

## Institutional Control Audit Site

The documentation contained within was collected by the WDNR Project Manager from existing documentation contained in the case file for audit purposes.

This case was closed by the WDNR prior to the existence of GIS Registry submittal requirements being in place.

Certain documents that are currently required in ch. NR 726, Wis. Adm. Code, for inclusion on the GIS Registry may therefore be unavailable.

## **GIS Registry Disclaimer**

This case was closed by the DNR prior to August 1, 2002, when DNR began adding approved cleanups with residual soil contamination into the GIS Registry. Certain documents that are currently required by ch. NR 726, Wis. Adm. Code may therefore not be included in this packet as they were unavailable at the time the original case was closed.

The information contained in this document was assembled by DNR from a previously closed case file, and added to the GIS Registry to provide the public with information on closed sites with residual soil and/or groundwater contamination remaining above applicable state standards.

## Source Property Information

CLOSURE DATE: 06/13/2000

**BRRTS #:** 03-34-001065  
**ACTIVITY NAME:** DRAEGER OIL ANTIGO NORTH STATION  
**PROPERTY ADDRESS:** 703 SUPERIOR ST  
**MUNICIPALITY:** ANTIGO  
**PARCEL ID #:** 201-2863.15

**FID #:** 734007230

**DATCP #:** NA

**PECFA#:** 54409246020

**\*WTM COORDINATES:**

X: 586912 Y: 521145

*\* Coordinates are in  
WTM83, NAD83 (1991)*

**WTM COORDINATES REPRESENT:**

Approximate Center Of Contaminant Source

Approximate Source Parcel Center

Please check as appropriate: (BRRTS Action Code)

### CONTINUING OBLIGATIONS

#### Contaminated Media for Residual Contamination:

Groundwater Contamination > ES (236)

Contamination in ROW

Off-Source Contamination

*(note: for list of off-source properties  
see "Impacted Off-Source Property Information,  
Form 4400-246" )*

Soil Contamination > \*RCL or \*\*SSRCL (232)

Contamination in ROW

Off-Source Contamination

*(note: for list of off-source properties  
see "Impacted Off-Source Property Information,  
Form 4400-246" )*

#### Site Specific Obligations:

Soil: maintain industrial zoning (220)

*(note: soil contamination concentrations  
between non-industrial and industrial levels)*

Structural Impediment (224)

Site Specific Condition (228)

Cover or Barrier (222)

Direct Contact

Soil to GW Pathway

Vapor Mitigation (226)

Maintain Liability Exemption (230)

*(note: local government unit or economic  
development corporation was directed to  
take a response action )*

#### Monitoring Wells:

Are all monitoring wells properly abandoned per NR 141? (234)

Yes  No  N/A

*\* Residual Contaminant Level*

*\*\*Site Specific Residual Contaminant Level*

The following site is being submitted for inclusion into the GIS registry:

This is a:	New Submittal
BRRTS ID (no dashes):	0334001065
Comm # (no dashes):	54409246020
County:	Langlade
Region:	Commerce
Site name:	Draeger Oil/Antigo North Station
Street Address:	2120 N Neva Rd
City:	Antigo
Closure Date	2000-06-13
Closure Conditions:	met
Offsite contamination?	No
Right-of-way contamination?	No
Contaminated media:	Groundwater
GPS Coordinates (meters in the <b>WTM91</b> projection)	
Easting (X):	586930.596520286
Northing (Y):	521086.65748806
Submitted by:	Cheryl Nelson

Checklist

- Final Closure Letter
- Copy of recorded deed Instrument for any property with GW >NR140 ES
- General Location Map
- Detailed Location Map showing property boundaries, buildings, etc for properties with GW >NR140 ES
- Latest Map(s) showing extent or outline of current GW plume
- GW flow direction
- MW(s) and/or potable wells
- Latest Table of GW results



ENVIRONMENTAL & REGULATORY SERVICES  
2129 Jackson Street  
Oshkosh, Wisconsin 54901  
Fax: (920) 424-0217  
TDD #: (608) 264-8777  
[www.commerce.state.wi.us](http://www.commerce.state.wi.us)  
**Tommy G. Thompson, Governor**  
**Brenda J. Blanchard, Secretary**

March 1, 2000

Draeger Oil  
Attn: James Draeger  
P.O. Box 340  
Antigo WI 54409

RE: **Commerce # 54409-2460-20**  
Draeger Oil – North Antigo, 2120 Neva Road, Antigo, WI

**Case Closure (conditional upon receipt of documentation)**

Dear Mr. Draeger:

On January 13, 2000 the Wisconsin Department of Natural Resources transferred this site to the Wisconsin Department of Commerce for regulatory oversight. On behalf of the Wisconsin Department of Commerce, I am reviewing this case for closure.

Using the standards established in NR 700, and the risk criteria of Comm 46, the Department has determined that this site does not pose a significant threat to the environment and human health, and no further investigation or remedial action is necessary. In making this determination, I reviewed the following documents prepared by Environmental Assessments, as well as other correspondence in the case file:

- *Contamination Investigation Work Plan*, December 15, 1994
- *Underground Storage Tank Site Characterization*, August 28, 1997
- *Remedial Action Plan*, February 19, 1998
- *Groundwater Monitoring Reports* dated March 20, 1995, September 11, 1995, March 20, 1996, November 21, 1995, December 9, 1997, March 25, 1998, October 22, 1999, January 5, 2000
- *Case Summary and Closure Request*, January 5, 2000

If, in the future, site conditions indicate that any contamination that might remain poses a threat, the need for further remediation would be determined and required if necessary. If subsequent information indicates a need to reopen this case, any original claim under the PECFA fund would also reopen and you may apply for assistance to the extent of remaining eligibility.

RE: Commerce # 54409-2460-20  
Draeger Oil - Antigo North  
2120 N. Neva Road, Antigo, WI

March 1, 2000

Page 2

**IMPORTANT:** we cannot list this case as "closed" on our computer database until we receive the following items.

- A notification must be placed on the property deed addressing residual groundwater impacts. For case closure we will need a copy of the deed notification that contains the County Register of Deeds' