.044	<0.005	182	182	1.3787 (1)	
Xylenes	<0.015	<0.040	<0.015	0.380	<0.015	260	260	3.96	
1,2-Dichloroethane	NA	<0.015	NA	NA	NA	2.87	0.652	0.0028	
GRO/DRO (mg/kg)						mg/kg	mg/kg	mg/kg	
GRO	NA	9.4	NA	NA	<5.0	NS	NS	NS	
DRO	38	162	6.2	42	<5.0	NS	NS	NS	
PAHs (ug/kg)						ug/kg	ug/kg	ug/kg	
Naphthalene	ND	NA	NA	NA	NA	NS	NS	NS	
PCBs (mg/kg)						mg/kg	mg/kg	mg/kg	
PCBs	NA	NA	NA	NA	NA	NS (2)	NS (2)	NS (2)	
RCRA Metals (mg/kg)						mg/kg	mg/kg	mg/kg	**Background Threshold Value mg/kg**
Arsenic	NA	NA	NA	NA	NA	3	0.677	0.584	8
Barium	NA	NA	NA	NA	NA	100,000	15,300	164.8	364
Chromium	NA	NA	NA	NA	NA	100,000	100,000	360,000	44
Lead	NA	7.6	NA	NA	7.7	800	400	27	52
Selenium	NA	NA	NA	NA	NA	5,840	391	0.52	NA

Notes:

Table includes detected analytes only.

Italicized Type indicates a contaminant concentration above the groundwater protection RCL, which may result in exceedance of groundwater quality standards.

Bold Type indicates contaminant a concentration exceeding the industrial direct contact exposure RCL in the upper four feet of the subsurface, which may pose a risk to human health through direct contact exposure. The property is zoned M-2 Heavy Manufacturing.

(1) The groundwater protection RCL applies to combined trimethylbenzenes.

RCL = Residual Contaminant Level
VOCs = Volatile Organic Compounds
GRO = Gasoline Range Organics
DRO = Diesel Range Organics
NA = Not Analyzed
NS = No Standard

TABLE 9 (Page 2 of 3)
Industrial Pumping Excavation Soil Sample Analytical Results Summary
On & Adjacent to Heimes Site
K. Singh - March 1995

Sampling Location	**C-3W**	**D-3B**	**D-3W**	**E-3B**	**E-3W**		**NR 720 RCLs**		
Sample Depth (ft-bls)	**5.0**	**8.0**	**5.0**	**8.0**	**5.0**				
Saturation Depth (ft-bls)	**6**	**6**	**6**	**6**	**6**				
Saturated/Unsaturated	**Unsat**	**Sat**	**Unsat**	**Sat**	**Unsat**				
Collection Date	**3/17/95**	**3/9/95**	**3/9/95**	**3/8/95**	**3/8/95**	**Industrial Direct Contact**	**Non-Industrial Direct Contact**	**Groundwater Protection**	
Parameter									
PVOCs & 1,2-DCA (mg/kg)						mg/kg	mg/kg	mg/kg	
Benzene	<0.0085	<0.005	<0.005	0.890	<0.005	7.07	1.6	0.0051	
Ethylbenzene	<0.030	<0.005	<0.005	<0.005	<0.005	35.4	8.02	1.57	
Methyl-tert-butyl-ether	<0.030	<0.005	<0.005	<0.005	<0.005	282	63.8	0.027	
Toluene	<0.030	<0.005	<0.005	<0.005	<0.005	818	818	1.1072	
1,2,4-Trimethylbenzene	<0.030	<0.005	<0.005	<0.005	<0.005	219	219	1.3787 (1)	
1,3,5-Trimethylbenzene	<0.030	<0.005	<0.005	<0.005	<0.005	182	182	1.3787 (1)	
Xylenes	0.380	<0.015	<0.015	<0.015	<0.015	260	260	3.96	
1,2-Dichloroethane	NA	NA	<0.005	23	NA	2.87	0.652	0.0028	
GRO/DRO (mg/kg)						mg/kg	mg/kg	mg/kg	
GRO	<5.9	NA	<5.0	<5.0	NA	NS	NS	NS	
DRO	21	22	<5.0	<5.0	<5.0	NS	NS	NS	
PAHs (ug/kg)						ug/kg	ug/kg	ug/kg	
Naphthalene	NA	NA	NA	ND	NA	NS	NS	NS	
PCBs (mg/kg)						mg/kg	mg/kg	mg/kg	
PCBs	NA	NA	NA	NA	NA	NS (2)	NS (2)	NS (2)	
RCRA Metals (mg/kg)						mg/kg	mg/kg	mg/kg	**Background Threshold Value mg/kg**
Arsenic	NA	NA	NA	NA	NA	3	0.677	0.584	8
Barium	NA	NA	NA	NA	NA	100,000	15,300	164.8	364
Chromium	NA	NA	NA	NA	NA	100,000	100,000	360,000	44
Lead	10	NA	7.8	8.6	NA	800	400	27	52
Selenium	NA	NA	NA	NA	NA	5,840	391	0.52	NA

Notes:

Table includes detected analytes only.

Italicized Type indicates a contaminant concentration above the groundwater protection RCL, which may result in exceedance of groundwater quality standards.

Bold Type indicates contaminant a concentration exceeding the industrial direct contact exposure RCL in the upper four feet of the subsurface, which may pose a risk to human health through direct contact exposure. The property is zoned M-2 Heavy Manufacturing.

(1) The groundwater protection RCL applies to combined trimethylbenzenes.

RCL = Residual Contaminant Level

VOCs = Volatile Organic Compounds

GRO = Gasoline Range Organics

DRO = Diesel Range Organics

NA = Not Analyzed

NS = No Standard

TABLE 9 (Page 3 of 3)
Industrial Pumping Excavation Soil Sample Analytical Results Summary
On & Adjacent to Heimes Site
K. Singh - March 1995

Sampling Location	**F-2W**	**F-3B**	**F-3W**	**G-2W**	**G-3B**		**NR 720 RCLs**		
Sample Depth (ft-bls)	**5.0**	**9.0**	**5.0**	**4.0**	**9.0**				
Saturation Depth (ft-bls)	**6**	**6**	**6**	**6**	**6**				
Saturated/Unsaturated	**Unsat**	**Sat**	**Unsat**	**Unsat**	**Sat**				
Collection Date	**3/16/95**	**3/15/95**	**3/17/95**	**3/15/95**	**3/15/95**	**Industrial Direct Contact**	**Non-Industrial Direct Contact**	**Groundwater Protection**	
Parameter									
PVOCs & 1,2-DCA (mg/kg)						mg/kg	mg/kg	mg/kg	
Benzene	<0.005	<0.005	<0.0095	<0.005	<0.005	7.07	1.6	0.0051	
Ethylbenzene	0.150	<0.005	<0.025	<0.005	<0.005	35.4	8.02	1.57	
Methyl-tert-butyl-ether	<0.015	<0.005	<0.025	<0.005	<0.005	282	63.8	0.027	
Toluene	<0.015	<0.005	<0.025	<0.005	<0.005	818	818	1.1072	
1,2,4-Trimethylbenzene	0.096	<0.005	<0.025	<0.005	<0.005	219	219	1.3787 (1)	
1,3,5-Trimethylbenzene	0.500	<0.005	<0.025	<0.005	<0.005	182	182	1.3787 (1)	
Xylenes	<0.045	<0.015	<0.035	<0.015	<0.015	260	260	3.96	
1,2-Dichloroethane	<0.005	NA	<0.013	NA	<0.005	2.87	0.652	0.0028	
GRO/DRO (mg/kg)						mg/kg	mg/kg	mg/kg	
GRO	150	NA	<6.6	NA	<5.0	NS	NS	NS	
DRO	120	10	47	5.8	10	NS	NS	NS	
PAHs (ug/kg)						ug/kg	ug/kg	ug/kg	
Naphthalene	NA	NA	NA	NA	NA	NS	NS	NS	
PCBs (mg/kg)						mg/kg	mg/kg	mg/kg	
PCBs	NA	NA	NA	NA	NA	NS (2)	NS (2)	NS (2)	
RCRA Metals (mg/kg)						mg/kg	mg/kg	mg/kg	**Background Threshold Value mg/kg**
Arsenic	NA	NA	NA	NA	NA	3	0.677	0.584	8
Barium	NA	NA	NA	NA	NA	100,000	15,300	164.8	364
Chromium	NA	NA	NA	NA	NA	100,000	100,000	360,000	44
Lead	12	NA	13	NA	6.3	800	400	27	52
Selenium	NA	NA	NA	NA	NA	5,840	391	0.52	NA

Notes:

Table includes detected analytes only.

Italicized Type indicates a contaminant concentration above the groundwater protection RCL, which may result in exceedance of groundwater quality standards.

Bold Type indicates contaminant a concentration exceeding the industrial direct contact exposure RCL in the upper four feet of the subsurface, which may pose a risk to human health through direct contact exposure. The property is zoned M-2 Heavy Manufacturing.

(1) The groundwater protection RCL applies to combined trimethylbenzenes.

RCL = Residual Contaminant Level

VOCs = Volatile Organic Compounds

GRO = Gasoline Range Organics

DRO = Diesel Range Organics

NA = Not Analyzed

NS = No Standard

Table 10 (Page 1 of 1)
Soil Analytical Results Table
Yutka Storage Site

Parameters	**SAMPLE DATA**				**RESIDUAL CONTAMINANT LEVELS**		
	MEC Site Investigation						
	HP-1 (4.5'-5')	**HP-2 (4.5'-5')**	**HP-3 (4'-4.5')**	**HP-4 (5'-5.5')**	**NTE I DC**	**NTE NI DC**	**GWP**
	12/22/17	12/22/17	12/22/17	12/22/17			
Saturation Depth (ft/bls)	6.75	6.5	6.0	6.0			
Saturated / Unsaturated	Unsat	Unsat	Unsat	Unsat			
Soil / Material Type	Clay	Clay	Clay	Clay			
PID FIELD SCREENING (ppm)	0	0	0	0			
PAHs (mg/kg)					mg/kg	mg/kg	mg/kg
Acenaphthene	0.0057	<0.0048	<0.0055	<0.0052	45,200	3,590	NS
Anthracene	0.0109	<0.0070	<0.0080	<0.0077	100,000	17,900	196.9492
Benzo(a)anthracene	0.0156	<0.0039	<0.0045	<0.0042	20.8	1.14	NS
Benzo(a)pyrene	0.0131	<0.0031	<0.0035	<0.0034	2.110	0.115	0.47
Benzo(b)fluoranthene	0.0170	<0.0035	<0.0040	<0.0038	21.1	1.15	0.4781
Benzo(g,h,i)perylene	0.0133	<0.0025	<0.0029	<0.0027	NS	NS	NS
Benzo(k)fluoranthene	0.0131	<0.0031	<0.0035	<0.0034	211	11.5	NS
Chrysene	0.0243	<0.0041	<0.0047	<0.0045	2,110	115	0.1442
Dibenz(a,h)anthracene	0.0035	<0.0027	<0.0031	<0.0030	2.11	0.115	NS
Fluoranthene	0.0272	<0.0064	<0.0073	<0.0070	30,100	2,390	88.8778
Fluorene	0.0200	<0.0051	<0.0058	<0.0055	30,100	2,390	14.8299
Indeno(1,2,3-cd)pyrene	0.0091	<0.0027	<0.0031	<0.0029	21.1	1.15	NS
1-Methylnaphthalene	0.0714	<0.0049	<0.0057	<0.0054	72.7	17.6	NS
2-Methylnaphthalene	0.119	0.0064	<0.0070	<0.0067	3,010	239	NS
Naphthalene	0.0539	<0.0103	<0.0118	<0.0113	24.1	5.52	0.6582
Phenanthrene	0.0617	<0.0143	<0.0164	<0.0156	NS	NS	NS
Pyrene	0.0286	<0.0055	<0.0063	<0.0060	22,600	1,790	54.5455
VOCs / PVOCs (mg/kg)					mg/kg	mg/kg	mg/kg
Benzene	<0.025	<0.025	<0.025	<0.025	7.07	1.6	0.0051
Ethylbenzene	<0.025	<0.025	<0.025	<0.025	35.4	8.02	1.57
Naphthalene	<0.040	<0.040	<0.040	<0.040	26	5.15	0.6582
Tetrachloroethene	*0.0441*	<0.025	<0.025	<0.025	145	33	0.0045
Toluene	<0.025	<0.025	<0.025	<0.025	818	818	1.1072
Trichloroethene	<0.025	<0.025	<0.025	<0.025	8.81	1.26	0.0036
GRO / DRO mg/kg							
GRO	NA	NA	NA	NA	NS	NS	NS
DRO	NA	NA	NA	NA	NS	NS	NS

Notes:

Table includes detected analytes only, which are right justified in the columns.
depth interval between 1 and 3 feet below land surface (bls).

Bold type indicates concentration within the upper 4 feet of the subsurface exceeds the non-industrial direct contact RCL and, if applicable, the background level, thus constituting a soil standard exceedance.

Italic type indicates a concentration exceeds the groundwater protection RCL and, if applicable the background level, thus constituting a soil standard exceedance.

PID - Photoionization Detector
NTE I DC - Not To Exceed Industrial Direct Contact
NTE NI DC - Not To Exceed Non-Industrial Direct Contact
GWP - Groundwater Protection
PAHs - Polynuclear Aromatic Hydrocarbons
VOCs / PVOCs - Volatile Organic Compounds / Petroleum Volatile Organic Compounds
GRO - Gasoline Range Organics
DRO - Diesel Range Organics
NS - No Standard
NA - Not Analyzed

Table 11 (Page 2 of 2)
Yutka Storage Investigative Groundwater Sample Analytical Results Summary
66th Street Right-of-Way
MEC 2017 - 2018

Parameters					**Groundwater Quality Standards**	
	HP-1WR	**HP-2WR**	**HP-3WR**	**HP-4WR**	**PAL**	**ES**
	1/19/18	**1/19/18**	**1/19/18**	**1/19/18**		
VOCs / PVOCs (ug/l)					ug/l	ug/l
Benzene	<0.50	<0.50	<0.50	<0.50	0.5	5
Chloroethane	<0.37	<0.37	<0.37	0.85	80	400
Chloromethane	1.0	<0.50	1.6	1.5	3	30
cis-1,2-Dichloroethene	1.2	0.33	<0.26	<0.26	7	70
trans-1,2-Dichloroethene	0.31	<0.26	<0.26	<0.26	20	100
Ethylbenzene	<0.50	<0.50	<0.50	<0.50	140	700
Isopropylbenzene (Cumene)	<0.14	<0.14	<0.14	<0.14	NS	NS
p-Isopropyltoluene	<0.50	<0.50	<0.50	<0.50	NS	NS
Methyl-tert-butyl-ether	<0.17	0.80	5.6	0.28	12	60
Naphthalene	<2.5	<2.5	<2.5	<2.5	10	100
n-Propylbenzene	<0.50	<0.50	<0.50	<0.50	NS	NS
Toluene	<0.50	<0.50	<0.50	<0.50	160	800
1,2,4-Trimethylbenzene	<2.2	<2.2	<2.2	<2.2	96 (1)	480 (1)
1,3,5-Trimethylbenzene	<0.50	<0.50	<0.50	<0.50	96 (1)	480 (1)
Trichloroethene	<0.33	<0.33	<0.33	<0.33	0.5	5
Vinyl Chloride	<0.18	<0.18	**4.2**	**0.60**	0.02	0.2
Xylenes	<1.5	<1.5	<1.5	<1.5	400	2000

Notes:

Table includes detected analytes only, which are right justified in the columns.

Italic type indicates concentration exceeds PAL.

Bold type indicates concentration exceeds ES.

VOCs - Volatile Organic Compounds

PVOCs - Petroleum Volatile Organic Compounds

PAL - NR 140 Preventive Action Limit

ES - NR 140 Enforcement Standard

NS - No Standard

Table 11 (Page 1 of 2)
Yutka Storage Investigative Groundwater Sample Analytical Results Summary
66th Street Right-of-Way
MEC 2017 - 2018

Parameters	**Sample ID, Collection Date, Results**				**Groundwater Quality Standards**	
	HP-1W	**HP-2W**	**HP-3W**	**HP-4W**	**PAL**	**ES**
	12/22/17	**12/22/17**	**12/22/17**	**12/22/17**		
VOCs / PVOCs (ug/l)					ug/l	ug/l
Benzene	<0.50	<0.50	<0.50	<0.50	0.5	5
Chloromethane	<0.50	<0.50	<0.50	<0.50	3	30
cis-1,2-Dichloroethene	1.2	<0.26	<0.26	<0.26	7	70
trans-1,2-Dichloroethene	0.49	<0.26	<0.26	<0.26	20	100
Ethylbenzene	<0.50	<0.50	<0.50	<0.50	140	700
Isopropylbenzene (Cumene)	<0.14	<0.14	<0.14	<0.14	NS	NS
p-Isopropyltoluene	<0.50	<0.50	<0.50	<0.50	NS	NS
Methyl-tert-butyl-ether	<0.17	0.71	5.7	<0.17	12	60
Naphthalene	<2.5	<2.5	<2.5	<2.5	10	100
n-Propylbenzene	<0.50	<0.50	<0.50	<0.50	NS	NS
Toluene	<0.50	<0.50	<0.50	<0.50	160	800
1,2,4-Trimethylbenzene	<2.2	<2.2	<2.2	<2.2	96 (1)	480 (1)
1,3,5-Trimethylbenzene	<0.50	<0.50	<0.50	<0.50	96 (1)	480 (1)
Trichloroethene	<0.33	<0.33	<0.33	<0.33	0.5	5
Vinyl Chloride	<0.18	<0.18	**1.4**	<0.18	0.02	0.2
Xylenes	<1.5	<1.5	<1.5	<1.5	400	2000

Notes:

Table includes detected analytes only, which are right justified in the columns.

Italic type indicates concentration exceeds PAL.

Bold type indicates concentration exceeds ES.

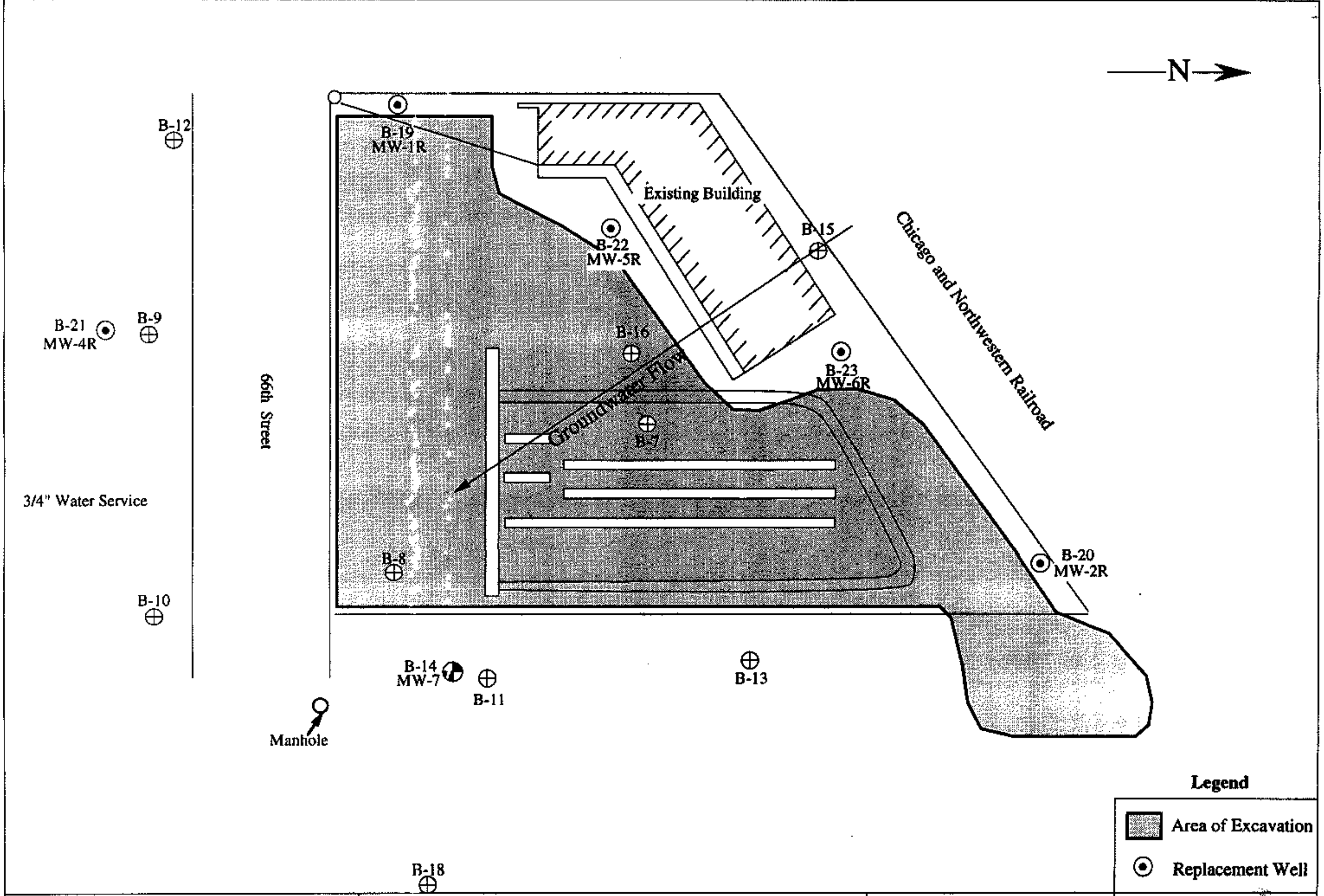
VOCs - Volatile Organic Compounds
PVOCs - Petroleum Volatile Organic Compounds
PAL - NR 140 Preventive Action Limit
ES - NR 140 Enforcement Standard
NS - No Standard

Table 11 (Page 2 of 2)
Yutka Storage Investigative Groundwater Sample Analytical Results Summary
66th Street Right-of-Way
MEC 2017 - 2018

Parameters					**Groundwater Quality Standards**	
	HP-1WR	**HP-2WR**	**HP-3WR**	**HP-4WR**	**PAL**	**ES**
	1/19/18	**1/19/18**	**1/19/18**	**1/19/18**		
VOCs / PVOCs (ug/l)					ug/l	ug/l
Benzene	<0.50	<0.50	<0.50	<0.50	0.5	5
Chloroethane	<0.37	<0.37	<0.37	0.85	80	400
Chloromethane	1.0	<0.50	1.6	1.5	3	30
cis-1,2-Dichloroethene	1.2	0.33	<0.26	<0.26	7	70
trans-1,2-Dichloroethene	0.31	<0.26	<0.26	<0.26	20	100
Ethylbenzene	<0.50	<0.50	<0.50	<0.50	140	700
Isopropylbenzene (Cumene)	<0.14	<0.14	<0.14	<0.14	NS	NS
p-Isopropyltoluene	<0.50	<0.50	<0.50	<0.50	NS	NS
Methyl-tert-butyl-ether	<0.17	0.80	5.6	0.28	12	60
Naphthalene	<2.5	<2.5	<2.5	<2.5	10	100
n-Propylbenzene	<0.50	<0.50	<0.50	<0.50	NS	NS
Toluene	<0.50	<0.50	<0.50	<0.50	160	800
1,2,4-Trimethylbenzene	<2.2	<2.2	<2.2	<2.2	96 (1)	480 (1)
1,3,5-Trimethylbenzene	<0.50	<0.50	<0.50	<0.50	96 (1)	480 (1)
Trichloroethene	<0.33	<0.33	<0.33	<0.33	0.5	5
Vinyl Chloride	<0.18	<0.18	**4.2**	**0.60**	0.02	0.2
Xylenes	<1.5	<1.5	<1.5	<1.5	400	2000

Notes:
Table includes detected analytes only, which are right justified in the columns.
Italic type indicates concentration exceeds PAL.
Bold type indicates concentration exceeds ES.
VOCs - Volatile Organic Compounds
PVOCs - Petroleum Volatile Organic Compounds
PAL - NR 140 Preventive Action Limit
ES - NR 140 Enforcement Standard
NS - No Standard

APPENDIX D
Industrial Pumping & Parrone Sites Groundwater Flow Maps



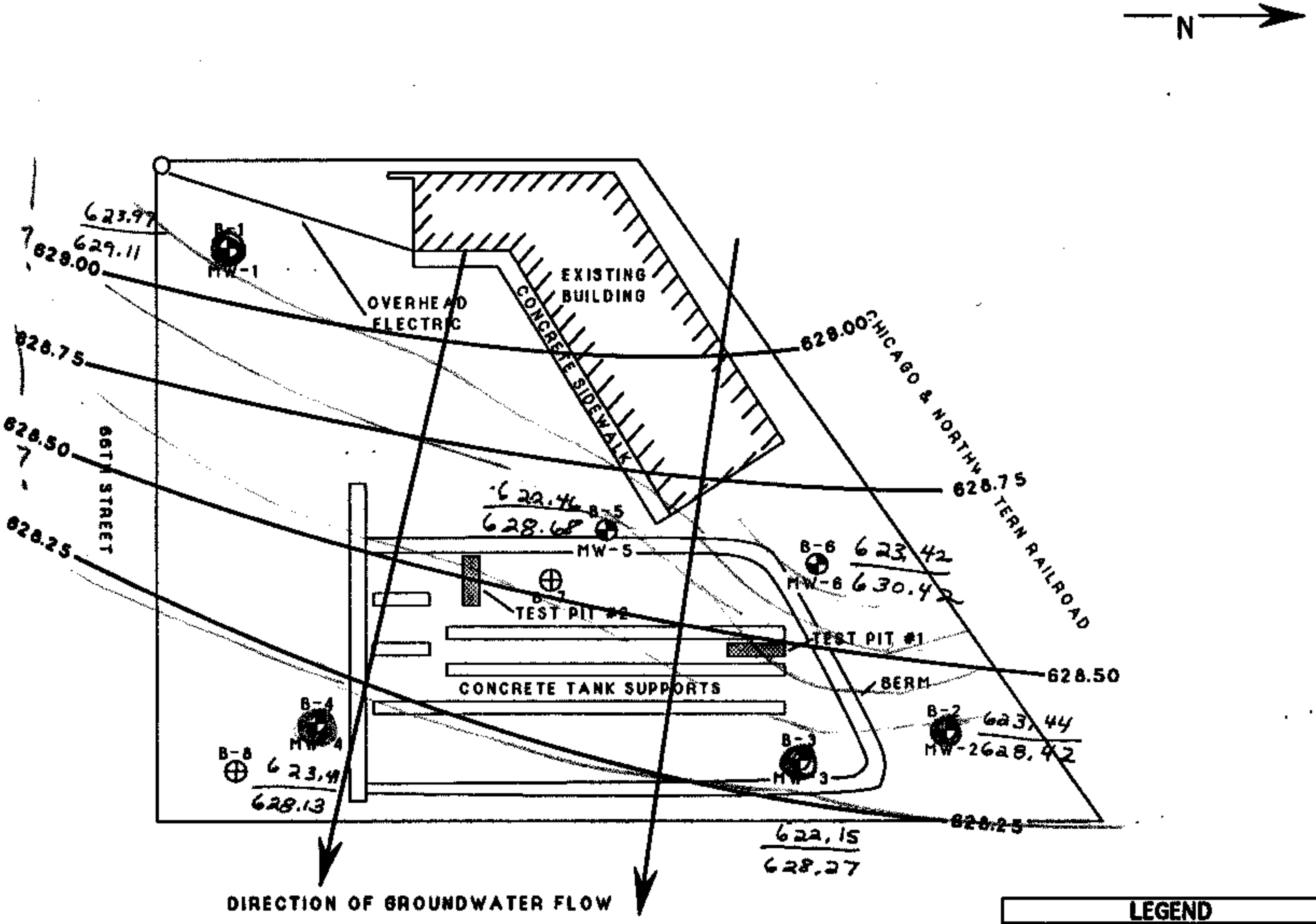
Owner
Industrial Pumping, Inc.

Project Location
3502 66th Street, Kenosha, Wisconsin

Engineer
K. SINGH & ASSOCIATES, INC.
Engineers & Environmental Management Consultants
1135 Legion Drive Elm Grove, WI (414) 821-1171

Figure 9. Location of Replacement Monitoring Wells

Date	Drawn By:	Project No.
March 23, 1995	T.L.O.	3000
	Checked By:	Sheet No.
0' 15' 30'	D.K.S.	1 of 1



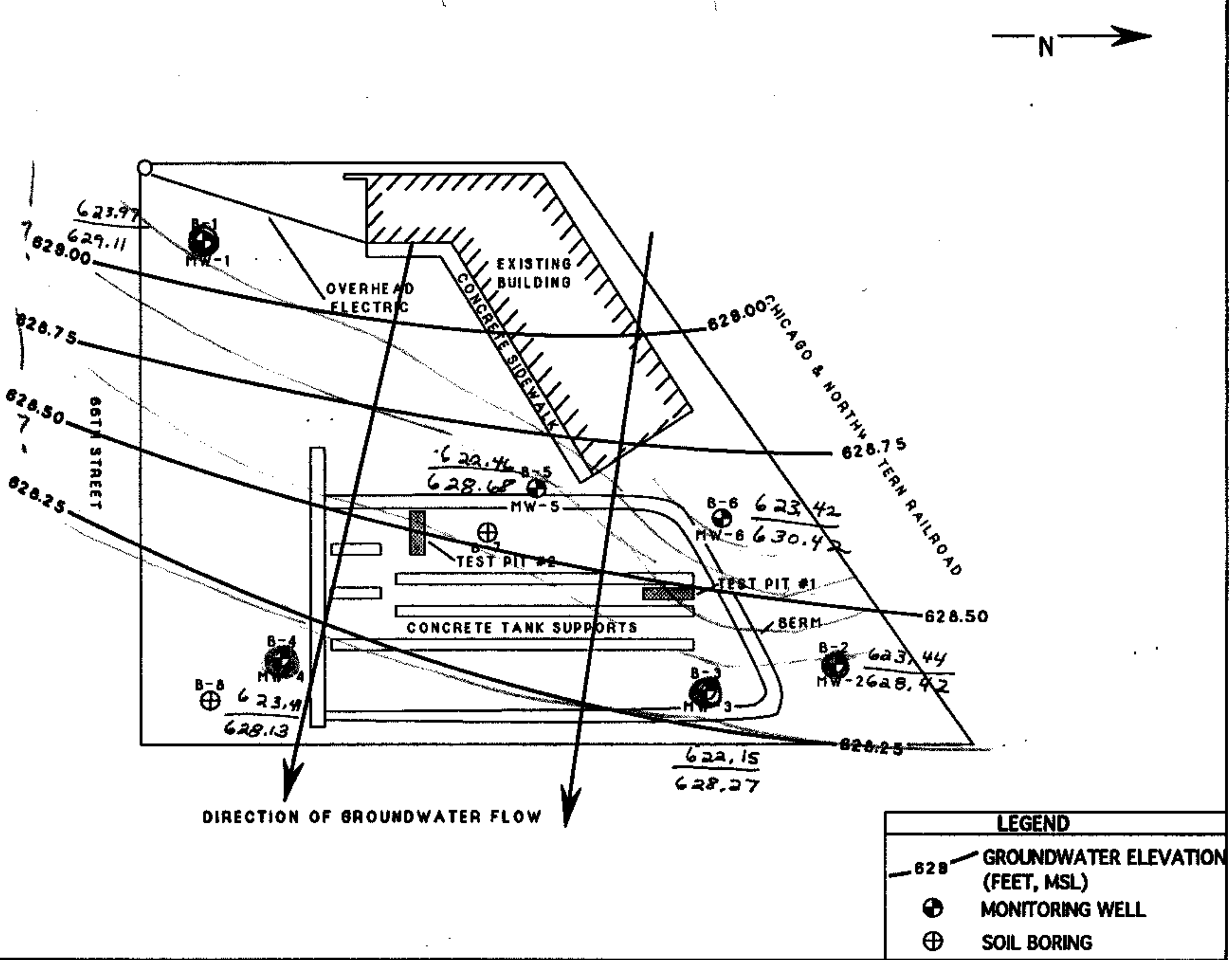
LEGEND

628 — GROUNDWATER ELEVATION (FEET, MSL)

⊕ MONITORING WELL

⊕ SOIL BORING

OWNER	ENGINEER	FIGURE 7. Groundwater Elevation Contour Map		
INDUSTRIAL PUMPING, INC.	**K. SINGH & ASSOCIATES, INC.**	DATE 10-02-92	DRAWN BY VLS	PROJECT NO. 3000
Project Location 3502 66th Street, Kenosha, Wisconsin	Engineers & Environmental Management Consultants 1135 Legion Drive Elm Grove, WI (414) 821-1171	0' 15' 30'	CHECKED BY PNS	SHEET NO. 1 OF 1



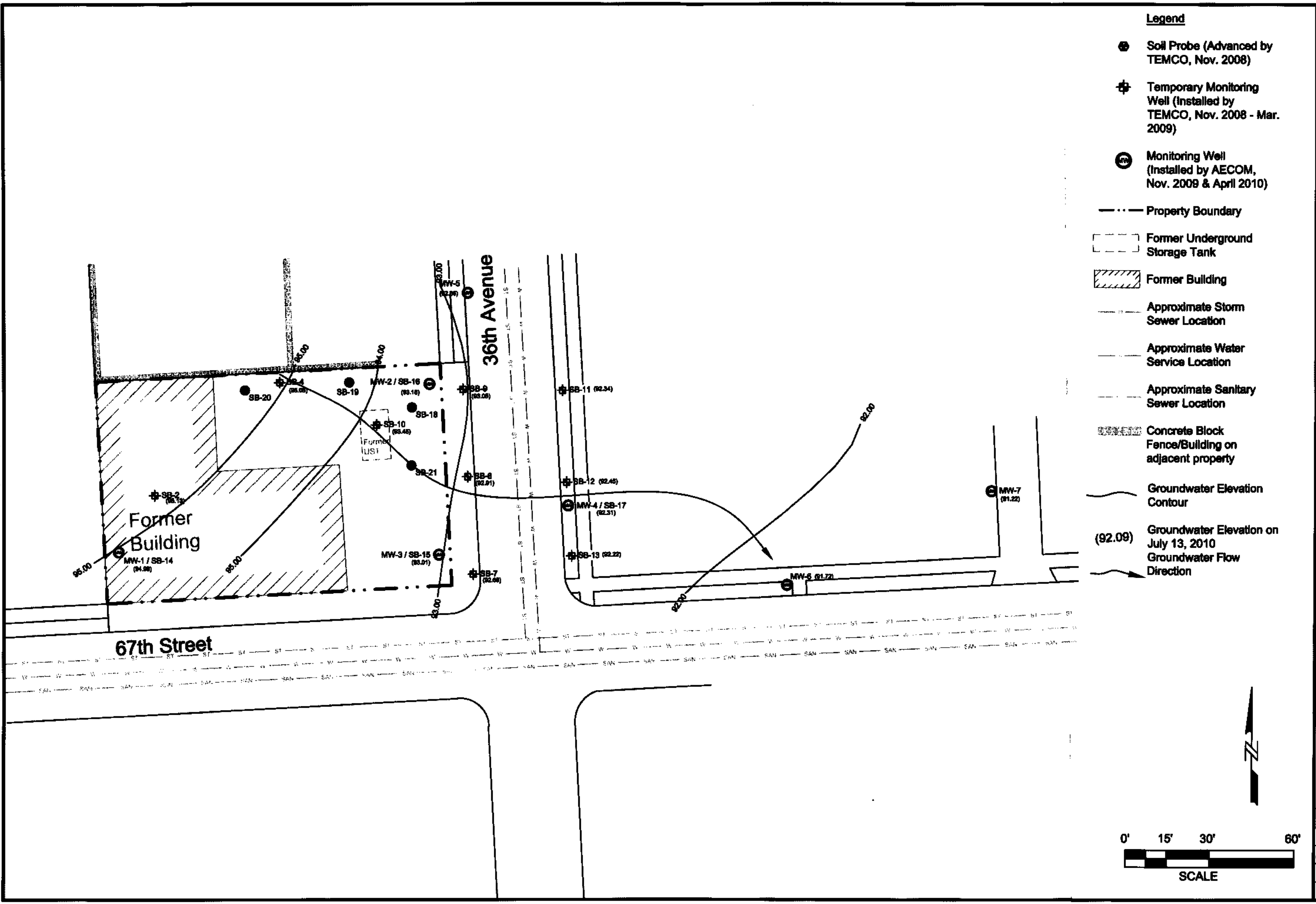
OWNER
INDUSTRIAL PUMPING, INC.
Project Location
3502 66th Street, Kenosha, Wisconsin

ENGINEER
K. SINGH & ASSOCIATES, INC.
Engineers & Environmental Management Consultants
1135 Legion Drive Elm Grove, WI (414) 821-1171

FIGURE 7. Groundwater Elevation Contour Map

DATE	DRAWN BY	PROJECT NO.
10-02-92	VLS	3000
0' 15' 30'	CHECKED BY	SHEET NO.
	PNS	1 OF 1

Filename: C:\Documents and Settings\prindivilles\Desktop\Kenosha\Parrone\67th St Kenosha WI - off site investigation - updated 2011.dwg



1 — 1-INCH — 1 VERIFY SCALE IF PLAN SHEET IS REDUCED

REV	DESCRIPTION	DRN	CHK	DATE

DRN BY: SAP
DSG BY:
CHK BY:
APP BY:

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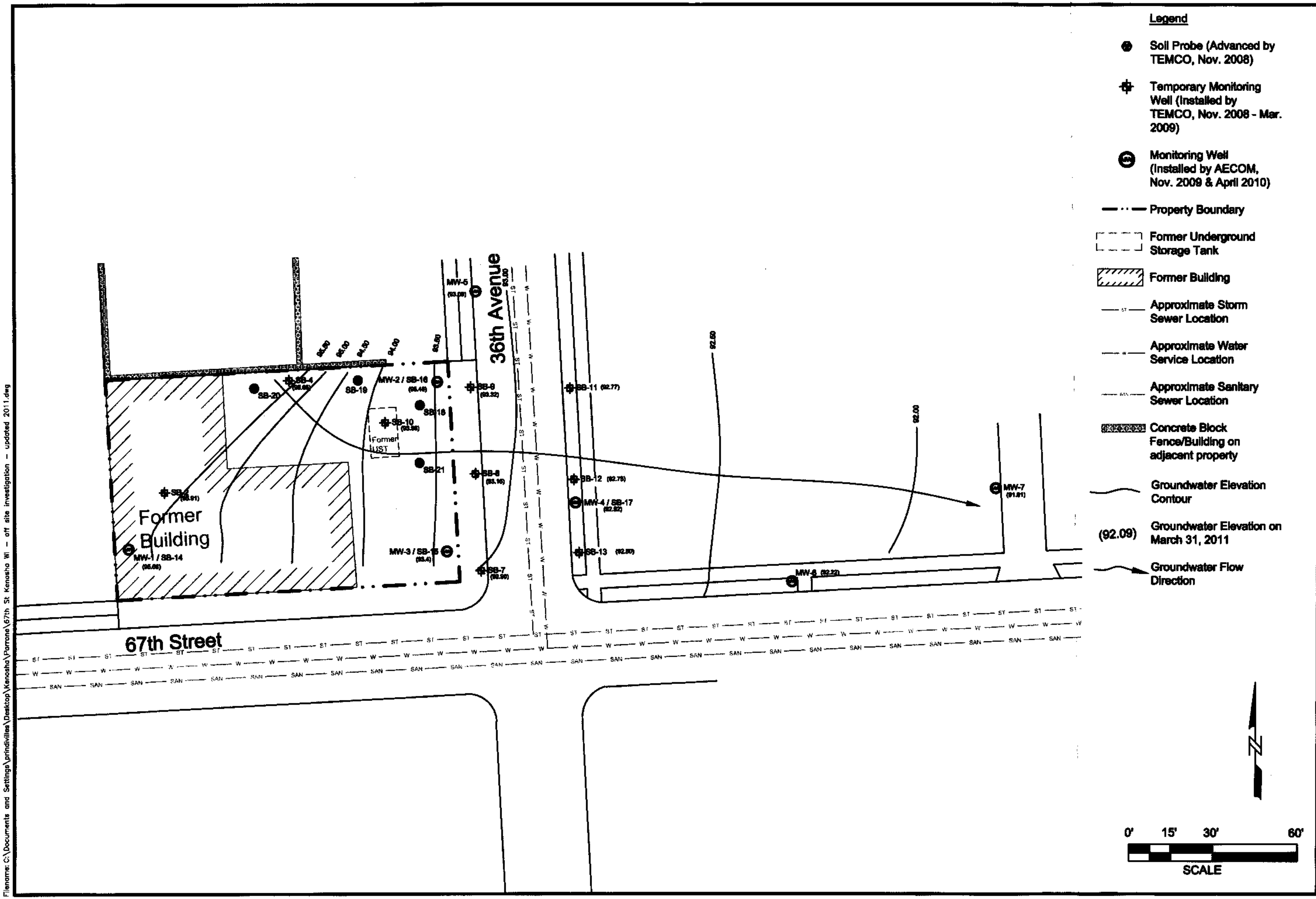
www.aecom.com

CITY OF KENOSHA
3604 67TH STREET
KENOSHA, WI

GROUNDWATER ELEVATION CONTOUR MAP (July 13, 2010)

DATE 10/18/2011
PROJECT NO. 60142151
FILENAME
SHEET NO.
DRAWING NO. FIGURE 4



CITY OF KENOSHA
3604 67TH STREET
KENOSHA, WI

GROUNDWATER ELEVATION CONTOUR MAP
(March 31, 2011)

AECOM
1020 North Broadway Street, Ste. 400
Milwaukee, WI 53202
T 414.225.5100 F 414.225.5111
www.aecom.com

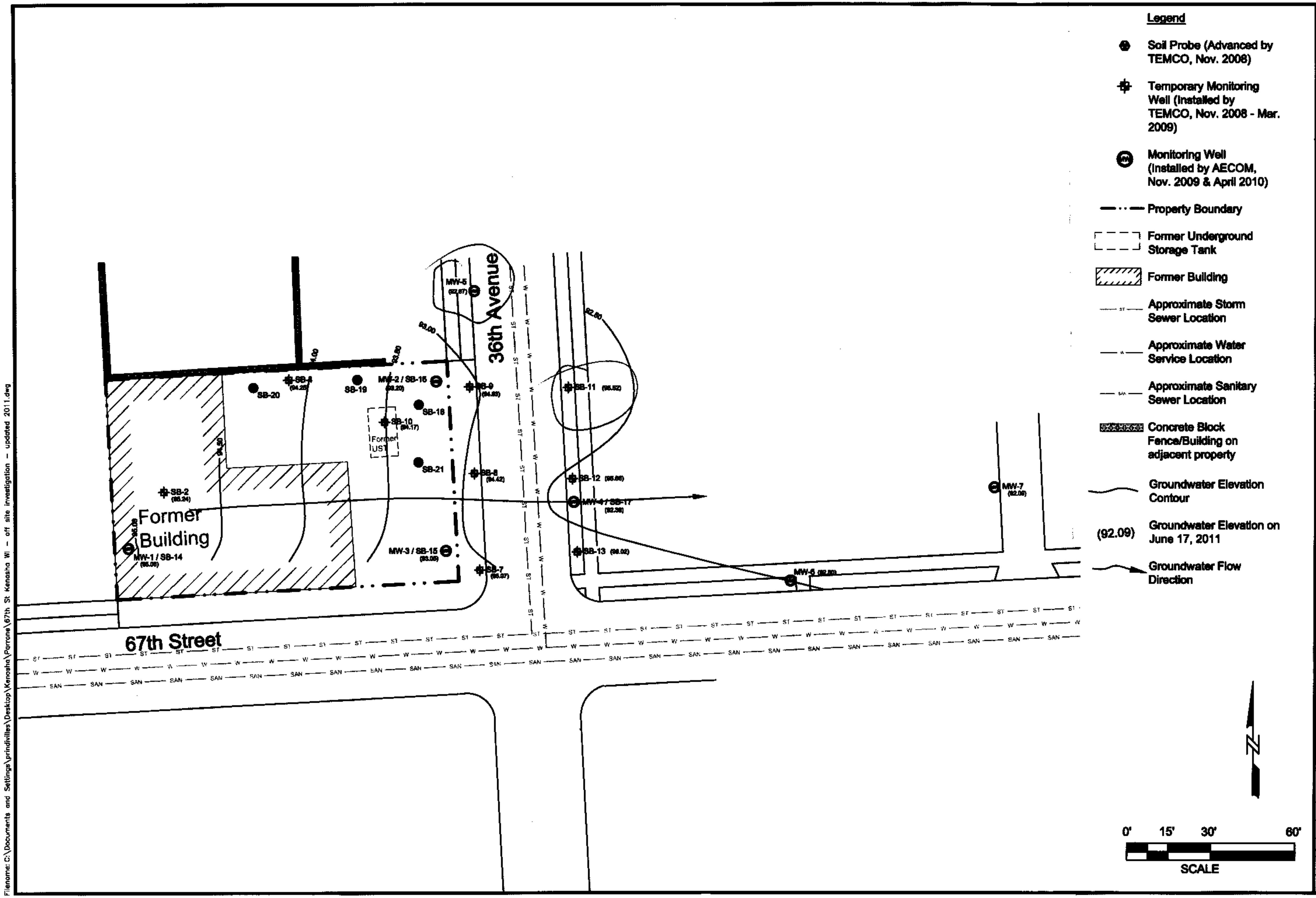
DSN BY: SAP
DES BY:
CHK BY:
APP BY:

1-INCH — VERIFY SCALE IF PLAN SHEET IS REDUCED

REV	DESCRIPTION	DRN	CHK	DATE

DATE 10/18/2011
PROJECT NO. 60142151
FILENAME
SHEET NO.
DRAWING NO. FIGURE 5

Filename: C:\Documents and Settings\prindivilles\Desktop\Kenosha\Parrone\67th St Kenosha WI - off site investigation - updated 2011.dwg



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CITY OF KENOSHA
3604 67TH STREET
KENOSHA, WI

GROUNDWATER ELEVATION CONTOUR MAP
(June 17, 2011)

AECOM
1020 North Broadway Street, Ste. 400
Milwaukee, WI 53202
T 414.225.5100 F 414.225.5111
www.aecom.com

DSN BY:	SAP
DRN BY:	
CHK BY:	
APP BY:	

1-INCH — VERIFY SCALE IF PLAN SHEET IS REDUCED

REV	DESCRIPTION	DRN	CHK	DATE

DATE	11/14/2011
PROJECT NO.	60142151
FILENAME	[illegible]
SHEET NO.	
DRAWING NO.	FIGURE 6

APPENDIX E
Kenosha Fire Department Records: Gabron-Girsh Oil, Inc., 1968 to 1974

[illegible]

FLAMMABLE LIQUID BULK PLANT INSPECTION REPORT Date September 9, 1968

[illegible] 3502-66th Street Firm Name Gabron-Girsh Oil Inc.

[illegible] Joseph Gabron - Fred Girsh Address 2102-52nd. Street [illegible] 657-3722

[illegible]

[illegible] X [illegible] X

[illegible] 6 [illegible] 73,000

[illegible] App. 2000 [illegible] Block

[illegible]

1) Vents [✓ OK] NO NA 2) Relief valves [✓ OK] NO NA 3) [illegible] [✓ OK] NO NA

4) Piping [✓ OK] NO NA 5) [illegible] OK [✓ NO] NA

6) [illegible] OK [✓ NO] NA 7) [illegible] [✓ OK] NO NA

8) Static grounding OK [✓ NO] NA 9) Placement of tanks [illegible] OK [✓ NO] NA

10) Diking [✓ OK] NO NA 11) Housekeeping OK [✓ NO] NA 12) Area [illegible] OK [✓ NO] NA

LOADING OR UNLOADING

1) Static protection OK [✓ NO] NA 2) Explosion proof equipment [✓ OK] NO NA

3) Railroad tank car service OK NO [✓ NA] 4) [illegible] tank [illegible] [✓ OK] NO NA

WAREHOUSE AND OUTSIDE STORAGE

1) Filling [illegible] containers OK NO [✓ NA] 2) Filling empty containers [✓ OK] NO NA

3) Building heating [✓ OK] NO NA 4) [illegible] [✓ OK] NO NA

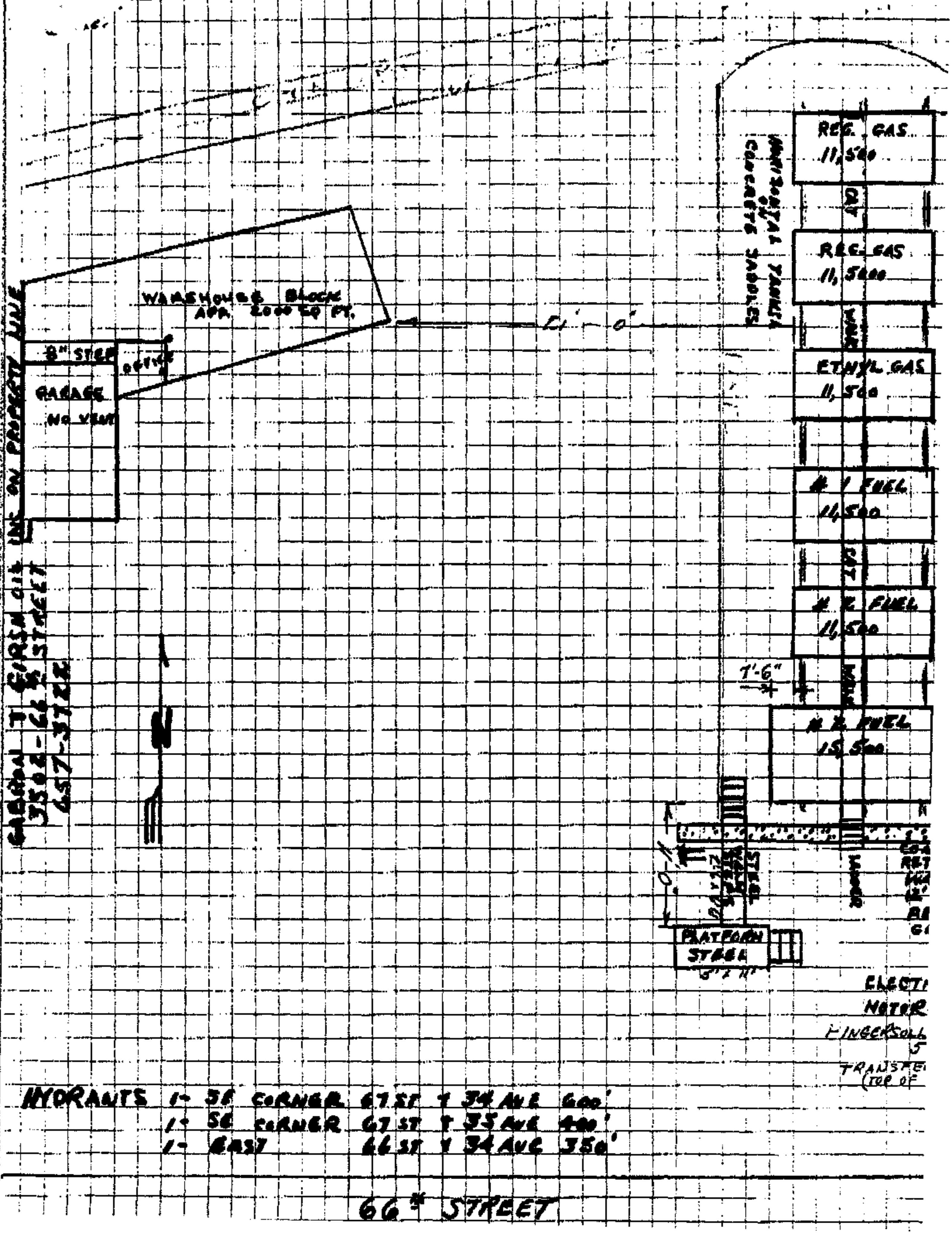
5) [illegible] [✓ OK] NO NA 6) [illegible]

[illegible] hydrant 850 66st & 34Ave. [illegible] hydrant availability Good

[illegible] of surrounding properties Another Bulk plant East of property. Also C N W R R

[illegible] Repair Catwalk; unstable. Diked area used for storage--weeds and brush should be cleared out. Largest tank is labeled "Flammabe-Keep Fire Away", other are not. Static ground cable not used while loading truck tank.

[illegible] Lieutenant Richard E. Brus



HYDRANTS 1- SE CORNER 67 ST & 34 AVE 600'
1- SE CORNER 67 ST & 35 AVE 400'
1- EAST 66 ST & 34 AVE 350'

KENOSHA FIRE DEPARTMENT
FIRE PREVENTION BUREAU
BUILDING RECORD

GABRON OIL CO.

FIRE LIMITS
IN____ OUT____

Dist____ Insp____
License____
Permit____

Occupant [illegible] Emergency Phone____
Owner/Agent____ Address____
Building Use (1st floor) [illegible] (upper)____
Manager JOSEPH GABRON Address____
Type of Construction Concrete [illegible] Stories____
Heating Unit____ Air Cond. Unit____
Incinerator____ Refuse Pick Up____
Fire Doors____ Stairs____ Exits____ Fire Escapes____
Alerting System____ Panel Location____ Master____
Extinguishing System(s)____
Fire Appliances____ Hose Cabinets____
Standpipes____ FD Connection____
Elevators____ Horiz/Vert Shafts____
Roof Entry____ Emergency Lighting____
Utilities____
Off Hour Surveillance____
Special Hazards____

DATE	INSPECTION	BY
[illegible]		[illegible]
8-9-74	CALL FOR INSPECTION, BULK PLANT	LT. CRUS
9-12-79	INSPECTION VIOLATIONS	LT. KING
10-18-79	NO COMPLIANCE - FOLLOW UP LETTER SENT	LT KING
11-20-79	NO COMPLIANCE - TURNED OVER TO CITY ATTY	LT KING

Midwest
Environmental
Consulting, LLC

APPENDIX F
Kenosha Fire Department Records: Heimes Garage

FID 230061700
ERA/ERP

K. SINGH & ASSOCIATES, INC.

Engineers and Environmental Management Consultants

1135 Legion Drive, Elm Grove, WI 53122 (414) 821 - 1171 FAX (414) 821 - 1174

September 30, 1996

Ms. Pamela Mylotta
Hydrogeologist, Remediation and Redevelopment Program
Wisconsin Department of Natural Resources
4041 N. Richards Street
P.O. Box 12436
Milwaukee, WI 53212-0436

Project # 3000

Subject: Information Concerning Neighboring Properties at Industrial Pumping Property, 3502 66th Street, Kenosha, Wisconsin

Dear Ms. Mylotta:

Thank you for your review of the request for closure of the referenced site. During interim soil remediation , an increase in PID readings was noted as the excavation was advanced off-site to the east (3418 66th Street). In the Interim Remedial Action Report, it was noted that a potential additional contamination source may have existed on the neighboring property. In your letter dated September 19, 1996, you requested documentation of any additional potential sources of contamination. Information regarding surface water drainage at the site was also requested.

A sketch map of tank inspection records for the property at 3418 66th Street was obtained from the Kenosha Fire Department. A copy of the sketch Map is enclosed. The sketch indicates that seven aboveground storage tanks existed at the referenced site; one 20,000 gallon #2 fuel oil tank, two 15,000 gallon unleaded gasoline tanks, one 15,000 gallon #1 fuel oil tank, one 15,000 gallon # 1 fuel oil tank, one 15,000 gallon kerosene tank, and one 15,000 gallon solvent tank. The Kenosha Fire Department does not have information regarding the date of tank closure.

Aerial photographs for the area of the referenced site were examined at the Southeastern Wisconsin Regional Planning Commission (SEWRPC). The pertinent area for the photograph taken in 1967 is shown on Figure 1. Six of the underground tanks on the Industrial Pumping property are visible on the photograph. The tanks are situated horizontally. What appear to be six vertically situated Aboveground Storage Tanks are visible on the property to the east. These tanks are visible on SEWRPC photographs from 1963 to 1970, but do not appear on the 1975 photograph. No other potential contamination sources are visible on the aerial photographs.

Based upon soil boring elevations, as well as field observations made prior to soil remediation, surface water drainage at the Industrial Pumping property was primarily to the south. Post-remediation surface water drainage also appears to be to the south.

In accordance of your letter dated September 19th, two additional rounds of quarterly groundwater monitoring shall be conducted at the referenced site. Based upon the information regarding the presence of former ASTs to the east of the site, it appears that a separate investigation for the property at 3418 66th Street is warranted. Please call us, if you have any questions regarding this submittal.

Sincerely,

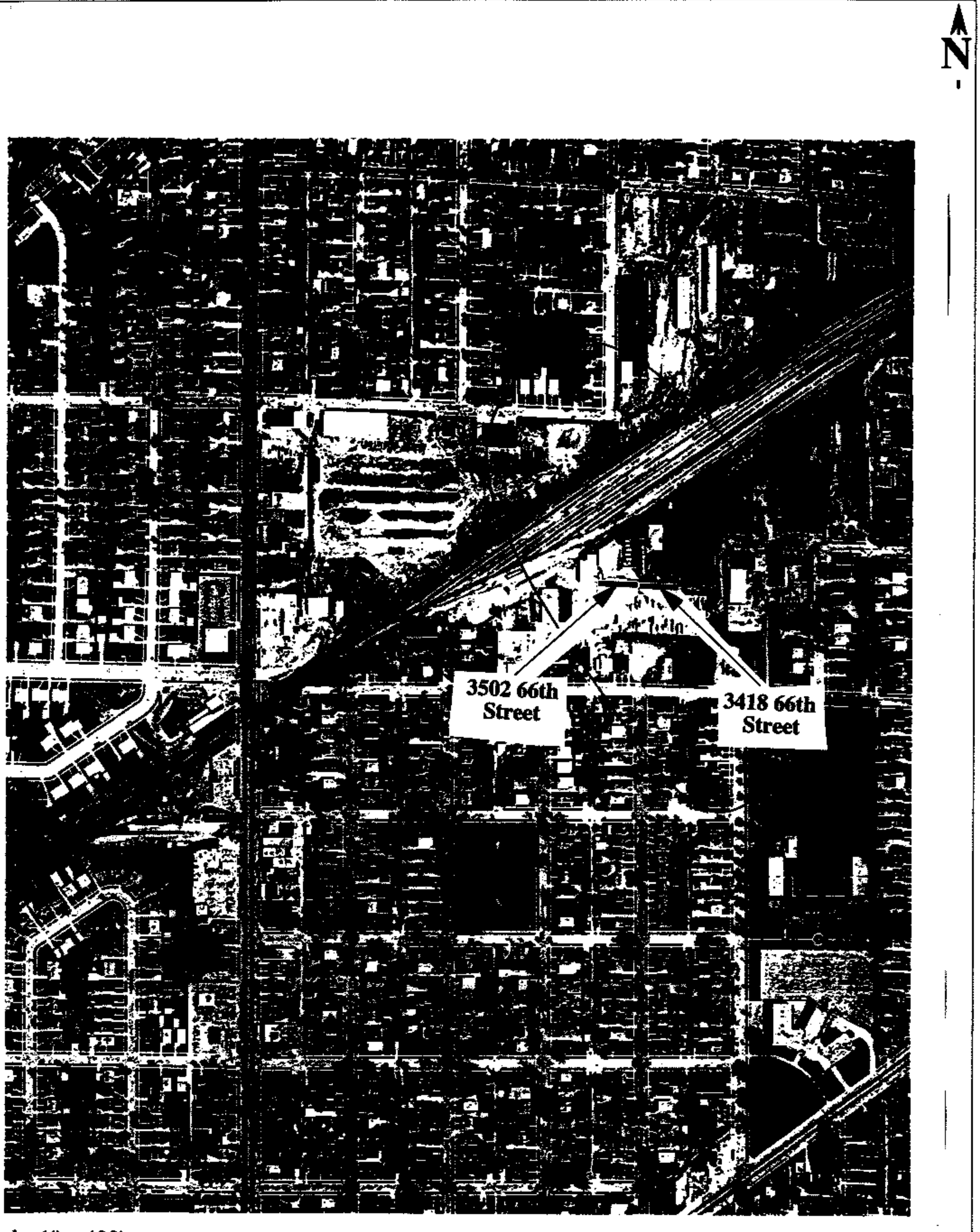
K SINGH & ASSOCIATES, INC.

Mark J. Peters
Staff Hydrogeologist

Pratap N. Singh, Ph.D., P.E.
Project Manager

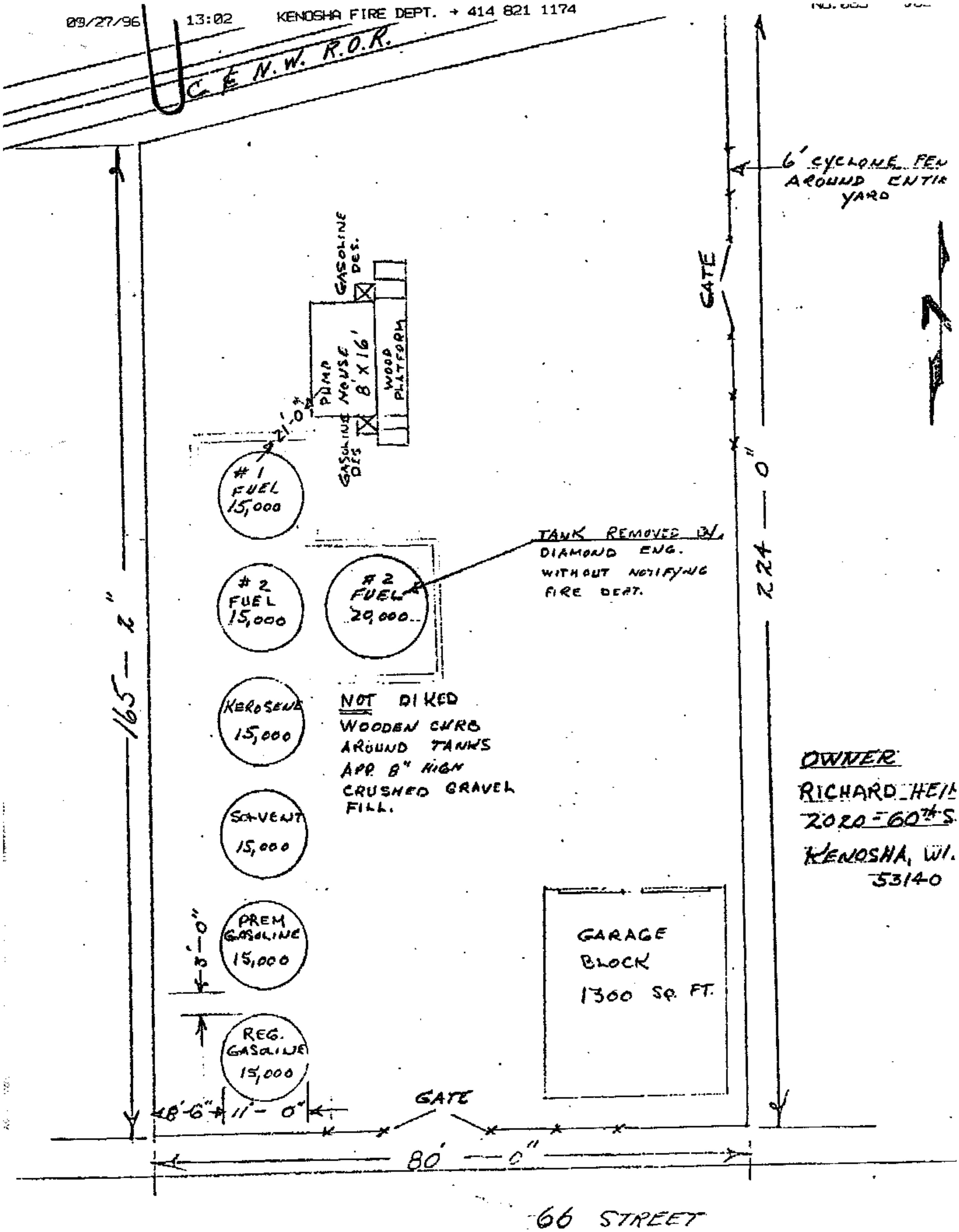
Enc: Figure 1
Kenosha Fire Department Sketch Map

cc: Ken Smith/ Industrial Pumping, Inc.
Kamala Singh/ PECFA Claim File



Scale: 1" = 400'

Figure 1- Aerial Photograph Showing Industrial Pumping Site and Neighboring Properties



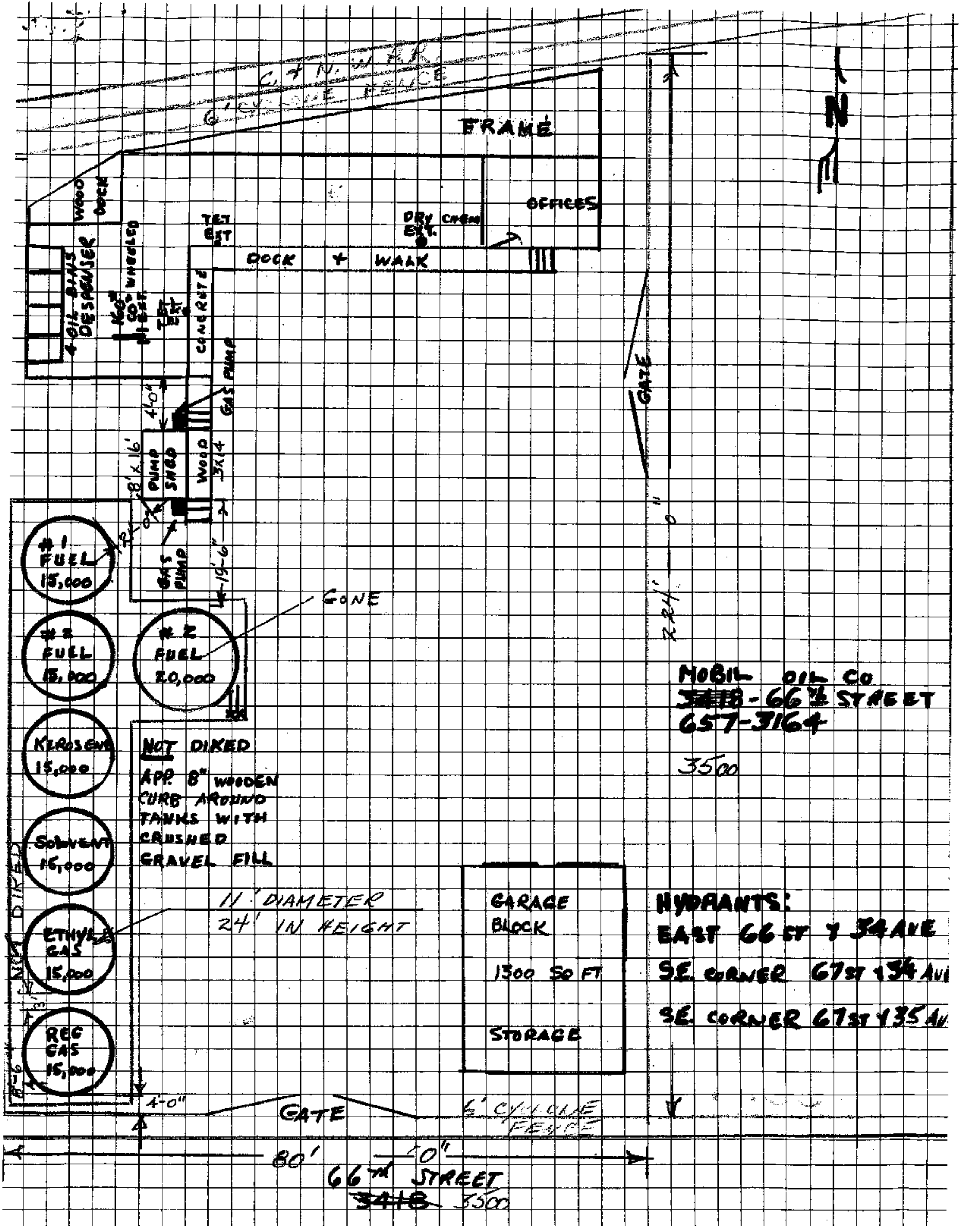
6' CYCLONE FEN
AROUND ENTIR
YARD

TANK REMOVED BY
DIAMOND ENG.
WITHOUT NOTIFYING
FIRE DEPT.

NOT DIKED
WOODEN CURB
AROUND TANKS
APP 8" HIGH
CRUSHED GRAVEL
FILL.

OWNER

RICHARD HEI
2020-60th S
KENOSHA, WI.
53140



MOBIL OIL CO
~~3418~~-66½ STREET
657-3164

3500

HYDRANTS:
EAST 66 ST & 34 AVE
SE. CORNER 67 ST & 34 AVE
SE. CORNER 67 ST & 35 AVE

KENOSHA FIRE DEPARTMENT
FIRE PREVENTION BUREAU

B-518

FLAMMABLE LIQUID BULK PLANT INSPECTION REPORT
(Wisconsin Administrative Codes)

Date September 9, 1968

Address 3418-66th Street Firm Name Mobil Oil Co.

Manager Clarence Willkomm Address 3418-66th Street Phone 657-3164

STORAGE FACILITIES

Flammable Liquids Stored. Class I X Class II ___ Class III X

Number of above ground tanks 7 Total Capacity 110,000 Gallons

Warehouse area 2000 sq. ft. Construction Brick and Frame

(NA means not apply - NO indicates unsatisfactory condition requiring attention)

TANKS:

(1) Vents [✓ OK] NO NA (2) Relief valves [✓ OK] NO NA (3) Hand valves [✓ OK] NO NA

(4) Piping [✓ OK] NO NA (5) Stairs, ladders, platforms and walkways [✓ OK] NO NA

(6) General tank condition [✓ OK] NO NA (7) Foundations and supports [✓ OK] NO NA

(8) Static grounding [✓ OK] NO NA (9) Placement of tanks and buildings [✓ OK] NO NA

(10) Diking OK NO [✓ NA] (11) Housekeeping OK [✓ NO] NA (12) Area condition OK [✓ NO] NA

LOADING OR UNLOADING:

(1) Static protection [✓ OK] NO NA (2) Explosion proof equipment [✓ OK] NO NA

(3) Railroad tank car service OK NO [✓ NA] (4) Truck tank service [✓ OK] NO NA

WAREHOUSE AND OUTSIDE STORAGE:

(1) Filling of containers [✓ OK] NO NA (2) Piling empty containers [✓ OK] NO NA

(3) Building heating [✓ OK] NO NA (4) Housekeeping and surrounding area [✓ OK] NO NA

(5) Fire protection devices [✓ OK] NO NA (6) NO SMOKING signs [✓ OK] NO NA

Distance to nearest hydrant 250 ft. Hydrant availability Good

Exposures of surrounding properties Bulk plant West of property. C. & N. W. R.R.

Recommendations: Cut out all weeds and brush around tanks and buildings.
Post legable "No Smoking" signs at loading platform and around grounds.

Inspector Lieutenant Richard E. Brus

B-515

KENOSHA FIRE DEPARTMENT
FIRE PREVENTION BUREAU
PERMIT FOR STORING AND HANDLING OF FLAMMABLE LIQUIDS

Building Inspection ______ Permit No. 74-16 FL Date Sept. 12, 1974

Address 3500-66th St. Company Name KMI

The undersigned hereby applies for a permit to store and handle flammable liquids according to the plans and specifications herein filed and hereby agrees that such flammable liquids shall be stored and handled in compliance with the Fire Prevention Code and other ordinances of the City of Kenosha and the Flammable Liquids Code of the State of Wisconsin (Chapter 8).

TANK STORAGE

					No. of Tanks	
New Installation		No. of Tanks	6	Gasoline	(6)	15,000 gal.
Temporary Installation		Retail		Naptha	( )	gal.
Replacement		Industrial		Fuel Oil	( )	gal.
Abandonment	✓	Marine		Diesel	( )	gal.

Wisconsin Department of Industry, Labor & Human Relations form SB-9 plan approval of ______ gallons.

Approval date ______.

Inspection Before Covering Installation. Before an installation is covered from sight, the Chief of the Fire Department or the Fire Prevention Bureau shall be notified by the permit holder and shall, **within 48 hours** after receipt of such notification, inspect the installation and give written approval or disapproval. Upon failure of the inspection department to inspect the installation or storage within the specified time, the installation may be covered.

Fee For Removal $12.00

(Signed) Ronald V. Thomas
OWNER/AGENT

BY Kenosha Material Inc.
CONTRACTOR

Address 5620-49 St. Kenosha

Address ______

Approval Date ______

By Lt. J. Mikeis
Kenosha Fire Department

KENOSHA WISCONSIN

FIRE DEPARTMENT
MUNICIPAL BUILDING
625-52ND STREET
KENOSHA WISCONSIN 53140

FRANK E. BLASI CHIEF

September 23, 1974

Mr. Richard Helmes
2020-60th. Street
Kenosha, Wi. 53140

Dick, I am sending in the report to the State of Wis. concerning the old bulk plant so that it is common knowledge that the plant no longer exists at the 3418-66th. Place address that you now own.

One more item I must bring up is the 300 gallon upright tank in your yard is not allowed under the State Statutes. This type of tank is ONLY allowed to be used on construction sites and by farmers. Section, Ind. 8.991

There had been two tanks and one was damaged by one of the tanks that struck it and broke off the valve to the hose line as you probablily know. If you are to dispense gasoline on the site for your use, you will have to install an underground flammable liquid tank (s).

Lieutenant Richard E. Brus
Fire Prevention Bureau
Kenosha Fire Dept.

KENOSHA WISCONSIN

FIRE DEPARTMENT
MUNICIPAL BUILDING
625-52ND STREET
KENOSHA WISCONSIN 53140

FRANK E. BLASI CHIEF

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Kenosha, Wi. 53140

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Lieutenant Richard E. Brue
Fire Prevention Bureau
Kenosha Fire Dept.

KENOSHA WISCONSIN

FIRE DEPARTMENT
MUNICIPAL BUILDING
625-52ND STREET
KENOSHA, WISCONSIN 53140

FRANK E. BLASI, CHIEF

September 23, 1974

Wisconsin Dept. of Industry,
Labor & Human Relations
Industrial Safety & Bldgs Div.
Post Office Box 2209
Madison, Wi. 53701

Subject: Mobile Oil Co., bulk plant
3418-66th. Place
Kenosha, Wi.

The Mobile Oil Co. bulk plant was discontinued at this location and all tanks have been removed from the property. There had been 1-20,000 & 6-15,000 flammable liquid tanks.

The 20,000 gallon tanks was relocated at the consolidated Racine & Kenosha Mobile Oil bulk plant on I-94 & County trunk E

The 6-15,000 gallon tanks were purchased and removed by the Kenosha Materials Inc. of Kenosha and taken to a mining site at the intersection of county trunks H & T there to be set up and used in the near future.

The Chief of the Pleasant Prairie Fire Dept. (Kenosha County) has been informed of the tank movings and the intended use of the tanks.
*Chief James Harman
Pleasant Prairie Fire Dept.
9915-39th. Avenue
Kenosha, Wi.

Lieutenant Richard E. Brus
Fire Prevention Bureau
Kenosha Fire Dept.

FIRE PREVENTION
FIRE SUPPRESSION
EMERGENCY MEDICAL SERVICES
FIRE SAFETY EDUCATION

Wisconsin Department of Industry,
Labor & Human Relations
Industrial Safety & Bldgs. Div.
Post Office Box 2209
Madison, Wisconsin 53701

FIRE DEPARTMENT INSPECTION REPORT

Kenosha Fire Dept.
625-52nd. Street

ADDRESS OF FIRE DEPARTMENT

INSPECTION DATE September 16, 1974	
OWNERS NAME	OCCUPANCY INSPECTED Mobile Oil Co. (NOW DISMANTIED)
MAILING ADDRESS	LOCATED AT (STREET ADDRESS) 3418-66th. Place

CITY	STATE	ZIP CODE	CITY Kenosha	COUNTY

☒ **INDICATES CODE VIOLATION AND CORRECTION SHALL BE REQUIRED**

☐ 1. **Ind 8.21 (4) (5)** Each storage tank shall be equipped with pressure and vacuum vents. Each storage tank shall also be equipped with an emergency relief vent or shall have some form of construction or device to relieve internal pressure caused by exposure fires.

☐ 2. **Ind. 8.21 (7) (b)** Because of proximity to water ways, character of topography, or nearness to structures of high value, or to places of habitation, storage tank shall be diked. Where a diked enclosure is required, it shall have a net capacity not less than that of the largest tank within the diked area.

☐ 3. **Ind 8.21 (9) (b)2** Pipeline connections below product level of tanks shall be equipped with emergency internal valves.

☐ 4. **Ind 8.21 (10)** Gasoline storage tanks shall be labeled in letters at least 5 inches high, the wording "Flammable -- Keep Fire Away."

☐ 5. **Ind 8.32 and Ind 8.36** All valves, pumps and pipe fittings shall be kept free from leaks.

☐ 6. **Ind 8.33** Supports for aboveground piping shall be of noncombustible material.

☐ 7. **Ind 8.36 (2)** Piping or valves shall have a definite scheme of identification such as stenciling, tagging or coloring so as to distinguish the class of product which is being carried by each line.

☐ 8. **Ind 8.61** Pump house buildings shall be ventilated at floor level.

☐ 9. **Ind 8.62** Grounding cable shall be provided at loading racks which dispense flammable liquids into open domes of tank trucks which may contain flammable vapors from previous cargoes of gasoline.

☐ 10. **Ind 8.64** Electric motors shall be explosionproof type which are installed in pump houses or load racks which dispense gasoline.

☐ 11. **Ind 8.65** "No Smoking" signs shall be conspicuously posted at load rack.

☐ 12. **Ind 8.67** A fire extinguisher of at least 8 B C rating shall be provided at bulk plant.

☐ 13. **Ind 8.68** Plant and tank yard shall be kept free from weeds and high grass.

☐ 14. **Ind 8.35** A check valve for automatic protection against backflow shall be installed in the transport and tank car unloading lines.

☐ 15. **Ind 8.62 (5) (d)** When tank cars are connected for the purpose of loading or unloading, a sign reading "Tank Car Connected" shall be displayed.

☐ 16. **Ind 8.952 (12)** If gasoline and fuel oils are to be delivered by pump, meter or hose from different compartments of one cargo tank load, separate pumps and meters shall be provided.

☐ 17. **Ind 8.953 (9)** All tank vehicles shall be provided with at least one portable fire extinguisher having not less than 12 B C rating. Two extinguishers each having at least 6 B C rating will be accepted. OSHA requires 1-20 B C or 2 extinguishers having at least a 10 B C rating.

☐ 18. **Ind 8.954** The driver, operator, or attendant of any tank vehicle shall not remain in cab of vehicle being loaded or unloaded and shall not leave the valves controlling the flow of the product until the operation is completed.

COMPLIANCE DATE

FIRE DEPARTMENT INSPECTOR

DILHR-15B-4526

FIRE DEPT. FILE

DEPARTMENT OF INDUSTRY, LABOR & HUMAN RELATIONS
P. O. Box 2209
Form SB-9 Madison, Wisconsin

APPLICATION FOR INSTALLATION BULK STORAGE FLAMMABLE LIQUID TANKS

Application is hereby made to the Department of Industry, Labor and Human Relations for permission to (~~install~~) a Dismantle; bulk plant (~~remodel~~) in accordance with the following detailed statement and attached plans subject to the orders of the Department of Industry, Labor and Human Relations. The installation, in all other respects, will comply with applicable provisions of Chapter Ind 8 of the Wisconsin Administrative Code, (Flammable Liquids).

Note. Plans must include (1) location of property lines; (2) buildings; (3) tanks; (4) load and unload racks; (5) streets and highways; (6) streams and other bodies of water within 100 feet of tanks.
Plans should be drawn in triplicate to scale and the scale indicated on he drawings.

1. Location (Street) 3500-66th. St. City Kenosha Date August 20, 1974
2. Owner Richard Heimes Street 2020-60th. Street City Kenosha
3. Name of Bulk Plant Former Mobile Oil Company City Kenosha
4. Tanks: List (1) number of tanks; (2) type (horizontal, vertical, or underground); (3) contents.

No. 6 Type Vert Length ____ Diam. ____ Cap. 15,000 Cont. Empty

No. ____ Type ____ Length ____ Diam. ____ Cap. ____ Cont. ____

No. ____ Type ____ Length ____ Diam. ____ Cap. ____ Cont. ____

TANK CONSTRUCTION: List thickness of metal.

Vertical Tanks

Bottom ____ Top ____ Shell-Lower Course ____ Remainder ____

Bottom ____ Top ____ Shell-Lower Course ____ Remainder ____

Horizontal Tanks

Aboveground Underground

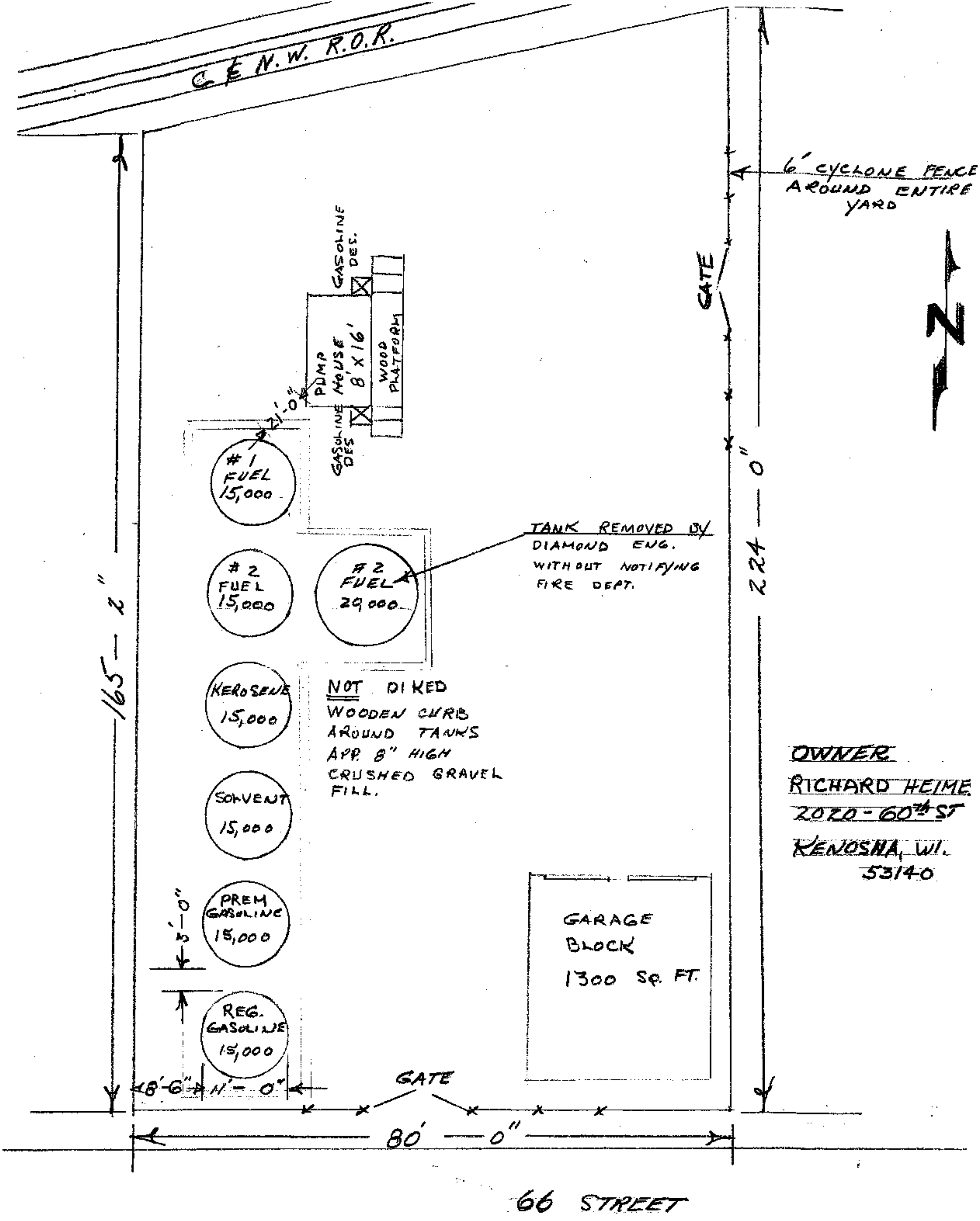
Capacity ____ Thickness ____ Capacity ____ Thickness ____

Capacity ____ Thickness ____ Capacity ____ Thickness ____

5. Are tanks UNDERWRITER approved? ____

6. TANK FOUNDATION. (Section Ind 8.21 (5)) Describe ____

(Over)



OWNER
RICHARD HEIME
2020-60th ST
KENOSHA, WI.
53140

8/20/7

1963

KENOSHA COUNTY
INTERACTIVE MAPPING

1 inch = 40 feet
Date Printed: 8/19/2019

1970

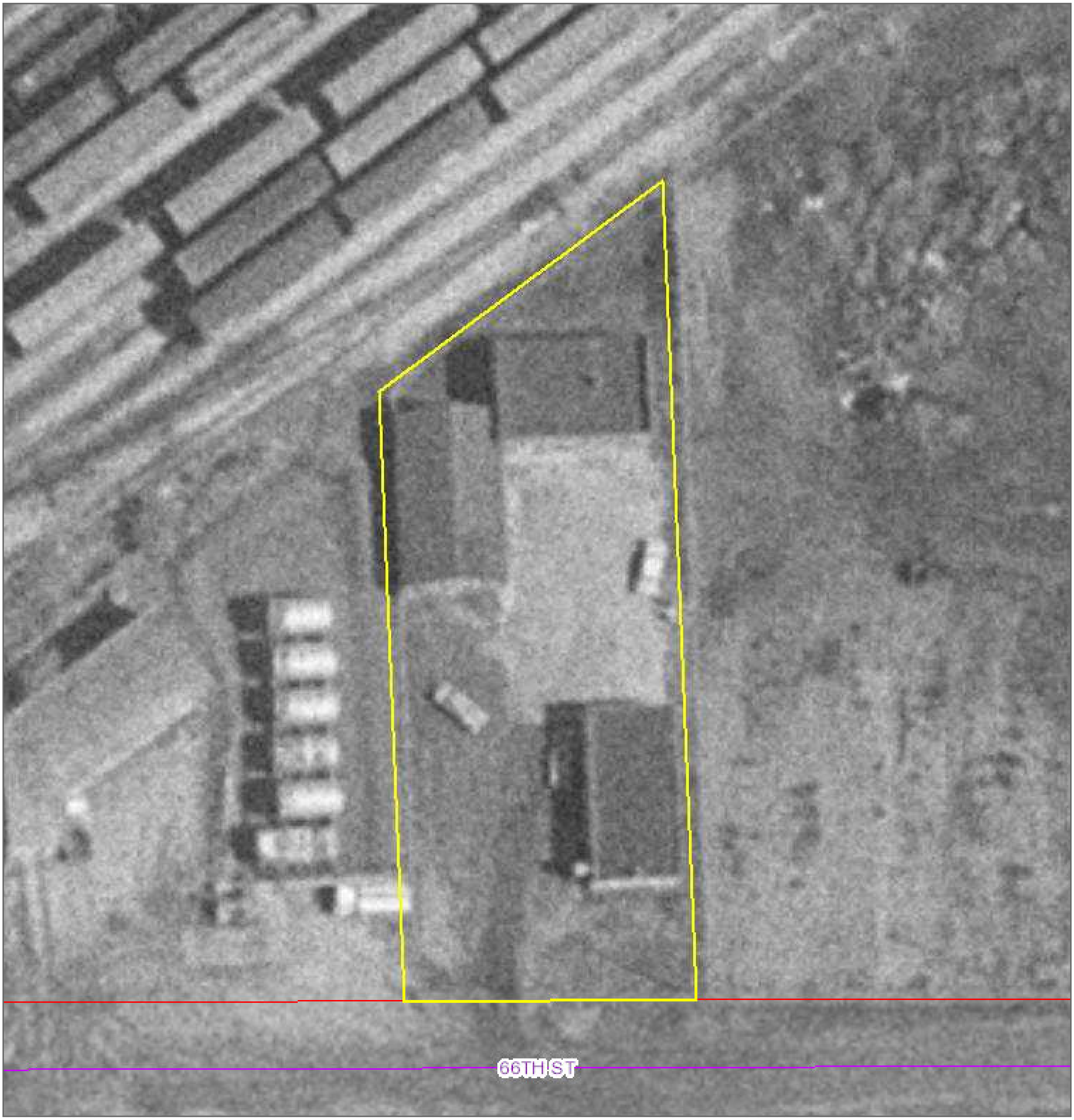
KENOSHA COUNTY
INTERACTIVE MAPPING

1 inch = 40 feet
Date Printed: 3/12/2017

1975

KENOSHA COUNTY
INTERACTIVE MAPPING

1 inch = 40 feet
Date Printed: 3/12/2017



UNDERGROUND FLAMMABLE LIQUID TANKS

Address 3418 - 66TH ST. Date 12-27-74

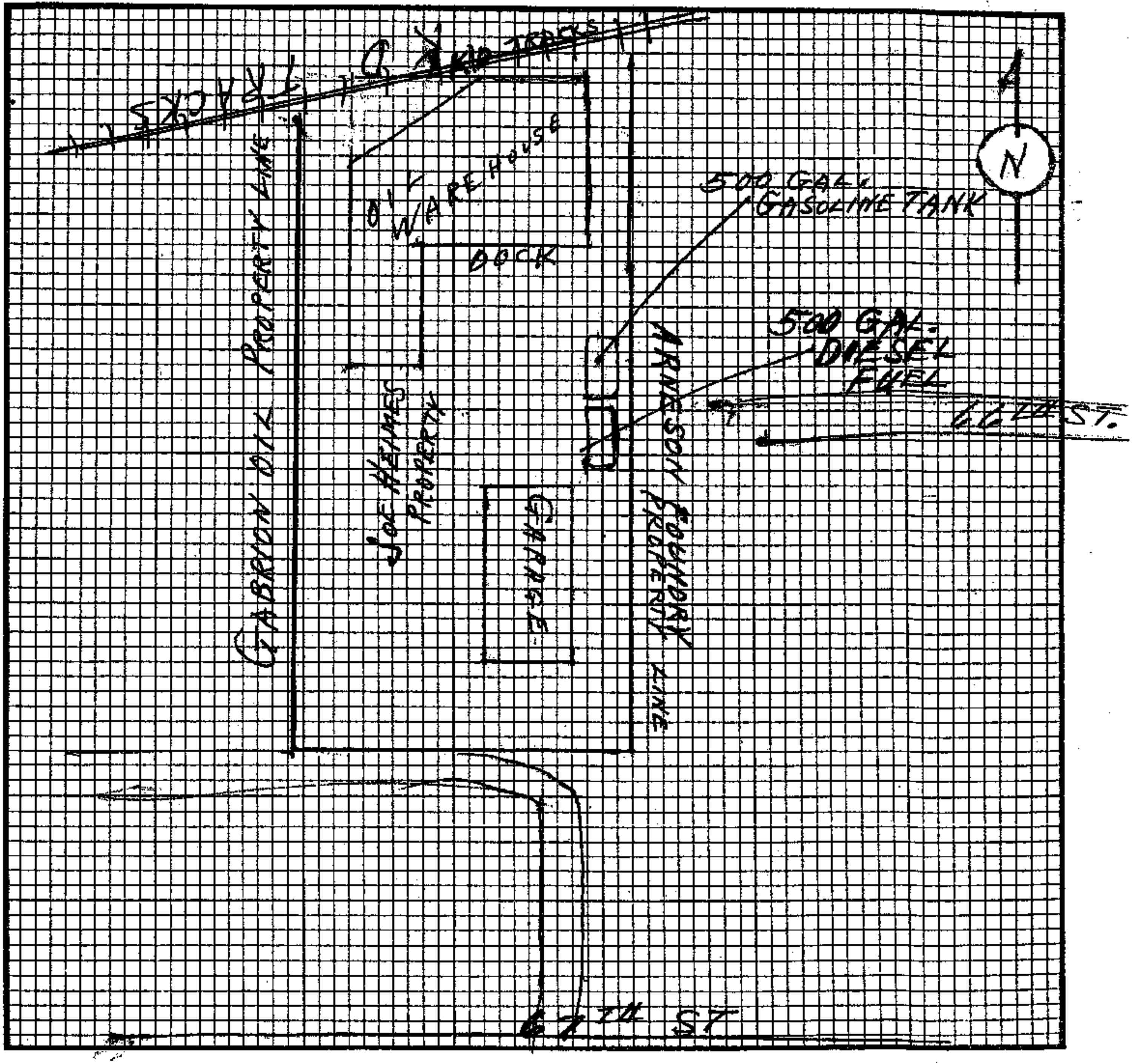
Work done by MOBILE OIL CORP. - JERRY WILKOM

Address ________ City ________

Number of underground tanks 2 Tank size by gallons 1. 500 2. 500

3. ____ 4. ____ 5. ____ 6. ____ 7. ____ 8. ____

Frontage Street Address



by LT. G. URBAN

FIRE PREVENTION BUREAU
PROCESSING PERMITS
UNDERGROUND TANKS

Dr 520

Address 3418 - 66TH ST. Permit No. 74-29FL Date 12-27-74

TANK LOCATION Insp. by LT. GEORGE URBAN

Class I or II

Minimum distance (1') from basement ✓ cellar ✓ pit ____
Minimum distance (3') from property line ✓

Class III

Minimum distance (1') from basement ✓ cellar ✓ pit ____
Minimum distance (1') from property line ✓

DEPTH & COVER

Danger to existing walls or foundations NONE
Set firmly ✓ enclosed with clean fill or dirt ✓

Standard Cover

2 feet clean fill ____
1 foot clean fill plus 4 inches reinforced concrete ____

Heavy Traffic Cover

3 feet clean fill ✓
18 inches clean fill plus 6 inches reinforced concrete ____
18 inches clean fill plus 8 inches asphalt concrete ✓

Partial Cover (extending above ground level)

2 feet of clean dirt sloped 1 foot to 1½ feet horizontal ____

PIPING

Venting Class I or II

Outside of building ✓ minimum 12 feet above ground ✓
Minimum 2 inch dia. ✓ unrestricted openings ✓
Proper distance from all doors ✓ windows ✓ eaves ____

Venting Class III

Outside of bldg. ✓ higher than fill pipe ✓ snow level ✓
Minimum 1¼ inch dia. ✓ large enough to prevent blow back ✓

General Venting

Protected from physical damage ✓ more than one vent ✓
Coupled vents ____ opening larger than connecting pipes ____
Connected to top of tank ✓ insert no more than 1 inch ✓

Fill and Discharge

Connected to top of tank ✓ graded to drain into tank ✓
Class I or II at least 5 feet from any opening ✓
Class III at least 2 feet from any opening ✓
Fill opening liquid tight ✓ opened with tank cover wrench ✓

Structural

Swing joints at least two elbow turns ✓ in all lines

CAPACITY

Under 8000 gal. ✓ over 8000 gal. ____ SB-9 Ind. Comm. form ____

[illegible] FIRE DEPARTMENT

FIRE PREVENTION BUREAU

PERMIT FOR STORING AND HANDLING OF FLAMMABLE LIQUIDS

[illegible] ________ [illegible] ________ [illegible] ________

[illegible] ________ [illegible] ________

The undersigned hereby applies for a permit to store and handle flammable liquids according to the plans [illegible] herein filed and hereby agrees that such flammable liquids shall be stored and handled in [illegible] Fire Prevention Code and other ordinances of the City of [illegible] and the Flammable Liquids Code [illegible]

TANK STORAGE

					No. of Tanks	
[illegible]	________	No. of Tanks	________	Gasoline		________
[illegible]	________	[illegible]	________	Naphtha		________
[illegible]	________	[illegible]	________	Fuel Oil		________
[illegible]	________	[illegible]	________	Diesel		________

[illegible] State Department of Industry, Labor & Human Relations [illegible] ________

Approved Date ________

[illegible] before the [illegible] is covered from sight, the Chief of the Fire Department or the Fire Prevention Bureau shall be notified by the permit holder [illegible] the installation or storage within the specified time, the permit [illegible] may be revoked.

[illegible] ________ By ________

Address ________ Address ________

Approved Date ________ By ________

APPENDIX G
USGS: Description, Properties and Degradation of Selected VOCs Detected in Ground Water

Prepared in cooperation with the Agency for Toxic Substances and Disease Registry,
U.S. Department of Health and Human Services

Description, Properties, and Degradation of Selected Volatile Organic Compounds Detected in Ground Water—A Review of Selected Literature

Open-File Report 2006-1338

U.S. Department of the Interior
U.S. Geological Survey

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U.S. Department of the Interior
DIRK KEMPTHORNE, Secretary

U.S. Geological Survey
Mark D. Myers, Director

U.S. Geological Survey, Reston, Virginia: 2006

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Abbreviations and Acronyms

ATSDR	Agency for Toxic Substances and Disease Registry
BTEX	benzene, toluene, ethylbenzene, xylenes
CA	chloroethane
CAA	Clean Air Act
CB	chlorobenzene
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CDC	Centers for Disease Control
CO_2	carbon dioxide
CSIA	compound-specific isotope analysis
CTET	carbon tetrachloride
CVOC	chlorinated volatile organic compounds
DCA	dichloroethane
11-DCA	1,1-dichloroethane
12-DCA	1,2-dichloroethane
12-DCB	1,2-dichlorobenzene
13-DCB	1,3-dichlorobenzene
14-DCB	1,4-dichlorobenzene
DCE	dichloroethene
12-cDCE	*cis*-1,2-dichloroethene
12-tDCE	*trans*-1,2-dichloroethene
DNA	deoxyribonucleic acid
DO	dissolved oxygen
FDA	U.S. Food and Drug Administration
gVOC	volatile gasoline compounds
H	Henry's Law constant
IUC	International Union of Chemistry
IUPAC	International Union of Pure and Applied Chemistry
K_{oc}	soil organic carbon partition coefficient
K_{ow}	octanol-water partition coefficient
MTBE	methyl *tert*-butyl ether
NAPL	non-aqueous phase liquid
ORD	Office of Research and Development
PCA	tetrachloroethane
PCE	tetrachloroethene
PLFA	phospholipid fatty acid
RCRA	Resource Conservation and Recovery Act
RFG	Reformulated Gasoline program
RNA	ribonucleic acid
SMA	signature metabolites analysis
TBA	*tert*-butyl alcohol
TCA	trichloroethane
112-TCA	1,1,2-trichloroethane
TCB	trichlorobenzene
123-TCB	1,2,3-trichlorobenzene
124-TCB	1,2,4-trichlorobenzene
TCE	1,1,2-trichloroethene
TEA	terminal electron acceptor
124-TMB	1,2,4-trimethylbenzene
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VC	vinyl chloride
VOC(s)	volatile organic compound(s)

Conversion Factors

Multiply	By	To obtain
microgram per liter (µg/L)	$6.243 \cdot 10^{8}$	pound per cubic foot
microgram per liter (µg/L)	$1\text{x}10^{-3}$	milligram per liter (mg/L)
milligram per liter (mg/L)	$6.243 \cdot 10^{5}$	pound per cubic foot
gram mole per cubic meter (g mol/m^3)	6.243×10^{5}	pound per cubic foot
kiloPascal (kPa)	$9.8692 \cdot 10^{-3}$	standard atmosphere

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8\times°C)+32$$

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows:

$$°C=(°F-32)/1.8$$

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Description, Properties, and Degradation of Selected Volatile Organic Compounds Detected in Ground Water—A Review of Selected Literature

By Stephen J. Lawrence

Abstract

This report provides abridged information describing the most salient properties and biodegradation of 27 chlorinated volatile organic compounds detected during ground-water studies in the United States. This information is condensed from an extensive list of reports, papers, and literature published by the U.S. Government, various State governments, and peer-reviewed journals. The list includes literature reviews, compilations, and summaries describing volatile organic compounds in ground water. This report cross-references common names and synonyms associated with volatile organic compounds with the naming conventions supported by the International Union of Pure and Applied Chemistry. In addition, the report describes basic physical characteristics of those compounds such as Henry's Law constant, water solubility, density, octanol-water partition (log K_{ow}), and organic carbon partition (log K_{oc}) coefficients. Descriptions and illustrations are provided for natural and laboratory biodegradation rates, chemical by-products, and degradation pathways.

Introduction

The presence of volatile organic compounds (VOCs) in ground water is a major concern to all who use ground water as a drinking water source because many of these compounds can adversely affect human health. Likewise, concern about VOCs in ground water is shared by State and Federal regulatory agencies responsible for protecting the ground-water resource from contaminants and for protecting human health. This report is prepared in cooperation with The Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services (ATSDR) and provides under one cover an abridged description of selected properties, and biodegradation information published in academic and government literature. In addition, the report cross references commonly used names with a generally accepted international naming convention for 27 VOCs frequently detected in ground water.

Purpose and Scope

The purpose of this report is to (1) list 27 VOCs frequently detected in ground water, (2) cross-reference common VOC names and synonyms associated with the naming conventions supported by the International Union of Pure and Applied Chemistry (IUPAC), (2) describe the basic chemical properties of selected VOCs by subclass, and (3) describe the various pathways and chemical by-products associated with the degradation of selected VOCs in ground water. The goal of the report is not to supplant previously published literature reviews on VOCs in ground water, but rather to condense that information, and information from other papers, into a "digest" or abridged document that describes only the most salient and generally accepted scientific information regarding nomenclature, properties, and degradation paths for 27 VOCs detected in ground water in the United States.

Available Literature Addressing Volatile Organic Compounds

The information for this report is condensed from selected academic and government literature published within the last 30 years (1975–2006) that describe laboratory and field experiments and ground-water studies of VOC. The 27 VOCs described in this report are among the VOCs commonly detected in aquifers and ground-water sources of drinking water in the United States (Zogorski and others, 2006).

The amount of academic, government, and popular literature addressing volatile organic compounds in ground water is vast and scattered among paper and electronic venues, some published and some unpublished. Reviewing this literature would be a daunting task and certainly beyond the scope for this report. Fortunately, a number of published papers and reports are readily available that reviewed, compiled, or summarized the properties, chemistry, or degradation paths of VOCs in ground water. Citations for several of these compilations and the information summarized are listed in table 1. Unless a report provided newly synthesized information, all facts or interpretations described in summary reports or literature reviews are cited using the primary source reported in the publication.

Table 1. List of selected publications providing literature reviews and summaries of volatile organic compound degradation and behavior in ground water.

[BTEX, benzene, toluene, ethyl benzene, xylenes; PCE, tetrachloroethylene; VOC, volatile organic compound; MTBE, methyl *tert*-butyl ether]

Publication citation	Subject
Aronson and others, 1999	Aerobic biodegradation rates for BTEX, PCE
Aronson and Howard, 1997	Anaerobic biodegradation rates for BTEX, naphthalene, styrene, chlorinated aliphatic compounds
Azadpour-Keeley and others, 1999	Microbial degradation and natural attenuation of VOCs in ground water
Beek, 2001	Natural degradation processes and rates for VOCs
Christensen and others, 2000	Oxidation-reduction conditions in ground-water contaminant plumes
Howard and others, 1991	Environmental degradation rates of chemical compounds
Vogel and others, 1987	Chemical reactions involved in VOC degradation
Vogel, 1994	Biodegradation of chlorinated solvents
Washington, 1995	Hydrolysis rates of dissolved VOCs
Wiedemeier and others, 1998	Natural attenuation of VOCs in ground water
Wilson and others, 2005	Natural attenuation of MTBE in ground water

Although a large amount of the citations in the academic or government literature or on the Internet are published through reliable agencies or entities, some citations reference obscure sources or sources that are generally inaccessible to the public. Because of this issue, the literature cited in this report is confined to the body of work that is available and easily accessed through mainstream academic journals, State or Federal agencies using various libraries, or online databases on the Internet.

In general, the academic literature focuses on VOCs from two perspectives: (1) analytical and physical chemistry and (2) environmental occurrence, transport, and fate. The analytical and physical chemistry literature provide information on the physico-chemical properties of VOCs—such as experimental and computed Henry's Law constants, fugacity, water solubility, organic carbon solubility, octanol-water partition coefficients, partitioning among various physical phases (that is, gas, liquid, solid), experimentally derived and computer-simulated reaction rates, microbial degradation, and reaction types (that is, hydrolysis, oxidation-reduction, dehalogenation). The literature describing the environmental occurrence, transport, and fate of VOCs in ground water primarily deals with site-specific contamination, and the abiotic and microbial transformation, attenuation, and degradation observed in ground water. Some of those documents attempt to confirm or apply in vitro (laboratory microcosm) results to contaminated areas in situ and many are written from a remediation perspective.

The local, State, territorial, and U.S. Government literature on VOCs in ground water typically encompass issues important to its citizenry in an environmental or regulatory context. This literature commonly involves larger geographical areas than those of a typical academic paper. With some exceptions, publications of the U.S. Geological Survey (USGS) are less attentive to site-specific contamination in ground water and more attentive to contamination issues of areal, regional, or national importance (Grady, 2003; Hamlin and others, 2002, 2005; Moran, 2006; Zogorski and others, 2006). One exception is the USGS Toxic Substances Hydrology Program (*http://toxics.usgs.gov/*), which routinely publishes USGS reports and scientific articles in refereed journals. The primary focus of that program is site-specific fate and transport studies involving trace metal and organic (including VOCs) contamination in ground water.

In contrast to USGS reports, the literature produced by the U.S. Environmental Protection Agency (USEPA) primarily focuses on applying scientific results to regulatory and remediation issues in compliance with the Clean Air and Clean Water Acts and their amendments, and those statutes underwriting the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Office of Research and Development (ORD) is the scientific research arm of the USEPA that routinely publishes reports addressing the fate and transport of VOCs in ground water within a regulatory context. Moreover, each State and territory within the United States publishes scientific and regulatory literature regarding the occurrence of VOCs in ground water and its transport, fate, and impact on human and ecological health that are specific to those States. Other government agencies such as the Centers for Disease Control (CDC) and the ATSDR publish printed and electronic literature relating the potential human-health effects of VOCs in drinking water.

Paper and electronic literature published by the popular press, such as sports and outdoor magazines, and publications of environmental groups such as the Sierra Club and the Nature Conservancy typically use academic and government publications as sources for their articles. These articles are intended to educate their readers and members on environmental contamination and regulatory issues. With the exception of literature published by the popular press, the literature selected and used in this report spans the venues described in preceding paragraphs. Most of this literature, particularly the environmental fate and transport literature, focuses on fewer than 30 VOCs in ground water.

Naming Conventions and Descriptions of Volatile Organic Compounds in Ground Water

The compounds addressed in this report belong to the class of organic chemicals called volatile organic compounds (VOCs). Depending on the source, a VOC has two definitions—one within a physico-chemical context and the other within a regulatory context. The physico-chemical definition of a VOC as stated by Australia's National Pollutant Inventory is: *Any chemical compound based on carbon chains or rings (and also containing hydrogen) with a vapor pressure greater than 2 mm of mercury (mm Hg) at 25 degrees Celsius (°C). These compounds may contain oxygen, nitrogen and other elements. Substances that are specifically excluded are: carbon dioxide, carbon monoxide, carbonic acid, carbonate salts, metallic carbides and methane* (Australian Department of Environment and Heritage, 2003). A physico-chemical definition of VOC as explicit as that from Australia and originating in the United States was not found during extensive Internet searches. In the United States, the regulatory definition of VOC is provided by the USEPA under the Clean Air Act and published in the Code of Federal Regulations—*Volatile organic compound (VOC) means any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions* (U.S. Environmental Protection Agency, 2000a).

Among the academic, government, and popular literature, it is common to find a confusing variety of names used to identify VOCs. For example, tetrachloroethene (IUPAC name) is also known as perchloroethylene, PCE, and tetrachloroethylene (table 2). Furthermore, some compounds are identified using the various brand names under which they are sold. The name used to identify any particular compound may depend on a number of variables. These variables include the area or region where the compound is used (for example, Europe, United States, Northeastern United States, and so forth), the type of publication referring to the compound (journal article, administrative report, government report, or popular magazine), the popularity of that name in recently published literature, and the profession of the person using the name (that is, analytical chemist, environmental scientist, environmental toxicologist, biologist or ecologist, organic chemist, journalist, farmer, and so forth). Because of the numerous name variations for VOCs, attempts to merge information from a variety of venues "on-the-fly" for a particular compound are tedious, confusing, and fraught with error. As early as the late 1800s, chemists and others recognized the need for a consistent naming convention for all chemical compounds.

In 1889, an international consortium of chemists, encouraged by the need for a consistent naming convention for all chemical compounds, formed the International Union of Chemistry (IUC). During 1892 at a meeting in Geneva, Switzerland, the IUC was formalized with a goal to create a system of rules for naming chemical compounds (Geneva Rules). The Geneva Rules established the foundation, the framework, and the initial rules for a consistent, international naming convention for all chemical compounds, including the complex organic compounds. Since this first meeting, the IUC has evolved into the International Union of Pure and Applied Chemistry (IUPAC), an organization responsible for creating new rules and keeping established rules current (Brown and LeMay, 1977, p. 723). The history of the IUPAC organization and the Geneva Rules establish provenance for the formal names given to the VOCs described in this report.

Under the IUPAC naming convention, VOCs are commonly assigned to two general groups: (1) aliphatic hydrocarbons (alkanes, alkenes), and (2) aromatic hydrocarbons (Brown and LeMay, 1977). An alkane is a straight chain or cyclic (ring-like; such as cycloalkane) structure that consists of carbon-carbon and carbon-hydrogen single bonds. A chlorinated alkane also contains at least one chlorine-carbon single bond. A chemical bond is the electrical attraction between two atoms, one that has a negative charge and the other a positive charge. In organic compounds, these chemical bonds are covalent, meaning that two bonded atoms share electrons (Brown and LeMay, 1977). An alkene is typically a straight-chain structure that contains at least one carbon-carbon double bond. A chlorinated alkene also contains at least one chlorine-carbon single bond. These double bonds indicate stronger covalent bonds between two carbon atoms and impart more stability to the compound than the single bond in an alkane compound.

In contrast to the aliphatic compounds, aromatic compounds are those with alternating carbon-carbon single and double bonds arranged in a ring structure. Benzene is the most commonly recognized aromatic compound (Brown and LeMay, 1977). Chlorinated aromatic compounds also contain one chlorine-carbon single bond (for example, chlorobenzene). Aromatic compounds are typically more resistant to degradation (more stable) than the alkane and alkene compounds.

The aliphatic and the aromatic hydrocarbons are commonly subgrouped even further based on the presence of attached halogen atoms (chlorine as chloro, bromine as bromo, or fluorine as fluoro) or functional groups including, but not limited to, alkyl radicals. The VOC subgroups include the alkyl benzenes (such as methylbenzene), chlorinated alkanes (such as 1,2-dichloroethane), chlorinated alkenes (such as 1,1-dichloroethene), and the chlorinated aromatics (such as 1,2-dichlorobenzene; table 2). The alkyl radicals are the lower molecular weight alkanes minus one hydrogen atom (table 3) and are highly reactive compounds that can easily displace a hydrogen atom on another molecule. Halogenated or alkylated aromatics such as chlorobenzene or toluene are more easily degraded than benzene in aerobic and anaerobic ground water because the stability of the benzene ring is reduced and the ring is weakened (Borden and others, 1997). Adding halides or alkyl groups to the ring structure disperses the electrical charges from the carbon-carbon bonds on the ring and weakens that bond.

Table 2. Names and synonyms of volatile organic compounds commonly detected in ground water.

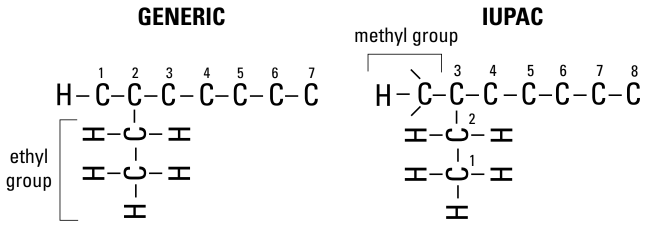
[IUPAC, International Union of Pure and Applied Chemistry; CAS, Chemical Abstract Services; —, not applicable]

IUPAC name[1]	Common or alternative name (synonyms)[2]	Other possible names[2]	Predominant source	CAS number[1]
		Alkyl benzenes		
1,2-dimethylbenzene	*o*-xylene	The X in BTEX, dimethyltoluene, Xylol	gasoline	95-47-6
1,3-dimethylbenzene	*m*-xylene			108-38-3
1,4-dimethylbenzene	*p*-xylene			106-42-3
ethylbenzene	—	The E in BTEX, Ethylbenzol, phenylethane	gasoline	100-41-4
methylbenzene	toluene	The T in BTEX, phenylmethane, Methacide, Toluol, Antisal 1A	gasoline	108-88-3
1,2,4-trimethylbenzene	pseudocumene	pseudocumol, asymmetrical trimethyl-benzene	gasoline	95-63-6
		Aromatic hydrocarbons		
benzene	—	The B in BTEX, coal naphtha, 1,3,5-cyclohexatriene, mineral naphtha	gasoline	71-43-2
naphthalene	naphthene	—	gasoline, organic synthesis	91-20-3
stryrene	vinyl benzene	phenethylene	gasoline, organic synthesis	100-42-5
		Ethers		
2-methoxy-2-methylpropane	methyl *tert*-butyl ether, MTBE	*tert*-butyl methyl ether	fuel oxygenate	1634-04-4
		Chlorinated alkanes		
chloroethane	ethyl chloride, monochloroethane	hydrochloric ether, muriatic ether	solvent	75-00-3
chloromethane	methyl chloride	—	solvent	74-87-3
1,1-dichloroethane	ethylidene dichloride	—	solvent, degreaser	75-34-3
1,2-dichloroethane	ethylidene dichloride	glycol dichloride, Dutch oil	solvent, degreaser	107-06-2
tetrachloromethane	carbon tetrachloride	perchloromethane, methane tetrachloride	solvent	56-23-5
1,1,1-trichloroethane	methyl chloroform	—	solvent, degreaser	71-55-6
		Chlorinated alkenes		
chloroethene	vinyl chloride	chloroethylene, monochloroethene, monovinyl chloride (MVC)	organic synthesis, degradation product	75-01-4
1,1-dichloroethene	1,1-dichloroethylene, DCE	vinylidene chloride	organic synthesis, degradation product	75-35-4
cis-1,2-dichloroethene	*cis*-1,2-dichloroethylene	1,2 DCE, Z-1,2-dichloroethene	solvent, degradation product	156-59-2
trans-1,2-dichloroethene	*trans*-1,2-dichloroethylene	1,2 DCE, E-1,2-dichloroethene	solvent, degradation product	156-60-2
dichloromethane	methylene chloride	—	solvent	74-09-2
		Chlorinated alkenes		
tetrachloroethene	perchloroethylene, PCE, 1,1,2,2-tetrachloroethylene	ethylene tetrachloride, carbon dichloride, PERC®, PERK®	solvents, degreasers	127-18-4
1,1,2-trichloroethene	1,1,2-trichloroethylene, TCE	acetylene trichloroethylene	solvents, degreasers organic synthesis	79-01-6
		Chlorinated aromatics		
chlorobenzene	monochlorobenzene	benzene chloride, phenyl chloride	solvent, degreaser	108-90-7
1,2-dichlorobenzene	o-dichlorobenzene	ortho dichlorobenzol	organic synthesis	95-50-1
1,2,3-trichlorobenzene	1,2,6-trichlorobenzene	—	organic synthesis	87-61-6
1,2,4-trichlorobenzene	1,2,4-trichlorobenzol	—	organic synthesis	102-82-1

[1] International Union of Pure and Applied Chemistry, 2006

[2] U.S. Environmental Protection Agency, 1995

The simplest IUPAC rules for naming organic chemicals are those for the alkane compounds. First, the compound is named for the longest carbon-carbon (C-C) chain in the compound. If the compound contains a halogen or a branching alkyl group, then each carbon in the compound is numbered starting at the end that is closest to the halogen or alkyl group. The longest carbon chain may include the original branching alkyl group and result in a branching alkyl group with a different carbon position and name. After identifying the longest C-C chain in the compound, the numerical position of the alkyl group or halogen, if any, on a particular carbon is determined. The alkyl group is named based on the number of carbon atoms it contains corresponding to a name in the alkane series (table 3). To illustrate the IUPAC naming process, consider the following example: before the IUPAC rules, a seven-carbon alkane (septane) with an ethyl functional group (table 3) on the second carbon would be named 2-ethyl septane (fig. 1). Under IUPAC rules, however, the longest carbon chain in this example begins at the first carbon in the ethyl group. This new carbon chain contains eight carbon atoms rather than the original seven and is now called octane. Moreover, the octane compound now has a methyl group branching from its third carbon. Therefore, the new IUPAC name is 3-methyl octane (fig. 1).



2-ethyl septane **3-methyl octane**

Figure 1. Generic and International Union of Pure and Applied Chemistry (IUPAC) naming conventions for the same aliphatic compound.

Table 3. The first four members of the straight-chain alkane series and associated alkyl radical.[1]

[IUPAC, International Union of Physical and Applied Chemistry; C, carbon atom; H, hydrogen atom; *n*, normal; *t,* tertiary; °C, degrees Celsius]

Alkane series condensed formula (IUPAC name)[2]	Number of carbon atoms in chain	Alkyl group, condensed formula (IUPAC name)[2]	Boiling point (°C)
CH_4 (*methane*)	1	CH_3-- [methyl]	–161
CH_3CH_3 (*ethane*)	2	CH_3CH_2-- [ethyl]	–89
$CH_3CH_2CH_3$ (*propane*)	3	$CH_3CH_2CH_2$-- [*n*-propyl] --$CHCH_3CH_3$ [isopropyl]	–44
$CH_3CH_2CH_2CH_3$ (*butane*)	4	$CH_3CH_2CH_2CH_2$-- [*n*-butyl] CH_3 CH_3C-- [*t*-butyl] CH_3	–0.5

Under IUPAC naming conventions, higher molecular weight alkanes are not typically present as alkyl radicals in volatile organic compounds

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[1] Brown and LeMay, 1977, tables 24.1, 24.2

[2] International Union of Pure and Applied Chemistry, 2006

Sources of Volatile Organic Compounds Detected in Ground Water

A relatively large amount of literature exists that describes VOCs in ground water at specific, known areas of contamination. Few documents, however, describe VOC contamination in a regional or national context. One report by Arneth and others (1989) lists the top 15 VOCs detected in ground water near landfills in the United States and in Germany (table 4). This list shows that the VOCs contaminating ground water near landfills are similar in both countries. Most of these VOCs are chlorinated solvents (CVOCs) and gasoline compounds (gVOCs). Furthermore, the frequency of VOCs detected in representative studies completed on national, regional, and site-specific scales in the United States show a remarkable similarity to those in table 4 (table 5; Delzer and Ivahnenko, 2003; Moran, 2006; Zogorski and others, 2006). Although the number of VOCs analyzed in ground-water samples is large for national and regional studies, the most commonly detected compounds, primarily CVOCs and gVOCs, are similar to those at site-specific studies completed at U.S. Department of Defense installations (table 6). The 10 most commonly detected VOCs in the studies summarized in tables 5 and 6 are methyl *tert*-butyl ether (MTBE), tetrachloroethene (PCE), 1,1,2-trichloroethene (TCE), methylbenzene (toluene), 1,1,1-trichloroethane (111-TCA), benzene, *cis*-1,2-dichloroethene (12-cDCE), 1,1-dichloroethane (11-DCA), *trans*-1,2-dichloroethene (12-tDCE), the dimethylbenzenes (*m*-, *o*-, *p*-xylenes)

Sources of Chlorinated Alkanes

The chlorinated solvents within the alkane group are listed in table 2. The CVOCs are typically used in the manufacturing of industrial, chemical, electronic, and consumer goods (Smith and others, 1988; U.S. Environmental Protection Agency, 2005b). In addition, these compounds are heavily used as solvents in cleaning and degreasing products. For example, 111-TCA is used as a solvent for adhesives and in metal degreasing, pesticides, textile processing, cutting fluids, aerosols, lubricants, cutting oil formulations, drain cleaners, shoe polishes, spot cleaners, printing inks, and stain repellents.

Carbon tetrachloride (CTET) was used as feedstock for the production of chlorofluorocarbon gases, such as dichlorodifluoromethane (F-12) and trichlorofluoromethane (F-11), which were used as aerosol propellants in the 1950s and 1960s (Holbrook, 1992). During 1974, the U.S. Food and Drug Administration (FDA) banned the sale of CTET in any product used in the home and the USEPA regulated the use of chlorofluorocarbon gases as aerosols or propellants. By 2000, CTET production for nonfeedstock purposes was phased-out completely.

Table 4. Volatile organic compounds ranked by those frequently detected in ground water near landfills and hazardous waste dumps in the United States and the Federal Republic of Germany.[1]

[IUPAC, International Union of Physical and Applied Chemistry; —, not applicable]

	United States of America		Federal Republic of Germany	
Rank	IUPAC name[2]	Common or alternative name	IUPAC name[2]	Common or alternative name
1	1,1,2-trichloroethene	1,1,2-trichloroethylene, TCE	tetrachloroethene	perchloroethylene, tetrachloroethylene, PCE
2	tetrachloroethene	perchloroethylene, tetrachloroethylene, PCE	1,1,2-trichloroethene	1,1,2-trichloroethylene, TCE
3	*cis*-1,2-dichloroethene	*cis*-1,2-DCE	*trans*-1,2-dichloroethene	*trans*-1,2-DCE
4	benzene	benzene	trichloromethane	—
5	chloroethene	vinyl chloride	1,1-dichloroethene	1,1-dichloroethylene, DCE
6	trichloromethane	—	dichloromethane	methylene chloride
7	1,1,1-trichloroethane	methyl chloroform	1,1,1-trichloroethane	methyl chloroform
8	dimethylbenzene	xylene	1,1-dichloroethane	ethylene dichloride
9	*trans*-1,2-dichloroethene	*trans*-1, 2-dichloroethylene	1,2-dichloroethane	ethylene dichloride
10	methylbenzene	toluene	phenol	—
11	ethylbenzene	ethylbenzene	acetone	dimethyl ketone, 2-propanone, and beta-ketopropane
12	dichloromethane	methylene chloride	toluene	methyl benzene
13	dichlorobenzene, total	—	bis-(2-ethylhexyl)-phthalate	—
14	chlorobenzene	chlorobenzene	benzene	benzene
15	tetrachloromethane	carbon tetrachloride	chloroethene	vinyl chloride

[1] Arneth and others, 1989, p. 399

[2] International Union of Pure and Applied Chemistry, 2006

Table 5. Volatile organic compounds detected in regional and national ground-water studies in the United States.

[µg/L, micrograms per liter; [12], percentage of samples above the analytical reporting limit; <, less than; ND, not detected above analytical reporting level]

Rank	Statewide, ground water in Wisconsin[1]	Ground water in the Santa Ana River Basin, California[2]	Ground-water and drinking-water supply wells in the United States (concentrations greater than 0.2 µg/L)[3]		
			Aquifer studies[4]	Domestic water-supply wells[5]	Public water-supply wells[6]
1	dichloromethane [16.3]	1,1,2-trichloroethene (TCE) [12]	tetrachloroethene (PCE) [3.7]	2-methoxy-2-methylpropane (MTBE) [2.9]	2-methoxy-2-methylpropane (MTBE) [5.4]
2	1,1-dichloroethane [13.6]	1,1,1-trichloroethane [10.5]	2-methoxy-2-methylpropane (MTBE) [2.8]	tetrachloroethene (PCE) [2.0]	tetrachloroethene (PCE) [5.3]
3	*cis*-1,2-dichloroethene, 1,1-dichloroethane [13.6]	tetrachloroethene (PCE) [9.1]	1,1,2-trichloroethene (TCE) [2.6]	1,1,1-trichloroethane [1.4]	1,1,2-trichloroethene (TCE) [4.3]
4	1,1,2-trichloroethene (TCE) [13.3]	1,1-dichloroethene [5.7]	methylbenzene [1.9]	methylbenzene [1.0]	1,1,1-trichloroethane [2.2]
5	methylbenzene [11.6]	2-methoxy-2-methylpropane (MTBE) [5.3]	1,1,1-trichloroethane [1.7]	chloromethane [.97]	1,1-dichloroethane [2.0]
6	tetrachloroethene (PCE) [9.8]	*cis*-1,2-dichloroethene [4.3]	chloromethane [1.1]	1,1,2-trichloroethene (TCE) [.92]	*cis*-1,2-dichloroethene [1.5]
7	benzene [8.5]	methylbenzene [3.8]	*trans*-1,2-dichloroethene [0.91]	dichloromethane [.67]	1,1-dichloroethene (DCE) [1.3]
8	chloroethene [8.0]	1,1-dichloroethane [2.9]	dichloromethane [0.89]	1,2,4-trimethylbenzene [.32]	*trans*-1,2-dichloroethene [1.0]
9	1,3- and 1,4-dimethylbenzenes [7.9]	benzene [1.4]	1,1-dichloroethane [0.86]	1,1-dichloroethane [.29]	methylbenzene [1.0]
10	1,1,1-trichloroethane [7.8]	1,2-dimethylbenzene [1.4]	1,1-dichloroethene [0.66]	benzene, 1,2-dichloroethane [.21]	tetrachloromethane [.73]
11	ethylbenzene [7.6]	1,3- and 1,4-dimethylbenzene [1.4]	benzene [.63]	tetrachloromethane [.21]	1,3- and 1,4-dimethylbenzene [0.60]
12	1,2,4-trimethylbenzene [7.1]	*trans*-1,2-dichloroethene [<1]	1,2,4-trimethylbenzene [.63]	1,1-dichloroethene [.21]	1,2-dichloroethane [.56]
13	1,2-dimethylbenzene [6.8]	dichloromethane [<1]	1,2-dichloroethane [.47]	total xylenes [0.21]	1,2-dimethylbenzene [.48]
14	chloromethane [6.7]	ethylbenzene [<1]	*cis*-1,2-dichloroethene [.42]	*cis*-1,2-dichloroethene [.18]	benzene, dichloromethane, ethylbenzene [.46]
15	naphthalene [6.5]	naphthalene [<1]	total xylenes [.38]	naphthalene [.15]	chloromethane [.38]
16	chloroethane [6.3]	tetrachloromethane [<1]	tetrachloromethane [.31]	ethylbenzene [.12]	1,2,4-trimethylbenzene [0.32]
17	chlorobenzene [4.3]	1,2,4-trimethylbenzene [<1]	chloroethane [.29]	chloroethane [.093]	chloroethane [.28]
18	1,2-dichloroethane [3.7]	chlorobenzene [ND]	chloroethene [.26]	chloroethene [.083]	vinyl benzene [.19]
19	*trans*-1,2-dichloroethene [3.3]	chloroethane [ND]	ethylbenzene [.26]	*trans*-1,2-dichloroethene [.045]	chlorobenzene, 1,2-dichlorobenzene [.18]
20	1,1-dichloroethene (DCE) [2.6]	chloromethane [ND]	chlorobenzene [.17]	chlorobenzene [.042]	chloroethene [.18]
21	1,2-dichlorobenzene [2.4]	chloroethene [ND]	naphthalene [.16]	1,2-dichlorobenzene [.042]	naphthalene [.10]
22	2-methoxy-2-methylpropane (MTBE) [2.3]	1,2-dichlorobenzene [ND]	1,2-dichlorobenzene [.12]	vinyl benzene [ND]	1,2,4-trichlorobenzene [ND]
23	tetrachloromethane [1.8]	1,2-dichloroethane [ND]	vinyl benzene [ND]	1,2,4-trichlorobenzene [ND]	1,3-dichlorobenzene [ND]
24	vinyl benzene [1.2]	1,2,3-trichlorobenzene [ND]	1,2,3-trichlorobenzene [ND]	1,1,2-trichloroethane [ND]	1,1,2-trichloroethane [ND]
25	1,2,4-trichlorobenzene, 1,1,2-trichloroethane [<1.0]	vinyl benzene [ND]		1,2,3-trichlorobenzene [ND]	1,2,3-trichlorobenzene [ND]

[1] 1,305–4,086 samples (Wisconsin Department of Natural Resources, 2000)

[2] 9–112 samples (Hamlin and others, 2002)

[3] Zogorski and others, 2006

[4] 1, 710–3,498 samples

[5] 1,190–1,208 samples

[6] 828–1,096 samples

Table 6. Volatile organic compounds detected in ground-water case studies at selected U.S. Department of Defense installations.

[[43.3], percentage of samples with a detected concentration; ND, not detected above analytical reporting level]

Rank	Dover Air Force Base, Maryland[1]	U.S. Army Armament Research and Development Center, Picatinny, New Jersey, 1958–85[2]	U.S. Naval Undersea Warfare Center, Washington, D.C.[3]	Wright-Patterson Air Force Base, Ohio, 1993–94[4]
1	2-methoxy-2-methylpropane (MTBE) [25.5]	1,1,2-trichloroethene (TCE) [58.5]	chloroethene [64]	1,1,2-trichloroethene (TCE) [12.5]
2	*cis*-1,2-dichloroethene [21.7]	tetrachloroethene (PCE) [24.9]	*cis*-1,2-dichloroethene [59]	tetrachloroethene (PCE) [5.8]
3	1,1,2-trichloroethene (TCE) [20.3]	*trans*-1,2-dichloroethene (DCE) [18.6]	*trans*-1,2-dichloroethene [44.8]	1,1,1-trichloroethane [2.3]
4	tetrachloroethene (PCE) [13.7]	1,1,1-trichloroethane [16.8]	1,1,2-trichloroethene (TCE) [40.4]	chloromethane [2.3]
5	benzene [10.4]	1,1-dichloroethane [9.6]	total BTEX compounds [40.1]	*cis*- and *trans*-1,2-dichloroethene [1.2]
6	methylbenzene [6.6]	*cis*-1,2-dichloroethene (DCE) [9.6]	1,1-dichloroethane [37.2]	chloroethene [.9]
7	dimethylbenzenes (*m*-, *p*-xylene) [3.7]	methylbenzene (toluene) [4.4]	chloroethane [33.9]	dichloromethane [.9]
8	ethylbenzene [2.3]	benzene [2.6]	1,1-dichloroethene [31.3]	methylbenzene [.6]
9	chloroethene [ND]	—	tetrachloroethene (PCE) [9.6]	benzene [.3]
10	—	—	1,1,1-trichloroethane [6.9]	chloroethane [.3]
11	—	—	—	tetrachloromethane [.3]

[1] 212 samples (Barbaro and Neupane, 2001; Guertal and others, 2004)

[2] 607 samples (Sargent and others, 1986)

[3] 121–179 samples (Dinicola and others, 2002)

[4] 343 samples (Schalk and others, 1996)

Chemical manufacturing is the largest use of 11-DCA and 1,2-dichloroethane (12-DCA). Both compounds serve as an intermediate during the manufacture of chloroethene (vinyl chloride, VC), 111-TCA, and to a lesser extent high-vacuum rubber. Both DCA isomers also are used as a solvent for plastics, oils, and fats, and in cleaning agents and degreasers (Agency for Toxic Substances and Disease Registry, 1990c, p. 51; 2001, p. 160). About 98 percent of the 12-DCA produced in the United States is used to manufacture VC. Smaller amounts of 12-DCA are used in the synthesis of vinylidene chloride, TCE, PCE, aziridines, and ethylene diamines, and in other chlorinated solvents (U.S. Environmental Protection Agency, 1995).

The compound 111-TCA was initially developed as a safer solvent to replace other chlorinated and flammable solvents. The compound is used as a solvent for adhesives (including food packaging adhesives) and in metal degreasing, pesticides, textile processing, cutting fluids, aerosols, lubricants, cutting oil formulations, drain cleaners, shoe polishes, spot cleaners, printing inks, and stain repellents, among other uses (Agency for Toxic Substances and Disease Registry, 2004, p. 181). The other TCA isomer, 1,1,2-trichloroethane (112-TCA), has limited use as a common, general-use solvent but is used in the production of chlorinated rubbers (Archer, 1979). In some cases, 112-TCA may be sold for use in consumer products (Agency for Toxic Substances and Disease Registry, 1989, p. 59).

Before 1979, the single largest use of chloroethane was in the production of tetraethyl lead. As recently as 1984, the domestic production of tetraethyl lead accounted for about 80 percent of the chloroethane consumed in the United States; whereas about 20 percent was used to produce ethyl cellulose, and used in solvents, refrigerants, topical anesthetics, and in the manufacture of dyes, chemicals, and pharmaceuticals. Since the 1979 ban on tetraethyl lead in gasoline and its subsequent phase out in the mid-1980, the production of chloroethane in recent years has declined substantially in the United States (Agency for Toxic Substances and Disease Registry, 1998, p. 95).

Sources of Chlorinated Alkenes and Benzenes

The chlorinated alkenes listed in table 2 include two of the most widely used and distributed solvents in the United States and Europe. These solvents, PCE and TCE, also are among the most common contaminants in ground water (tables 5 and 6). The textile industry uses the largest amount of PCE during the processing, finishing of raw and finished textiles, and for industrial and consumer dry cleaning (U.S. Environmental Protection Agency, 2005b, Web page: *http://www.epa.gov/opptintr/chemfact/f_perchl.txt*, accessed May 23, 2006). Most of the TCE used in the United States is for vapor degreasing of metal parts and some textiles (U.S. Environmental Protection Agency, 2005b, Web page: *http://www.epa.gov/OGWDW/dwh/t-voc/trichlor.html*, accessed May 23, 2006). Other uses of PCE and TCE include manufacturing of pharmaceuticals, other organic compounds, and electronic components, and in paint and ink formulations (Smith and others, 1988).

Four chlorinated benzenes commonly detected in ground-water contamination studies include chlorobenzene (CB), 1,2-dichlorobenzene (12-DCB), and two isomers of trichlorobenzene, 1,2,3-trichlorobenzene (123-TCB) and 1,2,4-trichlorobenzene (124-TCB; tables 5 and 6). Chlorobenzene is commonly used as a solvent for pesticide formulations, in the manufacturing of di-isocyanate, as a degreaser for automobile parts, and in the production of nitrochlorobenzene. Solvent uses accounted for about 37 percent of chlorobenzene consumption in the United States during 1981 (Agency for Toxic Substances and Disease Registry, 1990a, p. 45). The compound 12-DCB is used primarily to produce 3,4-dichloroaniline herbicides (Agency for Toxic Substances and Disease Registry, 1990b, p. 263). The two trichlorobenzene isomers are primarily used as dye carriers in the textile industry. Other uses include septic tank and drain cleaners, the production of herbicides and higher chlorinated benzenes, as wood preservatives, and in heat-transfer liquids (U.S. Environmental Protection Agency, 2005b, Web page: *http://www.epa.gov/OGWDW/dwh/t-voc/t-124-tric.html*, accessed May 23, 2006).

Sources of Gasoline Compounds

At a basic level, gasoline production is simply a process of sequential distillations that separate, by vaporization, volatile hydrocarbons from crude oil. Typically, these hydrocarbons are the lower molecular weight compounds that commonly are the most volatile compounds in crude oil. More advanced methods such as heat "cracking" are used to breakdown the complex aromatic hydrocarbons in crude oil into smaller, more volatile compounds that are easily distilled. Once the hydrocarbons are in a vapor form, a condensation process cools the vapor and the resulting liquid is collected for further refining. The hydrocarbon composition of gasoline depends on the source of the crude oil used, the refining process, the refiner, the consumer demand, the geographic location of the refinery, and the distributional area of the gasoline (Harper and Liccione, 1995).

Gasoline is typically a mixture of various hydrocarbons that include alkanes, cycloalkanes, cycloalkenes, akylbenzenes, and aromatic compounds, and some oxygenated alcohol additives (table 7). Many of the hydrocarbons in gasoline are additives and blending agents intended to improve the performance and stability of gasoline. These additives typically consist of oxygenates such as methyl *tert*-butyl ether (MTBE), ethanol, or methanol, antiknock agents, antioxidants, metal deactivators, lead scavengers, antirust agents, anti-icing agents, upper-cylinder lubricants, detergents, and dyes. At the end of the refining process, finished gasoline commonly contains more than 150 separate compounds; however, some blends may contain as many as 1,000 compounds (Harper and Liccione, 1995).

Table 7. Major organic compounds in a typical gasoline blend.[1]

[n, C_5-C_{13} carbon chain; MTBE, methyl *tert*-butyl ether; TBA, *tert*-butyl alcohol]

Major compounds	Percent composition by weight
n-alkanes	17.3
Branched alkanes	32.0
Cycloalkanes	5.0
Olefins	1.8
Aromatic hydrocarbons	30.5
Benzene	3.2
Toluene	4.8
Ethylbenzene	1.4
Xylenes	6.6
Other benzenes	11.8
Other aromatics	2.7
Other possible additives	
Octane enhancers: MTBE, TBA, ethanol	
Antioxidants: N, N'-dialkylphenylenediamines, di- and tri-alkylphenols, butylated methyl, ethyl and dimethyl phenols	
Metal deactivators: various N, N'-disalicylidene compounds	
Ignition controllers: tri-o-cresylphosphate (TOCP)	
Detergents/dispersants: alkylamine phosphates, poly-isobutene amines, long-chain alkyl phenols, alcohols, carboxylic acids, and amines	
Corrosion inhibitors: phosphoric acids, sulfonic acids, carboxylic acids	

[1] Harper and Liccione, 1995

BTEX Compounds (Benzene, Toluene, Ethylbenzene, and Xylene)

About 16 percent of a typical gasoline blend consists of BTEX compounds (collectively, benzene, toluene, ethlybenzene, and three xylene compounds; table 7). Of the different components contained in gasoline, BTEX compounds are the largest group associated with human-health effects. Because of the adverse impact on human health, BTEX compounds are typically the fuel components analyzed in ground-water samples collected from fuel-contaminated aquifers. Furthermore, three minor components of gasoline: naphthalene, vinyl benzene (styrene), and 1,2,4-trimethylbenzene (124-TMB) are commonly detected along with BTEX compounds and MTBE in contaminated ground water (tables 5 and 6). Although the individual BTEX compounds are widely used as solvents and in manufacturing (Swoboda-Colberg, 1995), gasoline leaks from underground storage tanks and distribution pipelines is the primary contributor of BTEX contamination in ground water (U.S. Environmental Protection Agency, 2000b; U.S. Environmental Protection Agency, 2005a).

Methyl *Tert*-butyl Ether

Methyl *tert*-butyl ether (MTBE; IUPAC 2-methoxy-2-methylpropane) is a gasoline additive within the class of fuel oxygenates. Oxygenates are organic compounds that enrich gasoline with oxygen to improve the combustion efficiency of gasoline and reduce carbon monoxide emissions in vehicle exhaust. Since the late 1980s, gasoline shipped to areas of the United States that fall under the Reformulated Gasoline (RFG) and Oxygenated Fuel (Oxyfuel) Programs of the Clean Air Act (CAA) and its amendments has contained oxygenates (Moran and others, 2004). Moreover, 30 percent of the gasoline used in the United States since 1998 contained oxygenates in compliance with RFG requirements while 4 percent of the gasoline used complied with the Oxyfuel requirements (U.S. Environmental Protection Agency, 1998). Reformulated gasoline contains about 11 percent MTBE by volume (Delzer and Ivahnenko, 2003).

Basic Properties of Selected Volatile Organic Compounds

Volatile organic compounds have a number of unique properties that both inhibit and facilitate ground-water contamination. Tables 8 through 12 list basic physical properties of 27 VOCs detected in ground water. Physical properties unique to each compound typically are governed by the number of carbons and the covalent bonding in the compound, the number and location of chlorine atoms, and the number, location and type of alkyl groups. The physical properties addressed in this report include the Henry's Law constant (H), water solubility, density, octanol-water partitioning (Log K_{ow}), and organic carbon partitioning (Log K_{oc}) of the non-aqueous phase liquid (NAPL). Models that estimate the fate and transport of VOCs in ground water depend on the accuracy and reliability of physical property measurements. Some models, such as the fugacity models, also use these properties to predict a compound's rate of movement into and out of environmental compartments (soil, water, air, or biota; Mackay, 2004). Predicting the environmental fate of a compound in ground water depends on data that quantifies: (1) the compound's tendency to volatilize (gaseous phase), (2) to dissolve in water (aqueous phase), (3) to float on or sink beneath the water surface, (4) to dissolve in or sorb to other organic compounds (including natural organic matter), and (5) the compound's affinity for ionically charged surfaces such as clay or soil particles. Fugacity models of varying complexity are in common use and rely on the physical properties of these compounds to estimate plume migration and persistence, and to guide the remediation of contaminated ground water (Mackay and others, 1996; Institute for Environmental Health, 2004; Saichek and Reddy, 2005).

Degradation of Selected Volatile Organic Compounds in Ground Water

Under specific conditions, most organic compounds degrade at a particular rate during a given length of time. The speed of the degradation depends on the presence and activity of microbial consortia (bacteria and fungi species), environmental conditions (temperature, aquifer materials, organic matter content), and the availability and concentration of carbon sources (primary substrate) available to the microbial consortia. The primary substrate can be a VOC or organic carbon found dissolved in water or sorbed to aquifer sediments. When primary substrate concentrations are small, the microbial population is small and biodegradation rates are relatively slow. As the substrate concentrations increase, the microbial population grows and the degradation rate increases concomitantly (Bradley and Chapelle, 1998). The microbial population will grow until they reach a maximum growth rate (Aronson and others, 1999).

The degradation of VOCs in ground water is a transformation of a parent compound to different compounds commonly called daughter products, degradates, or degradation by-products. These transformations can be grouped into two general classes: (1) those that require an external transfer of electrons, called oxidation-reduction reactions; and (2) those that do not involve a transfer of electrons, called substitutions and dehydrohalogenations (Vogel and others, 1987). Table 13 summarizes these reactions. Oxidation-reduction reactions are the dominant mechanisms driving VOC degradation and most of these reactions are catalyzed by microorganisms (Wiedemeier and others, 1998; Azadpour-Keeley and others, 1999). Substitution reactions that can remove chlorine atoms, such as hydrolysis, can degrade some chlorinated alkanes (trichloroethane) to nonchlorinated alkanes (ethane) with or without a microbial population catalyzing the reaction (Vogel and others, 1987; Olaniran and others, 2004). Typically, the polychlorinated compounds (for example, PCE and TCE) easily degrade under anaerobic conditions and are less mobile in soil and aquifer materials than the di- and mono-chlorinated compounds (fig. 2). Degradation pathways are illustrated in figures 3 through 19 for a subset of the compounds listed in table 2. These figures are modifications of pathways described in the University of Minnesota's biodegradation/biocatalysis database (Ellis and others, 2006) accessible via the Internet at *http://umbbd.msi.umn.edu*, accessed May 23, 2006.

Table 8. Henry's Law constants for selected volatile organic compounds detected in ground water.

[IUPAC, International Union of Physical and Applied Chemistry; kPa, kilopascals; m^3, cubic meter; mol, mole; °C, degrees Celsius; —, not applicable]

IUPAC name[1]	Common or alternative name[2]	Henry's Law[3] constant (H) ($kPa\ m^3\ mol^{-1}$ at 25°C)
tetrachloromethane	carbon tetrachloride	2.99
chloroethene	vinyl chloride, chloroethylene	2.68
1,1-dichloroethene	1,1-dichloroethylene, DCE	2.62
1,1,1-trichloroethane	methyl chloroform	1.76
tetrachloroethene	perchloroethylene, tetrachloroethylene, PCE	1.73
chloroethane	ethyl chloride, monochloroethane	[4]1.11
1,1,2-trichloroethene	1,1,2-trichloroethylene, TCE	1.03
trans-1,2-dichloroethene	*trans*-1,2-DCE, *trans*-1,2-dichloroethylene	.960
chloromethane	methyl chloride	[5].920
ethylbenzene	—	.843
1,3-dimethylbenzene	*m*-xylene	.730
1,4-dimethylbenzene	*p*-xylene	.690
methylbenzene	toluene	.660
1,1-dichloroethane	1,1-ethylidene dichloride	.630
benzene	—	.557
1,2-dimethylbenzene	*o*-xylene	.551
1,2,4-trimethylbenzene	pseudocumene	.524
cis-1,2-dichloroethene	*cis*-1, 2-dichloroethylene, *cis*-1,2-DCE	.460
chlorobenzene	monochlorobenzene	.320
stryrene	vinyl benzene	.286
1,2,4-trichlorobenzene	1,2,4-trichlorobenzol	.277
1,2,3-trichlorobenzene	1,2,6-trichlorobenzene	.242
1,2-dichlorobenzene	o-dichlorobenzene	.195
1,2-dichloroethane	1,2-ethylidene dichloride, glycol dichloride	.140
1,1,2-trichloroethane	methyl chloroform	.092
2-methoxy-2-methylpropane	methyl *tert*-butyl ether, MTBE	.070
naphthalene	naphthene	.043

Increasing tendency for a compound to move from the water phase to the vapor phase when in equilibrium with pure water

[1] International Union of Pure and Applied Chemistry, 2006

[2] U.S. Environmental Protection Agency, 1995

[3] Lide, 2003

[4] Gossett, 1987

[5] National Center for Manufacturing Sciences, 2006

Table 9. Water-solubility data for selected volatile organic compounds detected in ground water.

[IUPAC, International Union of Pure and Applied Chemistry; mg/L, milligrams per liter; °C, degrees Celsius; —, not applicable]

IUPAC name[1]	Common or alternative name[2]	Water solubility[3] (mg/L at 25°C)
2-methoxy-2-methylpropane	methyl *tert*-butyl ether, MTBE	36,200
1,2-dichloroethane	1,2-ethylidene dichloride, glycol dichloride	8,600
chloromethane	methyl chloride	[4]5,320
chloroethane	ethyl chloride, monochloroethane	[5]6,710
cis-1,2-dichloroethene	*cis*-1,2-dichloroethylene	6,400
1,1-dichloroethane	1,1-ethylidene dichloride	5,000
1,1,2-trichloroethane	methyl chloroform	4,590
trans-1,2-dichloroethene	*trans*-1,2-dichloroethylene	4,500
chloroethene	vinyl chloride, chloroethylene	2,700
1,1-dichloroethene	1,1-dichloroethylene, DCE	2,420
benzene	—	1,780
1,1,1-trichloroethane	methyl chloroform	1,290
1,1,2-trichloroethene	1, 1, 2-trichloroethylene, TCE	1,280
tetrachloromethane	carbon tetrachloride	1,200
methylbenzene	toluene	531
chlorobenzene	—	495
stryrene	vinyl benzene	321
tetrachloroethene	perchloroethylene, tetrachloroethylene, PCE	210
1,2-dimethylbenzene	*o*-xylene	207
1,4-dimethylbenzene	*p*-xylene	181
1,3-dimethylbenzene	*m*-xylene	161
ethylbenzene	—	161
1,2-dichlorobenzene	o-dichlorobenzene	147
1,2,4-trimethylbenzene	pseudocumene	57
1,2,4-trichlorobenzene	1,2,4-trichlorobenzol	37.9
naphthalene	naphthene	[6]31.0
1,2,3-trichlorobenzene	1,2,6-trichlorobenzene	30.9

↑ Increasing amount of non-aqueous phase liquid that can dissolve in water

[1] International Union of Pure and Applied Chemistry, 2006

[2] U.S. Environmental Protection Agency, 1995

[3] Lide, 2003

[4] National Center for Manufacturing Sciences, 2006

[5] Horvath, 1982

[6] Lyman, 1982

Table 10. Density of selected volatile organic compounds detected in ground water compared to the density of water at 20 degrees Celsius.

[IUPAC, International Union of Pure and Applied Chemistry; g/cm, grams per centimeter; °C, degrees Celsius; —, not applicable]

IUPAC name[1]	Common or alternative name[2]	Density[3] (g/cm^3, 20°C)	
1,2,3-trichlorobenzene	1,2,6-trichlorobenzene	[4]1.690	Increasing density (heavier than water)
tetrachloroethene	perchloroethylene, tetrachloroethylene, PCE	1.623	
tetrachloromethane	carbon tetrachloride	1.594	
1,1,2-trichloroethene	1,1,2-trichloroethylene, TCE	1.464	
1,2,4-trichlorobenzene	1,2,4-trichlorobenzol	[4]1.45	
1,1,2-trichloroethane	methyl chloroform	1.44	
1,1,1-trichloroethane	methyl chloroform	1.339	
1,2-dichlorobenzene	o-dichlorobenzene	1.306	
cis-1,2-dichloroethene	*cis*-1,2-dichloroethylene	1.284	
trans-1,2-dichloroethene	*trans*-1,2-dichloroethylene	1.256	
1,2-dichloroethane	1,2-ethylidene dichloride, glycol dichloride	1.235	
1,1-dichloroethene	1,1-dichloroethylene, DCE	1.213	
1,1-dichloroethane	1,1-ethylidene dichloride	1.176	
chlorobenzene	monochlorobenzene	1.106	
pure water at 20°C		1.000	
naphthalene	naphthene	.997	Decreasing density (lighter than water)
chloromethane	methyl chloride	.991	
chloroethane	ethyl chloride	.920	
chloroethene	vinyl chloride, chloroethylene	[4].910	
stryrene	vinyl benzene	.906	
1,2-dimethylbenzene	*o*-xylene	.880	
benzene	—	.876	
ethylbenzene	—	.867	
1,2,4-trimethylbenzene	pseudocumene	.876	
methylbenzene	toluene	.867	
1,3-dimethylbenzene	*m*-xylene	.864	
1,4-dimethylbenzene	*p*-xylene	.861	
2-methoxy-2-methylpropane	methyl *tert*-butyl ether, MTBE	.740	

[1] International Union of Pure and Applied Chemistry, 2006

[2] U.S. Environmental Protection Agency, 1995

[3] Lide, 2003

[4] Chiou and others, 1983

Table 11. Octanol-water partition coefficients for selected volatile organic compounds detected in ground water.

[IUPAC, International Union of Pure and Applied Chemistry; K_{ow}, octanol-water partition coefficient; —, not applicable]

IUPAC name[1]	Common or alternative name[2]	Octanol/ water partition coefficient[3] ($\log K_{ow}$)
1,2,3-trichlorobenzene	1,2,6-trichlorobenzene	[4]4.07
1,2,4-trichlorobenzene	1,2,4-trichlorobenzol	[4]4.04
1,2,4-trimethylbenzene	pseudocumene	3.65
1,2-dichlorobenzene	o-dichlorobenzene	3.46
naphthalene	naphthene	3.36
1,3-dimethylbenzene	*m*-xylene	3.20
ethylbenzene	ethylbenzene	3.15
1,4-dimethylbenzene	*p*-xylene	3.15
1,2-dimethylbenzene	*o*-xylene	3.12
stryrene	vinyl benzene	3.05
tetrachloroethene	perchloroethylene, tetrachloroethylene, PCE	2.88
chlorobenzene	monochlorobenzene	[4]2.84
methylbenzene	toluene	2.73
tetrachloromethane	carbon tetrachloride	[4]2.64
1,1,2-trichloroethene	1,1,2-trichloroethylene, TCE	[3]2.53
1,1,1-trichloroethane	methyl chloroform	[4]2.49
1,1,2-trichloroethane	methyl chloroform	2.38
1,1-dichloroethene	1,1-dichloroethylene, DCE	2.13
benzene	—	2.13
trans-1,2-dichloroethene	*trans*-1,2-dichloroethylene	1.93
cis-1,2-dichloroethene	*cis*-1,2-dichloroethylene	1.86
1,1-dichloroethane	1,1-ethylidene dichloride	[4]1.79
1,2-dichloroethane	1,2-ethylidene dichloride, glycol dichloride	[4]1.48
chloroethane	ethyl chloride	1.43
chloroethene	vinyl chloride, chloroethylene	1.38
2-methoxy-2-methylpropane	methyl *tert*-butyl ether, MTBE	.94
chloromethane	methyl chloride	.91

↑ Increasing affinity for organic matter and lipids

[1] International Union of Pure and Applied Chemistry, 2006

[2] U.S. Environmental Protection Agency, 1995

[3] Sangster, 1989

[4] Mackay and others, 1992a

Table 12. Soil-sorption partition coefficients for selected volatile organic compounds detected in ground water.

[IUPAC, International Union of Pure and Applied Chemistry; K_{oc}, soil organic carbon partition coefficient; —, not applicable]

IUPAC name[1]	Common or alternative name[2]	Soil-sorption coefficient (Log K_{oc} in soil)
1,2,4-trimethylbenzene	pseudocumene	[3]3.34
1,2,3-trichlorobenzene	1,2,6-trichlorobenzene	[4]3.18–[3]3.42
naphthalene	naphthene	[3]2.98
1,2,4-trichlorobenzene	1,2,4-trichlorobenzol	[5]2.94
vinyl benzene	styrene	[2]2.72–2.74
1,2-dichlorobenzene	o-dichlorobenzene	[6]2.46–[5]2.51
tetrachloroethene	perchloroethylene, tetrachloroethylene, PCE	[7]2.37
ethylbenzene	—	[5]2.22
1,1-dichloroethene	1,1-dichloroethylene, DCE	[2]2.18
1,3-dimethylbenzene	*m*-xylene	[7]2.11–2.46
1,1,1-trichloroethane	methyl chloroform	[8]2.03
1,1,2-trichloroethene	1,1,2-trichloroethylene, TCE	[7]2.00
chlorobenzene	monochlorobenzene	[5]1.91
1,1,2-trichloroethane	methyl chloroform	[7]1.78–2.03
tetrachloromethane	carbon tetrachloride	[9]1.78
methylbenzene	toluene	[7]1.75–[10]2.28
chloroethene	vinyl chloride, chloroethylene	[2]1.75
1,2-, 1,4-dimethylbenzene	*o*-xylene, *p*-xylene	[2]1.68–1.83
chloroethane	ethyl chloride	[4]1.62
cis-1,2-dichloroethene	*cis*-1,2-dichloroethylene	[2]1.56–1.69
1,2-dichloroethane	1,2-ethylidene dichloride, glycol dichloride	[6]1.52
trans-1,2-dichloroethene	*trans*-1,2-dichloroethylene	[2]1.56–1.69
1,1-dichloroethane	1,1-ethylidene dichloride	[12]1.52
benzene	—	[5]1.49–[7]1.73
methyl *tert*-butyl ether	MTBE	[11]1.09
chloromethane	methyl chloride	[3].778

↑ Increasing affinity for soil organic matter

[1] International Union of Pure and Applied Chemistry, 2006

[2] U.S. Environmental Protection Agency, 1995

[3] Boyd and others, 1990

[4] Schwarzenbach and Westall, 1981

[5] Chiou and others, 1983

[6] Chiou and others, 1979

[7] Seip and others, 1986

[8] Friesel and others, 1984

[9] Kile and others, 1996

[10] Garbarini and Lion, 1986

[11] U.S. Environmental Protection Agency, 1994

[12] U.S. Environmental Protection Agency, 2005b

Table 13. Common abiotic and biotic reactions involving halogenated aliphatic hydrocarbons.[1]

[+, plus; Cl, chloride]

Reactions	Potential reaction products
	Substitution
abiotic hydrolysis	alcohol then an acid or diol (chloroethanol → chloroacetic acid)
biotic hydrolysis	alcohol then an acid or diol via microbial enzymes (hydrolases or glutathione S-transferases; (chloroethanol → chloroacetic acid)
conjugation or nucleophilic reactions (biotic)	free halide plus a new compound with the nucleophile or conjugate
	Dehydrohalogenation
dehydrohalogenation	halogenated acid (chloroacetic acid), alkane to alkene (dichloroethane → chloroethane)
	Oxidation
α-hydroxylation	monochlorinated alkane to a monochlorinated alcohol (chloroethane → chloroethanol)
halosyl oxidation	monohalogenated alkane to a nonhalogenated alkane (chloroethane → ethane + Cl)
epoxidation	halogenated epoxide compound
biohalogenation	nonhalogenated alkene to a monohalogenated alcohol (ethene + Cl → chloroethanol)
	Reduction
hydrogenolysis	free halide and nonhalogenated compound (chloroethane → Cl + ethane)
dihaloelimination	dihalogenated alkane to a nonhalogenated alkene (dichloroethane → ethene)
coupling	combining of two halogenated compounds into one halogenated compound

[1] Vogel and others, 1987, figure 1

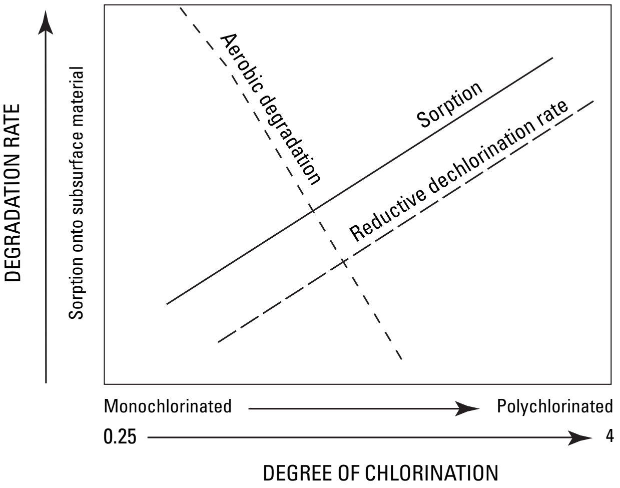

Figure 2. Relation between degree of chlorination and anaerobic reductive-dechlorination, aerobic degradation and sorption onto subsurface material (modified from Norris and others, 1993, p. 10–19). Degree of chlorination is number of chloride atoms divided by number of carbon atoms.

Aquifer conditions (aerobic and anaerobic) and microbial metabolism (respiration, fermentation, and co-metabolism) control the environmental degradation of VOCs in ground water. In aerobic environments, oxygen serves as the terminal electron acceptor (TEA) and compounds such as MTBE and BTEX are subsequently degraded (oxidized) to other compounds (Azadpour-Keeley and others, 1999). Furthermore, under aerobic conditions CVOCs can be inadvertently degraded (co-metabolized) via nonspecific enzymes (oxygenases) produced by microorganisms during the metabolism of other compounds serving as primary substrates (for example, BTEX, methane, propane, toluene, ammonia, ethene, ethane). Although the aerobic mineralization of most VOCs ultimately yields carbon dioxide and water, co-metabolic biodegradation of CVOCs generally proceeds via an unstable epoxide intermediate that spontaneously decomposes to carbon dioxide, chloride, or other organic by-products such as acetate (Roberts and others, 1986).

Anaerobic degradation is typically a series of decarboxylations and oxidation-reduction (redox) reactions catalyzed either by single microorganisms or by a consortium of microorganisms (Dolfing, 2000). During anaerobic degradation, CVOCs function as terminal electron acceptors in a process called reductive dechlorination (Vogel and others, 1987). Theoretically, reductive dechlorination is the sequential replacement of one chlorine atom on a chlorinated compound with a hydrogen atom. The replacement continues until the compound is fully dechlorinated. For example, PCE can undergo reductive dechlorination to less-chlorinated compounds, such as TCE or 12-DCE, or to nonchlorinated compounds such as ethene, ethane, or methane (methanogenesis). Each successive step in the dechlorination process is theoretically slower than the preceding step. The dechlorination process slows because as chlorines are removed the energy costs to remove another chlorine atom increases (free energy of the reaction decreases; Dolfing, 2000). As a result, biodegradation may not proceed to completion in some aquifers leaving intermediate compounds (for example, dichloroethenes and vinyl chloride) to accumulate in ground water (Azadpour-Keeley and others, 1999). Other constraints on biodegradation such as a reduction in or loss of primary substrate, or microbial suppression also can play a role in the accumulation of intermediate compounds. This is a particular concern with VC because it is a known human carcinogen (Agency for Toxic Substances and Disease Registry, 2005) and its accumulation may create a health issue that might not be a concern during the early stages of ground-water contaminated by TCE.

Degradation of the Chlorinated Alkanes

The degradation of chlorinated VOCs is fundamentally different from that of BTEX compounds (Wiedemeier and others, 1995). The chlorinated alkanes can be degraded by abiotic processes through hydrolysis or dehydrohalogenation or by biotic processes through reductive dechlorination or dichloroelimination. These degradation processes can proceed under either aerobic or anaerobic conditions (figs. 3–6; Vogel and McCarty, 1987a; Vogel, 1994). According to McCarty (1997), 111-TCA is the only chlorinated compound that can be degraded in ground water within 20 years under all likely ground-water or aquifer conditions.

Abiotic Transformation

Hydrolysis and dehydrohalogenation are two abiotic processes that may degrade chlorinated ethanes under either aerobic or anaerobic conditions. The tendency for a chlorinated ethane to degrade by hydrolysis depends on the ratio of chlorine to carbon atoms (fig. 2) or the location of chlorine atoms on the number 2 carbon in the compound. Chlorinated alkanes are more easily hydrolyzed when the chlorine-carbon ratio is less than two or when chlorine atoms are only located on the number 1 carbon atom (Vogel and McCarty, 1987b; Vogel, 1994). For example, chloroethane and 111-TCA have half-lifes that are measured in days or months (Vogel and others, 1987; Vogel, 1994; table 14). Conversely, the more chlorinated ethanes such as 1,1,1,2-tetrachloroethane (PCA) and those with chlorine atoms on the number 2 carbon tend to have half-lifes measured in decades or centuries (table 14). Dehydrohalogenation is the removal of one or two halogen atoms from an alkane (Vogel and McCarty, 1987a). The dehydrohalogenation of two chlorine atoms is called dichloroelimination.

Chen and others (1996) show that PCA can be abiotically transformed to TCE under methanogenic conditions (fig. 3). In addition, the abiotic degradation of 111-TCA has been well studied in the scientific literature (fig. 4; Jeffers and others, 1989; McCarty and Reinhard, 1993; Chen and others, 1996; McCarty, 1997). McCarty and Reinhard (1993) indicate that the transformation of 111-TCA by hydrolysis is about four times faster than by dehydrochlorination. During abiotic degradation, about 80 percent of 111-TCA is transformed to acetic acid by hydrolysis (McCarty, 1997), and the remaining 20 percent is transformed to 11-DCE by dehydrochlorination (table 7; Vogel and McCarty, 1987b; McCarty, 1997). The presence of 11-DCE in contaminated ground water is probably the result of the dehydrochlorination of 111-TCA (McCarty, 1997).

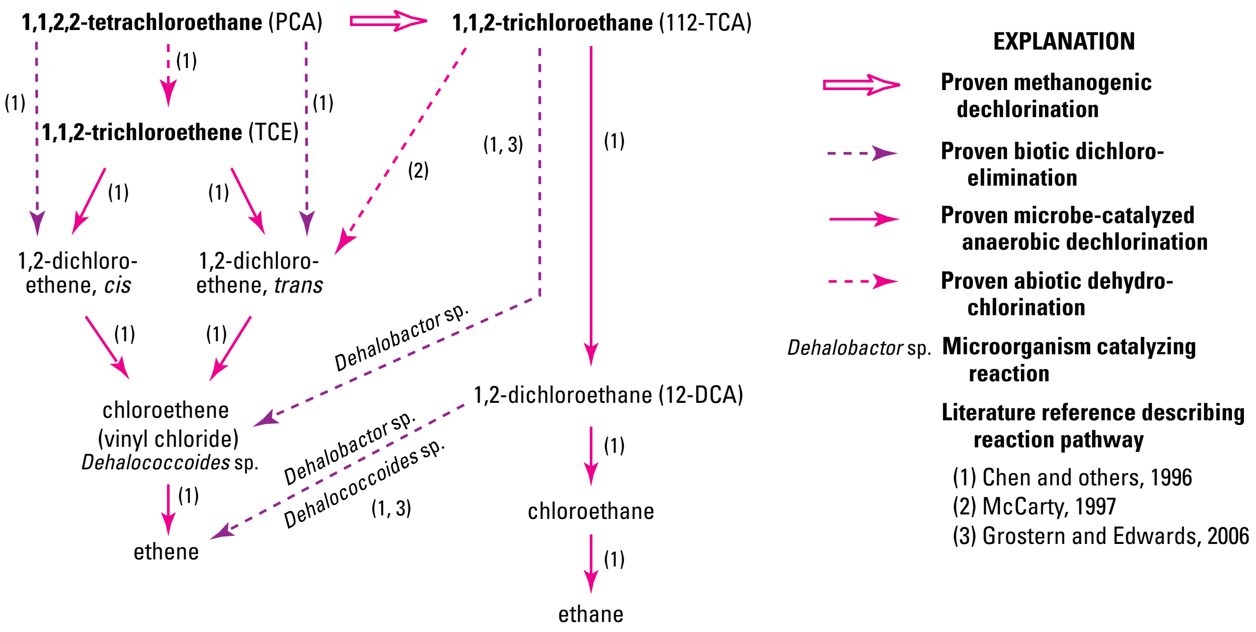

Figure 3. Laboratory-derived pathway for the abiotic degradation, anaerobic, and methanogenic biodegradation of 1,1,2,2-tetrachloroethane; 1,1,2-trichloroethene; and 1,1,2-trichloroethane (modified from Chen and others, 1996).

Table 14. Laboratory half-lifes and by-products of the abiotic degradation (hydrolysis or dehydrohalogenation) of chlorinated alkane compounds detected in ground water.

[IUPAC, International Union of Pure and Applied Chemistry; —, not applicable]

Compound (IUPAC name)[1]	Degradation by-products	Half-life	Literature reference
chloroethane	ethanol	44 days	Vogel and others, 1987
1,1-dichloroethane	—	61 years	Jeffers and others, 1989
1,2-dichloroethane	—	72 years	Jeffers and others, 1989
1,1,1-trichloroethane	acetic acid; 1,1-dichloroethane	1.1–2.5 years	Mabey and Mill, 1978; Jeffers and others, 1989; Vogel and McCarty, 1987a,b
1,1,2-trichloroethane	1,1-dichloroethane	140 years	Jeffers and others, 1989
1,1,1,2-tetrachloroethane	trichloroethene	47–380 years	Mabey and Mill, 1978; Jeffers and others, 1989
1,1,2,2-tetrachloroethane	1,1,2-trichloroethane; trichloroethene	146–292 days	Mabey and Mill, 1978; Jeffers and others, 1989

[1] International Union of Pure and Applied Chemistry, 2006

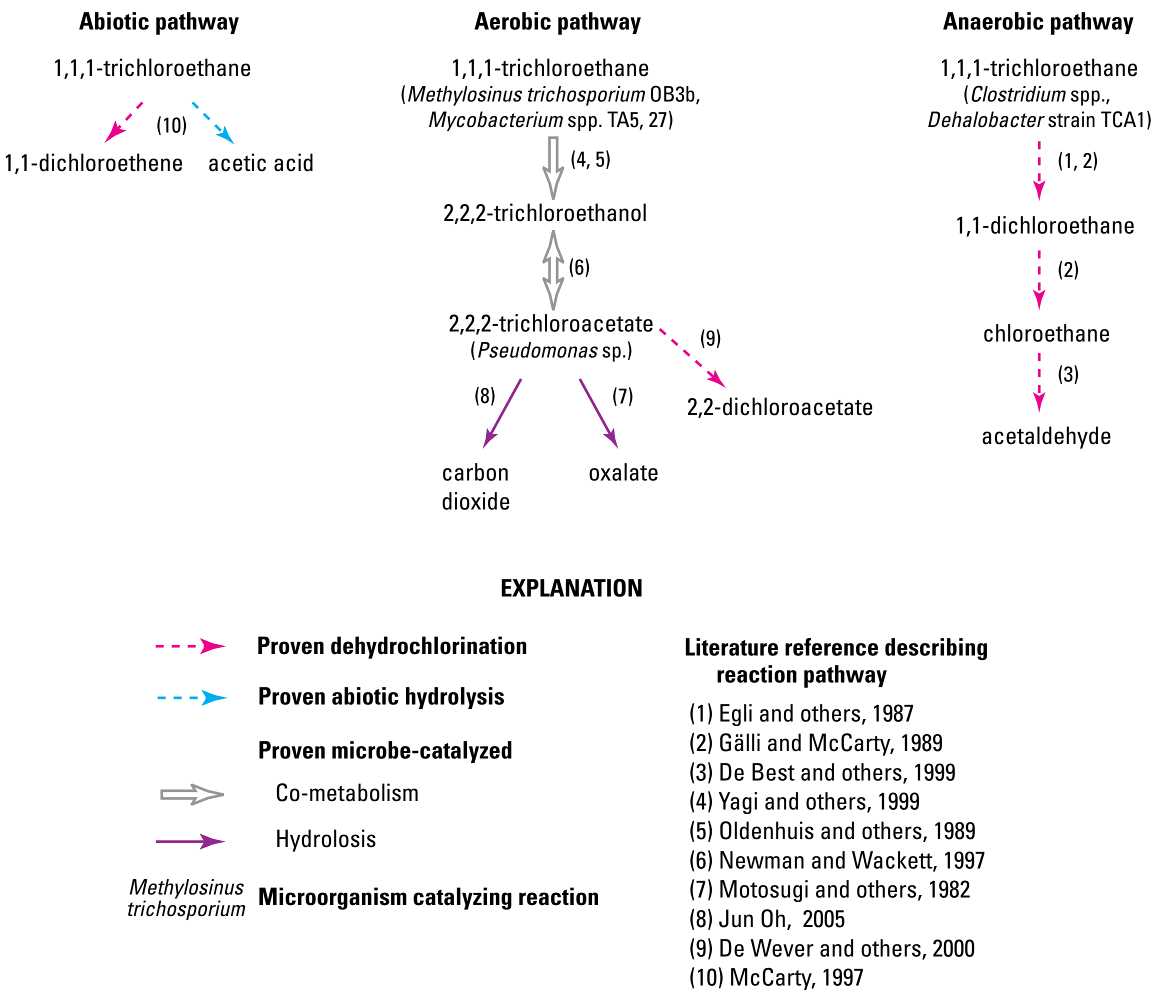

Figure 4. Laboratory-derived pathway for the abiotic, aerobic, and anaerobic biodegradation of 1,1,1-trichloroethane (modified from Sands and others, 2005; Whittaker and others, 2005).

Aerobic Biodegradation

According to the degradation pathway constructed by Sands and others (2005) and Whittaker and others (2005), the dichloroethanes are not a by-product of 111-TCA or 112-TCA biodegradation under aerobic conditions (fig. 4). Apparently, the only source of 11-DCA and 12-DCA via a degradation pathway is the reductive dechlorination of 111-TCA and 112-TCA, respectively, under anaerobic conditions (figs. 3 and 4). Under aerobic conditions, however, 12-DCA can be degraded when used as a carbon source by microorganisms. The intermediate by-product of this degradation is chloroethanol, which is then mineralized to carbon dioxide and water (fig. 5; Stucki and others, 1983; Janssen and others, 1985; Kim and others, 2000; Hage and others, 2001).

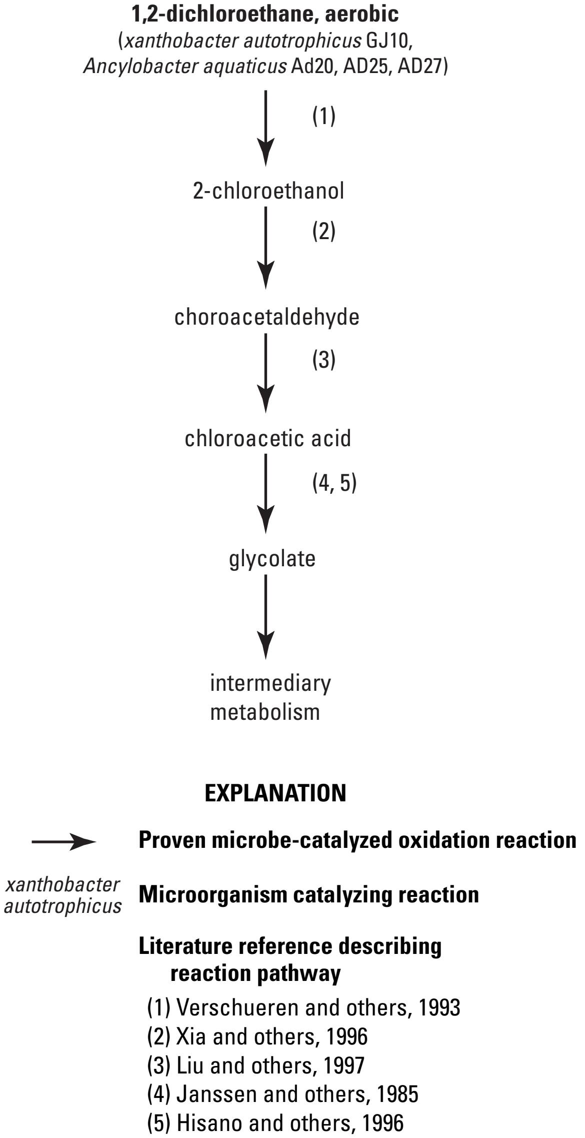

Figure 5. Laboratory-derived pathway for the aerobic biodegradation of 1,2-dichloroethane (modified from Renhao, 2005).

Anaerobic Biodegradation

While researching the scientific literature for their report, Wiedemeier and others (1998) did not find published studies describing anaerobic biodegradation of chlorinated ethanes in ground water. Since the publication of Wiedemeier and others (1998), however, numerous published studies describe the anaerobic biodegradation of chlorinated ethanes. McCarty (1997) indicates that carbon tetrachloride was transformed to chloroform under denitrifying conditions and mineralized to carbon dioxide and water under sulfate-reducing conditions (fig. 6). Adamson and Parkin (1999) show that under anaerobic conditions, carbon tetrachloride and 111-TCA tend to inhibit the degradation of each other. Adamson and Parkin (1999) also show that carbon tetrachloride was rapidly degraded by co-metabolism when acetate was the carbon source.

Chen and others (1996) describe how methanogenic conditions in a municipal sludge digester allowed the degradation of PCA to 112-TCA, and 112-TCA to 12-DCA through dehydrohalogenation (fig. 3). De Best and others (1999) report that co-metabolic transformations of 112-TCA will occur under methanogenic conditions. In this study, 112-TCA was degraded tochloroethane when sufficient amounts of the carbon source were present (fig. 3). This transformation was inhibited by the presence of nitrate, but not nitrite.

Dolfing (2000) discusses the thermodynamics of reductive dechlorination during the degradation of chlorinated hydrocarbons and suggests that fermentation of chloroethanes to ethane or acetate may be energetically more favorable than "classic" dechlorination reactions. Moreover, polychlorinated ethanes may degrade preferentially by reductive dechlorination under strongly reducing conditions. Dichloroelimination, however, may actually be the dominant degradation reaction for polychlorinated ethanes because more energy is available to microorganisms than is available during reductive dechlorination (Dolfing, 2000). During anaerobic biodegradation, the mean half-lifes of the chloroethane compounds can be as short as three days, in the case of 111-TCA, or as long as 165 days, in the case of 12-DCA (table 15).

Table 15. Mean half-life in days for the anaerobic biodegradation of selected chlorinated alkane and alkene compounds.[1]

[(27), number of samples used to derive the mean value; —, not available)

Compound	All studies	Field/in situ studies
chloroethene	0.018 (27)	0.0073 (19)
1,2-dichloroethane	63-165 (2)	63–165 (2)
tetrachloroethene (PCE)	239–3,246 (36)	239 (16)
tetrachloromethane	47 (19)	40 (15)
1,1,1-trichloroethane	2.3–2.9 (28)	—
1,1,2-trichloroethane	47–139 (1)	—
trichloroethene (TCE)	1,210 (78)	277 (30)

[1] Aronson and Howard, 1997, p. 111

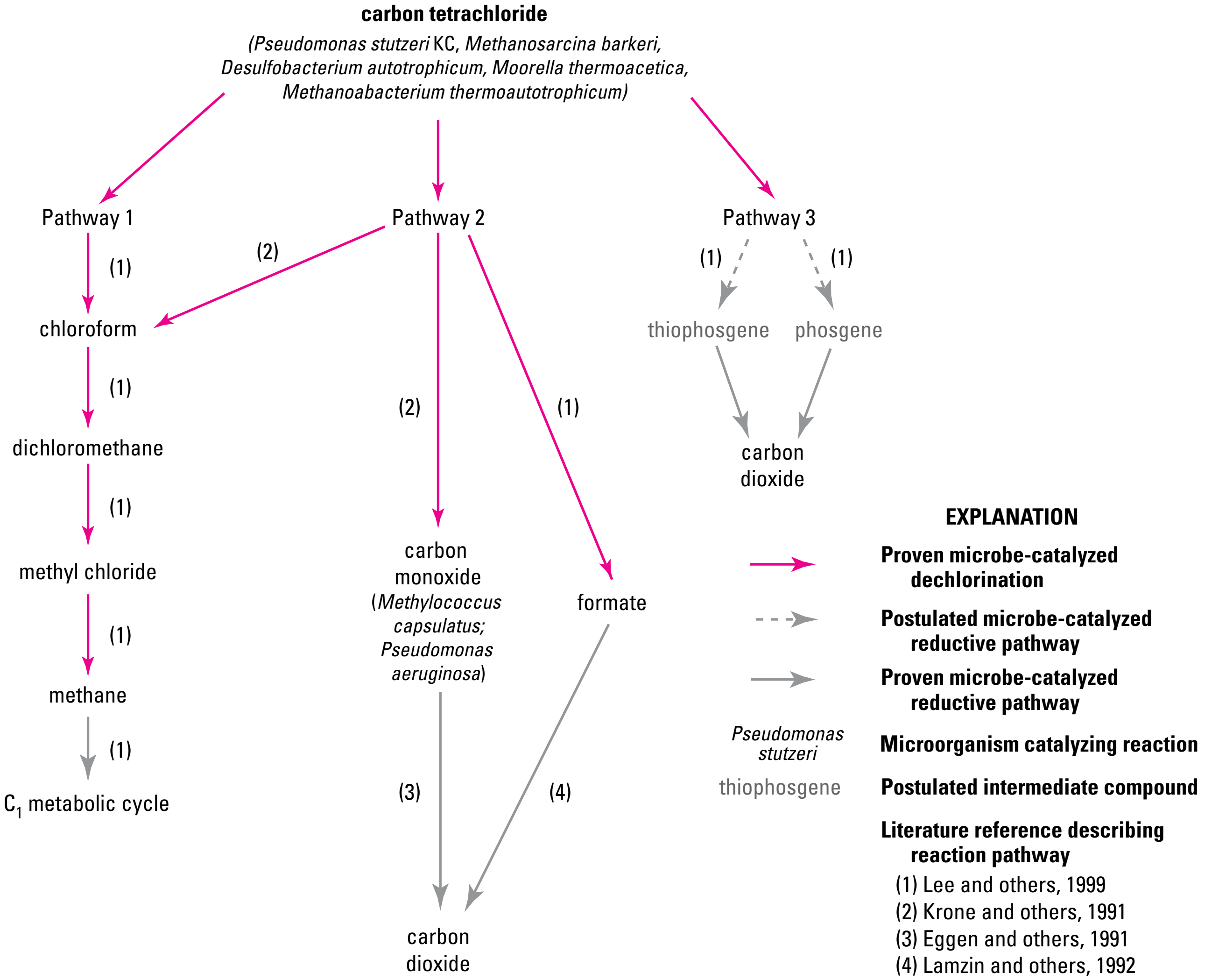

Figure 6. Laboratory-derived pathways for the anaerobic biodegradation of tetrachloromethane (carbon tetrachloride; modified from Ma and others, 2005; Sands and others, 2005).

Degradation of the Chlorinated Alkenes

The primary degradation of the most common chlorinated alkenes is microbial reductive dechlorination under anaerobic conditions. However, biodegradation of certain chlorinated compounds—such as trichloroethene, the dichloroethenes, vinyl chloride, or chloroethane—can also proceed via oxidative pathways under aerobic conditions. Two forms (isomers) of dichloroethene occur in ground water as chemical by-products of PCE and TCE biodegradation (Wiedemeier and others, 1998; Olaniran and others, 2004). Abiotic degradation of PCA to TCE can occur in PCA-contaminated ground water (fig. 3; Chen and others, 1996).

Aerobic Biodegradation

Several studies have shown that chlorinated ethenes, with the exception of PCE, can degrade under aerobic conditions by oxidation (Hartmans and De Bont, 1992; Klier and others, 1999; Hopkins and McCarty, 1995; Coleman and others, 2002) and by co-metabolic processes (Murray and Richardson, 1993; Vogel, 1994; McCarty and Semprini, 1994). Studies describing the degradation of PCE under aerobic conditions were not found in the peer-reviewed literature. In one study, aerobic biodegradation of PCE was not measurable beyond analytical precision after 700 days of incubation (Roberts and others, 1986). Furthermore, Aronson and others (1999) indicate that

PCE is not degraded when dissolved oxygen (DO) is greater than 1.5 mg/L, the approximate boundary between aerobic and anaerobic conditions (Stumm and Morgan, 1996). Chen and others (1996) suggest the structure and oxidative state of PCE prevents its aerobic degradation in water.

According to the aerobic biodegradation pathway constructed by Whittaker and others (2005), the dichloroethenes are not a by-product of TCE degradation under aerobic conditions (fig. 4). Rather, TCE is degraded along three different pathways by different microorganisms (fig. 7). These pathways do not form any of the dichlorothene compounds and the only apparent source of 12-DCE is by the reductive dechlorination of TCE under anaerobic conditions (figs. 3 and 8). The compounds 12-DCE and VC, however, can be degraded under aerobic conditions by microorganisms utilizing the compounds as a primary carbon source (fig. 5; Bradley and Chapelle, 1998).

Although PCE is not known to degrade through co-metabolism under aerobic conditions, co-metabolism is known to degrade TCE, the dichloroethenes, and VC. The rate of co-metabolism increases as the degree of chlorination decreases on the ethene molecule (Vogel, 1994). During aerobic co-metabolism, the chlorinated alkene is indirectly dechlorinated by oxygenase enzymes produced when microorganisms use other compounds, such as BTEX compounds, as a carbon source (Wiedemeier and others, 1998). The co-metabolic degradation of TCE, however, tends to be limited to low concentrations of TCE because high concentrations in the milligram per liter range are toxic to microbes catalyzing this reaction (Wiedemeier and others, 1998). In field studies by Hopkins and McCarty (1995), VC is shown to degrade by co-metabolism under aerobic conditions when phenol and toluene were used as a carbon source.

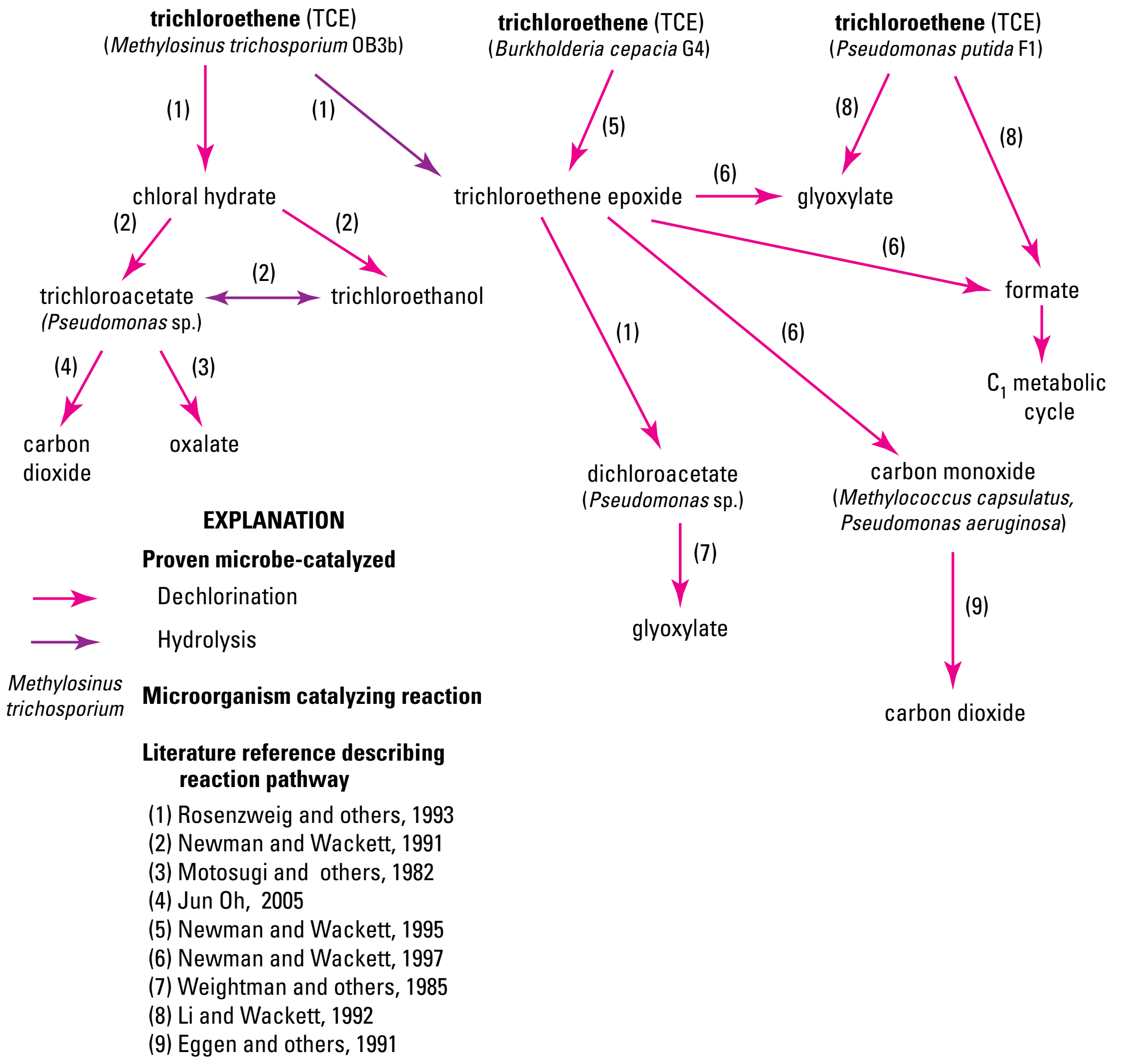

Figure 7. Laboratory-derived pathways for the aerobic biodegradation of trichloroethene (modified from Whittaker and others, 2005).

Anaerobic Biodegradation

Many laboratory and field studies have shown that microorganisms degrade chlorinated ethenes under anaerobic conditions (Bouwer and others, 1981; Bouwer, 1994, Dolfing, 2000). Ground water is considered anoxic when the dissolved oxygen concentration falls below 1.0–1.5 mg/L (Stumm and Morgan, 1996; Christensen and others, 2000). Under anoxic conditions, anaerobic or facultative microbes will use nitrate as an electron acceptor, followed by iron (III), then sulfate, and finally carbon dioxide (methanogenesis; Chapelle and others, 1995; Wiedemeier and others (1998). As the concentration of each electron acceptor sequentially decreases, the redox potential of the ground water becomes greater (more negative) and biodegradation by reductive dechlorination is favored.

Anaerobic conditions in ground water can be determined by measuring the vertical and spatial concentrations of oxygen, iron (II), manganese (II), hydrogen sulfide, or methane in ground water and using that data as a qualitative guide to the redox status (Stumm and Morgan, 1996; Christensen and others, 2000). Other measurements of anaerobic conditions involving microorganism biomarkers include volatile fatty acids, ester-linked phospholipid fatty acid (PLFA), deoxyribonucleic acid (DNA), and ribonucleic acid (RNA) probes, and TEAP bioassay (Christensen and others, 2000). The reduction of iron (III) to iron (II), manganese (IV) to manganese (II), sulfate to hydrogen sulfide, and carbon dioxide to methane during the microbial reduction of chlorinated VOCs can have a major influence on the distribution of iron (II), manganese (II), hydrogen sulfide, and methane concentrations in ground water (Stumm and Morgan, 1996; Lovley, 1991; Higgo and others, 1996; Braun, 2004).

The highly chlorinated alkenes are commonly used as electron acceptors during anaerobic biodegradation and are reduced in the process (Vogel and others, 1987). The primary anaerobic process driving degradation of CVOCs, except VC, is reductive dechlorination (figs. 3 and 8; Bouwer and others, 1981; Bouwer, 1994). Tetrachloroethene and TCE are the most susceptible to reductive dechlorination because they are the most oxidized of the chlorinated ethenes; however, the more reduced (least oxidized) degradation by-products such as the dichloroethenes and vinyl chloride are less prone to reductive dechlorination. The main by-product of anaerobic biodegradation of the polychlorinated ethenes is VC (fig. 8), which is more toxic than any of the parent compounds (Agency for Toxic Substances and Disease Registry, 2004). The rate of reductive dechlorination tends to decrease as the reductive dechlorination of daughter products proceeds (Vogel and McCarty, 1985; Bouwer, 1994). Murray and Richardson (1993) suggest that the inverse relation between the degree of chlorination and the rate of reductive dechlorination may explain the accumulation of 12-DCE and VC in anoxic ground water contaminated with PCE and TCE. In addition, the anaerobic reduction of VC to ethene is slow and inefficient under weak reducing conditions, which favors the persistence of VC in anoxic ground water (Freedman and Gossett, 1989).

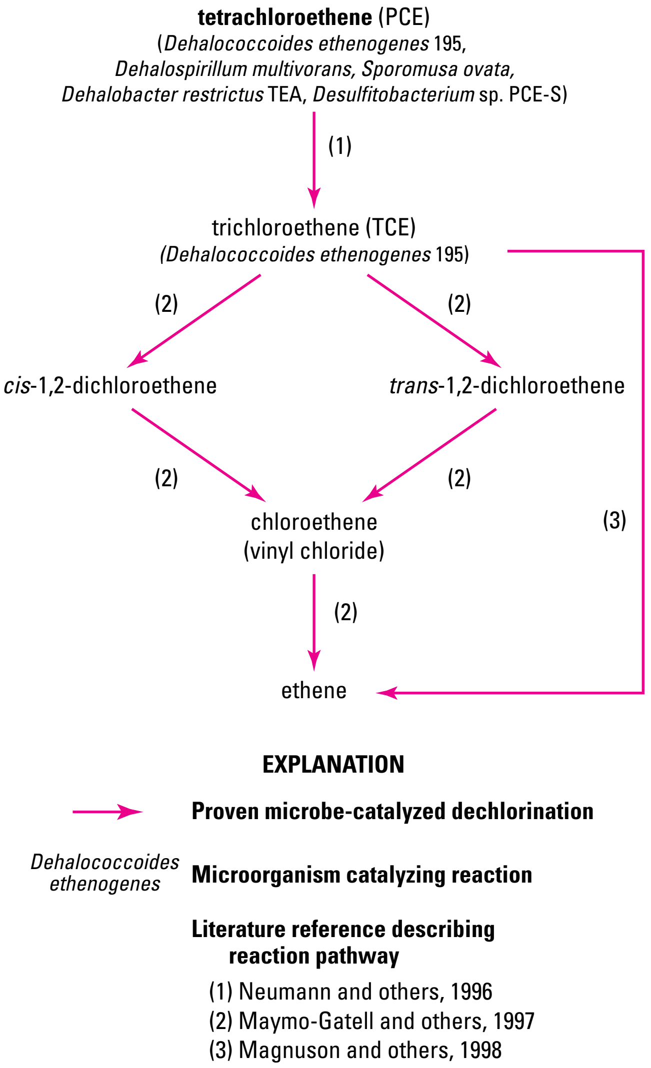

Figure 8. Laboratory-derived pathway for the anaerobic biodegradation of tetrachloroethene (modified from Ellis and Anderson, 2005).

Reductive dechlorination has been demonstrated under nitrate- and iron-reducing conditions (Wiedemeier and others, 1998). Reductive dechlorination of the CVOCs, however, may be more rapid and more efficient when oxidation-reduction (redox) conditions are below nitrate-reducing levels (Azadpour-Keeley and others, 1999). Sulfate-reducing and methanogenic ground-water conditions create an environment that facilitates not only biodegradation for the greatest number of CVOCs, but also more rapid biodegradation rates (Bouwer, 1994). Reductive dechlorination of DCE and VC is most apparent under sulfate reducing and methanogenic conditions (Wiedemeier and others, 1998). Anaerobic biodegradation rates for the chlorinated alkenes can be as short as 45 minutes, in the case of VC, to as long as 9 years for PCE (table 15).

Degradation of the Chlorinated Benzenes

Several studies have shown that chlorinated benzene compounds containing up to four chlorine atoms can be degraded by microorganisms under aerobic conditions (Reineke and Knackmuss, 1984; Spain and Nishino, 1987; Sander and others, 1991). Under aerobic conditions, 1,2,4-trichlorobenzene (124-TCB; Haigler and others, 1988) and chlorobenzene (CB; Sander and others, 1991) are used as a primary carbon source during biodegradation by microorganisms such as *Burkholdia* and *Rhodococcus* species (Rapp and Gabriel-Jürgens, 2003). During biodegradation, these compounds are completely mineralized to carbon dioxide (CO_2) (van de Meer and others, 1991). Rapp and Gabriel-Jürgens (2003) also indicate that all of the dichlorobenzene isomers were biodegraded by the *Rhodococcus* bacterium. The biodegradation pathways for 124-TCB, 14-DCB, 12-DCB, and CB, under aerobic conditions are shown in figures 9 to 11, respectively. These pathways are similar to that of benzene, except that one chlorine atom is eventually eliminated through hydroxylation of the chlorinated benzene to form a chlorocatechol, then ortho cleavage of the benzene ring (van der Meer and others, 1998).

Calculated and published degradation half-lifes for the chlorobenzenes under aerobic conditions are shown in table 16. The compounds 124-TCB, 12-DCB, and CB lose 50 percent of their initial mass within 180 days (table 16). Conversely, Dermietzel and Vieth (2002) show that chlorobenzene was rapidly mineralized to CO_2 in laboratory and in situ microcosm studies, with complete mineralization ranging from 8 hours to about 17 days. In addition, the compound 14-DCB was completely mineralized within 25 days. Nevertheless, under the aerobic conditions of Dermietzel and Vieth (2002) study, 124-TCB, 12-DCB, and 13-DCB were only partially degraded after 25 days. In another laboratory-microcosm study by Monferran and others (2005), all isomers of DCB were mineralized to CO_2 within 2 days by the aerobe *Acidovorax avenae*.

Although Wiedemeir and others (1998) indicate that few studies existed that described the anaerobic degradation of the chlorobenzene compounds, a study by Ramanand and others (1993) did suggest that 124-TCB could be biodegraded to chlorobenzene with 14-DCB as an intermediate compound under anaerobic conditions. Moreover, Middeldorp and others (1997) show that 124-TCB was reductively dechlorinated to 14-DCB, then to chlorobenzene in a methanogenic laboratory microcosm in which chlorobenzene-contaminated sediment was enriched with lactate, glucose, and ethanol. These compounds served as carbon sources. Furthermore, the microbial consortia facilitating the dechlorination of 124-TCB also was able to degrade isomers of tetrachlorobenzene to other isomers of TCB and 12-DCB. More recent studies show that a strain of the bacterium, *Dehalococcoides,* can reductively dechlorinate 124-TCB under anaerobic conditions (Holscher and others, 2003; Griebler and others, 2004a). In addition, Adrian and others (1998) suggest that fermentation is the primary degradation process for the chlorobenzenes under anaerobic conditions. This study also showed that the co-metabolism of 124-TCB was inhibited by the presence of sulfate, sulfite, and molybdate.

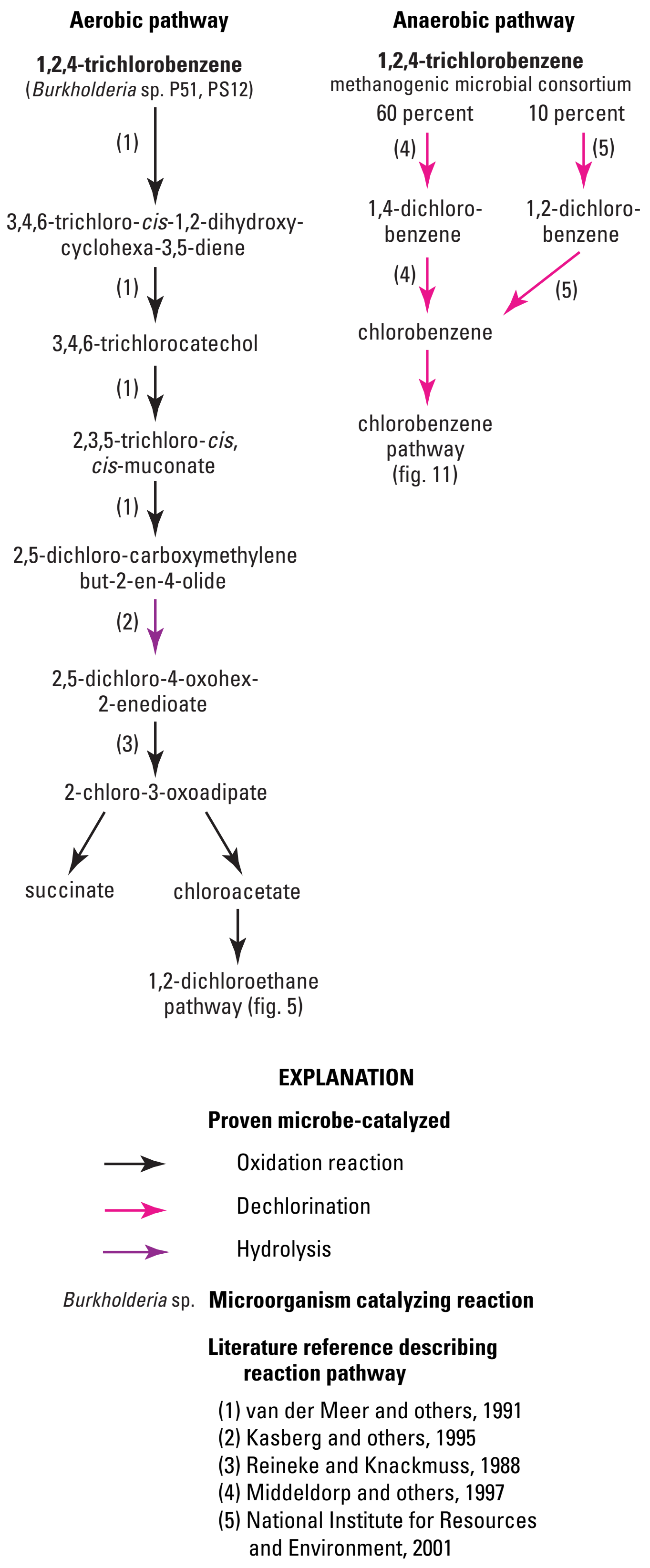

Figure 9. Laboratory-derived pathways for the aerobic and anaerobic biodegradation of 1,2,4-trichlorobenzene (modified from Yao, 2006).

Furthermore, Ramanand and others (1993) show that 124-TCB had declined by 63 percent within 30 days under anaerobic conditions. Dermietzel and Vieth (2002) show that the anaerobic biodegradation of 14-DCB was markedly slower under iron-reducing conditions than under aerobic conditions. In general, it appears that the biodegradation of the chlorinated benzenes is slower under anaerobic than under aerobic conditions.

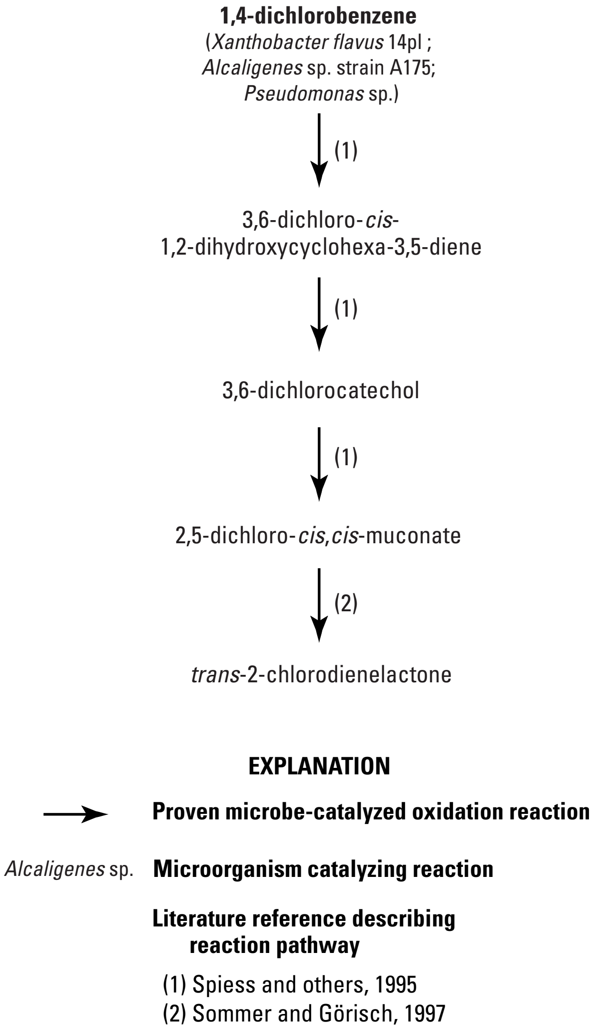

Figure 10. Laboratory-derived pathway for the aerobic biodegradation of 1,4-dichlorobenzene (modified from Liu, 2006).

Degradation of the Gasoline Compounds

Laboratory and field studies have shown that microorganisms mediate the degradation (biodegradation) of the common gasoline compounds (MTBE and BTEX) under both aerobic and anaerobic conditions. Aerobic microorganisms readily oxidize BTEX compounds while using them as primary substrates. The biodegradation of BTEX compounds under various redox conditions is well documented in the scientific literature (Vogel and Grbić-Galić, 1986; Kuhn and others, 1988; Lovley and Lonergan, 1990; Evans and others, 1991a,b; Hutchins and others, 1991; Rabus and others, 1993; Edwards and Grbić-Galić, 1994; Fries and others, 1994; Rabus and Widdel, 1995; Anderson and others, 1998).

Although early studies concluded that MTBE was recalcitrant to aerobic biodegradation (Squillace and others, 1997), more recent studies show that, once initiated, the aerobic biodegradation of MTBE is relatively rapid (Deeb and others, 2000), but markedly slower than BTEX degradation. In addition, the anaerobic biodegradation of MTBE is known to proceed, although slowly, under a variety of redox conditions. Until recently, however, little was known about specific pathways involved in the anaerobic degradation of MTBE.

Aerobic Biodegradation of BTEX Compounds

Laboratory and field studies show that microorganisms mediate the biodegradation of BTEX compounds under aerobic conditions (table 17; Aronson and others, 1999). The microbially catalyzed oxidation reaction between dissolved oxygen and BTEX is thermodynamically favored because BTEX compounds are in a highly reduced state and the preferred terminal electron acceptor (TEA) is oxygen (Brown and others, 1996). The microbially catalyzed oxidation of BTEX compounds requires 3.1 milligrams per liter (mg/L) of dissolved oxygen (DO) to 1 mg/L of a BTEX compound (Aronson and Howard, 1997). Some studies show that the rate of biodegradation tends to slow when DO concentrations are less than about 1–2 parts per million (ppm; equal to milligrams per liter, mg/L; Chiang and others, 1989; Salanitro, 1993). During laboratory studies in which the initial DO concentration was at least 8 mg/L, individual BTEX compounds or a BTEX mixture biodegraded rapidly to low concentrations until the DO concentration was less than 2 mg/L; At this threshold, biodegradation was rate limited, rather than substrate limited, because of the low DO concentration (Salanitro, 1993).

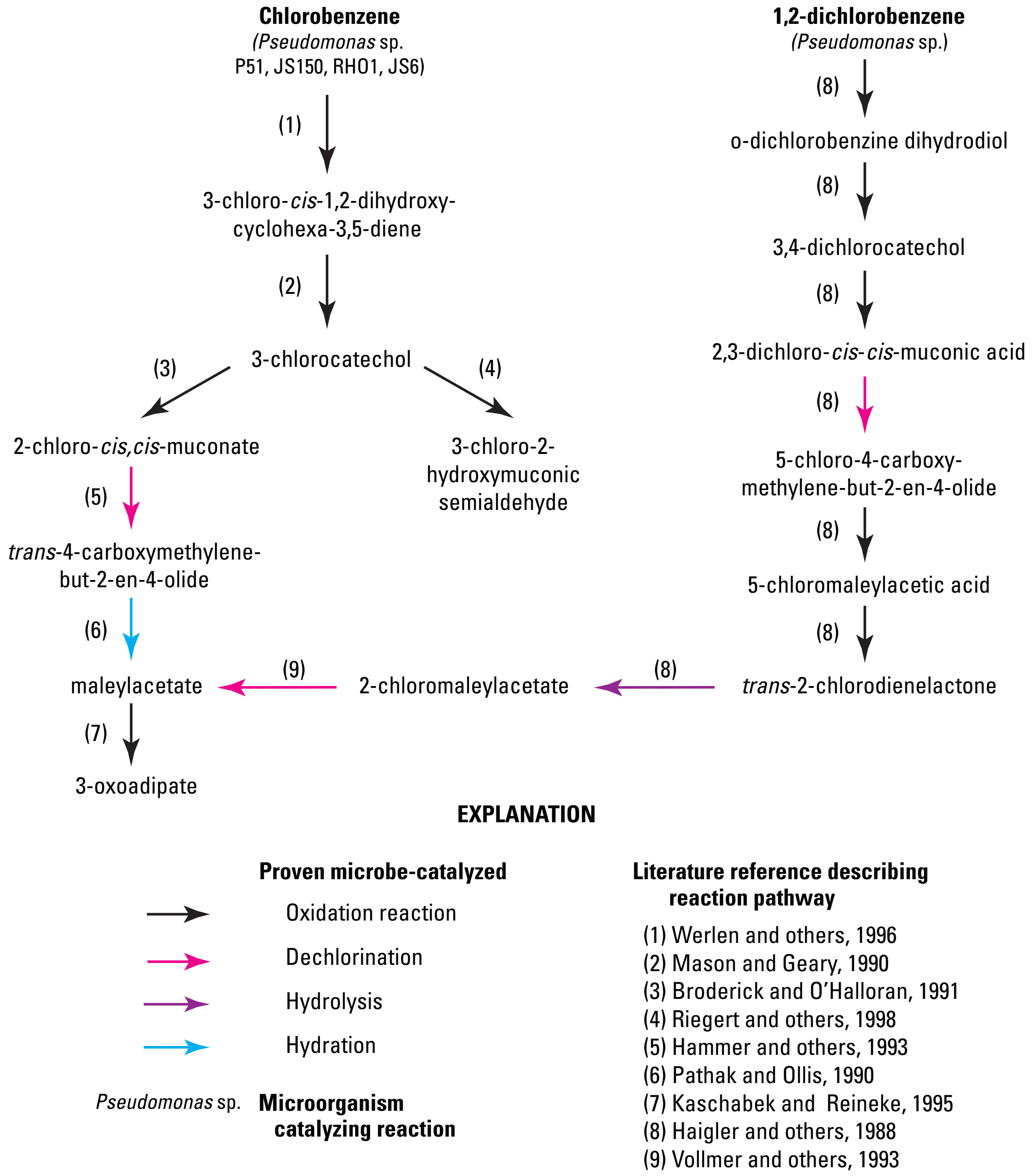

Figure 11. Laboratory-derived pathway for the aerobic biodegradation of chlorobenzene and 1,2-dichlorobenzene (modified from McLeish, 2005).

Aerobic microorganisms readily oxidize BTEX compounds while using them as primary substrates. The oxidation of BTEX compounds can proceed via several pathways (figs. 12–16). In one laboratory column study, methanol was added to a BTEX mixture to identify possible co-metabolic pathways. The methanol was not used as the primary substrate and appeared to depress the biodegradation of BTEX compounds (Hubbard and others, 1994). This study showed that BTEX degradation was not a result of co-metabolism. Benzene has been shown to degrade completely to carbon dioxide (mineralization; Gibson and others, 1968; Gibson and Subramanian, 1984; Edwards and Grbić-Galić, 1992). More recent laboratory experiments show that catechol is an intermediate compound in the benzene pathway (fig. 12). Five separate degradation pathways have been identified for toluene under aerobic conditions (fig. 13). One of these pathways shares a common intermediate compound (3-methylcatechol) with the degradation of *o*- and *m*-xylene (figs. 12 and 13). The pathway for *p*-xylene follows a similar pattern, but differs in the intermediate compounds formed. This difference is caused by the position of the methyl group on the benzene ring of *p*-xylene (fig. 14). The aerobic biodegradation of ethylbenzene follows three pathways depending on the microorganism using ethylbenzene as its carbon source (fig. 15). Based on laboratory and field microcosm studies, biodegradation of BTEX under aerobic conditions is more rapid in gasoline-contaminated aquifer sediments than in uncontaminated aquifer sediments (Aronson and others, 1999; table 17).

Table 16. Laboratory or environmental half-lifes and by-products for the aerobic and anaerobic biodegradation of selected chlorinated benzene compounds detected in ground water.

[IUPAC, International Union of Pure and Applied Chemistry; CO_2, carbon dioxide; DCB, dichlorobenzene]

Compound (IUPAC name)[1]	Degradation by-products	Half-life (days)	Literature reference
	Aerobic conditions		
chlorobenzene	3-chlorocatechol, CO_2	69–150	Rathbun, 1998; McLeish, 2005
1,2-dichlorobenzene	chlorobenzene	28–180	Rathbun, 1998
1,4-dichlorobenzene	chlorobenzene	28–180	Rathbun, 1998
1,2,4-trichlorobenzene	succinate, chloroacetate	28–180	Rathbun, 1998; Renhao, 2005; Yao, 2006
	Anaerobic conditions		
chlorobenzene	CO_2	280–580	Rathbun, 1998; Monferran and others, 2005
1,2-dichlorobenzene	CO_2	119–722	Rathbun, 1998
1,4-dichlorobenzene	chlorobenzene	112–722	Rathbun, 1998; Yao, 2006
1,2,4-trichlorobenzene	1,4-DCB, chlorobenzene	112–722	Rathbun, 1998; Yao, 2006

[1] International Union of Pure and Applied Chemistry, 2006

A nationwide survey of VOCs in ground water showed that toluene, representing BTEX compounds, was detected more frequently in oxic rather than in anoxic ground water (Squillace and Moran, 2006). In other studies, the loss of BTEX compounds along ground-water flowpaths was inversely related to dissolved-oxygen concentration, indicating that microbial activity (respiration) was related to BTEX degradation (Donaldson and others, 1990; Huesemann and Truex, 1996).

Morasch and others (2001, 2002), using stable isotope fractionation data, concluded that quantifying aerobic microbial degradation of BTEX in oxic environments may not be possible. Moreover, laboratory studies have shown that ethylbenzene can inhibit the microbial degradation of benzene, toluene, and the xylenes and does so until all of the ethylbenzene is degraded (Deeb and Alvarez-Cohen, 2000).

Anaerobic Biodegradation of BTEX Compounds

During anaerobic biodegradation, BTEX compounds are used metabolically as electron donors (carbon source, primary substrate) by select microbial populations to produce the energy for cell growth (Aronson and Howard, 1997). BTEX degradation can be limited by the availability of terminal electron acceptors such as nitrate, sulfate, carbon dioxide, or iron (III) in the aquifer (Lovley and others, 1989; Lovley and others, 1995). These electron acceptors, however, commonly exist in ground water at sufficient levels for these reactions to proceed (Lovley and Lonergan, 1990; Kuhn and others, 1988). Figure 16 shows the anaerobic biodegradation pathways for BTEX compounds.

Anaerobic biodegradation of benzene appears to be more aquifer specific than that for the other monoaromatic hydrocarbons. Current data indicates that biodegradation may not occur at all sites (Aronson and Howard, 1997). Some of these studies show that benzene resists anaerobic metabolism in the field (Reinhard and others, 1984; Barbaro and others, 1992) and in laboratory enrichments established with sewage sludge, aquifer sediments, and contaminated soils (Krumholz and others, 1996; Barbaro and others, 1992).

Conversely, several ground-water studies have shown that BTEX degradation rates decline in a sequence from mildly reducing conditions (nitrate reduction zone, Hutchins and others, 1991) to strongly reducing conditions (methanogenesis) in shallow aquifers (Kazumi and others, 1997; Lu and others, 1999; Roychoudhury and Merrett, 2005). Furthermore, other studies show that when conditions are favorable, benzene (and other BTEX compounds) can be oxidized to carbon dioxide under highly reducing conditions. For example, benzene was rapidly mineralized under sulfate-reducing conditions in marine and freshwater sediments, and in aquifer sediments (Lovley and Lonergan, 1990; Edwards and Grbić-Galić, 1992; Lovley and others, 1995; Phelps and others, 1996; Coates and others, 1996a,b; Weiner and Lovley, 1998).

The rate of anaerobic biodegradation of BTEX compounds was quickest under sulfate-reducing conditions in laboratory and field/in situ studies (Beller and others, 1992a,b; table 18). The anaerobic biodegradation of BTEX compounds in ground water was conclusively shown in situ by Griebler and others (2004b) using compound-specific isotope analysis and signature metabolites analysis. Figure 16 shows the anaerobic pathway for BTEX compounds developed from the intermediate compounds identified in ground-water samples by Griebler and others (2004b).

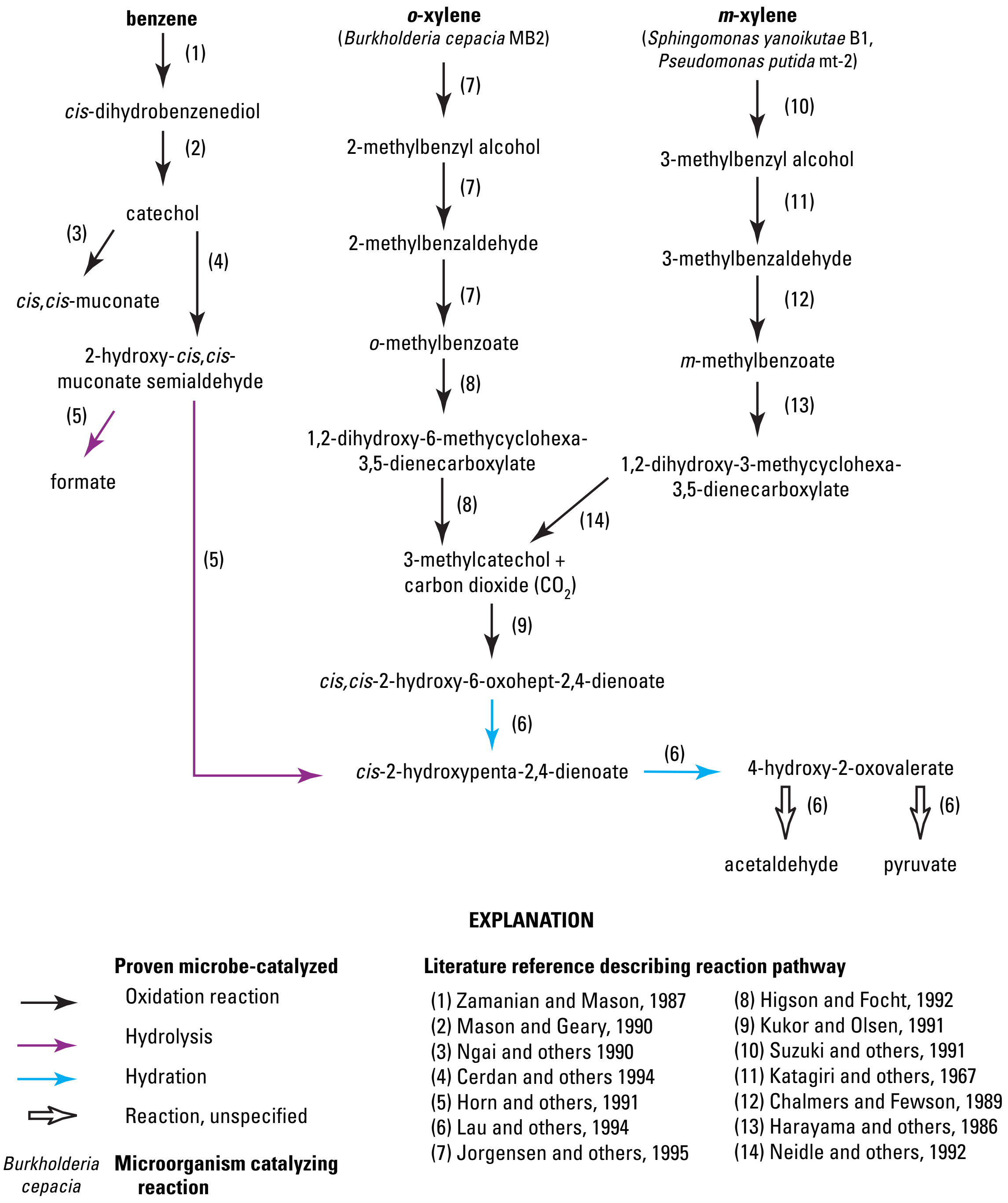

Figure 12. Laboratory-derived pathways for the aerobic biodegradation of benzene, *o*-, and *m*-xylene (modified from Hyatt and Jun Oh, 2005; Jun Oh, 2005).

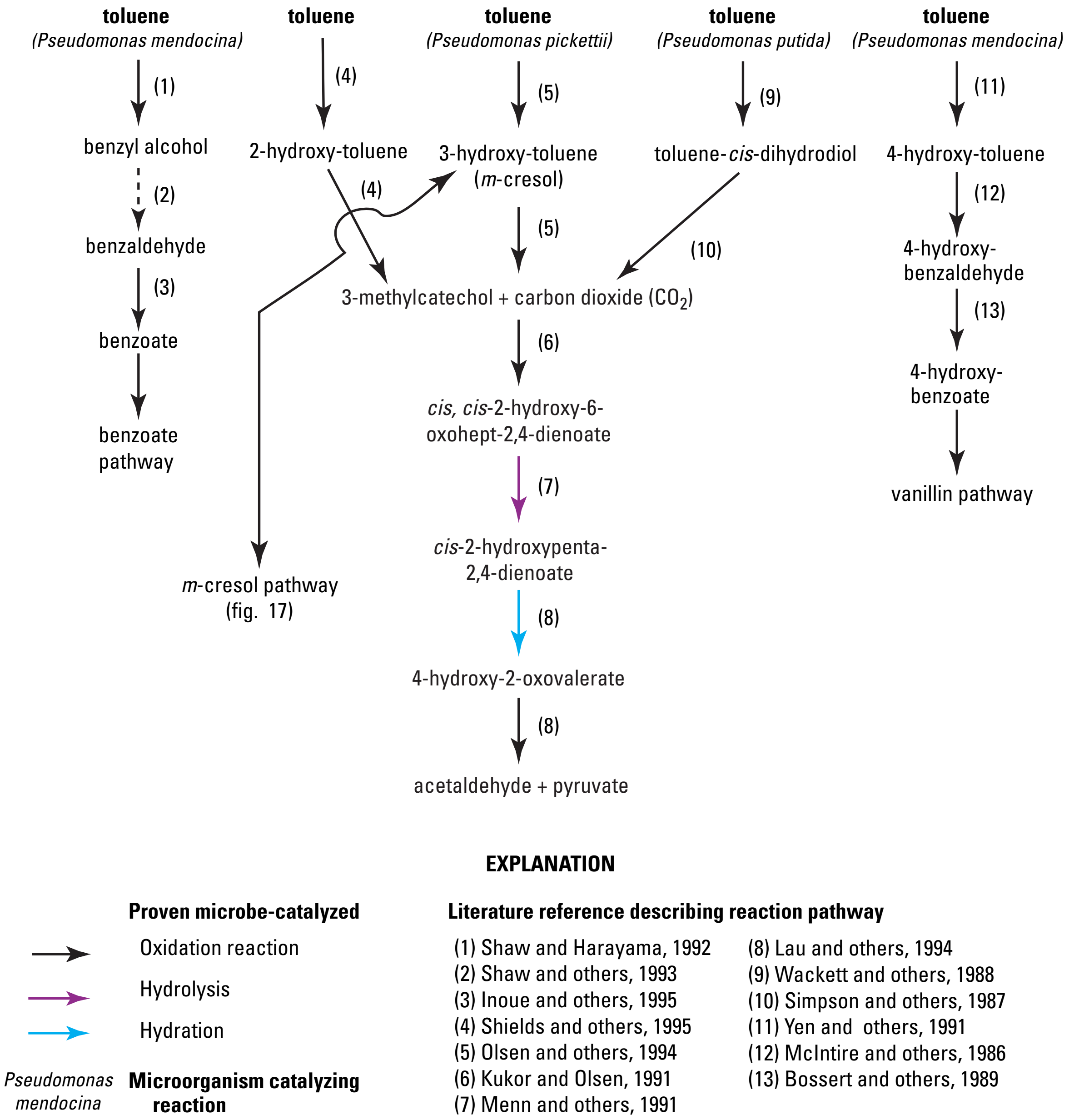

Figure 13. Laboratory-derived pathways for the aerobic biodegradation of toluene (modified from Wackett and Zeng, 2004).

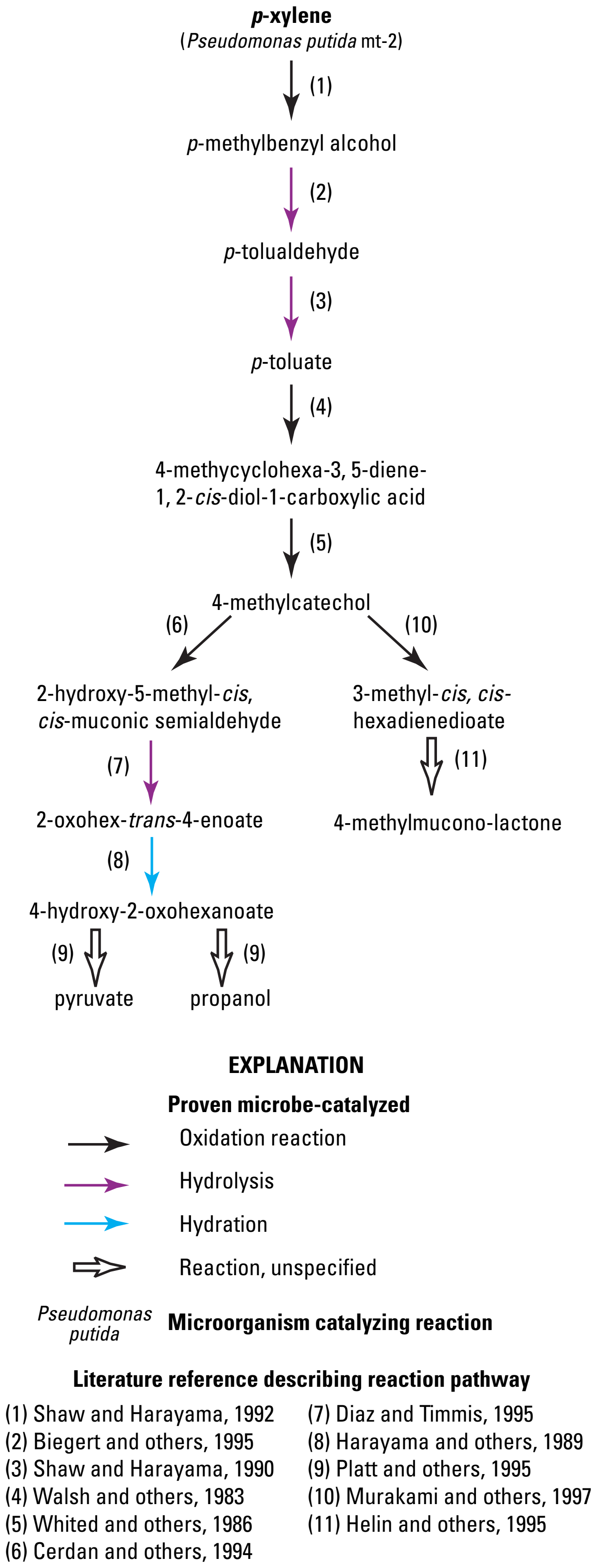

Figure 14. Laboratory-derived pathways for the aerobic biodegradation of *p*-xylene (modified from Mili and Stephens, 2006).

Aerobic Biodegradation of Methyl *Tert*-butyl Ether

The compound methyl *tert*-butyl ether contains ether bonds and branched hydrocarbon skeletons (*tert*-butyl branch) that are common to compounds that persist in the environment (Smith and others, 2003; Alexander, 1973). Although early studies concluded that MTBE was recalcitrant to biodegradation (Squillace and others, 1997), more recent studies show that, once initiated, the aerobic biodegradation of MTBE is relatively rapid (Deeb and others, 2000), but markedly slower than BTEX degradation (table 17). MTBE may appear to persist in contaminated ground water if ground-water studies are concluded too quickly, especially in areas where MTBE is a new contaminant. This time lag before degradation begins is the time it takes the microorganisms in the aquifer to adapt and begin to use MTBE as a carbon source (Drogos and Diaz, 2000; Wilson and others, 2000, 2005). Wilson and others (2005), using data from various studies, show that microorganisms capable of degrading MTBE take from 10 to 500 times longer to double their population than do those microbes that degrade BTEX compounds. Therefore, the capacity for the natural attenuation of MTBE depends on the age of the contamination and the presence of microorganisms capable of assimilating MTBE.

Although some studies concluded that MTBE degrades slowly in aerobic environments (Squillace and others, 1997), other more recent studies show that MTBE is easily degraded under the proper conditions. For example, in a laboratory study of lake and streambed sediments collected from 11 sites across the United States, MTBE completely degraded within 50 days (Bradley and others, 1999, 2001). A study by Landmeyer and others (2001) clearly shows that MTBE was recalcitrant under anaerobic conditions during 2 weeks of monitoring, but rapidly degraded when oxygen was added to a small, discrete flowpath in shallow ground water.

Although three different bacteria are able to aerobically degrade MTBE via two different pathways (fig. 17; Pedersen and Essenberg, 2005), the exact mechanisms driving MTBE degradation are not well known. *Tert*-butyl alcohol (TBA) is a commonly detected by-product of aerobic MTBE degradation (Steffan and others, 1997). Aerobic biodegradation rates for MTBE are difficult to find in the literature, but those that are published indicate that the rates are substantially slower than those for BTEX compounds (table 17). Some studies indicate that the degradation of MTBE may be inhibited by the presence of BTEX compounds (Deeb and Alvarez-Cohen, 2000); however, others indicate that BTEX compounds do not inhibit MTBE degradation (Aronson and others, 1999; Drogos and Diaz, 2000; Kane and others, 2001; Sedran and others, 2002).

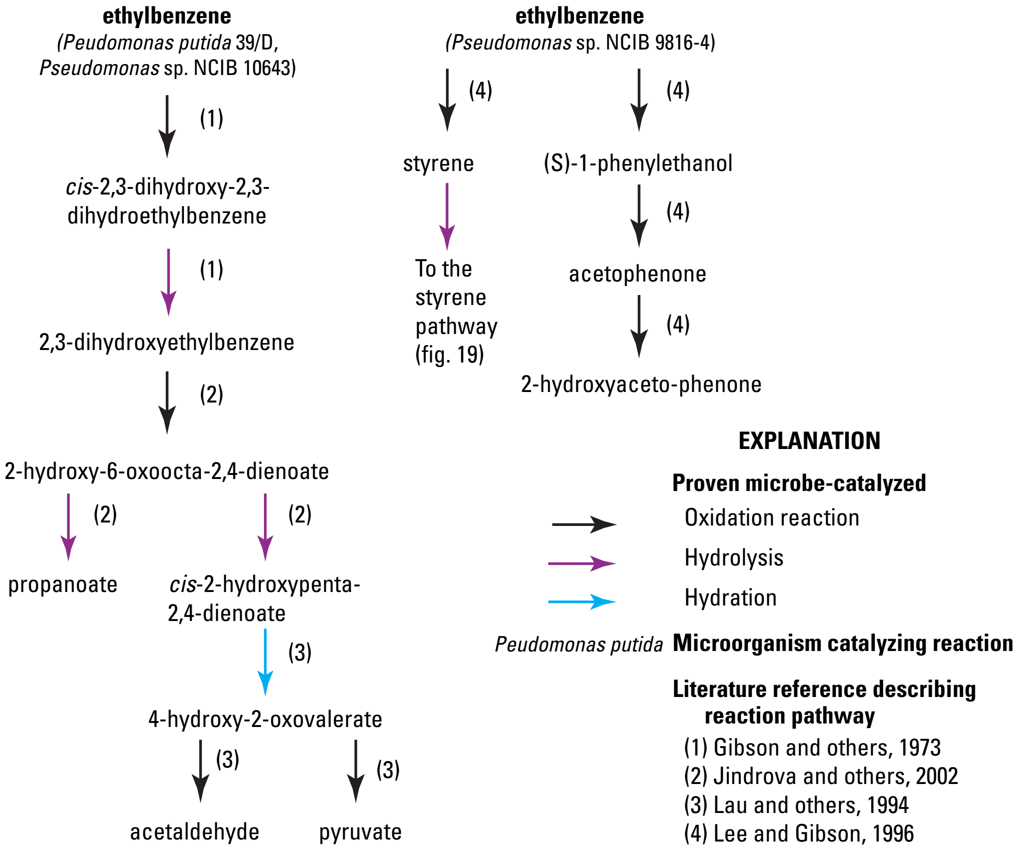

Figure 15. Laboratory-derived pathway for the aerobic biodegradation of ethylbenzene (modified from McLeish, 2005).

Anaerobic Biodegradation of Methyl *Tert*-butyl Ether

The anaerobic biodegradation of MTBE is known to proceed, although slowly, under methanogenic (Wilson and others, 2000; Wilson and others, 2005), sulfate-reducing (Somsamak and others, 2001), iron-reducing (Finneran and Lovley, 2001), and nitrate-reducing (Bradley and others, 2001) conditions. Little is presently known, however, about the pathway of MTBE biodegradation under any of these conditions, although it has been suggested that anaerobic biodegradation could be initiated by a hydrolytic mechanism (O'Reilly and others, 2001; Kuder and others, 2005).

In a six-state ground-water study, Kolhatkar and others (2000) observed the degradation of MTBE and TBA in anoxic zones near 76 gas stations. Using data from four of those sites, degradation rates were calculated for MTBE and TBA. These degradation rates ranged from 0.0011 to 0.0271 day^{-1} for MTBE and 0.0151 to 0.0351 day^{-1} for TBA. MTBE and TBA degradation were observed only at sites that were methanogenic (dissolved methane >0.5 mg/L). Furthermore, these sites were depleted in sulfate relative to background concentrations. Kolhatkar and others (2002) confirmed the anaerobic degradation of MTBE and TBA in anoxic ground water using stable carbon isotope analysis. This study also concludes that the anaerobic biodegradation rates of MTBE and TBA may exceed those estimated for aerobic biodegradation.

Table 17. Average half-life for the aerobic biodegradation of the fuel compounds BTEX and methyl *tert*-butyl ether to carbon dioxide in an uncontaminated and contaminated matrix of aquifer sediments and ground water.[1]

[—, no studies referenced; <, less than]

Compound	Median[1] primary degradation rate (day^{-1})	Average half-life in uncontaminated matrix (days)			Average half-life in contaminated matrix (days)		
		Field setting[2]	Laboratory column[3]	Laboratory microcosm	Field setting	Laboratory column[4]	In situ microcosm
benzene	0.096	238	1.5	408	[5]58	[3]1−2.3	[6,10]3−31
toluene	.20	[8]135−238	4–7	[8,9]40−60	[7]5	2.3	[6]4.5−7
ethylbenzene	.113	238	—	[9]60−139	—	2.3	[13,11]11
m-, *p*-xylene	.054	238	—	[8,9]31−60	—	.350	[12,11]3.5−11
o-xylene	.054	238	1–4	[9]12−25	—	2.3	[6,10]14−83
methyl *tert*-butyl ether	[12].0039	—	—	—	—	—	[13]<365

[1] Aronson and others, 1999

[2] American Petroleum Institute, 1994

[3] Alvarez and others, 1998

[4] Anid and others, 1993

[5] Kemblowski and others, 1987

[6] Nielsen and others, 1996

[7] McCarty and others, 1998

[8] Barker and others, 1987

[9] Hubbard and others, 1994

[10] Holm and others, 1992

[11] Thomas and others, 1990

[12] Laboratory microcosm

[13] Fenner and others, 2000

Table 18. Mean half-life in days for the anaerobic biodegradation of the fuel compounds BTEX, and methyl *tert*-butyl ether, *tert*-butyl alcohol under various reducing conditions.[1]

[(46), number of samples used to derive the mean value; MTBE, methyl *tert*-butyl ether; TBA, *tert*-butyl alcohol; —, not available]

Environmental condition	Benzene	Toluene	Ethylbenzene	*o*-Xylene	*m*-Xylene	*p*-Xylene	MTBE	TBA
Field/in situ studies	210 (41)	12 (46)	46 (37)	33 (33)	43 (34)	46 (26)	—	—
Nitrate-reducing studies	97 (38)	13 (42)	104 (28)	108 (46)	113 (35)	108 (29)	—	—
Iron-reducing studies	140 (11)	516 (10)	1,828 (4)	1,822 (8)	1,822 (8)	1,822 (8)	—	—
Sulfate-reducing studies	50 (9)	61 (14)	197 (7)	109 (9)	141 (8)	198 (5)	—	—
Methanogenic studies	61 (16)	50 (24)	229 (8)	304 (14)	317 (10)	406 (7)	[2,3]30–7,302	[2,3]15–502

[1] Aronson and Howard, 1997, p. 16

[2] Kolhatkar and others, 2000

[3] Wilson and others, 2005

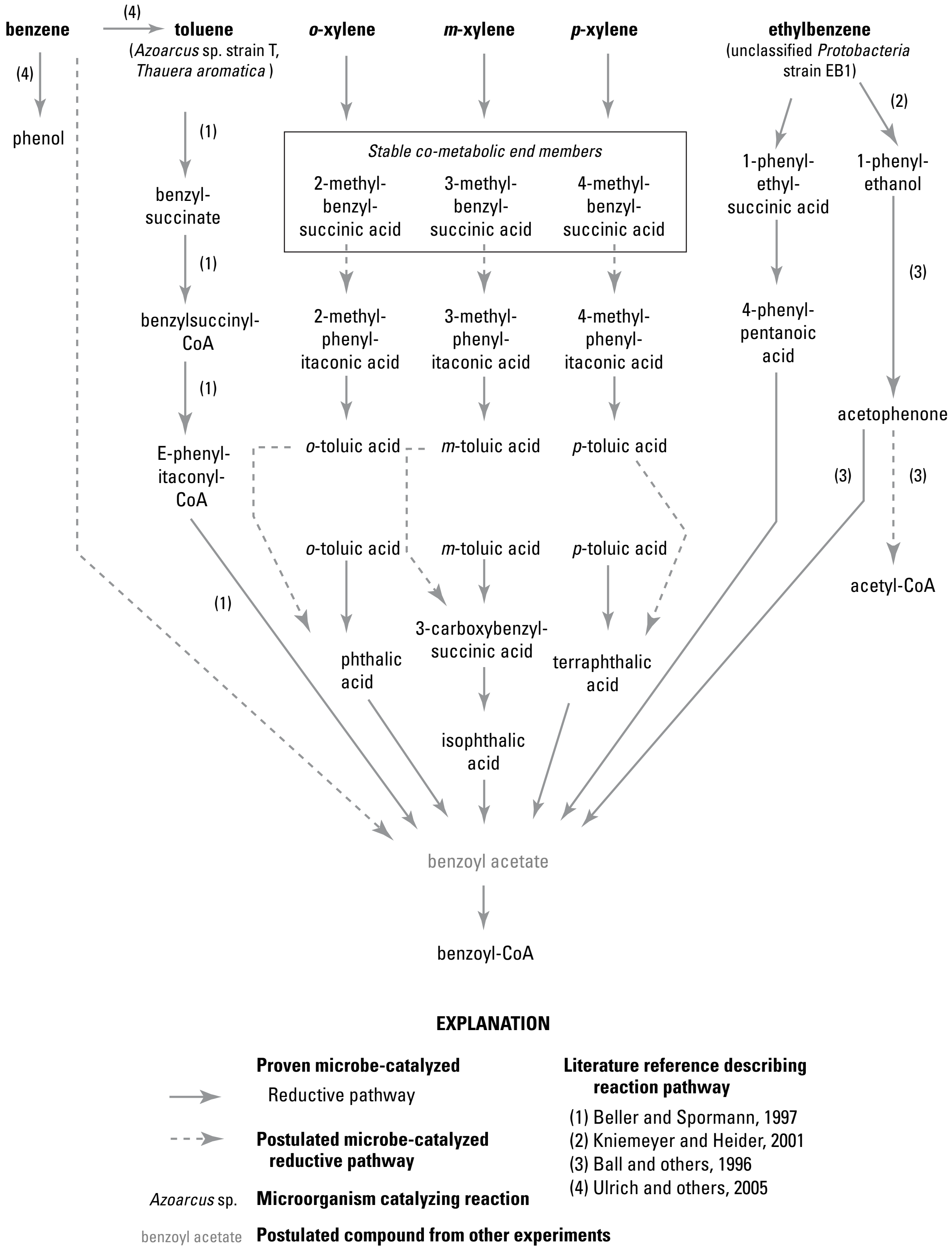

Figure 16. Field and laboratory-derived pathways for the anaerobic biodegradation of the BTEX compounds—benzene, toluene, ethylbenzene, and xylene (modified from Edwards and Grbić-Galić, 1994; and Griebler and others, 2004b).

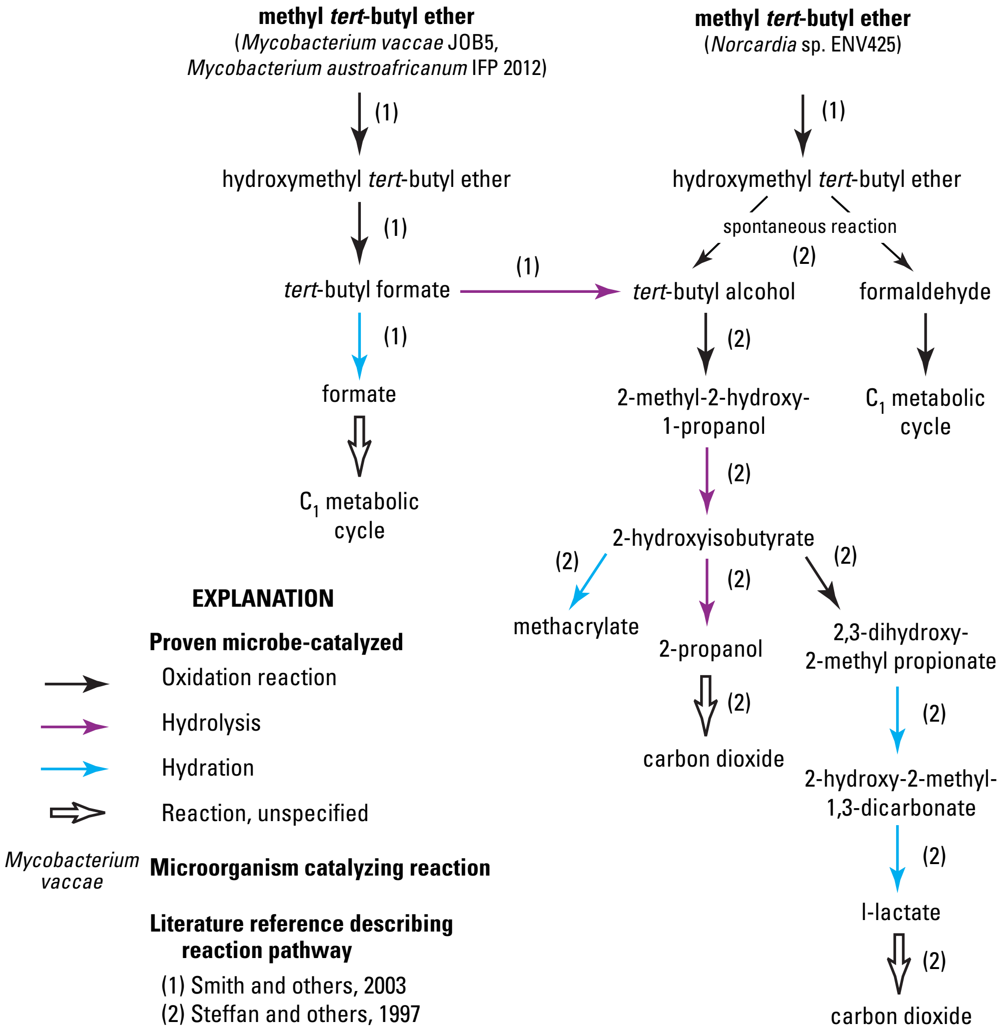

Figure 17. Laboratory-derived pathway for the aerobic biodegradation of methyl *tert*-butyl ether (modified from Pedersen and Essenberg, 2005).

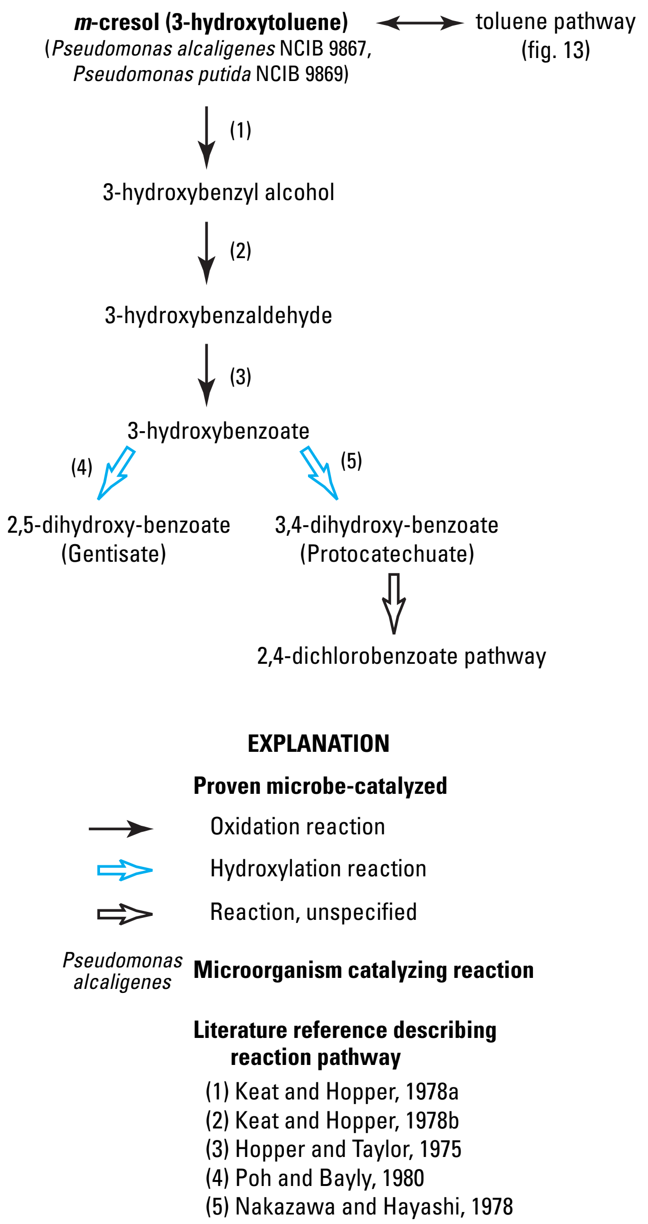

Figure 18. Laboratory-derived pathway for the aerobic biodegradation of *m*-cresol (modified from Sakai and others, 2005).

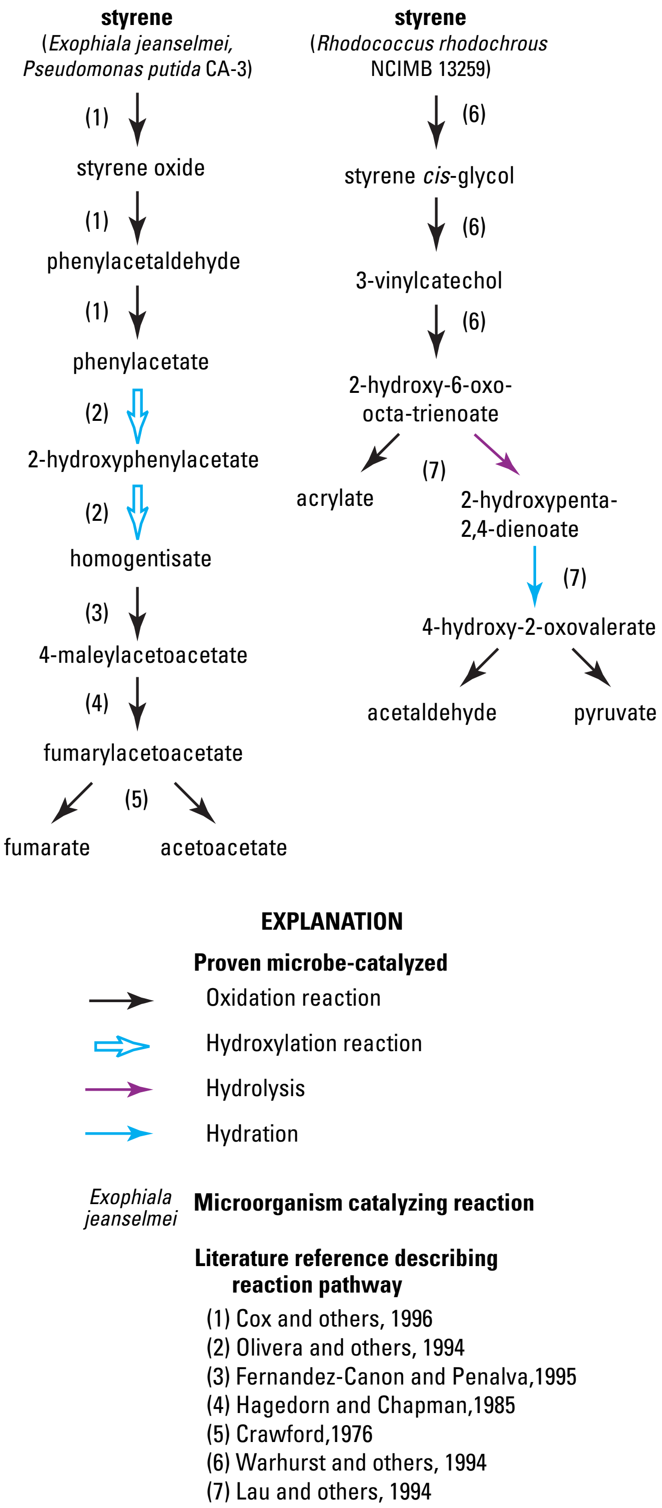

Figure 19. Laboratory-derived pathways for the aerobic biodegradation of styrene (modified from Kraus and others, 2005).

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Glossary

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A

abiotic Not associated with living organisms. Synonymous with abiological.[1]

abiotic transformation Process in which a substance in the environment is modified by nonbiological mechanisms.[1]

absorption The penetration of atoms, ions, or molecules into the bulk mass of a substance.[2]

adsorption The retention of atoms, ions, or molecules onto the surface of another substance.[2]

aerobe An organism that needs oxygen for respiration and hence for growth.[1]

aerobic An environment or process that sustains biological life and growth, or occurs only when free (molecular) oxygen is present.[2]

aerobic conditions Conditions for growth or metabolism in which the organism is sufficiently supplied with oxygen.[1]

alcohols Compounds in which a hydroxy group, –OH, is attached to a saturated carbon atom R3COH. The term *hydroxyl* refers to the radical species, HO.[1]

aldehydes Compounds RC(= O)H, in which a carbonyl group is bonded to one hydrogenatom and to one R group[1]. R represents a functional group such as an alkyl group (methyl or ethyl radical).[1]

aliphatic compounds A broad category of hydrocarbon compounds distinguished by a straight, or branched, open chain arrangement of the constituent carbon atoms, excluding aromatic compounds. The carbon-carbon bonds may be either single or multiple bonds. Alkanes, alkenes, and alkynes are aliphatic hydrocarbons.[2]

alkanes The homologous group of linear (acyclic) aliphatic hydrocarbons having the general formula C_nH_{2n+2}. Alkanes can be straight chains, branched chains, or ring structures, sometimes called paraffins.[1]

alkenes Acyclic branched or unbranched hydrocarbons having one carbon–carbon double bond and the general formula C_nH_{2n}, sometimes called olefins.[1]

alkyl groups Univalent groups derived from alkanes by removal of a hydrogen atom from any carbon atom with the general form of $–C_nH_{2n+1}$. The groups derived by removal of a hydrogen atom from a terminal carbon atom of unbranched alkanes form a subclass called normal alkyl (n-alkyl) groups $H[CH_2]_n$.[1]

alkyl radicals Carbon-centered radicals derived formally by removal of one hydrogen atom from an alkane, e.g., CH_3CH_2—(ethyl radical).[1]

alkynes The group of acyclic branched or unbranched hydrocarbons having a carbon-carbon triple bond that have the general formula C_nH_{2n-2}.[1]

ambient The surrounding environment and prevailing conditions.[2]

anaerobe An organism that does not need free-form oxygen for growth. Many anaerobes are even sensitive to free oxygen.[1]

anaerobic A biologically-mediated process or condition not requiring molecular or free oxygen.[1]

analyte The component of a system to be analyzed.[1] For example, chemical elements or ions in ground-water sample.[2]

anoxic An environment without oxygen.[2]

aquifer A water-bearing layer of soil, sand, gravel, rock or other geologic formation that will yield usable quantities of water to a well under normal hydraulic gradients or by pumpage.[3]

aromatic A group of organic compounds that are cyclic, contain resonant carbon-carbon double bonds in the form of at least one 6-carbon benzene ring.[2] In the traditional sense, “having a chemistry typified by benzene.”[1]

attenuation The set of human-made or natural processes that either reduce or appear to reduce the amount of a chemical compound as it migrates away from one specific point towards another point in space or time. For example, the apparent reduction in the amount of a chemical in a ground-water plume as it migrates away from its source. Degradation, dilution, dispersion, sorption, or volatilization are common processes of attenuation.[2]

B

biodegradation Transformation of substances into new compounds through biochemical reactions or the actions of microorganisms, such as bacteria. Typically expressed in terms of a rate constant or half-life.[2]

biota Living organisms.[2]

breakdown product A compound derived by chemical, biological, or physical action on a chemical compound. The breakdown is a process which may result in a more toxic or a less toxic compound and a more persistent or less persistent compound than the original compound.[2]

C

carbon Element number 6 in the periodic table of elements. For a description of the various types of carbon as a solid, the term carbon should be used only in combination with an additional noun or a clarifying adjective (that is, organic carbon).[1]

catabolism The breakdown of complex molecules into simpler ones through the oxidation of organic substrates to provide biologically available energy (for example, ATP, adenosine triphosphate).[1]

catalysis The process where a catalyst increases the rate of a chemical reaction without modifying the overall standard Gibbs energy change in the reaction.[1]

catalyst Substances that increases the rate of a chemical reaction. The catalyst is both a reactant and product of the reaction. The words catalyst and catalysis should not be used when the added substance reduces the rate of reaction (see inhibitor).[1]

chemical bond The forces acting among two atoms or groups of atoms that lead to the formation of an aggregate with sufficient stability to make it convenient for the chemist to consider it as an independent “molecular species.”[1]

chemical induction (coupling) When one reaction accelerates another in a chemical system there is said to be chemical induction or coupling. Coupling is caused by an intermediate or by-product of the inducing reaction that participates in a second reaction. Chemical induction is often observed in oxidation–reduction reactions.[1]

chemical reaction A process that results in the interconversion of chemical species. Chemical reactions may be elementary reactions or stepwise reactions.[1]

chlorinated solvent A volatile organic compound containing chlorine. Some common solvents are trichloroethylene, tetrachloroethylene, and carbon tetrachloride.[2]

***cis, trans* isomers** The difference in the positions of atoms (or groups of atoms) relative to a reference plane in an organic molecule. In a *cis*-isomer, the atoms are on the same side of the molecule, but are on opposite sides in the *trans*-isomer. Sometimes called stereoisomers, these arrangements are common in alkenes and cycloalkanes.[1]

co-metabolism The simultaneous metabolism of two compounds, in which the degradation of the second compound (the secondary substrate) depends on the presence of the first compound (the primary substrate). For example, in the process of degrading methane, some bacteria can degrade chlorinated solvents that would otherwise not be degraded under the same conditions.[2]

concentration Composition of a mixture characterized in terms of mass, amount, volume or number concentration with respect to the volume of the mixture.[1]

conservative constituent or compound One that does not degrade, is unreactive, and its movement is not retarded within a given environment (aquifer, stream, contaminant plume, and so forth).[4]

constituent An essential part or component of a system or group (that is, an ingredient of a chemical mixture). For instance, benzene is one constituent of gasoline.[4]

covalent bond A region of relatively high electron density between atomic nuclei that results from sharing of electrons and that gives rise to an attractive force and a characteristic internuclear distance. Carbon-hydrogen bonds are covalent bonds.[1]

D

daughter product A compound that results directly from the degradation of another. For example *cis*-1,2-dichloroethene (12-cDCE)is commonly a daughter product of trichloroethene (TCE) degradation. This is a term that has currently (2006) fallen out of general use. See metabolic by-product.[3]

dehydrohalogenation Removal of hydrogen and halide ions from an alkane resulting in the formation of an alkene.[3]

denitrification Bacterial reduction of nitrate to nitrite to gaseous nitrogen or nitrous oxides under anaerobic conditions.[4]

density (ρ) The ratio of the mass of a substance to the mass of an equal volume of distilled water at 4 degrees Celsius. Since the mass of one milliliter (ml) of water at 4 degrees Celsius is exactly 1 gram, the specific gravity (unitless) is numerically equivalent to its density (in grams per ml).[1]

detection limit (in analysis) The minimum single result that, with a stated probability, can be distinguished from a representative blank value during the laboratory analysis of substances such as water, soil, air, rock, biota, tissue, blood, and so forth.[1]

dichloroelimination Removal of two chlorine atoms from an alkane compound and the formation of an alkene compound within a reducing environment.[4]

dihaloelimination Removal of two halide atoms from an alkane compound and the formation of an alkene compound within a reducing environment.[3]

diols Chemical compounds that contain two hydroxy (--OH) groups, generally assumed to be, but not necessarily, alcoholic. Aliphatic diols are also called glycols.[1]

downgradient In the direction of decreasing static hydraulic head (potential).[4]

E

electron acceptor A compound capable of accepting electrons during oxidation-reduction reactions. Microorganisms obtain energy by transferring electrons from electron donors such as organic compounds (or sometimes reduced inorganic compounds such as sulfide) to an electron acceptor. Electron acceptors are compounds that are relatively oxidized and include oxygen, nitrate, iron (III), manganese (IV), sulfate, carbon dioxide, or in some cases chlorinated aliphatichydrocarbons such as perchloroethene (PCE), TCE, DCE, and vinyl chloride.[2]

electron donor A compound capable of supplying (giving up) electrons during oxidation-reduction reactions. Microorganisms obtain energy by transferring electrons from electron donors such as organic compounds (or sometimes reduced inorganic compounds such as sulfide) to an electron acceptor. Electron donors are compounds that are relatively reduced and include fuel hydrocarbons and native organic carbon.[3]

electronegativity Concept introduced by Nobel Laureate Linus Pauling as the power of an atom to attract electrons to itself.[1]

elimination Reaction where two groups such as chlorine and hydrogen are lost from adjacent carbon atoms and a double bond is formed in their place.[3]

endergonic reaction A chemical reaction that requires energy to proceed. A chemical reaction is endergonic when the change in free energy is positive.[3]

enzyme Macromolecules, mostly proteins or conjugated proteins produced by living organisms, that facilitate the degradation of a chemical compound (catalyst). In general, an enzyme catalyzes only one reaction type (reaction specificity) and operates on only one type of substrate (substrate specificity).[1, 4]

epoxidation A reaction wherein an oxygen molecule is inserted in a carbon-carbon double bond and an epoxide is formed.[3]

epoxides A subclass of epoxy compounds containing a saturated three-membered cyclic ether. See epoxy compounds.[1]

epoxy compounds Compounds in which an oxygen atom is directly attached to two adjacent or nonadjacent carbon atoms in a carbon chain or ring system; thus cyclic ethers.[1]

F

facultative anaerobes Microorganisms that use (and prefer) oxygen when it is available, but can also use alternate electron acceptors such as nitrate under anaerobic conditions when necessary.[3]

fermentation Microbial metabolism in which a particular compound is used both as an electron donor and an electron acceptor resulting in the production of oxidized and reduced daughter products.[3]

functional group An atom, or a group of atoms attached to the base structure of a compound that has similar chemical properties irrespective of the compound to which it is a part. It defines the characteristic physical and chemical properties of families of organic compounds.[1]

G

H

half-life ($t_{1/2}$) The time required to reduce the concentration of a chemical to 50 percent of its initial concentration. Units are typically in hours or days.[2]

halide An element from the halogen group. These include fluorine, chlorine, bromine, iodine, and astatine.[5]

halogen Group 17 in the periodic table of the elements. These elements are the reactive nonmetals and are electronegative.[5]

Henry's Law The relation between the partial pressure of a compound and the equilibrium concentration in the liquid through a proportionality constant known as the Henry's Law constant.[4]

Henry's Law constant The concentration ratio between a compound in air (or vapor) and the concentration of the compound in water under equilibrium conditions.[4]

heterogeneous Varying in structure or composition at different locations in space.[4]

heterotrophic Organisms that derive carbon from organic matter for cell growth.[4]

homogeneous Having uniform structure or composition at all locations in space.[4]

hydration The addition of a water molecule to a compound within an aerobic degradation pathway.[5]

hydrogen bond A form of association between an electronegative atom and a hydrogen atom attached to a second, relatively electronegative atom. It is best considered as an electrostatic interaction, heightened by the small size of hydrogen, which permits close proximity of the interacting dipoles or charges.[1]

hydrogenation A process whereby an enzyme in certain microorganisms catalyzes the hydrolysis or reduction of a substrate by molecular hydrogen.[2]

hydrogenolysis A reductive reaction in which a carbon-halogen bond is broken, and hydrogen replaces the halogen substituent.[3]

hydrolysis A chemical transformation process in which a chemical reacts with water. In the process, a new carbon-oxygen bond is formed with oxygen derived from the water molecule, and a bond is cleaved within the chemical between carbon and some functional group.[1]

hydroxylation Addition of a hydroxyl group to a chlorinated aliphatic hydrocarbon.[3]

I

inhibition The decrease in rate of reaction brought about by the addition of a substance (inhibitor), by virtue of its effect on the concentration of a reactant, catalyst, or reaction intermediate.[1]

in situ In its original place; unmoved; unexcavated; remaining in the subsurface.[4]

J

K

L

lag phase The growth interval (adaption phase) between microbial inoculation and the start of the exponential growth phase during which there is little or no microbial growth.[1]

M

measurement A description of a property of a system by means of a set of specified rules, that maps the property onto a scale of specified values, by direct or "mathematical" comparison with specified reference(s).[1]

metabolic by-product (by-product) A product of the reaction between an electron donor and an electron acceptor. Metabolic by-products include volatile fatty acids, daughter products of chlorinated aliphatic hydrocarbons, methane, and chloride.[3]

metabolism The entire physical and chemical processes involved in the maintenance and reproduction of life in which nutrients are used to generate energy and in the process degrade to simpler molecules (catabolism), which by themselves may be used to form more complex molecules (anabolism).[1]

methanogens Strictly anaerobic archaebacteria, able to use only a very limited spectrum of substrates (for example, molecular hydrogen, formate, methanol, methylamine, carbon monoxide or acetate) as electron donors for the reduction of carbon dioxide to methane.[1]

methanogenic The formation of methane by certain anaerobic bacteria (methanogens) during the process of anaerobic fermentation.[4]

microcosm A diminutive, representative system analogous to a larger system in composition, development, or configuration.[4]

microorganisms Microscopic organisms that include bacteria, protozoans, yeast, fungi, mold, viruses, and algae.[4]

mineralization The release of inorganic chemicals from organic matter in the process of aerobic or anaerobic decay.[4]

monoaromatic Aromatic hydrocarbons containing a single benzene ring.[4]

N

nucleophile A chemical reagent that reacts by forming covalent bonds with electronegative atoms and compounds.[4]

nutrients Major elements (for example, nitrogen and phosphorus) and trace elements (including sulfur, potassium, calcium, and magnesium) that are essential for the growth of organisms.[3]

O

octanol-water partition coefficient (K_{ow}) The equilibrium ratio of a chemical's concentration in octanol (an alcoholic compound) to its concentration in the aqueous phase of a two-phase octanol/water system, typically expressed in log units (log K_{ow}). K_{ow} provides an indication of a chemical's solubility in fats (lipophilicity), its tendency to bioconcentrate in aquatic organisms, or sorb to soil or sediment.[2]

order of reaction A chemical rate process occurring in systems for which concentration changes (and hence the rate of reaction) are not themselves measurable, provided it is possible to measure a chemical flux.[1]

organic carbon (soil) partition coefficient (K_{oc}) The proportion of a chemical sorbed to the solid phase, at equilibrium in a two-phase, water/soil or water/sediment system expressed on an organic carbon basis. Chemicals with higher K_{oc} values are more strongly sorbed to organic carbon and, therefore, tend to be less mobile in the environment.[2]

oxidation In general, a reaction in which electrons are transferred from a chemical to an oxidizing agent, or where a chemical gains oxygen from an oxidizing agent.[2]

P

Q

R

rate Derived quantity in which time is a denominator quantity. Rate of x is dx/dt.[1]

rate constant, k See order of reaction.[1]

rate-controlling step (rate-limiting step, rate-determining step) The elementary reaction having the largest control factor exerts the strongest influence on the rate (v). A step having a control factor much larger than any other step is said to be rate-controlling.[1]

recalcitrant Unreactive, nondegradable, refractory.[4]

redox Reduction-oxidation reactions. Oxidation and reduction occur simultaneously; in general, the oxidizing agent gains electrons in the process (and is reduced) while the reducing agent donates electrons (and is oxidized).[2]

reduction In general, a reaction in which electrons are transferred to a chemical from a reducing agent, or where oxygen is removed from a chemical.[2]

respiration The process of coupling oxidation of organic compounds with the reduction of inorganic compounds, such as oxygen, nitrate, iron (III), manganese (IV), and sulfate.[2]

S

solvolysis Generally, a reaction with a solvent, involving the rupture of one or more bonds in the reacting solute. More specifically the term is used for substitution, elimination, or fragmentation reactions in which a solvent species is the nucleophile (hydrolysis, if the solvent is water or alcoholysis, if the solvent is an alcohol).[1]

stable As applied to chemical species, the term expresses a thermodynamic property, which is quantitatively measured by relative molar standard Gibbs energies. A chemical species A is more stable than its isomer B if $\Delta rGo > 0$ for the (real or hypothetical) reaction A → B, under standard conditions.[1]

substrate Component in a nutrient medium, supplying microorganisms with carbon (C-substrate), nitrogen (N-substrate) as "food" needed to grow.[1]

T

terminal electron acceptor (TEA) A compound or molecule that accepts an electron (is reduced) during metabolism (oxidation) of a carbon source. Under aerobic conditions molecular oxygen is the terminal electron acceptor. Under anaerobic conditions a variety of terminal electron acceptors may be used. In order of decreasing redox potential, these TEAs include nitrate, manganic manganese, ferric iron, sulfate, and carbon dioxide. Microorganisms preferentially utilize electron acceptors that provide the maximum free energy during respiration. Of the common terminal electron acceptors listed above, oxygen has the highest redox potential and provides the most free energy during electron transfer.[4]

U

unsaturated zone The zone between land surface and the capillary fringe within which the moisture content is less than saturation and pressure is less than atmospheric. Soil pore spaces also typically contain air or other gases. The capillary fringe is not included in the unsaturated zone.[4]

upgradient In the direction of increasing potentiometric (piezometric) head.[4]

V

vadose zone The zone between land surface and the water table within which the moisture content is less than saturation (except in the capillary fringe) and pressure is less than atmospheric. Soil pore spaces also typically contain air or other gases. The capillary fringe is included in the vadose zone.[4]

vapor pressure (Pv) The force per unit area exerted by a vapor in an equilibrium state with its pure solid, liquid, or solution at a given temperature. Vapor pressure is a measure of a substance's propensity to evaporate. Vapor pressure increases exponentially with an increase in temperature. Typical units are millimeter of mercury (mm Hg), torr, or inches of mercury (in. Hg).[2]

W

water solubility (S) The maximum amount of a chemical that can be dissolved in a given amount of pure water at standard conditions of temperature and pressure. Typical units are milligrams per liter (mg/L), gallons per liter (g/L), or pounds per gallon (lbs/gal).[2]

X

Y

Z

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APPENDIX H
February 1988 Industrial Pumping Oil Spill WDNR Information

Wisconsin Department of Natural Resources

Environmental Cleanup & Brownfields Redevelopment

BRRTS on the Web

Click the Location Name below to view the Location Details page for this Activity. Other Activities, if present, may be viewed from that page.

BOTW Home > **Basic Search** >> 04-30-042541 Activity Details

04-30-042541 3500 BLK OF 66TH ST [HISTORIC SPILL]

HISTORIC SPILL

Location Name (Click Location Name to View Location Details)			County	WDNR Region
3500 BLK OF 66TH ST			KENOSHA	SOUTHEAST
Address			**Municipality**	
3500 BLK OF 66TH ST			KENOSHA	
Public Land Survey System		**Latitude**	**Google Maps**	**RR Sites Map**
Additional Location Description		**Longitude**	**Facility ID**	**Size (Acres)**
			NONE	UNKNOWN

Jurisdiction	PECFA No.	EPA Cerclis ID	Start Date	End Date	Last Action
DNR RR			1988-02-08		1988-02-08

Comments

OLD SPILL ID: 880208-01 HISTORIC SPILL. FURTHER ACTION MAY NOT BE NECESSARY. PLEASE CONTACT DNR SPILL COORDINATOR IN SE REGION FOR FILE INFORMATION.

Characteristics

PECFA Tracked?	EPA NPL Site?	Eligible for PECFA Funds?	Above Ground Storage Tank?	Drycleaner?	Co-Contamination?	On GIS Registry?
No	No	No	No	No	No	No

Actions

Place Cursor Over Action Code to View Description

Date	Code	Name	Comment
1988-02-08	1	Spill Incident Occurred	Auto populated via migration process
1988-02-08	5	Spill Reported to DNR	
1988-02-08	777	Historic Spill	

Impacts

Type	Comment
Soil Contamination	SOIL

Spill Information

Incident Date	Reported Date	Investigator	Source
02/08/1988	02/08/1988	UNKNOWN	Power Generating Plant/Utility Co/Electrical Trnsf/Dist Stn

Cause: HOLE WAS POKED IN TANK CAR

Comment: NONE

Spiller Actions

Action	Comment
No Action Taken	SOIL

Who

Role	Name/Address
Responsible Party	CHRYSLER CORP 5555 30TH AVE. KENOSHA, WI 53140

The Official Internet site for the Wisconsin Department of Natural Resources
101 S. Webster Street . PO Box 7921 . Madison, Wisconsin 53707-7921 . 608.266.2621

Release 2.5.4 | 01/10/2017 | Release Notes

State of Wisconsin
Department of Natural Resources

TOXIC AND HAZARDOUS SPILL REPORT

Form 4400-91 Rev. 6-86

State Div. Emergency Gov't.	(608) 266-3232
U.S. Nat'l. Response Center	(800) 424-8802
Chemtrec/Pesticides/Chlorine	(800) 424-9300

Spill ID Number
__ __ __ __ __ __ __
Y Y M M D D 0-99

Date of Incident 2-8-88	Day of Week Mon	Time of Incident	☐ A.M. ☐ P.M.
Date Reported 2-8-88	Day of Week Mon	Time Reported 2:30	☐ A.M. ☒ P.M.

Substance Involved Unknown	Quantity approx 100	Units gal
Substance Involved	Quantity	Units

Physical Characteristics
☐ Solid ☒ Liquid Color ____
☐ Semisolid ☐ Gas Odor ____

Cause of Incident
Leaking Storage tanks

Exact Location Description (intersection, mileage, etc.)
Alley adjacent to I. P.

County Location Kenosha	¼¼, ¼, Section, Town, Range ___, ___, ___, T___ N, R ___

DNR Dist SE	DNR Area MILW	Groundwaters Affected ☐ Yes ☐ No ☒ Potential

Surface Waters Affected ☐ Yes ☐ No ☒ Potential	Name of Surface Water

Date District Notified 2-8-88	Day of Week Mon	Time District Notified 2:30	☐ A.M. ☒ P.M.

District Person Notified Robert Maslowski	Telephone Number (414) 562-9684

Date Investigated 2-8-88	Day of Week MON	Time Investigated 4:30	☐ A.M. ☒ P.M.

Person Investigating Dean Kelley	Telephone Number (414) 562-9656

Action Taken By DNR
☐ No Action Taken ☒ Investigation ☐ Supervise/Conduct Cleanup
☐ Spiller Required To Take Action; Type ____
☐ Contractor Hired By DNR; Name ____
☐ Amount Recovered ____
☐ 29.29 Enforcement

Other Agencies on Scene
Local Kenosha DEG / Kenosha Haz Mat
State ____
Federal ____

Reported By (Name) Paul Hess	Telephone Number (414) 656-6595
Agency or Firm Reporting Kenosha EG	Reported thru Div. Emergen. Gov't. ☒ Yes ☐ No

Person or Firm Responsible
Industrial Pumping Inc

Contact Name Ken Smith	Telephone Number (414) 552-9788

Address — Street or Route

City, State, Zip Code
Kenosha, WI

Action Taken By Spiller
☒ No Action Taken ☐ No Notification ☐ Investigate
☐ Containment; Type ____
☐ Cleanup; Method ____
☐ Amount Recovered ____
☐ Monitor ____
☐ Contractor Hired; Name ____
☐ Other Action ____

Spill Location
☒ Industrial Facility/Paper Mill/Chem. Co.
☐ Gas/Service Station/Garage, Auto Dealer, Repair Shop
☐ Ag Coop/Facility/Cheese Factory/Creamery
☐ Other Small Business (bank, grocery, insurance co., etc.)
☐ Public Property (city, county, state, church, school, etc.)
☐ Utility Co., Power Generating/Transfer Facility
☐ Private Property (home/farm)
☐ Pipeline, Terminal, Tank Farm, Oil Jobber/Wholesaler
☐ Transportation Accident, Fuel Supply Tank Spill
☐ Transportation Accident, Load Spill
☐ Construction, Excavation, Wrecking, Quarry, Mine
☐ Other ____

Spilled Substance Destination
☐ Air
☒ Soil
☐ Groundwater
☐ Surface Water
☒ Storm Sewer
☐ Sanitary Sewer
☒ Contained/Recovered
☐ Other ____

Person Filing This Report (print name)
Robert Maslowski

Signature	Date Signed

Additional Comments:
Kenosha Haz Mat contained majority of spill. May prosecute as an unlicensed storage facility and waste hauler.

ENFORCEMENT

Sample(s) will be disposed of ninety days from date of receipt (date in lower right hand corner of lab sheet next to number), unless this form is completed and returned to:

Water Chemistry Unit
Wis. State Lab. of Hygiene
465 Henry Mall
Madison, WI 53706

Collector Kelley Dean

District/area Milw

Phone number ______

Sample number(s) 62062

______

______

DATE ____/____/____

___ Retain sample(s) for _____ days.

___ Retain sample(s) until further notice.

Hyg. 7/83

Department of Natural Resources

WATER CHEMISTRY—LAW ENFORCEMENT
Form 3200-32 Rev. 9-84

THIS REPORT FOR USE BY LAW ENFORCEMENT PERSONNEL ONLY

Sample Description: 4 oz collected by HAZ-MAT TEAM CITY OF KENOSHA FIRE DEPT FOR ME DURING SPILL RESPONSE

Field No.: 002 DMK

[redacted] SOL ENF

Send Report To:
Name: DEAN KELLEY SED-DMK
Address: 2300 N. Martin Luther King Dr.
City, State, Zip Code: MILWAUKEE, WI 53212

Collected By: Dean Kelley

Shaded Areas for Lab Use Only: LE001

Time Collected (24 Hr. Clock): 18:00
Collection Date: 02 08 88

Body of Water: ____

Primary Sta. No.

County	Kenosha	Section	____
Town	____	Quarter	____
Range	____	Quarter	____

BOD Estimate ____ MFFCC Estimate ____

	131	Temp (°C) Field	
	091	DO Field	
	096	pH (su) Field	
☐	026	BOD-5 Tot.	
☐	134	MFFCC*	
☐	097	pH (su) Lab.	
☐	138	Total Solids	
☐	107	Vol. Total Solids	
☐	106	Suspended Solids	
☐	109	Vol. Susp. Solids	

Parameter Code (Lab. Use)	Name	
☒	As	<10 mg/kg
☒	Cd	<2 mg/kg
☒	Cr	<10 mg/kg
☒	Pb	590 mg/kg
☒	Hg	Q.C.
☒	Se	<5 mg/kg
☒	Ag	<2.5 mg/kg
☑	PREP II DIG MET	
☑	PREP II DIG AsSe	
☐	I495 BET DIG Hg I495 BET DIG Ag	

Additional Analysis: Heavy Metals requested - oil is "Cutting oil" field test indicated PCB less than 50 ppm

Comments: Spiller: Industrial Pumping Inc. Kenosha WI.

☒ PREP III SIEVE

BAS

**SAMPLE WILL AUTOMATICALLY BE DESTROYED AFTER 90 DAYS UNLESS FURTHER NOTIFICATION IS RECEIVED.

Disposition of Sample
☐ Return
☐ Destroy
☐ Retain**

Date Received ____
Lab. No. C 62062
Date Reported FEB 18 88 AUG 2 1988 AUG 2 1988

R.H. Laessig, Ph.D., Director
Wisconsin State Laboratory of Hygiene
Madison, Wisconsin 53706

CHAIN OF CUSTODY RECORD

SAMPLE COLLECTOR DEAN M. KELLEY TITLE/WORK STATION EMERG. RESP. SPEC. SED. TELEPHONE NO. 414-562-9656

PROPERTY OWNER INDUSTRIAL PUMPING, INC. PROPERTY ADDRESS 3223 47th AVE
Kenosha, WI. 53142 TELEPHONE NO. 414-552-9788

PHOTOGRAPHS (Optional): YES [✓ NO] (Circle One)

FACILITY PROPERTY OWNER SPLIT SAMPLES

ACCEPTED ________ SIGNATURE ____________

REJECTED ________ SIGNATURE ____________

SAMPLE ID NO.	DATE	TIME	COMP.	GRAB.	STATION LOCATION SAMPLE DESCRIPTION	LAB ID NUMBER	COMMENTS
DMK 002	2/8/88	6:00pm		X	Oil from leaking tanker collected by HAZ-MAT TEEM FOR me	62064	

I hereby certify that I received, properly handled, and disposed of these samples as noted below:

Relinquished by:(Signature)	Date/Time	Received by:(Signature)	Relinquished by:(Signature)	Date/Time	Received by:(Signature)
Dean M. Kelley	2/8/88 4:40pm				

Relinquished by:(Signature)	Date/Time	Received by:(Signature)	Received for Laboratory by: (Signature)	Date/Time
			George T Bowman	2/8/88 4:22 pm

Disposition of Unused Portion of Sample
Dispose ________ Retain for ______ days
Return ________ Other ____________

3015Y

SED

Department of Natural Resources

WATER CHEMISTRY—LAW ENFORCEMENT
Form 3200-32 Rev. 9-84

THIS REPORT FOR USE BY LAW ENFORCEMENT PERSONNEL ONLY

Sample Description
4 oz collected by HAZ-MAT TEAM CITY OF KENOSHA FIRE DEPT FOR ME DURING SPILL RESPONSE

Field No. 002 DMK

[redacted] SOL ENF

Send Report To:
Name DEAN KELLEY SED-DMK
Address 2300 N. Martin Luther King Dr.
City, State, Zip Code MILWAUKEE, WI 53212

Time Collected (24 Hr. Clock) 18:00 (H H M M)

Collection Date 0 2 0 8 8 8 (M M D D Y Y)

Body of Water ______

Primary Sta. No.

County Kenosha Section ______

Town ______ Quarter ______

Range ______ Quarter ______

RECEIVED 1988 AUG -9 AM 8:31 DNR/HEADQUARTERS SED

Collected By Dean Kelley

Shaded Areas for Lab Use Only LE001

BOD Estimate ______ MFFCC Estimate ______

	131 Temp (°C) Field	___ ___ ___
	091 DO Field	___ ___.___
	096 pH (su) Field	___ ___.___
☐	026 BOD-5 Tot.	___ ___ ___.___
☐	134 MFFCC*	___ ___ ___ ___
☐	097 pH (su) Lab.	___ ___.___
☐	138 Total Solids	___ ___ ___ ___
☐	107 Vol. Total Solids	___ ___ ___ ___
☐	106 Suspended Solids	___ ___ ___ ___
☐	109 Vol. Susp. Solids	___ ___ ___ ___

Additional Analysis:
Heavy Metals requested - oil is "Cutting oil" field test indicated PCB less than 50 ppm

Parameter Code (Lab. Use)	Name		
☒	As	<10 mg/kg	___ ___ ___.___
☒	Cd	<2 mg/kg	___ ___ ___.___
☒	Cr	<10 mg/kg	___ ___ ___.___
☒	Pb	590 mg/kg	___ ___ ___.___
☒	Hg	Q.C.	___ ___ ___.___
☒	Se	<5 mg/kg	___ ___ ___.___
☒	Ag	<2.5 mg/kg	___ ___ ___.___
☒	PREP II DIG MET		___ ___ ___.___
☑	PREP II DIG AsSe		___ ___ ___.___
☐	I495 BET DIG Hg I495 BET DIG Ag		___ ___ ___.___

Comments:
Spiller: Industrial Pumping Inc.
Kenosha WI.
☒ PREP III SIEVE

BAS

**SAMPLE WILL AUTOMATICALLY BE DESTROYED AFTER 90 DAYS UNLESS FURTHER NOTIFICATION IS RECEIVED.

Disposition of Sample
☐ Return
☐ Destroy
☐ Retain**

Date Received ______
Lab. No. FEB 18 88 C62062
Date Reported AUG 2 1988

R.H. Laessig, Ph.D., Director
Wisconsin State Laboratory of Hygiene
Madison, Wisconsin 53706

CHAIN OF CUSTODY RECORD

SAMPLE COLLECTOR DEAN M. KELLEY TITLE/WORK STATION EMERG. RESP. SPEC. SED. TELEPHONE NO. 414-562-9656

PROPERTY OWNER INDUSTRIAL PUMPING, INC. PROPERTY ADDRESS 3223 47th AVE
Kenosha, WI. 53142
TELEPHONE NO. 414-552-9788

PHOTOGRAPHS (Optional): YES [✓ NO] (Circle One)

FACILITY PROPERTY OWNER SPLIT SAMPLES

ACCEPTED ________ SIGNATURE ____________________

REJECTED ________ SIGNATURE ____________________

SAMPLE ID NO.	DATE	TIME	COMP.	GRAB.	STATION LOCATION SAMPLE DESCRIPTION	LAB ID NUMBER	COMMENTS
DMK 002	2/8/88	6:00pm		X	Oil from leaking tanker collected by HAZ-MAT STEEM FOR ME	62062	

I hereby certify that I received, properly handled, and disposed of these samples as noted below:

Relinquished by:(Signature)	Date/Time	Received by:(Signature)	Relinquished by:(Signature)	Date/Time	Received by:(Signature)
Dean M. Kelley	2/8/88 4:48pm				
Relinquished by:(Signature)	Date/Time	Received by:(Signature)	Received for Laboratory by: (Signature)	Date/Time	
			George T Bowman	2/8/88 4:22 pm	

Disposition of Unused Portion of Sample

Dispose ________ Retain for ______ days

Return ________ Other ____________

4015Y

2-9-88

Bob,

I was at Kenosha at the spill site till 6:30 pm last night. The field test showed no pcb's so I told them to deal with it as a routine petro spill.

Before you close out your report let me see it,

If you have any questions give me a call at home on Wed night or I'll be back in on Thursday,

Thanks,

Dean Kelly

State of Wisconsin \ **DEPARTMENT OF NATURAL RESOURCES**
P.O. Box 12436
Milwaukee, WI 53212

Carroll D. Besadny
Secretary

March 7, 1988

File Ref: 3210

Mr. Ken Smith, President
Industrial Pumping Incorporated
3223 47th Avenue
Kenosha, WI 53140

Dear Mr. Smith:

As per our conversation earlier today I am following up in writing the requirements we discussed concerning your oil storage facility.

Since the spill incident occurred on your site I find it imperative you provide documentation regarding the kinds and quantities of waste oil products and other non-waste products you have stored at your facility.

To provide the necessary information I request you provide to me the following information within seven days of receipt of this letter.

1. Drawing indicating size and description of each storage tank on the facility both exterior and interior, above and underground.
2. Indentification of kind and quantity of each commodity stored in each tank.
3. Description of destination of each commodity stored whether disposal, recycling, or burning.
4. Installation of security devices (valve locks, fences or both) to prevent unauthorized entry and discharges of stored materials.

Upon receipt of this information from you and the laboratory results from the sample taken at the time of the spill, we will be able to properly assess the situation and deal with it accordingly.

I will provide you a copy of the sample analysis as soon as I receive it.

Thank you for your continued cooperation in this spill cleanup activity. Your prompt response is appreciated.

Sincerely,

Dean M. Kelley

Dean M. Kelley
Emergency Response Specialist

jw

0847-1
DS1WWW

INDUSTRIAL PUMPING INC.
3223 – 47th Avenue
KENOSHA, WISCONSIN 53142
(414) 552-9788

March 14, 1988

Dean M. Kelley
Department of Natural Resources
P.O. Box 12436
Milwaukee, WI 53212

Dear Mr. Kelley:

Enclosed please find the requested information regarding the size and description of tanks and quantities of waste oil stored at our facility. We hope the included information is sufficient in answering any questions you might have. If not, please feel free to contact us for further clarification.

Thank you for your cooperation in handling this hit and run accident that caused the spill, and know that we are attempting to cooperate in every way we can.

Sincerely,

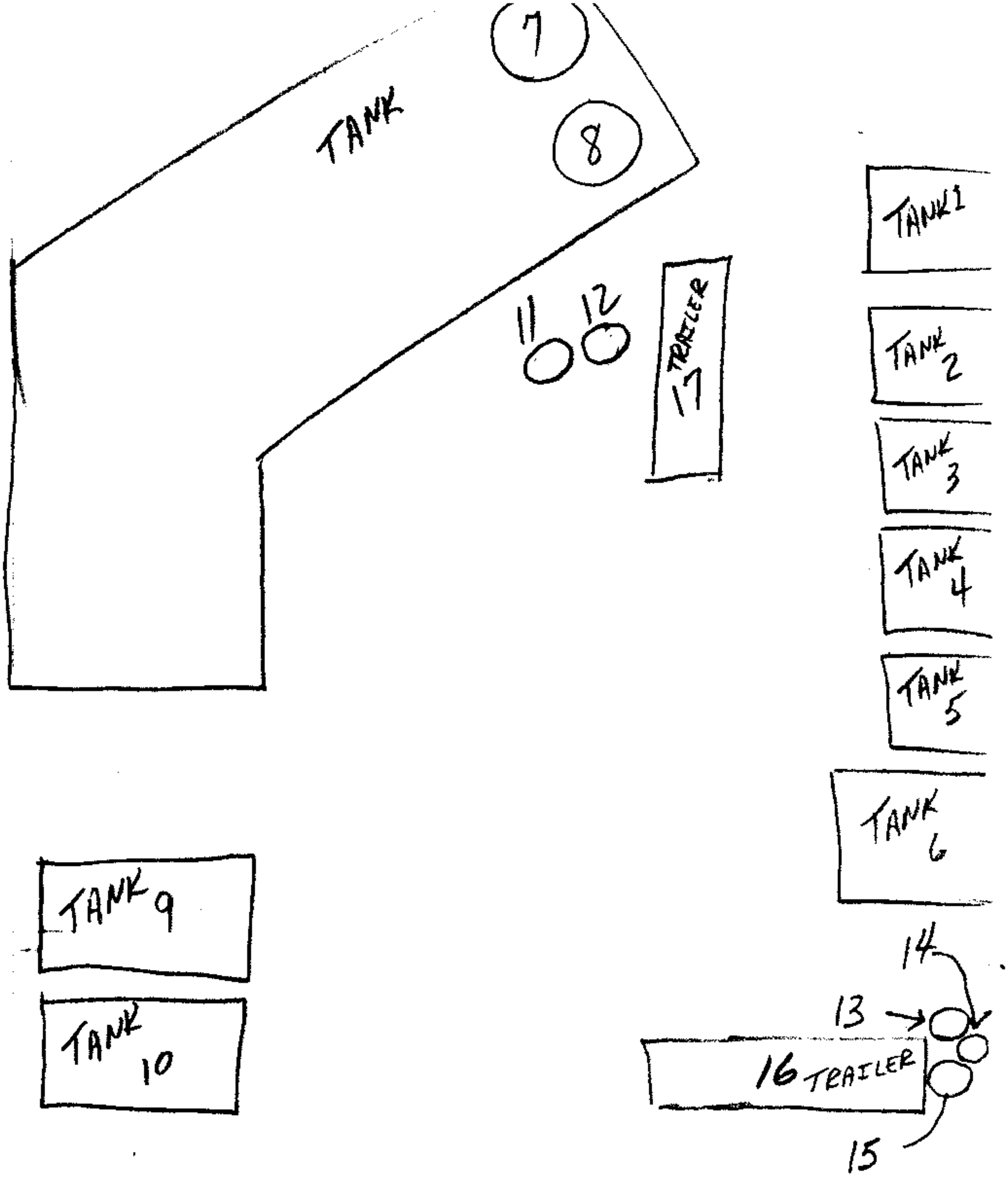
Ken Smith

Ken Smith
Industrial Pumping, Inc.

TANK	SIZE	IDET.	QUANT.	DEST.
1	11,000	WASTE OIL	1200	RECYCLE
2	11,000	#4 FUEL	7500	"
3	11,000	WASTE OIL	350	"
4	11,000	"	800	"
5	11,000	"	1950	"
6	15,000	COOLANT	2400	"
7	5,000	WASTE OIL	2800	"
8	5,000	"	4000	"
9	7,000	"	6200	"
10	7,000	COOLANT	1700	"
11	2000	WASTE OIL	600	"
12	2000	WASTE OIL	1000	"
13	2,000	EMPTY	—	—
14	2000	"	—	—
15	4,000	WASTE OIL	500	"
16	5,000	"	3000	"
17	4,500	"	1800	"

TOTAL CAPACITY = 115,500 GAL

WASTE OIL = 24,200 GAL
COOLANT = 4,100 GAL
#4 FUEL = 7,500 GAL
35,800 GAL


TANK
7
8
11
12
TRAILER
17
TANK 1
TANK 2
TANK 3
TANK 4
TANK 5
TANK 6
TANK 9
TANK 10
14
13
16 TRAILER
15

State of Wisconsin \ **DEPARTMENT OF NATURAL RESOURCES**
P.O. Box 12436
Milwaukee, WI 53212

Carroll D. Besadny
Secretary

April 6, 1988

File Ref: 3210

Mr. Ken Smith, President
Industrial Pumping Inc.
3223 47th Avenue
Kenosha, WI 53140

Dear Mr. Smith:

To follow up our conversation earlier this morning and close out our file regarding the recent spill at your facility, please review the following.

One item you stated you had done to insure security was to install caps on the ends of lines to prevent accidental or unauthorized discharges from storage tanks. You may wish to provide additional security by installing locks on all values. A routine scheduled inspection of the facility by you or an employee where condition of the values, lines, tanks etc are noted and any repairs or equipment changes are also recorded would be wise. I recommend a once a month at a minimum inspection, preferably a weekly inspect.

When I was at your facility I noticed a small area where oil had leaked while hoses were coupled/uncoupled. This area's soil should be cleaned up - soil removed, disposed of - and a portable catch basin used under the couplings when this area is being used to catch any "drippings".

Please notify the Local Authorities of your plans for the site and give them a map as you have sent to me, designating the storage areas, tanks, and commodities stored at your facility.

Thank you for your cooperation.

Sincerely,

Dean Kelley

Dean M Kelley
Emergency Response Specialist

DMK:fb

C: Kenosha Fire Department - Haz/Mat

TO: Kenosha Fire Dept.
HAZ-MAT TEAM

FROM: DEAN KELLY – DNR
MILWAUKEE, WI

SUBJECT–MESSAGE

Regarding Industrial Pumping Inc.
3223 47th AVE.
Kenosha, WI.

Here are copies of our Correspondence Regarding this firm. Please call if you need any additional action on my part.

SIGNED Dean M Kelly DATE 4/7/88

REPLY

SENDER RETAIN THIS COPY

SIGNED ____________________ DATE __________

SOUTHEAST DISTRICT

Solid Waste Section

TO:

______ Gloria McCutcheon - D.D.
______ Ron Kazmierczak - A.D.D.
______ Darryl Gerlat - Enf.
______ Finance Personnel - SED
__X__ Frank Schultz - Solid Waste Coordinator

Solid Waste Unit

______ Frances Koonce - Unit Leader
______ Elizabeth Duchelle
______ Ken Hein
______ Roger Klett
______ Mike Zillmer

Hazardous Waste Unit

______ Walt Ebersohl - Unit Leader
______ Pat Brady
______ Richard Brown
______ Dolores Hayden
______ Sandy Miller
______ Pam Mylotta
______ John Lubbers

Environmental Response Unit

______ Jim Schmidt - Unit Leader
______ Margaret Graefe
__X__ Dean Kelley
______ John Krahling
______ Bernice Aument
______ Sharon Cutright - Program Assistant
______ Marie Barner - Clerical Assistant

FROM: Walt E. 11/22/88

__X__ For your information
______ Prepare and return comments by ______
______ File
______ Take action
______ See me
______ Sign
______ Prepare reply for my signature
______ Reply directly to ______
______ Route to: ______

______ Return to: ______

COMMENTS: Ken Thiesen & the EPA emergency response team were at the Industrial Pumping site on Mon. Nov 21, 1988. Also, I recommend sending Paul Hess a copy of the company's response (3/14/88) to the [illegible]

mb

APPENDIX I
September 1989 Industrial Pumping Oil Sample WDNR Information

LABORATORY REPORT

3307 - 14th Avenue
Kenosha, Wisconsin 53140
Phone (414) 652-5656

Fax (414) 652-5902
1-800-284-3823

gabriel - midwest, ltd.
Environmental & Technical Services

TO: Mr. Ken Smith, Industrial Pumping, Kenosha, WI
SUBJECT: Analysis of Oil Sample
WI CERTIFICATION ID #: 252037440
P.O. #: Verbal/Smith
SAMPLE DATE: NOT GIVEN
DATE RECEIVED: 09/14/89
GML SAMPLE CODE: 4028I-89
REPORT NUMBER: 5708
ANALYSIS COMPLETED: 10/02/89
REPORT DATE: 10/04/89

ANALYSIS

TOTAL METALS [UNITS = mg/kg]

1. Arsenic	0.55	5. Lead	140.0
2. Barium	9.5	6. Mercury	0.067
3. Cadmium	1.0	7. Selenium	<0.25
4. Chromium	8.35	8. Silver	5.35

ADDITIONAL INFORMATION AND IEPA TESTING

1. EOX: 3,014 ppm
2. PCB's: <2 ppm

Extractible organic halides

LABORATORY REPORT

3307 - 14th Avenue
Kenosha, Wisconsin 5314
Phone (414) 652-5656

Fax (414) 652-5902
1-800-284-3823

gabriel - midwest, ltd.
Environmental & Technical Services

TO: Mr. Ken Smith, Industrial Pumping, Kenosha, WI
SUBJECT: Analysis of Sludge Sample
WI CERTIFICATION ID #: 252087440
P.O. #: Verbal/Smith
SAMPLE DATE: NOT GIVEN DATE RECEIVED: 09/12/89
GML SAMPLE CODE: 39521-89
REPORT NUMBER: 5647
REPORT DATE: 09/27/89

ANALYSIS

1. Flashpoint deg. F	>212
2. pH, Standard Units	5.20
3. Total Solids [%]	37.26
4. Total Cyanide	0.166 ppm

TOTAL METALS [UNITS = ppm]

1. Arsenic	0.32	6. Mercury	0.083
2. Barium	<1.0	7. Nickel	13.44
3. Cadmium	0.60	8. Selenium	<0.10
4. Chromium	,005 6.2	9. Silver	2.28
5. Lead	3.8	10. Zinc	57.6

ADDITIONAL INFORMATION AND LEPA TESTING

1. Density: 0.87 g/cc
2. PCB's: <2 ppm
3. Phenols: 2 mg/L
4. Sulfide: <1 ppm
5. Chlorine: 6,000 ppm
6. Color: Black
7. Layers: 2
8. Odor: Musty/Organic

White Copy - Client

LAB DIRECTOR

LABORATORY REPORT

3307 - 14th Avenue
Kenosha, Wisconsin 53140
Phone (414) 652-5656

Fax (414) 652-5902
1-800-284-3823

gabriel - midwest, ltd.
Environmental & Technical Services

TO: Mr. Ken Smith, Industrial Pumping, Kenosha, WI
SUBJECT: Analysis of Sludge Sample
WI CERTIFICATION ID #: 252087440
P.O. #: Verbal/Smith
SAMPLE DATE: NOT GIVEN
GML SAMPLE CODE: 39521-89
REPORT NUMBER: 5647A
REPORT DATE: 09/27/89

DATE RECEIVED: 09/12/89
ANALYSIS COMPLETED: 10/24/89
REPORT COMPLETED: 10/25/89
PAGE 2 OF 2

COPMOUND	RESULTS	DETECTION LIMIT
Chloromethane	NOT DETECTED	400 ug/kg
Vinyl Chloride	NOT DETECTED	400 ug/kg
Bromomethane	NOT DETECTED	400 ug/kg
Chloroethane	NOT DETECTED	400 ug/kg
Trichlorofluoromethane	NOT DETECTED	200 ug/kg
1,1-Dichloroethene	580 ug/kg	
Carbon Disulfide	NOT DETECTED	200 ug/kg
Acetone	1,703 ug/kg	
Methylene Chloride	446 ug/kg	
1,2-Dichloroethene (trans)	NOT DETECTED	200 ug/kg
Hexane	561 ug/kg	
1,1-Dichloroethane	6,860 ug/kg	
Vinyl Acetate	NOT DETECTED	200 ug/kg
2-Butanone	NOT DETECTED	400 ug/kg
Chloroform	NOT DETECTED	200 ug/kg
1,1,1-Trichloroethane	11,900 ug/kg	
Carbon Tetrachloride	NOT DETECTED	200 ug/kg
Benzene	458 ug/kg	
1,2-dichloroethane	NOT DETECTED	200 ug/kg
Trichloroethene	2,800 ug/kg	
1,2-Dichloropropane	NOT DETECTED	200 ug/kg
Bromodichloromethane	NOT DETECTED	200 ug/kg
2-Chloroethylvinylether	NOT DETECTED	400 ug/kg
cis-1,3-Dichloropropene	NOT DETECTED	200 ug/kg
2-Hexanone	NOT DETECTED	400 ug/kg
Toluene	6,437 ug/kg	
Trans-1,3-Dichloropropene	NOT DETECTED	200 ug/kg
1,1,2-Trichloroethane	NOT DETECTED	200 ug/kg
Tetrachloroethene	1,100 ug/kg	
Dibromochloromethane	NOT DETECTED	200 ug/kg
4-Methyl-2-Pentanone	NOT DETECTED	400 ug/kg
Chlorobenzene	NOT DETECTED	200 ug/kg
Ethylbenzene	2,320 ug/kg	
Total Xylene	13,338 ug/kg	
Styrene	NOT DETECTED	200 ug/kg
Bromoform	NOT DETECTED	200 ug/kg
1,1,2,2-Tetrachloroethane	NOT DETECTED	200 ug/kg
1,3-Dichlorobenzene	NOT DETECTED	200 ug/kg
1,4-Dichlorobenzene	NOT DETECTED	200 ug/kg
1,2-Dichlorobenzene	NOT DETECTED	200 ug/kg

SWANSON ENVIRONMENTAL INC.

3150 North Brookfield Road
Brookfield, Wisconsin 53005
telephone (414) 783-6111
facsimile (414) 783-5752

ANALYTICAL REPORT

AIHA Accreditation #352
WDNR Certification #26818170

REPORT NUMBER: 89399

Industrial Pumping, Inc.
[illegible] 47th Avenue
Kenosha, WI 53142

Attn: Mr. Ken Smith

DATE: November 2, 1989
PURCHASE ORDER:
SEI JOB NO: WL1022
DATE COLLECTED: 10/24/89
DATE RECEIVED: 10/24/89

Oil Sample

Units: mg/kg (ppm)
Detection Limit: Noted below in ( )

	SEI ID	1022-1
VOLATILES	**Sample ID**	**Oil**
Acetone (20)		ND
Benzene (4)		19
Bromodichloromethane (60)		ND
Bromoform (60)		ND
Bromomethane (20)		ND
2-Butanone (12)		ND
Carbon tetrachloride (60)		130
Chlorobenzene (6)		ND
Chlorodibromomethane (60)		ND
Chloroethane (16)		ND
Chloroform (60)		ND
Chloromethane (20)		ND
1,1-Dichloroethene (40)		ND
1,2-Dichloroethane (10)		ND
1,1-Dichloroethane (10)		ND
trans-1,2-Dichloroethene (20)		ND
1,2-Dichloropropane (10)		ND
cis-1,3-Dichloropropene (12)		ND
trans-1,3-Dichloropropene (12)		ND
Ethylbenzene (4)		130

ND--Not Detected

Reviewed & Approved by:

Rosemary L. Dineen

Rosemary L. Dineen
Laboratory Supervisor

swanson environmental inc.

3150 North Brookfield Road
Brookfield, Wisconsin 53005
telephone (414) 783-6111
facsimile (414) 783-5752

ANALYTICAL REPORT

AIHA Accreditation #352
WDNR Certification #26818170

REPORT NUMBER: B9399

Industrial Pumping, Inc.
3223 47th Avenue
Kenosha, WI 53142

Attn: Mr. Ken Smith

DATE: November 2, 1989
PURCHASE ORDER:
SEI JOB NO: WL1022
DATE COLLECTED: 10/24/89
DATE RECEIVED: 10/24/89

Oil Sample

Units: mg/kg (ppm)
Detection Limit: Noted below in ( )

	SEI ID	1022-1
VOLATILES	**Sample ID**	**Oil**
2-Hexanone (6)		27
Methylene chloride (8)		ND
4-Methyl-2-pentanone (6)		ND
Styrene (20)		ND
1,1,2,2-Tetrachloroethane (20)		ND
Tetrachloroethene (20)		ND
Toluene (4)		187
1,1,1-Trichloroethane (14)		120
1,1,2-Trichloroethane (14)		ND
Trichloroethene (14)		65
Vinyl acetate (14)		ND
Vinyl chloride (14)		ND
Xylenes (6)		557

ND--Not Detected

Reviewed & Approved by:

Rosemary L. Dineen
Laboratory Supervisor

APPENDIX J
August 1990 Industrial Pumping Oil Spill WDNR Information

State of Wisconsin
Department of Natural Resources

TOXIC AND HAZARDOUS SPILL REPORT

Form 4400-91 Rev. 6-86

State Div. Emergency Gov't.	(608) 266-3232
U.S. Nat'l. Response Center	(800) 424-8802
Chemtrec/Pesticides/Chlorine	(800) 424-9300

Spill ID Number ___ ___ ___ ___ ___ ___ ___
Y Y M M D D 0-99

Date of Incident	Day of Week	Time of Incident ☐ A.M. ☐ P.M.	Reported By (Name) Paul Hess	Telephone Number (414) 791-7498
Date Reported Aug 7, 1990	Day of Week Tue	Time Reported 1335 ☐ A.M. ☒ P.M.	Agency or Firm Reporting Kenosha EG	Reported thru Div. Emergen. Gov't. ☒ Yes ☐ No

Substance Involved petroleum product | Quantity 100 | Units GA
Substance Involved | Quantity | Units

Person or Firm Responsible Industrial Plumbing
Contact Name Ken Smith
Telephone Number ( )
Address — Street or Route 3502 62nd St
City, State, Zip Code Kenosha

Physical Characteristics
☐ Solid ☒ Liquid Color ______
☐ Semisolid ☐ Gas Odor ______

Cause of Incident

Exact Location Description (intersection, mileage, etc.)

County Location Kenosha
¼¼, ¼, Section, Town, Range ___, ___, ___, T ___ N, R ___

DNR Dist SED
DNR Area
Groundwaters Affected ☐ Yes ☐ No ☒ Potential

Surface Waters Affected ☐ Yes ☒ No ☐ Potential
Name of Surface Water ——

Date District Notified ~~Aug~~ Aug 7, 1990
Day of Week Tue
Time District Notified 1335 ☐ A.M. ☒ P.M.

District Person Notified Wynette Davis
Telephone Number (414) 263-8668

Date Investigated
Day of Week
Time Investigated ☐ A.M. ☐ P.M.

Person Investigating
Telephone Number ( )

Action Taken By DNR
☐ No Action Taken ☐ Investigation ☐ Supervise/Conduct Cleanup
☒ Spiller Required To Take Action; Type CLEAN-UP
☐ Contractor Hired By DNR; Name ______
☐ Amount Recovered ______
☐ 29.29 Enforcement

Other Agencies on Scene
Local KENOSHA CO. DEPT. EMERG. GOVT.
State ______
Federal KEN THEISEN - US. EPA (NOTIFIED BY HESS. NOT ON SCENE)

Action Taken By Spiller
☐ No Action Taken ☐ No Notification ☐ Investigate
☐ Containment; Type ______
☒ Cleanup; Method ABSORBANTS
☐ Amount Recovered ______
☐ Monitor ______
☐ Contractor Hired; Name ______
☐ Other Action ______

Spill Location
☐ Industrial Facility/Paper Mill/Chem. Co.
☐ Gas/Service Station/Garage, Auto Dealer, Repair Shop
☐ Ag Coop/Facility/Cheese Factory/Creamery
☐ Other Small Business (bank, grocery, insurance co., etc.)
☐ Public Property (city, county, state, church, school, etc.)
☐ Utility Co., Power Generating/Transfer Facility
☐ Private Property (home/farm)
☒ Pipeline, Terminal, Tank Farm, [✓ Oil Jobber/Wholesaler]
☐ Transportation Accident, Fuel Supply Tank Spill
☐ Transportation Accident, Load Spill
☐ Construction, Excavation, Wrecking, Quarry, Mine
☐ Other ______

Spilled Substance Destination
☐ Air
☒ Soil
☐ Groundwater
☐ Surface Water
☐ Storm Sewer
☐ Sanitary Sewer
☐ Contained/Recovered
☐ Other

Person Filing This Report (print name) FRANK SCHULTZ
Signature
Date Signed 8/7/90

Additional Comments:
Paul says this facility has several outstanding violations, & he (Paul) wants DNR action right away.

8/7/90 - CALLED PAUL HESS ABOUT 2:15 PM. HE REQUESTED: ① [redacted] ANALYSIS OF A SAMPLE THEY COLLECTED (TURN-AROUND AS QUIK AS POSSIBLE) ② PROPER CLEAN-UP OF THIS SPILL, ③ COMPLIANCE W/ LAST ORDER, & ④ ANY NECESSARY ADDITIONAL INVESTIGATIONS. I LEFT MESSAGES FOR KEN. CO. WARDENS TODD SCHALLER & ROY KUBISIAK.

DISTRICT

State of Wisconsin
Department of Natural Resources

CHAIN OF CUSTODY RECORD
Form 4100-145 7-87

Sample Collector(s) Paul M. Hess	Title/Work Station Kenosha County Emergency Services Director	Telephone No. (include area code) 414-656-6595
Property Owner	Property Address	Telephone No. (include area code)

Split Samples: Offered? ☐ Yes ☐ No (Check One)
Accepted? ☐ Yes ☐ No (Check One) Accepted By: ____________________
Signature

Field ID No.	Date	Time	Sample Type		Station Location Sample Description	Lab ID Number	No. of Containers	Comments
			Comp	Grab				
	8/7/90	1:30			3302 66 St. Kenosha Oil spill		1	

I hereby certify that I received, properly handled, and disposed of these samples as noted below:

Relinquished By (Signature) Paul M. Hess	Date/Time 8/8/90	Received by: (Signature) Jon Korff
Relinquished By (Signature) Jon Korff	Date/Time 8/8/90 3:52p	Received by: (Signature) Greg Ruckel
Relinquished By (Signature)	Date/Time	Received for Laboratory By: (Signature)

Disposition of Unused Portion of Sample:

Dispose ________ Retain for ________ days

Return ________ Other ________

DONOHUE ANALYTICAL CERTIFICATE OF ANALYSIS

Copies to
Jim S
Walt E.

MR. FRANK SCHULTZ
WISCONSIN DNR
PO BOX 12436
MILWAUKEE WI 53212

RECEIVED
AUG 1 5 1990
D.N.R. SED Hqtrs.
Milwaukee, WI

DATE REPORTED: 14-AUG-90
PROJECT NUMBER: 65007.115
RECV. GROUP NO: 84701
DATE RECEIVED: 08-AUG-90
TIME RECEIVED: 10:11

CLIENT NAME: Wisconsin DNR
P.O. NO: SAMPLER: Client
TIME COLLECT: 00:00 DATE COLLECT: 07-AUG-90
SAMPLE NO: 84701 MATRIX: HAZRD DESC: Oil Spill Sample

ANALYTE NAME	RESULT	UNITS	RQ	ANALYZED	METHOD
Arochlor 1016	<0.5	mg/kg	WB	13-AUG-90	8080
Arochlor 1221	<0.5	mg/kg	WB	13-AUG-90	8080
Arochlor 1232	16	mg/kg	WB	13-AUG-90	8080
Arochlor 1242	<0.5	mg/kg	WB	13-AUG-90	8080
Arochlor 1248	<0.5	mg/kg	WB	13-AUG-90	8080
Arochlor 1254	3	mg/kg	WB	13-AUG-90	8080
Arochlor 1260	<0.5	mg/kg	WB	13-AUG-90	8080
PCB - Oil	19	mg/kg	WB	13-AUG-90	8080
1,1,1-Trichloroethane	<1	mg/kg	WB	10-AUG-90	8021
1,1,2,2-Tetrachloroethane	<1	mg/kg	WB	10-AUG-90	8021
1,1,2-Trichloroethane	<1	mg/kg	WB	10-AUG-90	8021
1,1-Dichloroethane	61	mg/kg	WB	10-AUG-90	8021
1,1-Dichloroethylene	<1	mg/kg	WB	10-AUG-90	8021
1,2-Dichlorobenzene	16	mg/kg	WB	10-AUG-90	8021
1,2-Dichloroethane	<1	mg/kg	WB	10-AUG-90	8021
1,2-Dichloropropane	<1	mg/kg	WB	10-AUG-90	8021
1,3-Dichlorobenzene	12	mg/kg	WB	10-AUG-90	8021
1,4-Dichlorobenzene	7	mg/kg	WB	10-AUG-90	8021
2-Chloroethylvinyl ether	<1	mg/kg	WB	10-AUG-90	8021
Benzene	<1	mg/kg	WB	10-AUG-90	8021
Bromodichloromethane	<1	mg/kg	WB	10-AUG-90	8021
Bromoform	<1	mg/kg	WB	10-AUG-90	8021
Carbon tetrachloride	<1	mg/kg	WB	10-AUG-90	8021
Chlorobenzene	<1	mg/kg	WB	10-AUG-90	8021
Chloroform	4	mg/kg	WB	10-AUG-90	8021
Dibromochloromethane	<1	mg/kg	WB	10-AUG-90	8021
Ethylbenzene	25	mg/kg	WB	10-AUG-90	8021
Methylene chloride	59	mg/kg	WB	10-AUG-90	8021
Tetrachloroethylene	<1	mg/kg	WB	10-AUG-90	8021
Toluene	93	mg/kg	WB	10-AUG-90	8021
Total Xylenes	74	mg/kg	WB	10-AUG-90	8021
Trichloroethylene	<1	mg/kg	WB	10-AUG-90	8021
Vinyl chloride	<2	mg/kg	WB	10-AUG-90	8021

Analyses performed in accordance with procedures approved by the U.S. EPA. Certified by the State of Wisconsin DNR. Laboratory I.D. No. 460060920.

Kerry DeKeyser
Project Manager

8-14-90
Date

Donohue
4738 North 40th Street
P.O. Box 1067
Sheboygan, Wisconsin 53082-1067
414.458.8711
Telefax 414.458.0537

DONOHUE ANALYTICAL CERTIFICATE OF ANALYSIS

Page 2 of 2

P.O. NO: SAMPLER: Client
TIME COLLECT: 00:00 DATE COLLECT: 07-AUG-90
SAMPLE NO: 84701 MATRIX: HAZRD DESC: Oil Spill Sample

ANALYTE NAME	RESULT	UNITS	RQ	ANALYZED	METHOD
cis-1,2-Dichloroethylene	4	mg/kg	WB	10-AUG-90	8021
cis-1,3-Dichloropropene	<1	mg/kg	WB	10-AUG-90	8021
trans-1,2-Dichloroethylene	3	mg/kg	WB	10-AUG-90	8021
trans-1,3-Dichloropropene	<1	mg/kg	WB	10-AUG-90	8021

RQ (Result Qualifier):
WB = Results expressed as is (wet basis).

Analyses performed in accordance with procedures approved by the U.S. EPA. Certified by the State of Wisconsin DNR. Laboratory I.D. No. 460060920.

Kerry DeKeyser
Project Manager

8-14-90
Date

DNR OFFICE MEMO
Form 9500-43 Rev. 5-89

To Watt Frances	**Date** 8/16	**Time**
From [illegible] for F.S. Watt		
Of		
Phone	**Received by**	

☐ **Please Call** ☐ **Returning Your Call** ☐ **Will Call Again** ☐ **Called to See You**

☐ **Comment**
☐ **For Your Information**
☐ **See Me**
☐ **Take Action**
☐ **Approve**
☐ **Sign**
☐ **Revise**
☐ **Prepare Reply For My Signature**
☐ **Reply Direct**
☐ **Per Your Request**
☐ **Code**
☐ **Route to:**

☐ **Return**
☐ **File**

Please review & comment on these results which pertain to your program objectives

This sample does not appear to be a hazardous waste WAE

DONOHUE ANALYTICAL CERTIFICATE OF ANALYSIS

Page 1 of 2

MR. FRANK SCHULTZ
WISCONSIN DNR
PO BOX 12436
MILWAUKEE WI 53212

Low Hs, characteristic
Hazardous Waste F501

DATE REPORTED: 14-AUG-90
PROJECT NUMBER: 65007.115
RECV. GROUP NO: 84701
DATE RECEIVED: 08-AUG-90
TIME RECEIVED: 10:11

CLIENT NAME: Wisconsin DNR
P.O. NO: SAMPLER: Client
TIME COLLECT: 00:00 DATE COLLECT: 07-AUG-90
SAMPLE NO: 84701 MATRIX: HAZRD DESC: Oil Spill Sample

ANALYTE NAME	RESULT	UNITS	RO	ANALYZED	METHOD
Arochlor 1016	<0.5	mg/kg	WB	13-AUG-90	8080
Arochlor 1221	<0.5	mg/kg	WB	13-AUG-90	8080
Arochlor 1232	16	mg/kg	WB	13-AUG-90	8080
Arochlor 1242	<0.5	mg/kg	WB	13-AUG-90	8080
Arochlor 1248	<0.5	mg/kg	WB	13-AUG-90	8080
Arochlor 1254	3	mg/kg	WB	13-AUG-90	8080
Arochlor 1260	<0.5	mg/kg	WB	13-AUG-90	8080
PCB - Oil	19	mg/kg	WB	13-AUG-90	8080
1,1,1-Trichloroethane	<1 10,000 ppm for F500	mg/kg	WB	10-AUG-90	8021
1,1,2,2-Tetrachloroethane	<1	mg/kg	WB	10-AUG-90	8021
1,1,2-Trichloroethane	<1	mg/kg	WB	10-AUG-90	8021
1,1-Dichloroethane	61	mg/kg	WB	10-AUG-90	8021
1,1-Dichloroethylene	<1	mg/kg	WB	10-AUG-90	8021
1,2-Dichlorobenzene	16	mg/kg	WB	10-AUG-90	8021
1,2-Dichloroethane	<1	mg/kg	WB	10-AUG-90	8021
1,2-Dichloropropane	<1	mg/kg	WB	10-AUG-90	8021
1,3-Dichlorobenzene	12	mg/kg	WB	10-AUG-90	8021
1,4-Dichlorobenzene	7	mg/kg	WB	10-AUG-90	8021
2-Chloroethylvinyl ether	<1	mg/kg	WB	10-AUG-90	8021
Benzene	<1	mg/kg	WB	10-AUG-90	8021
Bromodichloromethane	<1	mg/kg	WB	10-AUG-90	8021
Bromoform	<1	mg/kg	WB	10-AUG-90	8021
Carbon tetrachloride	<1	mg/kg	WB	10-AUG-90	8021
Chlorobenzene	<1	mg/kg	WB	10-AUG-90	8021
Chloroform	4	mg/kg	WB	10-AUG-90	8021
Dibromochloromethane	<1	mg/kg	WB	10-AUG-90	8021
Ethylbenzene	25	mg/kg	WB	10-AUG-90	8021
Methylene chloride	59	mg/kg	WB	10-AUG-90	8021
Tetrachloroethylene	<1	mg/kg	WB	10-AUG-90	8021
Toluene	93	mg/kg	WB	10-AUG-90	8021
Total Xylenes	74	mg/kg	WB	10-AUG-90	8021
Trichloroethylene	<1	mg/kg	WB	10-AUG-90	8021
Vinyl chloride	<2	mg/kg	WB	10-AUG-90	8021

Analyses performed in accordance with procedures approved by the U.S. EPA. Certified by the State of Wisconsin DNR. Laboratory I.D. No. 460060920.

KS 8-14-90
Project Manager Date

DONOHUE ANALYTICAL CERTIFICATE OF ANALYSIS

Page 2 of 2

P.O. NO:
SAMPLER: Client
TIME COLLECT: 00:00 DATE COLLECT: 07-AUG-90
SAMPLE NO: 84701 MATRIX: HAZRD DESC: Oil Spill Sample

ANALYTE NAME	RESULT	UNITS	RQ	ANALYZED	METHOD
cis-1,2-Dichloroethylene	4	mg/kg	WB	10-AUG-90	8021
cis-1,3-Dichloropropene	<1	mg/kg	WB	10-AUG-90	8021
trans-1,2-Dichloroethylene	3	mg/kg	WB	10-AUG-90	8021
trans-1,3-Dichloropropene	<1	mg/kg	WB	10-AUG-90	8021

RQ (Result Qualifier):
WB = Results expressed as is (wet basis).

Analyses performed in accordance with procedures approved by the U.S. EPA. Certified by the State of Wisconsin DNR. Laboratory I.D. No. 460060920.

4738 North 40th Street
P.O. Box 1067
Sheboygan, Wisconsin 53082-1067
414.458.8711
Telefax 414.458.0537

Project Manager Date

656-6595

8-20-90 Conference Call w/Kenosha County
Kenosha Industrial Pumping - Ken Smith
samples run →

site security:
soil clean up:

Waste oil activities from the site

DILHR → Bureau of Petroleum Inspection
regulation under storage

Semi Trailer adjacent to Ken Smith's
property

RESPONDENCE/MEMORANDUM **State of Wisconsin**

ate: August 21, 1990 **File Ref:** 4400

To: Pat Sheehan - SED

From: Frank Schultz - SED Frank Schultz

Cost Recovery?

I ✓ Spill files - can't find an incident report!

Subject: Laboratory Analyses Performed by Donohue & Associates, Sheboygan

On Tuesday, August 7th I received a call from Paul Hess, Kenosha County Emergency Government Coordinator, about a spill at Industrial Pumping in Kenosha, Wisconsin. The Kenosha Hazardous Materials Investigation Team had collected a sample of spilled material. Mr. Hess requested DNR's assistance in having this sample analyzed. He felt that rapid turn-around on this analysis was important to ensure proper clean-up and disposal of contaminated soils.

I checked with five (5) laboratories (CBC - Oak Creek, SET - Wheeling, Illinois, Aqua-Tech - Port Washington, Swanson Environmental - Brookfield, and Donohue & Associates - Sheboygan) about analyzing this sample. The best lab for this analysis, when considering cost and turn-around time seemed to be Donohue & Associates. They gave me a verbal quote of $430.00 to provide a VOC scan and PCB analysis in 2-3 days. I sent the sample to Donohue and directed them to do the analyses.

Donohue called me after they began their PCB analysis and said that they would have to do additional laboratory procedures to obtain the results that I needed. This meant that the total cost of the analysis would be about $530.00. Since it would have been impossible to transfer the sample to another lab at that point, I told Donohue to continue with their analysis.

I believe that this was the correct course of action to follow to protect the environment, and that Donohue's charges are reasonable and justified. I am asking for payment of the attached invoice even through proper fiscal procedures (3 bids for expenditures greater than $500.00) were not followed.

Approved by:

Ted Bosch

for Ronald W. Kazmierczak

Attachment

Frank - I looked in '90 spills file and could not locate a spill report on this. Can you fill in any details

RWK

Aug90\2957\4

EARTH YEAR
WISCONSIN
1970 April 22 1990

To: Southeast Finance Office

Date: 9/6/90

From: DEAN KELLEY FOR FRANK SCHULTZ

Station: MKE

Supv Signoff:

Pay To: DONOHUE

Address: SHEBOYGAN

Purchase Order Number: NR

Item Purchased: LABORATORY SERVICES

Description of Use: EMERGENCY SPILL RESPONSE

Invoice Number	Invoice Date	Date Item Received		Checkbook	Subunit	PMN		Amount
9007047	8/23/90	8/7/90		SW62	ERP	SP901		530 00

SED FIELD PURCHASE ADVICE
Form 9300-196 8-89

Department of Natural Resources

PURCHASER/PREPARER

Department of Natural Resources

SOLID WASTE MANAGEMENT FACILITY CONTACT FORM

Form 4400-106 6-86

NOTE: DO NOT USE THIS FORM WHEN DOCUMENTING INSPECTIONS AT HAZARDOUS WASTE AND SOLID WASTE FACILITIES. SEE BACK SIDE OF THIS FORM FOR MORE INFORMATION.

ATTN: ____________________

☐ Residuals Management SW/3
☐ District ____________
☐ Hazardous Waste Management SW/3
Unit ____________
☐ Environmental Enforcement EE/5
☐ Systems Management SW/3
☐ ____________

License Number
_ _ _ _ _

EPA ID Number
WI-_ _ _ _ _ _ _ _ _ _

Facility ID Number
_ _ _ _ _ _ _ _ _ _

Facility/Company Name INDUSTRIAL	Location (Address or ¼¼) 3302 66TH ST.	City, State, Zip Code KENOSHA, WI

Facility Type WASTE TRANSPORT	District SED	County KENOSHA	Contact Method ☒ Telephone ☐ In-Person	Date 08 / 24 / 90 M M D D Y Y	Time (24-Hour Clock) _ _ _ _

Facility Representative Contacted KEN SMITH	Title or Position of Representative OWNER	Telephone Number (include area code) (414) 552-9788

KEN SMITH CALLED TO SAY THAT IND. PUMPING HAD CLEANED UP THE SPILL of 8/7/90 AND HAD BEEN WAITING TO HEAR IF FURTHER WORK WAS REQUIRED. HE FELT THAT THEY HAD DONE AN ADEQUATE JOB AND WANTED TO PUT THIS INCIDENT BEHIND THEM.

I SAID THAT, UNLESS HE HEARD FROM PAUL HESS OR OUR WARDEN, HE COULD CONSIDER THIS CLEAN-UP COMPLETE.

Check if additional sheets attached ☐

By

TO: KIM McCUTCHEON - SW/3

FROM: FRANK SCHULTZ - SED

SUBJECT - MESSAGE

RE: SUMMARY OF 8/7/90 PETROLEUM SPILL @ INDUSTRIAL PLATING / KENOSHA

HERE ARE THE IMPT. FACTS ON THIS INCIDENT AS I RECOLLECT THEM.

8/7/90 - PAUL HESS (KEN. CO. [illegible]) CALLED SPILL IN. HE WAS VERY CONCERNED ABOUT WHAT THE SPILLED MATERIAL WAS. KENOSHA CO. [illegible] WERE NOT IMMEDIATELY AVAILABLE. HOWEVER, BECAUSE OF HESS'S [illegible], RELATIVELY SMALL AMOUNT OF PETRO SPILLED (EST. 100 GAL), RP WAS TAKING ACTION, AND LOCATION IN AN INDUSTRIAL/COMMERCIAL AREA MADE HEALTH AND/OR ENV. DAMAGE UNLIKELY, IMMEDIATE RESPONSE BY DNR DIDN'T SEEM NECESSARY.

8/8/90 - DNR/SED RECEIVED A SAMPLE OF THE SPILLED MATERIAL FROM KENOSHA CO. [illegible] AND TRANSPORTED IT TO DONOHUE IN SHEBOYGAN FOR ANALYSIS.

8/15/90 - RECEIVED LAB REPORT FROM DONOHUE ON SPILLED MATERIAL. WHILE CONTAINING MANY ORGANIC COMPOUNDS, IT DID NOT APPEAR TO BE HAZARDOUS WASTE. WE DECIDED NOT TO PURSUE [illegible] ENFORCEMENT

SIGNED DATE

REPLY

AT THAT TIME.

8/29/90 - KEN SMITH OF IND. PLATING CALLED TO SAY THAT THEY HAD BEEN WAITING TO HEAR IF FURTHER CLEAN-UP WAS NECESSARY. I SAID THAT UNLESS PAUL HESS OR OUR WARDENS CONTACTED HIM HE WAS FINISHED WITH THIS INCIDENT.

I BELIEVE THAT ONE OF OUR WARDENS VIEWED THE CLEAN-UP BUT I HAVEN'T FOUND A REPORT. FS - 9/4/91

SENDER RETAIN THIS COPY SIGNED DATE

APPENDIX K
September 1991 Industrial Pumping Oil Spill WDNR Information through 1994

Department of Natural Resources

SOLID WASTE MANAGEMENT FACILITY CONTACT FORM

Form 4400-106 6-86

NOTE: DO NOT USE THIS FORM WHEN DOCUMENTING INSPECTIONS AT HAZARDOUS WASTE AND SOLID WASTE FACILITIES. SEE BACK SIDE OF THIS FORM FOR MORE INFORMATION.

ATTN:

☐ Residuals Management SW/3 ☐ District

☐ Hazardous Waste Management SW/3 Unit ☐ Environmental Enforcement EE/5

☐ Systems Management SW/3 ☐

License Number

EPA ID Number WI-

Facility ID Number

Facility/Company Name: INDUSTRIAL PUMPING

Location (Address or ¼¼):

City, State, Zip Code:

Facility Type	District	County	Contact Method	Date	Time (24-Hour Clock)
WASTE OIL	SED	KENOSHA	☒ Telephone ☐ In-Person	09/06/91 M M D D Y Y	1619

Facility Representative Contacted	Title or Position of Representative	Telephone Number (include area code)
—		( )

PAUL HESS CALLED AGAIN ABOUT INDUSTRIAL PUMPING. THE LICENSE PLATE # ON THE TRUCK IS JB 3208-102. THERE ARE OIL DRUMS INSIDE THIS TRUCK.

PAUL IS VERY CONCERNED ABOUT THE SPILLED MATERIALS. HE FEELS THAT THEY COULD BE HAZARDOUS WASTES AND THAT WITHOUT CLOSE SUPERVISION THESE MATERIALS WILL BE IMPROPERLY HANDLED. HE WANTS TO FIND OUT WHAT THE SPILLED MATERIAL IS AS SOON AS POSSIBLE.

Check if additional sheets attached ☐

By

C 1287

HAZARDOUS WASTE COMPLIANCE MONITORING AND ENFORCEMENT (CME) FORM

Form 4430-5 Rev. 1-90

State of Wisconsin
Department of Natural Resources

Pg 1 of 1

A. GENERAL INFORMATION:

Date Sent to HW- SW/3	Date Received by HW-SW/3	HW-SW/3 Review Date	Initials	CMEL Data Entry Date	Initials	Entrack Data Entry Date	Initials

Facility Name (As shown in a current EPA Notification Printout) Industrial Pumping

EPA ID Number W I

FID Number 230061790

Street/Location 3502 South 66 th Street

____ 1/4 of ____ 1/4 of Section ____ Town ____ Range ____

Notification Status (As shown in a current EPA Notification Printout) (Circle all that apply)
LQG SQG VSQG TRANS TSD
Other ____

City, Zip Code Kenosha 53142

District/County SED / Kenosh

Contact Name/Phone Ken Smith (414) 652-3075

Type of Contact ☒ Field Inspection ☐ Other ____ ☐ Conference

Contact Date 8-12-93

B. FACILITY INSPECTED AS (Check one box only):

Note: The box checked here, the Notification Status circled in Section A and the type of Inspection Form completed must all be status consistent.

☐ Commercial Treatment/Storage
☐ Non-Commercial Treatment/Storage
☐ Land Disposal Facility
☐ Incinerator
☐ Generator - Large Quantity
☐ Generator - Small Quantity
☐ Generator -Very Small Quantity
☐ Transporter
☐ Under Review for Activity (Recommended Status Is ____)
☐ Non-Hazardous Waste Entity
☐ Other ____

C. NOTIFICATION CHANGE:

☐ Status Change (Attach Status Change Form 4430-12): Field Verified Status Is ____
☐ Name Change: Change Name To ____

D. EVALUATION TYPE (Check all that apply):

☐ Compliance Evaluation Insp (1)
☐ Land Disposal Restriction Insp (13)
☐ Follow-up Insp (Date ____) (5)
☐ Routine Surveillance (10)
☐ Activity Verification (8)
☐ Complaint (6)
☐ Sampling Insp (2)
☐ Case Development (11)
☐ Immediate Threat (14)
☐ Record Review (3) [FRR __]
☐ Comp GW Monitoring Eval (4)
☐ O & M Inspection (12)
☐ Closure/Long Term Care (9)
☐ Licensing Evaluation (7)
☐ Other ____ (15)

E. ENFORCEMENT ACTIONS (List violation and/or enf. type separately):

Viol Type Class 1	Viol Type Class 2	Enf Type	Violation Discovery Date MM DD YY	Date Issued MM DD YY	Response Due MM DD YY	Actual Comp MM DD YY	Enf Stat	NR 181 or NR 600 Citation	Additional Information
			- -	- -	- -	- -			
			- -	- -	- -	- -			
			- -	- -	- -	- -			
			- -	- -	- -	- -			
			- -	- -	- -	- -			
			- -	- -	- -	- -			

F. SPECIALTIES (CHECK ONLY IF VIOLATION(S) HAVE BEEN CONFIRMED WITH OFFICE OF ENVIRONMENTAL ENFORCEMENT):

This facility is: ☐ High Priority Violator (H) ☐ Violating CA Schedule (C) ☐ Violating Insurance/Liability Regs (I)

District/Area Comments: ____

HW-SW/3 Comments: ____

District/ Area Signature(s) Mike Ellenbecker

Date 9-24-93

Documentation ☐ Inspection Form; Attachment #____ ☒ Letter/NON/NOV to Facility
☐ Status Change Form ☐ Other ____

District Review

Date

Distribution: Copy 1 - District Copy 2 - HW-SW/3; Rtn to Dist after CMEL entry Copy 3 - HW-SW/3 Copy 4 - Area

CORRESPONDENCE/MEMORANDUM

State of Wisconsin

DATE: September 16, 1993

IN RESPONSE REFER TO: EPA#: None
FID#: None
County of Kenosha
HW/ CMEL

TO: Industrial Pumping File

FROM: Michael J. Ellenbecker

SUBJECT: Site visit at Industrial Pumping, Nardi Electric, and Ken Smith

On Thursday August 12, 1993, at approximately 09:30 hours Michael J,. Ellenbecker arrived at Nardi Electric located at 3506 South 67th Street, Kenosha, Wisconsin, 53142. The purpose for the site visit is to assist EPA in providing background information regarding the criminal investigation.

At approximately 08:00 hours Ellenbecker arrived at the Kenosha Fire Department located at 625 52nd Street and met Paul Lazzari, FBI Special Agent; James Q. Swanson, EPA Special Agent; Swanson's assistant (name unknown); Raghavender R. Nagam, Ecology and Environmental, Inc.; and Michael F. Kulikowski, Ecology and Environmental, Inc.; and another person (name unknown) also from Ecology and Environmental, Inc. Nagam, Kulikowski, and the other person are consultants working for EPA.

After arriving on the site Nagam and Kulikowski, with the assistance of Arneson Foundry, open up the Nardi Electric trailer. Nagam, Kulikowski then dressed ion level B and entered the trailer.

Industrial Pumping is located at 3502 South 66th Street, Kenosha, Wisconsin, 53142. This building appears to be abandoned. Heavy vegetation surrounds the east and north sides of the building.

During the site visit an EPA field person (name unknown) told Ellenbecker that he had heard from a person--working in one of the buildings west of the Nardi trailer--that the Industrial Pumping building should be check out. Ellenbecker walked around the Industrial Pumping building and did not observe any open windows. Ellenbecker checked the garage doors and found them to be locked. Ellenbecker check a door and found it not locked. Ellenbecker open the door and observe several tanks containing a oil like liquid. Ellenbecker did not enter the building. The tanks appear to be approximately 500 gallons in size. Ellenbecker closed the door.

At approximately 12:45 p.m. Ellenbecker and Swanson arrived at the residence of Ken Smith, who is believed to be the owner of the building located at 3502 South 66th Street. Ellenbecker knocked on the door, but no one answered. Ellenbecker recorded the following plate numbers from the property: DDC-624, LNS-273, ACIO-511, LA-923, BAS098 (Michigan), N23-634/

HAZARDOUS WASTE COMPLIANCE MONITORING AND ENFORCEMENT (CME) FORM

Form 4430-5 Rev. 1-94

State of Wisconsin
Department of Natural Resources

ID 391
Pg 1 of 1

A. GENERAL INFORMATION:

Date Sent to HW-SW/3	Date Receivedby HW-SW/3	HW-SW/3 Review Date Initials	CMEL Data Entry Date Initials	Entract Data Entry Date Initials

Facility Name (As shown on current EPA Notification Printout): INDUSTRIAL PUMPING INC
EPA ID Number:
FID Number: 230061700
Street/Location: 3502 SOUTH 66TH STREEET
____1/4 of____1/4 of Section____Town____Range____
City, Zip Code: KENOSHA 53142
County: KENOSHA
District: SED
Contact Name/ Phone: KEN SMITH (414) 652-3075
Notification Status (As shown in a current EPA Notification Printout)
Principle Notified Status NRG
This Facility is also a (circle all that apply) LQG SQG VSQG TRANS TSD
Other
Type of Contact: Field Inspection
Contact Date: 3/14/94

B. FACILITY INSPECTED AS:

Facility Inspected As : __________

C. NOTIFICATION CHANGE:

Status Change (Attach Status Change Form 4430-12): Field Verified Staus Is __________
Name Change : Change Name To __________

D. EVALUATION TYPE (Check all that apply):

- ☐ Compliance Evaluation Ins (1)
- ☐ Land Disposal Restriction (13)
- ☐ Follow-up Insp. (Date________) (5)
- ☐ Routine Surveillance (10)
- Yes Activity Verfication (8)
- ☐ Interview
- ☐ Complaint (6)
- ☐ Sampling Insp. (2)
- ☐ Case Development (11)
- ☐ Immediate Threat (14)
- ☐ Record Review (3) [FRR_____]
- ☐ Comp GW Monitoring Eval (4)
- ☐ O & M Inspection (12)
- ☐ Closure/Long Term Care (9)
- ☐ Licensing Evaluation (7)
- ☐ Great Lakes Initiative
- Yes Other Dept. Invest.

E. ENFORCEMENT ACTIONS (List violation and/or enf. type separately):

Viol Type Class 1	Viol Type Class 2	Enf Type	Violation Discovery Date	Date Issued	Response Due	Actual Comp.	Enf Stat.	NR 600 Citation or State Stats.	Additional Information

F. SPECIALTIES (CHECK ONLY IF VIOLATION(S) HAVE BEEN CONFIRMED WITH OFFICE OF ENVIROMENTAL ENFORCEMENT):

This Facility is: High Priority Violator (H) ☐ Violating CA Schedule (C) ☐ Violating Insurance/Liability Regs (I) ☐

District/Area Comments: On site with Ken Smith. Observed approx. 75 drums containing waste oil and PCBs.

HW-SW/3 Comments:

District/Arear Signature(s) Mike Ellenbecker
Date: March 15, 1994

Documentation ☐ Inspection Form; Attachment #____ ☐ Letter/NON/NOV/ to Facility
☐ Status Change Form ☐ Other________
District Review
Date

Distribution: Copy 1 - District Copy 2 - HW-SW/3; Rtn to Dist after CMEL entry Copy 3 - HW-SW/3 Copy 4 - Area

Chemical Waste Mgmt.
6915 S. Timber Ridge #3110
Oak Creek, WI. 53154
414-761-3438 fax:414-761-3557

FAX COVER SHEET

From: Jeff Nelson **Date:** 4/7/94

To: MIKE ELLENBECKER
Fax: 961-2770

Number of Pages: 3

Comments:

ATTACHED ARE COPIES OF THE TWO PROFILES THAT WE HAVE ON THE MATERIAL AT INDUSTRIAL PUMPING. AS OF THIS WE HAVE NOT RECEIVED ANY OF THIS MATERIAL. IF YOU HAVE ANY QUESTIONS PLEASE CONTACT ME AT THE ABOVE NUMBER.

THANKS,
JEFF

Date Printed 10/01/93 **Chemical Waste Management, Inc.** EME AF8287

WASTE PROFILE Profile #

(_) Check here if this is a Recertification LOCATION OF ORIGINAL MIDWEST REGIONAL LAB

GENERAL INFORMATION

1. Generator Name: INDUSTRIAL PUMPING Generator USEPA ID: APPL

2. Generator Address: 3502 66TH ST.
KENOSHA WI 53142

Billing Address: (_) Same
INDUSTRIAL PUMPING
3223 47TH. ST.
KENOSHA WI 53144

3. Technical Contact/Phone: KEN SMITH 414/552-9788

4. Alternate Contact/Phone:

Billing Contact/Phone: KEN SMITH 414/552-9788

PROPERTIES AND COMPOSITION

5. Process Generating Waste: CLEANOUT OF OIL PROCESSING FACILITY

6. Waste Name: OILY LIQUIDS

7A. Is this a USEPA hazardous waste (40 CFR Part 261)? Yes (_) No (X)

B. Identify ALL USEPA listed and characteristic waste code numbers (D,F,K,P,U):

State Waste Codes:

8. Physical State @ 70F: A. Solid(_) Liquid(X) Both(_) Gas(_) B. Single Layer (X) Multilayer (_) C. Free Liq. range 95 to 100%

9A. pH: Range 4.0 to 10.0 or Not applicable (_) B. Strong Odor (_);describe

10. Liquid Flash Point: < 73F (_) 73-99F (_) 100-139F (_) 140-199F (_) >= 200F (X) N.A. (_) Closed Cup (X) Open Cup (_)

11. CHEMICAL COMPOSITION: List ALL constituents (incl. halogenated organics) present in any concentration and forward analysis

Constituents	Range	Unit Description
OIL	70 to 100	%
WATER	0 to 10	%
DIRT, SEDIMENT	0 to 20	%
	to	
	to	
	to	
TOTAL COMPOSITION (MUST EQUAL OR EXCEED 100%):	130.000000	

12. OTHER: PCBs if yes, concentration _ ppm, PCBs regulated by 40 CFR 761 (_). Pyrophoric (_) Explosive (_) Radioactive (_) Benzene if yes, concentration _ ppm. NESHAP (_) Shock Sensitive (_) Oxidizer (_) Carcinogen (_) Infectious (_) Other

13. If waste subject to the land ban & meets treatment standards, check here: _ & supply analytical results where applicable.

SHIPPING INFORMATION

14. PACKAGING: Bulk Solid (_) Bulk Liquid (_) Drum (X) Type/Size: 55 GALLON DRUM Other 12.5 TONS

15. ANTICIPATED ANNUAL VOLUME: 50 Units: DRUMS Shipping Frequency: ONE TIME

SAMPLING INFORMATION Sample Tracking Number: 4418429

16a. Sample source (drum, lagoon, pond, tank, vat, etc.): VAT & DRUMS

Date Sampled: 9/16/93 Sampler's Name/Company: KEN SMITH INDUSTRIAL PUMPING

16b. Generator's Agent Supervising Sampling: 17. (_) No sample required (See instructions.)

GENERATOR'S CERTIFICATION

I hereby certify that all information submitted in this and all attached documents contains true and accurate descriptions of this waste. Any sample submitted is representative as defined in 40 CFR 261 - Appendix I or by using an equivalent method. All relevant information regarding known or suspected hazards in the possession of the generator has been disclosed. I authorize CWM to obtain a sample from any waste shipment for purposes of recertification.

Signature on original profile AF8287

Signature Name and Title Date

Date Printed 10/05/93 **Chemical Waste Management, Inc.** CWM AF8288

WASTE PROFILE Profile #

(_) Check here if this is a Recertification LOCATION OF ORIGINAL MIDWEST REGIONAL LAB

GENERAL INFORMATION

1. Generator Name: INDUSTRIAL PUMPING Generator USEPA ID: APPL

2. Generator Address: 1502 66TH ST. Billing Address: INDUSTRIAL PUMPING

(_) Same 3223 47TH. ST.

KENOSHA WI 53142

3. Technical Contact/Phone: KEN SMITH 414/552-9788 KENOSHA WI 53144

4. Alternate Contact/Phone: Billing Contact/Phone: JEN SMITH 414/552-9788

PROPERTIES AND COMPOSITION

5. Process Generating waste: CLEANOUT OF OIL PROCESSING FACILITY

6. Waste Name: OILY SOLIDS

7A. Is this a USEPA hazardous waste (40 CFR Part 261)? Yes (_) No (X)

B. Identify ALL USEPA listed and characteristic waste code numbers (D,F,K,P,U):

State Waste Codes:

8. Physical State @ 70F: A. Solid(_) Liquid(_) Both(X) Gas(_) B. Single Layer (_) Multilayer (X) C. Free liq. range 1 to 50%

9A. pH: Range 4.0 to 10.0 or Not applicable (_) B. Strong Odor (_):describe

10. Liquid Flash Point: < 73F (_) 73-99F (_) 100-139F (_) 140-199F (_) >= 200F (X) N.A. (_) Closed Cup (X) Open Cup (_)

11. CHEMICAL COMPOSITION: List ALL constituents (incl. halogenated organics) present in any concentration and forward analysis

Constituents	Range	Unit Description
OIL	30 to 70	%
WATER	0 to 40	%
DIRT, RUST, SCALE	30 to 70	%
	to	
	to	
	to	
TOTAL COMPOSITION (MUST EQUAL OR EXCEED 100%):	180.000000	

12. OTHER: PCBs if yes, concentration 532 ppm. PCBs regulated by 40 CFR 761 (X). Pyrophoric (_) Explosive (_) Radioactive (_) Benzene if yes, concentration _ ppm. NESHAP (_) Shock Sensitive (_) Oxidizer (_) Carcinogen (_) Infectious (_) Other

13. If waste subject to the land ban & meets treatment standards, check here: _ & supply analytical results where applicable.

SHIPPING INFORMATION

14. PACKAGING: Bulk solid (_) Bulk Liquid (_) Drum (X) Type/Size: 55 GALLON DRUM Other

15. ANTICIPATED ANNUAL VOLUME: 50 Units: DRUMS Shipping Frequency: ONE TIME

SAMPLING INFORMATION Sample Tracking Number: 4418428

16a. Sample source (drum, lagoon, pond, tank, vat, etc.): DRUM

Date Sampled: 9/16/93 Sampler's Name/Company: KEN SMITH INDUSTRIAL PUMPING

16b. Generator's Agent Supervising Sampling: 17. (_) No sample required (See instructions.)

GENERATOR'S CERTIFICATION

I hereby certify that all information submitted in this and all attached documents contains true and accurate descriptions of this waste. Any sample submitted is representative as defined in 40 CFR 261 - Appendix I or by using an equivalent method. All relevant information regarding known or suspected hazards in the possession of the generator has been disclosed. I authorize CWM to obtain a sample from any waste shipment for purposes of recertification.

Signature on original profile AF8288

Signature Name and Title Date

APPENDIX L
April 1994 WDNR Information Request & May 1994 K. Singh Response

WISCONSIN
DEPT. OF NATURAL RESOURCES

George E. Meyer
Secretary

State of Wisconsin \ DEPARTMENT OF NATURAL RESOURCES

Southeast District - Annex Building
Post Office Box 12436
4041 N. Richards St.
Milwaukee, Wisconsin 53212
TELEPHONE: 414-961-2727
TELEFAX #: 414-961-2770

April 7, 1994

File Ref: FID# 230061700
ERR/ERP
Kenosha Co.

Mr. Kenneth Smith
3223 47th Avenue
Kenosha, Wisconsin 53142

Dear Mr. Smith:

RE: Industrial Pumping, Inc.; 3502 66th Street, Kenosha, WI
Remedial Investigation and Remedial Action Plan

The Wisconsin Department of Natural Resources (WDNR) has completed its review of the document titled "Site Assessment Report and Interim Remedial Action Plan", submitted on your behalf, for the above referenced site, by K. Singh & Associates, Inc. in January 1993. The WDNR has also received the Form 4 of your application for reimbursement from the Petroleum Storage Remedial Action Fund. The Form 4 has been checked for "Completion of Site Investigation (Step 1) and Proposed Remedial Action Plan (Step 2)". Based on the information reviewed, the WDNR cannot approve the Form 4 at this time, because the degree and extent of contamination have not been adequately defined to allow approval of the remediation plan. The following specific WDNR comments on your submittal should explain this decision. The WDNR will reconsider your Form 4, upon completion of the actions required in this letter.

1. The history of the site usage and product handling has not been adequately described. The following questions should be answered:

   a. How long has the site been used for petroleum product storage and what products were stored in the past at this site? Is there documentation that gasoline was managed at the site? Were mineral spirits, naphtha, stoddard solvent or other parts cleaning solvents ever handled or stored at the property?

   b. What type(s) of "waste oil" were handled at the facility, and is there any documentation or analytical data for this material?

   c. How were the tanks filled and emptied? Was there a rail loading/off-loading area? Were there any dump tanks, pump islands or piping on the property?

2. The locations of underground utilities, such as sanitary and storm sewers, water and gas lines, have not been provided. Knowledge of the layout and depth of these features is important for understanding the shallow ground water flow and the movement of contaminants on and off the site.

3. Based on the information presented in the report, it is apparent that the full nature and extent of contamination has not been defined in the soil or ground water. Specifically:

   a. A soil sample taken from soil boring B-1 documents shallow contamination in the southwest part of the property. The lateral extent of this contamination has not been defined in any direction. It is not clear from the investigation whether this data represents a continuous extension of contamination from the east side of the site, as depicted in Figures 8 and 9 of the report, or whether there is a separate area of shallow contamination due to the tanks previously located in the immediate vicinity of B-1.

      The deepest soil sample taken in B-1 had an elevated PID reading (70 units), yet no laboratory analysis was done on this sample to determine what this reading might mean. Hence the vertical extent of soil contamination in this area is not clearly defined.

   b. Soil samples from soil borings B-4 and B-8 document shallow soil contamination in the southeast corner of the property. Although the logs for borings to the south (B-10) and east (B-11) indicate that the contamination does not extend to those locations, no analytical samples were taken from these borings in the shallow interval to verify this. Even if these locations (B-10 & B-11) are clean, the iso-concentration contours shown in Figures 8 and 9 could not be definitively drawn within the east and south property lines.

   c. A soil sample from boring B-2 documents soil contamination in the northeast corner of the property. The lateral extent of this contamination has not been defined to the north or east.

   d. No soil samples were taken in the areas of tanks 7, 8, 11 or 12. No justification for excluding these potential source areas from the site investigation was provided.

   e. The soil samples were analyzed for GRO, DRO, TRPH, PVOC's and lead. Based on the products and wastes apparently handled on the property, the soils should also have been assessed for full VOC's, PCB's, PAH's and other heavy metals such as cadmium.

   f. The WDNR does not consider the ground water analytical results obtained from Mac Donald Research Group, Inc. to be valid, due to that laboratory's withdrawal from the state laboratory certification program. Thus the extent and degree of ground water contamination has not been defined.

4. Additional soil investigation is needed at the site to clarify the issues presented in comment 3., above. The ground water monitoring wells must be re-sampled and a certified laboratory should be used for the analysis. Ground water samples should be analyzed for full VOC's, GRO, DRO, heavy metals, PCB's and PAH's. Water levels should be determined when the wells are sampled. A scope of work for the needed investigation should be submitted for review. Additional monitoring wells may be necessary to complete the ground water contamination definition.

5. Although additional investigation is needed, it appears that the proposed remedial action may be acceptable. The WDNR encourages the use of bioremediation where it is an appropriate remedy. The presence of heavy metals, chlorinated VOC's, PCB's or PAH's in the soil requiring remediation could limit or prohibit the use of this remedy at your site, however, and thus no final approval can be issued for the proposed soil treatment until those parameters have been evaluated. The following comments on the remediation proposal can, however, be made at this time:

    a. The pH of the soil should be evaluated, both before and after the addition of the ammonium sulfate during the bench scale testing, to determine whether buffering additives will be necessary in the field application.

    b. Oxygen and moisture levels within the "biopile" should be regularly monitored during the field application of this remedy, in order to determine that optimal conditions for biodegradation are being maintained in the soil pile.

    c. Verification samples for the Phase I soil pile treatment should be taken for every 100 cubic yards of treated soil and analyzed for DRO and TRPH. One sample in every 300 cubic yards of treated soil should also be analyzed for GRO, VOC's, (and PAH's if the additional site investigation indicates it is necessary). If the Phase I verification sampling yields consistent results, Phase II and III verification sampling may be modified to one sample every 300 yards only, to be analyzed for all applicable constituents.

    d. The soil storage and treatment requirements stated in Chapter NR 718, Wisconsin Administrative Code should be followed. These requirements will come into effect on May 1, 1994.

    e. The proposed "leachate collection system" for the soil piles was not described. The report should detail how the presence of leachate will be determined and how leachate will be collected from the pile.

6. Upon receipt of the sample results from the additional investigation required in comments 3. and 4., above, the known extent and degree of soil and ground water contamination and the need for additional sampling or monitoring points should be evaluated. A report documenting this additional investigation should be submitted for review. The report should contain the information requested in comments 1, 2, and 5.e., above, as well as a response to comments 5.a-d., above.

    The report should also include revised contaminant iso-concentration diagrams. Based on recent WDNR case closeout guidelines, a 100 mg/kg total GRO/DRO contour line should be interpreted on these diagrams. The revised diagrams should also correct the following deficiencies noted in the recent submittal:

    a. Contours must be dashed where data points are not available to allow interpolation.
    b. The contour locations must be interpolated appropriately between data points and should not be distorted to follow property lines.
    c. The data from the two test pits must be incorporated into the diagrams.

Please be aware that Chapters NR 700, 714, 716, 718, 724 and 726, Wisconsin Administrative Code, containing additional requirements for carrying out and documenting remediation, will come into effect on May 1, 1994. You should comply with the applicable requirements from this Code series for future work and submittals. Please also note that the WDNR has recently issued a policy memorandum (Paul Didier memo, dated January 27, 1994) regarding "Case Closeout Guidelines for Hazardous Substance/Waste Releases", which will be explained in an upcoming *Release News*, a publication by the WDNR.

The WDNR regrets that the extreme number of environmental cleanup review requests received within the past two years has not allowed us to address your case until now. If you have any questions regarding the requirements in this letter, please contact me at (414) 961-2726.

Sincerely,

Pamela A. Mylotta
Hydrogeologist, Environmental Repair Program

c: Pratap Singh - K. Singh & Associates
Wisconsin Department of Industry, Labor and Human Relations
SED Casefile

230061700
ERR/ERP

Received 5/12/94
WDNR-SED

K. SINGH & ASSOCIATES, INC.
Engineers and Environmental Management Consultants
1135 Legion Drive, Elm Grove, WI 53122 (414) 821 - 1171 FAX (414) 821 - 1174

May 10, 1994

Ms. Pamela A. Mylotta
Hydrogeologist, Environmental Repair Program
Wisconsin Department of Natural Resources
P.O. Box 12436
4041 N. Richards Street
Milwaukee, WI 53212

Job # 3000

Subject : Additional Information for Industrial Pumping at
3502 66th Street, Kenosha, WI

Dear Ms. Mylotta :

We are pleased to respond to your letter of April 7, 1994, concerning approval of the site assessment report and interim remedial action plan for the referenced project. Our comments are as follows :

1) Site Usage and Product Handling

1a). The site is known to have been used for petroleum product storage since 1965. The product was stored in above ground storage tanks and used as a bulk plant. The site was reportedly owned and operated by Continental Oil Company. At that time, a storage capacity of 31,800 gallons of petroleum product was available. Of the 31,800 gallons capacity, 1,800 gallon capacity was for fuel oil storage and 30,000 gallon capacity for gasoline storage.

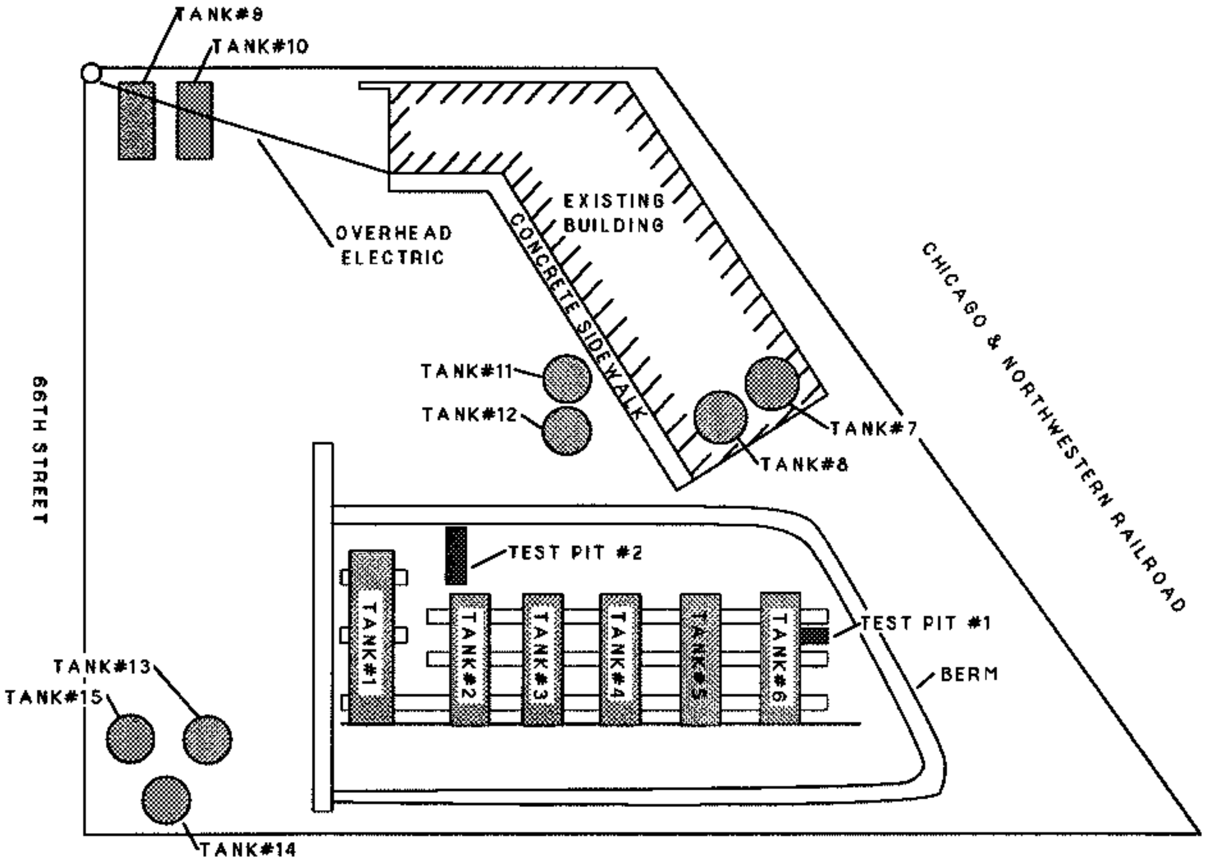
Petroleum storage appears to have been increased to 73,000 gallon capacity between 1965 and 1968 as indicated in Attachment A. Information from the City of Kenosha indicate that three tanks, 11,500 gallons each were used for storage of gasoline, and three tanks (two 11,500 and 15,500 gallons), were used for storage of heating oil.

In 1971 Continental Oil Company and Gabron-Girsh Oil, Inc. became the joint owner of the property. The bulk plant remained in operation until 1979. The bulk plant appears to have been inactive for some time. Industrial Pumping reportedly purchased the property sometime between 1980 and 1981.

Tank registration data indicate 15 tanks (Refer to Figure 1). Tank # 1 through 6 were old tanks. The use of the tanks changed from fuel oil and gasoline to waste oil under the ownership of Industrial Pumping.

Mr. Ken Smith indicated that he never used mineral spirits, naphtha, stoddard solvent, or other solvents for storage. However, traces of solvents may have entered into the waste oil because of the manner waste oil was brought, handled, and managed on the site.

TANK	CONTENTS	CAPACITY
#1	COOLANT	15,000
#2	WASTE OIL	11,000
#3	WASTE OIL	11,000
#4	WASTE OIL	11,000
#5	#4 FUEL OIL	11,000
#6	WASTE OIL	11,000
#7	WASTE OIL	5,000
#8	WASTE OIL	5,000
#9	COOLANT	7,000
#10	WASTE OIL	7,000
#11	WASTE OIL	2,000
#12	WASTE OIL	2,000
#13	EMPTY	2,000
#14	EMPTY	2,000
#15	WASTE OIL	4,000



Where are sewer lines?

LEGEND

▨ FORMER TANK LOCATION

■ TEST PIT LOCATION

OWNER
INDUSTRIAL PUMPING, INC.

Project Location
3502 66th Street, Kenosha, Wisconsin

ENGINEER
K. SINGH & ASSOCIATES, INC.
Engineers & Environmental Management Consultants
1135 Legion Drive Elm Grove, WI (414) 821-1171

Figure 1. Facility Layout

DATE	DRAWN BY	PROJECT NO.
09-30-92	VLS	3000
0' 15' 30'	CHECKED BY	SHEET NO.
	PNS	1 OF 1

1b) Waste Oil from numerous sources were brought on-site in a tanker by Industrial Pumping. Waste oil was collected from oil change facilities at service stations, trucking terminals, and local governments. A sample of typical facilities are included below :

American Motors , Kenosha
Clark Union 76, Kenosha
Lesko Transport Co., Kenosha
Pine Tree Standard, Kenosha
Birdshall Construction Co., Kenosha
Lannon Trucking, Kenosha
Blackman Trucking, Kenosha
Village of Sommers
Jelco Bus, Kenosha

Waste oil from the listed facilities were crank case oil. In addition , coolant and cutting oil were also brought on site. Coolant was reportedly brought from ACME Die Casting, Racine.

Based on conversation with Mr. Ken Smith, a substantial portion of the waste oil was brought from American Motors. The business went down when Industrial Pumping lost contract with American Motors. Mr. Smith provided analytical testing data for sludge characterization (Refer to Attachment B). Laboratory test results indicate the presence of low levels of E.P. Toxic Metals. The waste characterization was conducted to manage sludge in 1989. Test results indicate a mixture of petroleum hydrocarbons, solvents, and low levels of metals.The sludge was disposed off-site.

1c) Tankers were used to bring waste stream on-site. Reportedly, no transport of petroleum hydrocarbon took place through rail road. There were no dump tanks. A network of piping still exists at the site. There were no pump islands.It is our understanding that waste constituents were brought on-site by a tanker, stored on site in tanks # 13 to 15 located at southwest corner of the building.

The waste stream was transferred to the Heat Tank # 7 where temperature was increased to 180 Degree F. Water was separated from oil as a result of heating. Additional separation of solids, water and oil was performed in the treat tank (Tank # 8) During this process reclaimed oil was stored in tanks # one through six. The reclaimed oil was sold back to American Motors, Amber Oil in Milwaukee, ?

The waste stream that could not be reclaimed was stored in tanks # 11 and 12 and was forwarded to Amber Oil.

2) **Location of Underground Utility**

There is no storm water sewer system on the site. An approximate horizontal alignment of sanitary sewer is shown on Figure 1. Water line and sewer line were reported to be in the same trench. The vertical alignment of the sewer and water line is estimated to be approximately five feet below existing grade. The sewer line is reported to be four inches in diameter.

3) Extent of Contamination

3a) Test boring B-1 confirms low level of soil contamination with respect to DRO. The extent of contamination to the west could not be determined because of the presence of a building immediately west of the property line. The extent of contamination to the north could not be determined because of the presence of an overhead power line. Test boring B-9 was performed to determine the south boundary of the plume. We did not consider the need for performing a test boring between B-1 and B-8 because the area was heavily used for handling waste streams. It may be useful to perform a test boring (B-12) west of B-9 and south of B-1 to address the southern extent of contamination. The location of the proposed soil boring is shown on Figure 2.

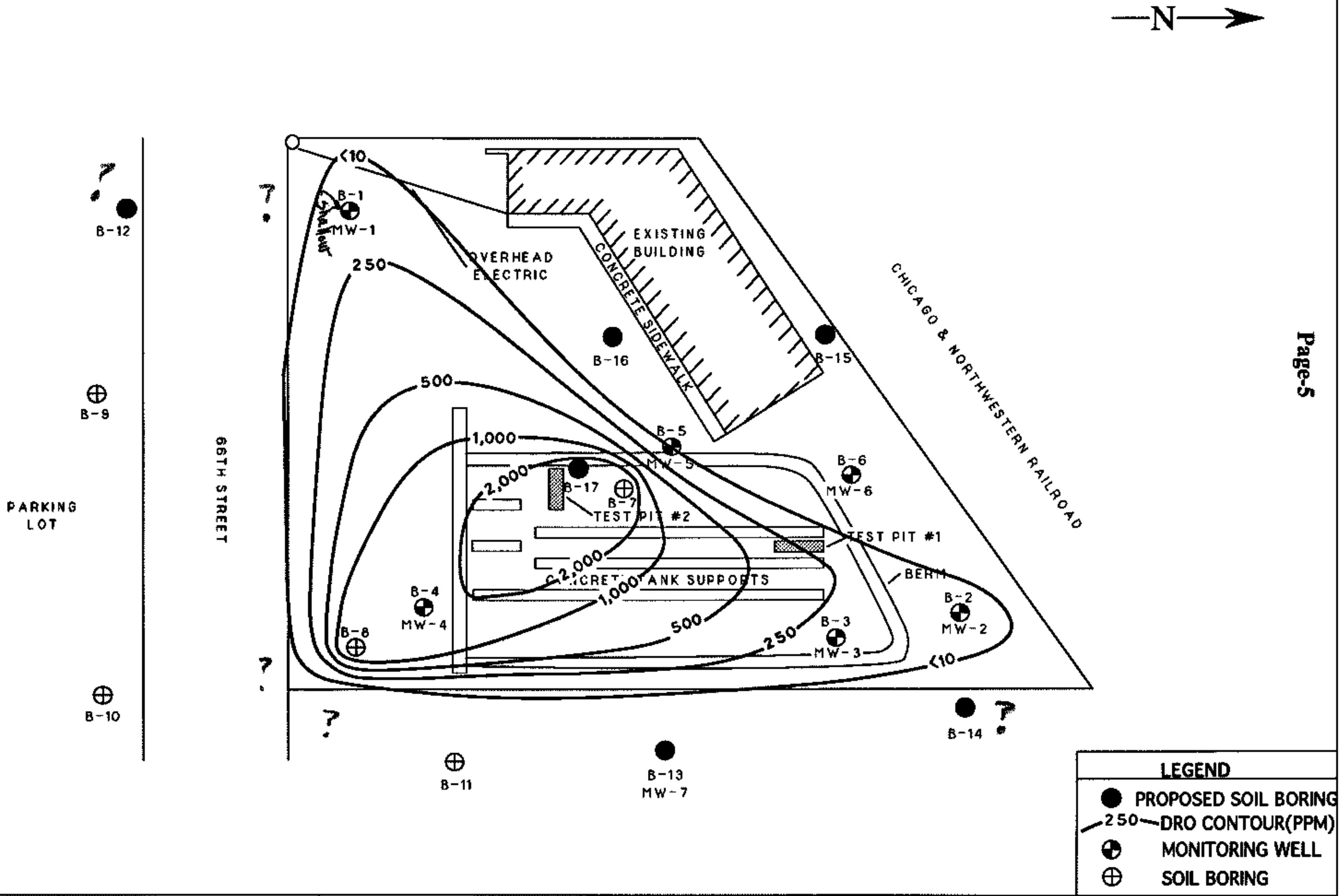
Elevated reading was noted in one of the soil samples (PID 70) at about 12 feet below grade. Because of the sandy nature of soil, and shallow depth to groundwater, the elevated reading is less likely to be representative of the contamination at that depth. Please note that the test boring was converted into a monitoring well and during two rounds of sampling, groundwater was not affected. In view of the groundwater quality data, the extent of contamination appears to have been defined. The vertical extent of contamination does not appear to have extended down to the groundwater level. Additional groundwater monitoring is suggested.

3b) Soil samples recovered from test borings B-10 and B-11 indicate that the shallow contamination was at background levels. Sample # 4 in both of the test borings indicate low levels of DRO contamination. The samples were taken at about groundwater level to also assess the potential of groundwater contamination. Shallow verification sampling and testing would have been useful but not cost effective. We will consider performing shallow soil boring (B-13). The location of the proposed soil boring is shown on Figure 2.

We agree that the contamination plume could not be definitively drawn in Figures 8 and 9.

3c) The soil boring B-2 was performed as far northeast as possible. In this boring DRO contamination was noted at 90 ppm. Additional investigation to the north will require seeking permit from Chicago & Northwestern Railroad, which is time consuming. Please note that the test boring B-2 is a sidegradient boring and groundwater at this location is not impacted. While additional information can be gathered, we are not sure about the benefit of that information. This is particularly true in view of recent changes in developing cleanup goal for soil. The Case Closeout Guideline for Waste Releases indicates that a cleanup goal of 100 ppm for DRO may be acceptable, if certain conditions are met.

This is based on the assumption that groundwater is not affected by petroleum hydrocarbons. If necessary, we suggest performing a soil boring (B-14) east of MW-2 to determine the east boundary of contamination.



Page-5

OWNER	ENGINEER	Figure 2. Proposed Location of Soil Borings		
INDUSTRIAL PUMPING, INC.	**K. SINGH & ASSOCIATES, INC.**	DATE 11-11-92	DRAWN BY RBS	PROJECT NO. 3000
Project Location 3502 66th Street, Kenosha, Wisconsin	Engineers & Environmental Management Consultants 1135 Legion Drive Elm Grove, WI (414) 821-1171	0' 15' 30'	CHECKED BY PNS	SHEET NO. 1 OF 1

3d) Tank # 7 and 8 were installed inside the building on a concrete slab (refer to Figure 1). No visible cracks were noted in the slab. Based on the structural integrity of the slab, we did not consider it necessary to perform a soil boring inside the building. It may be appropriate to perform a shallow soil boring (B-15) between the building and the railroad (refer to Figure 2). why?

The nearest test boring B-5 did not show any significant contamination. This test boring was close to tanks # 11 and 12. We suggest that a test boring (B-16) be performed west of Tank # 11 (refer to Figure 2). Soil boring B-17 is proposed to be performed south of soil boring B-7 as shown on Figure 2.

3e) We suggest that a limited sampling and testing be conducted for full VOCs, PCBs, PAH and cadmium. This information shall be used to assess the contamination plume. The remedial action plan may need to be revised in view of the additional information developed as a part of the proposed investigation.

3f) Groundwater sampling shall be performed to delineate the extent of contamination. First round of samples shall be tested for VOCs, PAHs, GRO, DRO, PCBs, dissolved lead, cadmium, and chromium. The second round of testing shall be for GRO, DRO, PVOCs, PAHs, and metals.

Groundwater appears to flow in the easterly direction. Based on the groundwater quality test results of two monitoring wells (MW-3 and MW-4), proposed soil boring B-13 may be converted into a monitoring well (MW-7).

4) Proposed Investigation

We suggest performing six test borings B-12 through B-17 to complete the delineation of soil contamination plume and to fill the data gaps as required by the Department (Refer to Figure 2). Soil borings shall be performed using ASTM standards. Test borings shall be approximately 10 feet deep. Test boring B-15 will be shallow (approximately 5 feet) and shall be performed using a hand auger.

Recovered soil samples with highest PID reading shall be tested for full VOCs, GRO, DRO, PAH's , PCBs, cadmium, lead, and chromium. A soil sample from within the 2000 ppm plume shall also be tested to characterize the waste stream (refer to Figure 2). If the level of metal contamination is more than 100 ppm, TCLP testing will be performed.

We will evaluate the groundwater quality data from the first round of sampling. If plume does not appear to be fully delineated, we will install additional wells to delineate the plume.

5) Plan for Soil Remediation

The plan for site remediation may need to be revised. Soil bio-pile may not be cost effective in view of additional information developed for the waste stream managed at the site. We will assess our plan for soil remediation after gathering additional information proposed to be developed in the near future.

6) Report Preparation

We intend to implement our plan for additional investigation after seeking your approval. Our schedule is as follows :

1.	Seek approval of the proposed plan	May 17,1994
2.	Select contractors for groundwater testing	May 17, 1994
3.	Perform first round of groundwater sampling	May 18, 1994
4.	Identify the need for additional wells	June 10, 1994
5.	Seek private party permit	June 10, 1994
6.	Select contractors for drilling and soil testing	June 10, 1994
7.	Perform soil borings	June 20, 1994
8.	Install monitoring well MW-7, if necessary	June 20, 1994
9.	Perform second round of groundwater sampling	June 25, 1994
10.	Prepare a remedial investigation and a remedial action plan for regulatory approval	August 20, 1994

We will submit a revised report incorporating the suggestions made by you in our August 20 submittal. Please call us, if you have any questions regarding this submittal.

Sincerely,

K. SINGH & ASSOCIATES, INC.

Raghu B. Singh
Raghu B. Singh, Ph.D.
Project Scientist

Pratap N. Singh
Pratap N. Singh, Ph.D.,P.E.
Project Manager

CC : Ken Smith / Industrial Pumping
Mike Naidicz / Bank One, Kenosha
Kamala Singh / PECFA Claim File

Attachment A
Information Concerning Tanks and Products Stored

[illegible]

[illegible] PLANT INSPECTION REPORT Date September 9, 1968

[illegible] 3502-66th Street [illegible] Name Gabron-Girsh Oil Inc.

[illegible] Joseph Gabron - Fred Girsh [illegible] 2102-52nd. Street [illegible] 657-372

[illegible]

[illegible] X [illegible] X

[illegible] 6 [illegible] 73,000

[illegible] App. 2000 [illegible] Block

[illegible]

1) [illegible] [✓ OK] NO NA 2) Relief valves [✓ OK] NO NA 3) [illegible] [✓ OK] NO NA

4) [illegible] [✓ OK] NO NA 5) [illegible] OK [✓ NO] NA

6) [illegible] OK [✓ NO] NA 7) Foundations and supports [✓ OK] NO NA

8) Static grounding OK [✓ NO] NA 9) [illegible] OK [✓ NO] NA

10) [illegible] [✓ OK] NO NA 11) housekeeping OK [✓ NO] NA 12) [illegible] OK [✓ NO] NA

LOADING OR UNLOADING

1) Static protection OK [✓ NO] NA 2) Explosion proof equipment [✓ OK] NO NA

3) Railroad tank car service OK NO [✓ NA] 4) [illegible] [✓ OK] NO NA

WAREHOUSE AND OUTSIDE STORAGE

1) Filling [illegible] containers OK NO [✓ NA] 2) [illegible] containers [✓ OK] NO NA

3) [illegible] [✓ OK] NO NA 4) [illegible] [✓ OK] NO NA

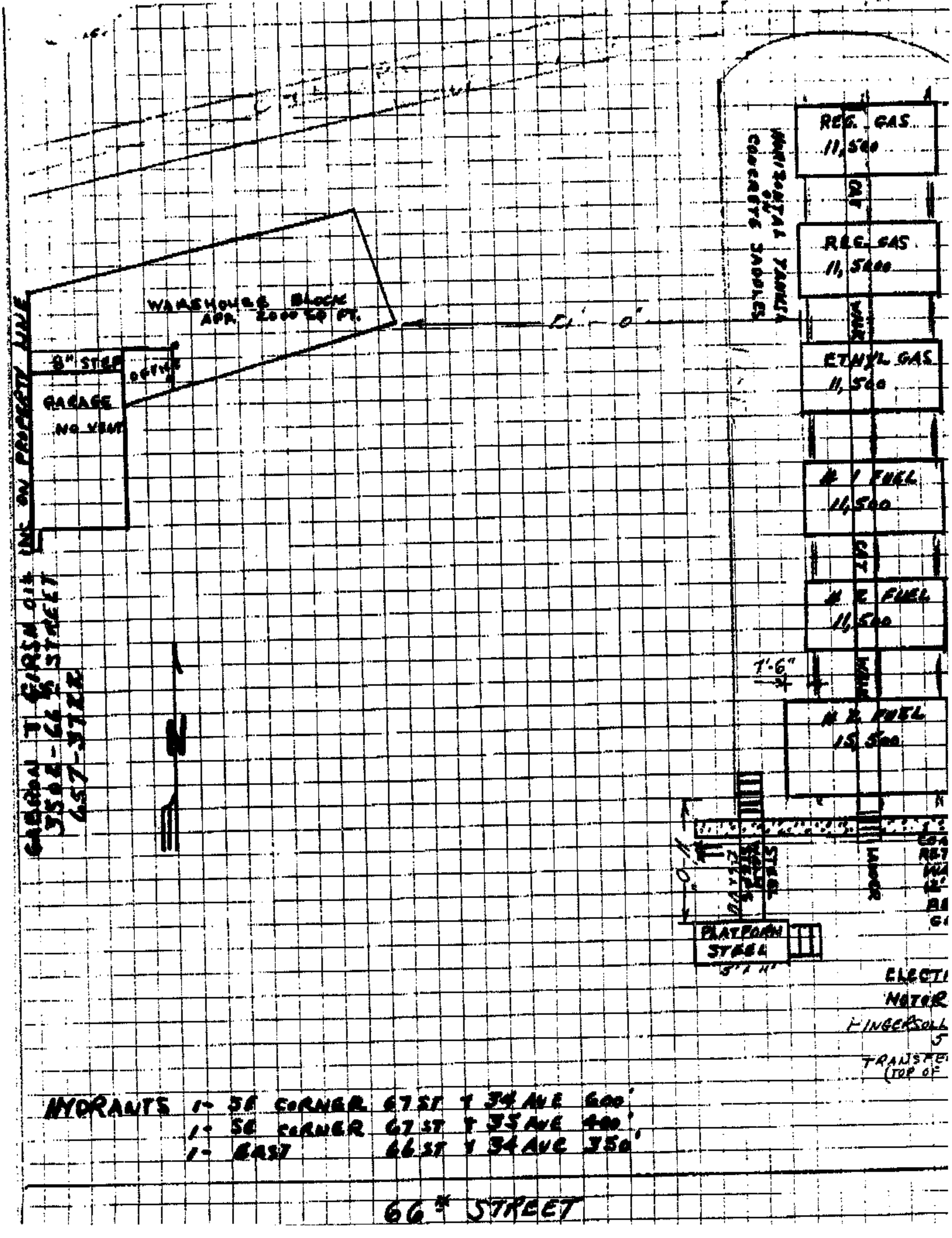
5) [illegible] [✓ OK] NO NA 6) [illegible]

[illegible] hydrant $50 66st & 34Ave. [illegible] Good

[illegible] Another Bulk plant East of property. Also C N W R R

[illegible] Repair Catwalk; unstable. Diked area used for storage--weeds and brush should be cleared out. Largest tank is labeled "Flammabe-Keep Fire Away", other are not. Static ground cable not used while loading truck tank.

[illegible] Lieutenant Richard E. Brus



HYDRANTS 1- SE CORNER 67 ST & 34 AVE 600'
1- SE CORNER 67 ST & 35 AVE 400'
1- EAST 66 ST & 34 AVE 350'

KENOSHA FIRE DEPARTMENT

FIRE PREVENTION BUREAU

BUILDING RECORD

GABRON OIL CO.

FIRE LIMITS
IN____ OUT____

Dist________ Insp________
License________
Permit________

Occupant________ Emergency Phone________
Owner/Agent________ Address________
Building Use (1st floor) [illegible] (upper)________
Manager JOSEPH GABRON Address________
Type of Construction CONCRETE [illegible] Stories________
Heating Unit________ Air Cond. Unit________
Incinerator________ Refuse Pick Up________
Fire Doors________ Stairs________ Exits________ Fire Escapes________
Alerting System________ Panel Location________ Master________
Extinguishing System (s)________
Fire Appliances________ Hose Cabinets________
Standpipes________ FD Connection________
Elevators________ Horiz/Vert Shafts________
Roof Entry________ Emergency Lighting________
Utilities________
Off Hour Surveillance________
Special Hazards________

DATE	INSPECTION	BY
[illegible]		[illegible]
8-9-74	CALL FOR INSPECTION, BULK PLANT	Lt. CRUS
9-12-79	INSPECTION VIOLATIONS	Lt. King
10-18-79	NO COMPLIANCE - FOLLOW UP LETTER SENT	[illegible]
11-20-79	NO COMPLIANCE - TURNED OVER [illegible] ATTY	Lt King

LABORATORY REPORT

gabriel - midwest, ltd.
Environmental & Technical Services

3307 - 14th Avenue
Kenosha, Wisconsin 53140
Phone (414) 652-5656

Fax (414) 652-5902
1-800-284-3823

TO: Mr. Ken Smith, Industrial Pumping, Kenosha, WI
SUBJECT: Analysis of Oil Sample
WI CERTIFICATION ID #: 252037440
P.O. #: Verbal/Smith
SAMPLE DATE: NOT GIVEN
DATE RECEIVED: 09/14/89
GML SAMPLE CODE: 40231-89
REPORT NUMBER: 5708
ANALYSIS COMPLETED: 10/02/89
REPORT DATE: 10/04/89

ANALYSIS

TOTAL METALS [UNITS = mg/kg]

1. Arsenic	0.55	5. Lead	140.0
2. Barium	9.5	6. Mercury	0.067
3. Cadmium	1.0	7. Selenium	<0.25
4. Chromium	8.35	8. Silver	5.35

ADDITIONAL INFORMATION AND IEPA TESTING

1. EOX: 3,014 ppm
2. PCB's: <2 ppm

Extractable organic halides

LABORATORY REPORT

3307 - 14th Avenue
Kenosha, Wisconsin 5314
Phone (414) 652-5656

Fax (414) 652-5902
1-800-284-3823

gabriel - midwest, ltd.
Environmental & Technical Services

TO: Mr. Ken Smith, Industrial Pumping, Kenosha, WI
SUBJECT: Analysis of Sludge Sample
WI CERTIFICATION ID #: 252087440
P.O. #: Verbal/Smith
SAMPLE DATE: NOT GIVEN DATE RECEIVED: 09/12/89
GML SAMPLE CODE: 39521-89
REPORT NUMBER: 5647
REPORT DATE: 09/27/89

ANALYSIS

1. Flashpoint deg. F	>212
2. pH, Standard Units	5.20
3. Total Solids [%]	37.26
4. Total Cyanide	0.166 ppm

TOTAL METALS [UNITS = ppm]

1. Arsenic	0.32	6. Mercury	0.083
2. Barium	<1.0	7. Nickel	13.44
3. Cadmium	0.60	8. Selenium	<0.10
4. Chromium	,005 6.2	9. Silver	2.28
5. Lead	3.8	10. Zinc	57.6

ADDITIONAL INFORMATION AND LEPA TESTING

1. Density: 0.87 g/cc
2. PCB's: <2 ppm
3. Phenols: 2 mg/L
4. Sulfide: <1 ppm
5. Chlorine: 6,000 ppm
6. Color: Black
7. Layers: 2
8. Odor: Musty/Organic

White Copy - Client

LAB DIRECTOR

LABORATORY REPORT

3307 - 14th Avenue
Kenosha, Wisconsin 53140
Phone (414) 652-5656

Fax (414) 652-5902
1-800-284-3823

gabriel - midwest, ltd.
Environmental & Technical Services

TO: Mr. Ken Smith, Industrial Pumping, Kenosha, WI
SUBJECT: Analysis of Sludge Sample
WI CERTIFICATION ID #: 252087440
P.O. #: Verbal/Smith
SAMPLE DATE: NOT GIVEN
GML SAMPLE CODE: 3952I-89
REPORT NUMBER: 5647A
REPORT DATE: 09/27/89

DATE RECEIVED: 09/12/89
ANALYSIS COMPLETED: 10/24/89
REPORT COMPLETED: 10/25/89
PAGE 2 OF 2

COPMOUND	RESULTS	DETECTION LIMIT
Chloromethane	NOT DETECTED	400 ug/kg
Vinyl Chloride	NOT DETECTED	400 ug/kg
Bromomethane	NOT DETECTED	400 ug/kg
Chloroethane	NOT DETECTED	400 ug/kg
Trichlorofluoromethane	NOT DETECTED	200 ug/kg
1,1-Dichloroethene	580 ug/kg	
Carbon Disulfide	NOT DETECTED	200 ug/kg
Acetone	1,703 ug/kg	
Methylene Chloride	446 ug/kg	
1,2-Dichloroethene (trans)	NOT DETECTED	200 ug/kg
Hexane	561 ug/kg	
1,1-Dichloroethane	6,860 ug/kg	
Vinyl Acetate	NOT DETECTED	200 ug/kg
2-Butanone	NOT DETECTED	400 ug/kg
Chloroform	NOT DETECTED	200 ug/kg
1,1,1-Trichloroethane	11,900 ug/kg	
Carbon Tetrachloride	NOT DETECTED	200 ug/kg
Benzene	458 ug/kg	
1,2-dichloroethane	NOT DETECTED	200 ug/kg
Trichloroethene	2,800 ug/kg	
1,2-Dichloropropane	NOT DETECTED	200 ug/kg
Bromodichloromethane	NOT DETECTED	200 ug/kg
2-Chloroethylvinylether	NOT DETECTED	400 ug/kg
cis-1,3-Dichloropropene	NOT DETECTED	200 ug/kg
2-Hexanone	NOT DETECTED	400 ug/kg
Toluene	6,437 ug/kg	
Trans-1,3-Dichloropropene	NOT DETECTED	200 ug/kg
1,1,2-Trichloroethane	NOT DETECTED	200 ug/kg
Tetrachloroethene	1,100 ug/kg	
Dibromochloromethane	NOT DETECTED	200 ug/kg
4-Methyl-2-Pentanone	NOT DETECTED	400 ug/kg
Chlorobenzene	NOT DETECTED	200 ug/kg
Ethylbenzene	2,320 ug/kg	
Total Xylene	13,338 ug/kg	
Styrene	NOT DETECTED	200 ug/kg
Bromoform	NOT DETECTED	200 ug/kg
1,1,2,2-Tetrachloroethane	NOT DETECTED	200 ug/kg
1,3-Dichlorobenzene	NOT DETECTED	200 ug/kg
1,4-Dichlorobenzene	NOT DETECTED	200 ug/kg
1,2-Dichlorobenzene	NOT DETECTED	200 ug/kg

SWANSON ENVIRONMENTAL INC.

3150 North Brookfield Road
Brookfield, Wisconsin 53005
telephone (414) 783-6111
facsimile (414) 783-5752

ANALYTICAL REPORT

AIHA Accreditation #352
WDNR Certification #26818170

REPORT NUMBER: 89399

Industrial Pumping, Inc.
[illegible] 47th Avenue
Kenosha, WI 53142

Attn: Mr. Ken Smith

DATE: November 2, 1989
PURCHASE ORDER:
SEI JOB NO: WL1022
DATE COLLECTED: 10/24/89
DATE RECEIVED: 10/24/89

Oil Sample

Units: mg/kg (ppm)
Detection Limit: Noted below in ( )

VOLATILES	SEI ID Sample ID	1022-1 Oil
Acetone (20)		ND
Benzene (4)		19
Bromodichloromethane (60)		ND
Bromoform (60)		ND
Bromomethane (20)		ND
2-Butanone (12)		ND
Carbon tetrachloride (60)		130
Chlorobenzene (6)		ND
Chlorodibromomethane (60)		ND
Chloroethane (16)		ND
Chloroform (60)		ND
Chloromethane (20)		ND
1,1-Dichloroethene (40)		ND
1,2-Dichloroethane (10)		ND
1,1-Dichloroethane (10)		ND
trans-1,2-Dichloroethene (20)		ND
1,2-Dichloropropane (10)		ND
cis-1,3-Dichloropropene (12)		ND
trans-1,3-Dichloropropene (12)		ND
Ethylbenzene (4)		130

ND--Not Detected

Reviewed & Approved by:

Rosemary L. Dineen
Rosemary L. Dineen
Laboratory Supervisor

SWANSON ENVIRONMENTAL INC.

3150 North Brookfield Road
Brookfield, Wisconsin 53005
telephone (414) 783-6111
facsimile (414) 783-5752

AIHA Accreditation #352
WDNR Certification #26818170

ANALYTICAL REPORT

REPORT NUMBER: 89399

Industrial Pumping, Inc.
3223 47th Avenue
Kenosha, WI 53142

Attn: Mr. Ken Smith

DATE: November 2, 1989
PURCHASE ORDER:
SEI JOB NO: WL1022
DATE COLLECTED: 10/24/89
DATE RECEIVED: 10/24/89

Oil Sample

Units: mg/kg (ppm)
Detection Limit: Noted below in ( )

	SEI ID	1022-1
VOLATILES	**Sample ID**	**Oil**
2-Hexanone (6)		27
Methylene chloride (8)		ND
4-Methyl-2-pentanone (6)		ND
Styrene (20)		ND
1,1,2,2-Tetrachloroethane (20)		ND
Tetrachloroethene (20)		ND
Toluene (4)		187
1,1,1-Trichloroethane (14)		120
1,1,2-Trichloroethane (14)		ND
Trichloroethene (14)		65
Vinyl acetate (14)		ND
Vinyl chloride (14)		ND
Xylenes (6)		557

ND--Not Detected

Reviewed & Approved by:

Rosemary L. Dineen

Rosemary L. Dineen
Laboratory Supervisor

KENOSHA FIRE DEPARTMENT
INSPECTION RECORD

B-502A

District 89
Card No. E17 Station No. 4
No. of Bldgs. 5
1. Address 3417 - 66th St
2. Occupant MOBIL OIL
3. 1st Floor Use
4. Above 1st Floor Use

Fire Limits
Insp. per Yr.
Code
Emerg. Phone 694-0458
No. of Occupants
6 A.M. - 12 A.M. Day 2
12 A.M. - 6 A.M. Nite 0

5. Owner/Agent MOBIL OIL No. of Rooms
6. Address 6525 - W. Bluemound Rd City Mil State Wis
7. Construction BRICK - BLOCK Stories
8. Basement NONE Entry Location(s)
9. Electric Wiring/Service NORTH WEST
10. Heating Unit/Type SPACE HEATER Fuel OIL
11. Heating Enclosure NO Incinerator
12. Refuse Pick-up SELF
13. Air Condition/Type NONE Refrigeration NONE
14. Stairways NONE Exits Lighting
15. Aisles Passageways
16. Elevators NONE Roof Openings
17. Horizontal Shafts NONE Vertical Shafts NONE
18. Fire Doors NONE Fire Escapes
19. Emergency Lighting NONE
20. Gas/Electric Appliances NONE
21. Utility Shut-offs Office - N
22. Alerting System NONE
23. Extinguishing System NONE
24. Alarm Panel Location NONE No. Stations
25. Fire Appliances 2 ANSUL 3 TANKS OF [illegible]
26. Combustible Materials NONE 10000 - 15000 [illegible]
27. Flammable Liquids/Gases TANK GAS AND OIL
28. Areas/General Housekeeping Good.
29. Special Hazards/Processes
30. Miscellaneous

APPENDIX M
Industrial Pumping Laboratory Report Excerpts with CVOC Detections

Mac Donald Research Group, Inc.

1441 North Mayfair Road
Milwaukee, Wisconsin 53226

4 August 1992

K. Singh & Associates, Inc.
1135 Legion Drive
Elm Grove, Wisconsin 53122

Project: #3000-Kenosha, WI
Invoice: #7642 Extraction date: 7-2-92 Analysis date: 7-16-92

Compound	Limit (ppb) (water)	Limit (ppm) (soil)	Sample results MW - 6 (ppb)
Benzene	<0.04	<0.15	below MLD
Bromobenzene	<0.20	<0.15	below MLD
Bromochloromethane	<0.20	<0.15	below MLD
Bromodichloromethane	<0.20	<0.15	below MLD
Bromoform	<0.20	<0.15	below MLD
Bromomethane	<0.20	<0.15	below MLD
n-Butylbenzene	<0.20	<0.15	below MLD
sec-Butylbenzene	<0.20	<0.15	below MLD
tert-Butylbenzene	<0.20	<0.15	below MLD
Carbon Disulfide	<0.20	<0.15	below MLD
Carbon Tetrachloride	<0.20	<0.15	below MLD
Chlorobenzene	<0.20	<0.15	below MLD
Chlorodibromethane	<0.20	<0.15	below MLD
Chloroethane	<0.20	<0.15	below MLD
Chloromethane	<0.20	<0.15	below MLD
1,2-dibromoethane (EDB)	<0.20	<0.8	below MLD
2-Chloroethylvinyl ether	<0.20	<0.15	below MLD
Chloroform	<0.20	<0.15	below MLD
0-Chlorotoluene	<0.20	<0.15	below MLD
P-Chlorotoluene	<0.20	<0.15	below MLD
Dibromomethane	<0.20	<0.15	below MLD
Dibromochloromethane	<0.20	<0.15	below MLD
1,2-Dibromo-3-Chloropropane	<0.20	<0.15	below MLD
1,2-Dichlorobenzene	<0.20	<0.15	below MLD
1,3-Dichlorobenzene	<0.20	<0.15	below MLD
1,4-Dichlorobenzene	<0.20	<0.15	below MLD
1,1-Dichloroethane	<0.20	<0.15	below MLD
1,2-Dichloroethane	<0.20	<0.15	below MLD
1,1-dichloroethene	<0.20	<0.15	1.6ppb
1,2-Dichloroethylene, cis	<0.20	<0.15	below MLD
1,1-Dichloroethylene	<0.20	<0.15	below MLD
1,2-Dichloroethylene,trans	<0.20	<0.15	below MLD
1,2-Dichloropropane	<0.20	<0.15	below MLD
1,3-Dichloropropane	<0.20	<0.15	below MLD
2,2-Dichloropropane	<0.20	<0.15	below MLD
1,1-Dichloropropene	<0.20	<0.15	below MLD
1,3-Dichloropropene,cis	<0.20	<0.15	below MLD

(414) 491-2949

Office — (414) 771-7151

NET
NATIONAL
ENVIRONMENTAL
TESTING, INC.

Watertown Division
602 Commerce Drive
P.O. Box 288
Watertown, WI 53094
Tel: (414) 261-1660
Fax: (414) 261-8120

ANALYTICAL REPORT

Mr. Mark Peters
K. SINGH & ASSOCIATES, INC
1135 Legion Drive
Elm Grove, WI 53122

08/12/1994
Job No: 94.03723
Sample No: 104947
Account No: 43125
Page 14

JOB DESCRIPTION: #3000
PROJECT DESCRIPTION: Soil Analysis
SAMPLE DESCRIPTION: B-14 S-3 6-7 #3000
Recv'd 3.0 C

Date Taken: 07/22/1994 12:30 Date Received: 07/25/1994

Parameter	Results	Units	Method	Detection Limit	Date Analyzed
Solids, Total	80.0	%	E-160.3	n/a	08/05/1994
Arsenic, GFAA	2.4	mg/kg	S-7060	0.20	08/09/1994
Barium, AA	24	mg/kg	S-7080	12	08/03/1994
Cadmium, AA	<1.0	mg/kg	S-7130	1.0	08/04/1994
Chromium, AA	5.5	mg/kg	S-7190	1.0	08/04/1994
Lead, AA	7.6	mg/kg	S-7420	3.0	08/01/1994
Mercury, CVAA	<0.050	mg/kg	S-7471	0.050	07/29/1994
Selenium, GFAA	0.67	mg/kg	S-7740	0.12	08/08/1994
Silver, AA	<1.0	mg/kg	S-7760	1.0	07/29/1994
DRO Extraction	07/25/94		WDNR		08/04/1994
GRO - Nonaqueous	80	mg/kg	WDNR	5.0	08/03/1994
VOC NONAQUEOUS - EPA 8021					
Benzene	<0.50	mg/kg	S-8021	0.10	08/04/1994
Bromobenzene	<0.50	mg/kg	S-8021	0.10	08/04/1994
Bromochloromethane	<0.50	mg/kg	S-8021	0.10	08/04/1994
Bromodichloromethane	<0.50	mg/kg	S-8021	0.10	08/04/1994
Bromoform	<1.0	mg/kg	S-8021	0.20	08/04/1994
Bromomethane	<2.0	mg/kg	S-8021	0.40	08/04/1994
n-Butylbenzene	0.98	mg/kg	S-8021	0.10	08/04/1994
sec-Butylbenzene	<0.50	mg/kg	S-8021	0.10	08/04/1994
tert-Butylbenzene	<0.50	mg/kg	S-8021	0.10	08/04/1994
Carbon Tetrachloride	<0.50	mg/kg	S-8021	0.10	08/04/1994
Chlorobenzene	0.75	mg/kg	S-8021	0.10	08/04/1994
Chlorodibromethane	<0.50	mg/kg	S-8021	0.10	08/04/1994
Chloroethane	<2.0	mg/kg	S-8021	0.40	08/04/1994
Chloroform	<0.50	mg/kg	S-8021	0.10	08/04/1994
Chloromethane	<2.0	mg/kg	S-8021	0.40	08/04/1994
2-Chlorotoluene	<0.50	mg/kg	S-8021	0.10	08/04/1994
4-Chlorotoluene	<0.50	mg/kg	S-8021	0.10	08/04/1994
1,2-Dibromo-3-Chloropropane	<1.0	mg/kg	S-8021	0.20	08/04/1994
1,2-Dibromoethane (EDB)	<0.50	mg/kg	S-8021	0.10	08/04/1994
Dibromomethane	<0.50	mg/kg	S-8021	0.10	08/04/1994
1,2-Dichlorobenzene	<0.50	mg/kg	S-8021	0.10	08/04/1994
1,3-Dichlorobenzene	<0.50	mg/kg	S-8021	0.10	08/04/1994

Brian D. DeJong, Organic Operation Manager
Certification No. 128053530

ANALYTICAL REPORT

Mr. Mark Peters
K. SINGH & ASSOCIATES, INC
1135 Legion Drive
Elm Grove, WI 53122

08/12/1994
Job No: 94.03723
Sample No: 104949
Account No: 43125
Page 27

JOB DESCRIPTION: #3000
PROJECT DESCRIPTION: Soil Analysis
SAMPLE DESCRIPTION: B-16 S-3 6-7.5 #3000
Recv'd 3.0 C

Date Taken: 07/22/1994 18:30 Date Received: 07/25/1994

Parameter	Results	Units	Method	Detection Limit	Date Analyzed
1,4-Dichlorobenzene	<0.20	mg/kg	S-8021	0.10	08/04/1994
Dichlorodifluoromethane	<0.60	mg/kg	S-8021	0.30	08/04/1994
1,1-Dichloroethane	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,2-Dichloroethane	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,1-Dichloroethene	<0.40	mg/kg	S-8021	0.20	08/04/1994
cis-1,2-Dichloroethene	<0.20	mg/kg	S-8021	0.10	08/04/1994
trans-1,2-Dichloroethene	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,2-Dichloropropane	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,3-Dichloropropane	<0.20	mg/kg	S-8021	0.10	08/04/1994
2,2-Dichloropropane	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,1-Dichloropropene	<0.20	mg/kg	S-8021	0.10	08/04/1994
cis-1,3-Dichloropropene	<0.20	mg/kg	S-8021	0.10	08/04/1994
trans-1,3-Dichloropropene	<0.20	mg/kg	S-8021	0.10	08/04/1994
Ethylbenzene	0.26	mg/kg	S-8021	0.10	08/04/1994
Hexachlorobutadiene	<0.40	mg/kg	S-8021	0.20	08/04/1994
Isopropylbenzene	<0.20	mg/kg	S-8021	0.10	08/04/1994
p-Isopropyltoluene	<0.20	mg/kg	S-8021	0.10	08/04/1994
Methylene Chloride	<1.0	mg/kg	S-8021	0.50	08/04/1994
Naphthalene	<0.20	mg/kg	S-8021	0.10	08/04/1994
n-Propylbenzene	<0.20	mg/kg	S-8021	0.10	08/04/1994
Styrene	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,1,1,2-Tetrachloroethane	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,1,2,2-Tetrachloroethane	<0.20	mg/kg	S-8021	0.10	08/04/1994
Tetrachloroethene	<0.20	mg/kg	S-8021	0.10	08/04/1994
Toluene	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,2,3-Trichlorobenzene	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,2,4-Trichlorobenzene	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,1,1-Trichloroethane	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,1,2-Trichloroethane	<0.20	mg/kg	S-8021	0.10	08/04/1994
Trichloroethene	0.63	mg/kg	S-8021	0.10	08/04/1994
Trichlorofluoromethane	<0.80	mg/kg	S-8021	0.40	08/04/1994
1,2,3-Trichloropropane	<0.20	mg/kg	S-8021	0.10	08/04/1994
1,2,4-Trimethylbenzene	0.30	mg/kg	S-8021	0.10	08/04/1994
1,3,5-Trimethylbenzene	0.20	mg/kg	S-8021	0.10	08/04/1994

Brian D. DeJong, Organic Operation Manager
Certification No. 128053530

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ANALYTICAL REPORT

Mr. Raghu Singh
K. SINGH & ASSOCIATES, INC
1135 Legion Drive
Elm Grove, WI 53122

08/11/1994
Job No: 94.03744
Sample No: 105025
Account No: 43125
Page 14

JOB DESCRIPTION: Industrial Pumping #3000
PROJECT DESCRIPTION: Soil Analysis
SAMPLE DESCRIPTION: B-17 S-7 16-17.5 #3000
Recv'd 4.0 C

Date Taken: 07/25/1994 11:00 Date Received: 07/26/1994

Parameter		Results	Units	Method	Detection Limit	Date Analyzed
Solids, Total		86.6	%	E-160.3	n/a	08/09/1994
Arsenic, GFAA		3.0	mg/kg	S-7060	0.20	08/09/1994
Barium, AA		20	mg/kg	S-7080	12	08/03/1994
Cadmium, AA		<1.0	mg/kg	S-7130	1.0	08/04/1994
Chromium, AA		3.9	mg/kg	S-7190	1.0	08/04/1994
Lead, AA		9.9	mg/kg	S-7420	3.0	08/01/1994
Mercury, CVAA		<0.050	mg/kg	S-7471	0.050	07/29/1994
Selenium, GFAA		0.20	mg/kg	S-7740	0.12	08/09/1994
Silver, AA		<1.0	mg/kg	S-7760	1.0	07/29/1994
DRO Extraction		07/27/94		WDNR		08/04/1994
GRO - Nonaqueous	H	68	mg/kg	WDNR	5.0	08/05/1994
VOC NONAQUEOUS - EPA 8021						
Benzene		<0.10	mg/kg	S-8021	0.10	08/04/1994
Bromobenzene		<0.10	mg/kg	S-8021	0.10	08/04/1994
Bromochloromethane		<0.10	mg/kg	S-8021	0.10	08/04/1994
Bromodichloromethane		<0.10	mg/kg	S-8021	0.10	08/04/1994
Bromoform		<0.20	mg/kg	S-8021	0.20	08/04/1994
Bromomethane		<0.40	mg/kg	S-8021	0.40	08/04/1994
n-Butylbenzene		1.4	mg/kg	S-8021	0.10	08/04/1994
sec-Butylbenzene		<0.10	mg/kg	S-8021	0.10	08/04/1994
tert-Butylbenzene		<0.10	mg/kg	S-8021	0.10	08/04/1994
Carbon Tetrachloride		<0.10	mg/kg	S-8021	0.10	08/04/1994
Chlorobenzene		0.10	mg/kg	S-8021	0.10	08/04/1994
Chlorodibromethane		<0.10	mg/kg	S-8021	0.10	08/04/1994
Chloroethane		<0.40	mg/kg	S-8021	0.40	08/04/1994
Chloroform		<0.10	mg/kg	S-8021	0.10	08/04/1994
Chloromethane		<0.40	mg/kg	S-8021	0.40	08/04/1994
2-Chlorotoluene		<0.10	mg/kg	S-8021	0.10	08/04/1994
4-Chlorotoluene		<0.10	mg/kg	S-8021	0.10	08/04/1994
1,2-Dibromo-3-Chloropropane		<0.20	mg/kg	S-8021	0.20	08/04/1994
1,2-Dibromoethane (EDB)		<0.10	mg/kg	S-8021	0.10	08/04/1994
Dibromomethane		<0.10	mg/kg	S-8021	0.10	08/04/1994
1,2-Dichlorobenzene		<0.10	mg/kg	S-8021	0.10	08/04/1994
1,3-Dichlorobenzene		<0.10	mg/kg	S-8021	0.10	08/04/1994

Brian DeJong

Brian D. DeJong, Organic Operation Manager
Certification No. 128053530

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ANALYTICAL REPORT

Mr. Raghu Singh
K. SINGH & ASSOCIATES, INC
1135 Legion Drive
Elm Grove, WI 53122

08/11/1994
Job No: 94.03744
Sample No: 105026
Account No: 43125
Page 20

JOB DESCRIPTION: Industrial Pumping #3000
PROJECT DESCRIPTION: Soil Analysis
SAMPLE DESCRIPTION: B-18 S-4 8.5-10 #3000
Recv'd 4.0 C

Date Taken: 07/25/1994 13:00 Date Received: 07/26/1994

Parameter	Results	Units	Method	Detection Limit	Date Analyzed
Solids, Total	82.8	%	E-160.3	n/a	08/09/1994
Arsenic, GFAA	2.6	mg/kg	S-7060	0.20	08/09/1994
Barium, AA	23	mg/kg	S-7080	12	08/03/1994
Cadmium, AA	<1.0	mg/kg	S-7130	1.0	08/04/1994
Chromium, AA	7.0	mg/kg	S-7190	1.0	08/04/1994
Lead, AA	7.6	mg/kg	S-7420	3.0	08/01/1994
Mercury, CVAA	<0.050	mg/kg	S-7471	0.050	07/29/1994
Selenium, GFAA	0.62	mg/kg	S-7740	0.12	08/09/1994
Silver, AA	<1.0	mg/kg	S-7760	1.0	07/29/1994
DRO Extraction	07/27/94		WDNR		08/05/1994
GRO - Nonaqueous	5.7	mg/kg	WDNR	5.0	08/05/1994
VOC NONAQUEOUS - EPA 8021					
Benzene	<0.10	mg/kg	S-8021	0.10	08/04/1994
Bromobenzene	<0.10	mg/kg	S-8021	0.10	08/04/1994
Bromochloromethane	<0.10	mg/kg	S-8021	0.10	08/04/1994
Bromodichloromethane	<0.10	mg/kg	S-8021	0.10	08/04/1994
Bromoform	<0.20	mg/kg	S-8021	0.20	08/04/1994
Bromomethane	<0.40	mg/kg	S-8021	0.40	08/04/1994
n-Butylbenzene	0.24	mg/kg	S-8021	0.10	08/04/1994
sec-Butylbenzene	<0.10	mg/kg	S-8021	0.10	08/04/1994
tert-Butylbenzene	<0.10	mg/kg	S-8021	0.10	08/04/1994
Carbon Tetrachloride	<0.10	mg/kg	S-8021	0.10	08/04/1994
Chlorobenzene	0.21	mg/kg	S-8021	0.10	08/04/1994
Chlorodibromethane	<0.10	mg/kg	S-8021	0.10	08/04/1994
Chloroethane	<0.40	mg/kg	S-8021	0.40	08/04/1994
Chloroform	<0.10	mg/kg	S-8021	0.10	08/04/1994
Chloromethane	<0.40	mg/kg	S-8021	0.40	08/04/1994
2-Chlorotoluene	<0.10	mg/kg	S-8021	0.10	08/04/1994
4-Chlorotoluene	<0.10	mg/kg	S-8021	0.10	08/04/1994
1,2-Dibromo-3-Chloropropane	<0.20	mg/kg	S-8021	0.20	08/04/1994
1,2-Dibromoethane (EDB)	<0.10	mg/kg	S-8021	0.10	08/04/1994
Dibromomethane	<0.10	mg/kg	S-8021	0.10	08/04/1994
1,2-Dichlorobenzene	<0.10	mg/kg	S-8021	0.10	08/04/1994
1,3-Dichlorobenzene	<0.10	mg/kg	S-8021	0.10	08/04/1994

Brian D. DeJong, Organic Operation Manager
Certification No. 128053530

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WDNR No. 128053530

ANALYTICAL REPORT

Mr. Todd Ormiston
K. SINGH & ASSOCIATES, INC
1135 Legion Drive
Elm Grove, WI 53122

04/05/1995
Job No: 95.01576
Sample No: 126045
Account No: 43125
Page 12

JOB DESCRIPTION: 3000 Industrial Pumping
PROJECT DESCRIPTION: Soil Analysis
SAMPLE DESCRIPTION: Stockpile #2 #3000
3502 66th Street; Kenosha, Wi
Recv'd 4.0 C

Date Taken: 03/17/1995 15:40   Date Received: 03/20/1995

Parameter		Results	Units	MDL	LOQ	Method	Date Analyzed	Prep/Run Batch
C - METHANOL - 8260								
Hexachlorobutadiene		<42	ug/kg	34	120	S-8260	03/31/1995	193
Isopropylbenzene		72	ug/kg	12	44	S-8260	03/31/1995	193
Isopropyltoluene		<30	ug/kg	19	67	S-8260	03/31/1995	193
thylene Chloride	L	119	ug/kg	50	180	S-8260	03/31/1995	193
Methyl-t-butyl ether		<30	ug/kg	14	51	S-8260	03/31/1995	193
phthalene		1,550	ug/kg	17	61	S-8260	03/31/1995	193
Propylbenzene		239	ug/kg	13	46	S-8260	03/31/1995	193
,1,2,2-Tetrachloroethane		<30	ug/kg	15	54	S-8260	03/31/1995	193
Tetrachloroethene		1,430	ug/kg	14	50	S-8260	03/31/1995	193
luene		263	ug/kg	7.2	25	S-8260	03/31/1995	193
2,3-Trichlorobenzene		<30	ug/kg	23	82	S-8260	03/31/1995	193
1,2,4-Trichlorobenzene		<30	ug/kg	22	79	S-8260	03/31/1995	193
1,1,1-Trichloroethane		<30	ug/kg	11	39	S-8260	03/31/1995	193
1,2-Trichloroethane		<30	ug/kg	18	62	S-8260	03/31/1995	193
ichloroethene		<30	ug/kg	18	64	S-8260	03/31/1995	193
Trichlorofluoromethane		<30	ug/kg	15	55	S-8260	03/31/1995	193
1,2,4-Trimethylbenzene		346	ug/kg	10	36	S-8260	03/31/1995	193
3,5-Trimethylbenzene		131	ug/kg	9.2	33	S-8260	03/31/1995	193
nyl Chloride		<30	ug/kg	23	81	S-8260	03/31/1995	193
Xylenes, Total		562	ug/kg	31	110	S-8260	03/31/1995	193
urr: Dibromofluoromethane		46.9	%	n/a	n/a	S-8260	03/31/1995	193
urr: Toluene-d8		52.5	%	n/a	n/a	S-8260	03/31/1995	193
surr: Bromofluorobenzene		49.4	%	n/a	n/a	S-8260	03/31/1995	193

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ANALYTICAL REPORT

Mr. Todd Ormiston
K. SINGH & ASSOCIATES, INC
1135 Legion Drive
Elm Grove, WI 53122

03/29/1995
Job No: 95.01452
Sample No: 125554
Account No: 43125
Page 5

JOB DESCRIPTION: 3000 Industrial Pumping
PROJECT DESCRIPTION: Soil Analysis
SAMPLE DESCRIPTION: A-7W 6.0' #3000
3502 66th Street; Kenosha, Wi
Recv'd 4.0 C

Date Taken: 03/14/1995 09:00 Date Received: 03/15/1995

Parameter	Results	Units	Method	Reporting Limit	Date Analyzed
VOC - NONAQUEOUS - 8260					
Benzene	<5.0	ug/kg	S-8260	5.0	03/24/1995
Bromobenzene	<5.0	ug/kg	S-8260	5.0	03/24/1995
Bromochloromethane	<5.0	ug/kg	S-8260	5.0	03/24/1995
Bromodichloromethane	<5.0	ug/kg	S-8260	5.0	03/24/1995
Bromoform	<10	ug/kg	S-8260	10	03/24/1995
Bromomethane	<20	ug/kg	S-8260	20	03/24/1995
n-Butylbenzene	<5.0	ug/kg	S-8260	5.0	03/24/1995
sec-Butylbenzene	<5.0	ug/kg	S-8260	5.0	03/24/1995
tert-Butylbenzene	<5.0	ug/kg	S-8260	5.0	03/24/1995
Carbon Tetrachloride	<5.0	ug/kg	S-8260	5.0	03/24/1995
Chlorobenzene	<5.0	ug/kg	S-8260	5.0	03/24/1995
Chlorodibromomethane	<5.0	ug/kg	S-8260	5.0	03/24/1995
Chloroethane	<20	ug/kg	S-8260	20	03/24/1995
Chloroform	<5.0	ug/kg	S-8260	5.0	03/24/1995
Chloromethane	<20	ug/kg	S-8260	20	03/24/1995
2-Chlorotoluene	<5.0	ug/kg	S-8260	5.0	03/24/1995
4-Chlorotoluene	<5.0	ug/kg	S-8260	5.0	03/24/1995
1,2-Dibromo-3-Chloropropane	<50	ug/kg	S-8260	50	03/24/1995
1,2-Dibromoethane	<50	ug/kg	S-8260	50	03/24/1995
Dibromomethane	<5.0	ug/kg	S-8260	5.0	03/24/1995
1,2-Dichlorobenzene	<5.0	ug/kg	S-8260	5.0	03/24/1995
1,3-Dichlorobenzene	<5.0	ug/kg	S-8260	5.0	03/24/1995
1,4-Dichlorobenzene	<5.0	ug/kg	S-8260	5.0	03/24/1995
Dichlorodifluoromethane	<15	ug/kg	S-8260	15	03/24/1995
1,1-Dichloroethane	<5.0	ug/kg	S-8260	5.0	03/24/1995
1,2-Dichloroethane	<5.0	ug/kg	S-8260	5.0	03/24/1995
1,1-Dichloroethene	<10	ug/kg	S-8260	10	03/24/1995
cis-1,2-Dichloroethene	280	ug/kg	S-8260	5.0	03/24/1995
trans-1,2-Dichloroethene	24	ug/kg	S-8260	5.0	03/24/1995
1,2-Dichloropropane	<5.0	ug/kg	S-8260	5.0	03/24/1995
1,3-Dichloropropane	<5.0	ug/kg	S-8260	5.0	03/24/1995
2,2-Dichloropropane	<5.0	ug/kg	S-8260	5.0	03/24/1995
1,1-Dichloropropene	<5.0	ug/kg	S-8260	5.0	03/24/1995
cis-1,3-Dichloropropene	<5.0	ug/kg	S-8260	5.0	03/24/1995

Brian D. DeJong, Organic Operation Manager
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ANALYTICAL REPORT

Mr. Todd Ormiston
K. SINGH & ASSOCIATES, INC
1135 Legion Drive
Elm Grove, WI 53122

03/21/1995
Job No: 95.01332
Sample No: 125108
Account No: 43125
Page 10

JOB DESCRIPTION: 3000 Industrial Pumping
PROJECT DESCRIPTION: Soil Analysis
SAMPLE DESCRIPTION: E-3B 8.0' #3000
3502 66th Street; Kenosha, WI
Recv'd 4.0 C

Date Taken: 03/08/1995 11:40 Date Received: 03/09/1995

Parameter	Results	Units	Method	Detection Limit	Date Analyzed
VOC - NONAQUEOUS - 8260					
Benzene	890	ug/kg	S-8260	5.0	03/17/1995
Bromobenzene	<5.0	ug/kg	S-8260	5.0	03/17/1995
Bromochloromethane	<5.0	ug/kg	S-8260	5.0	03/17/1995
Bromodichloromethane	<5.0	ug/kg	S-8260	5.0	03/17/1995
Bromoform	<10	ug/kg	S-8260	10	03/17/1995
Bromomethane	<20	ug/kg	S-8260	20	03/17/1995
n-Butylbenzene	<5.0	ug/kg	S-8260	5.0	03/17/1995
sec-Butylbenzene	<5.0	ug/kg	S-8260	5.0	03/17/1995
tert-Butylbenzene	<5.0	ug/kg	S-8260	5.0	03/17/1995
Carbon Tetrachloride	<5.0	ug/kg	S-8260	5.0	03/17/1995
Chlorobenzene	<5.0	ug/kg	S-8260	5.0	03/17/1995
Chlorodibromomethane	<5.0	ug/kg	S-8260	5.0	03/17/1995
Chloroethane	<20	ug/kg	S-8260	20	03/17/1995
Chloroform	<5.0	ug/kg	S-8260	5.0	03/17/1995
Chloromethane	<20	ug/kg	S-8260	20	03/17/1995
2-Chlorotoluene	<5.0	ug/kg	S-8260	5.0	03/17/1995
4-Chlorotoluene	<5.0	ug/kg	S-8260	5.0	03/17/1995
1,2-Dibromo-3-Chloropropane	<50	ug/kg	S-8260	50	03/17/1995
1,2-Dibromoethane	<50	ug/kg	S-8260	50	03/17/1995
Dibromomethane	<5.0	ug/kg	S-8260	5.0	03/17/1995
1,2-Dichlorobenzene	<5.0	ug/kg	S-8260	5.0	03/17/1995
1,3-Dichlorobenzene	<5.0	ug/kg	S-8260	5.0	03/17/1995
1,4-Dichlorobenzene	<5.0	ug/kg	S-8260	5.0	03/17/1995
Dichlorodifluoromethane	<15	ug/kg	S-8260	15	03/17/1995
1,1-Dichloroethane	<5.0	ug/kg	S-8260	5.0	03/17/1995
1,2-Dichloroethane	23	ug/kg	S-8260	5.0	03/17/1995
1,1-Dichloroethene	<10	ug/kg	S-8260	10	03/17/1995
cis-1,2-Dichloroethene	<5.0	ug/kg	S-8260	5.0	03/17/1995
trans-1,2-Dichloroethene	<5.0	ug/kg	S-8260	5.0	03/17/1995
1,2-Dichloropropane	<5.0	ug/kg	S-8260	5.0	03/17/1995
1,3-Dichloropropane	<5.0	ug/kg	S-8260	5.0	03/17/1995
2,2-Dichloropropane	<5.0	ug/kg	S-8260	5.0	03/17/1995
1,1-Dichloropropene	<5.0	ug/kg	S-8260	5.0	03/17/1995
cis-1,3-Dichloropropene	<5.0	ug/kg	S-8260	5.0	03/17/1995

Brian DeJong
Brian D. DeJong, Organic Operation Manager
Certification No. 128053530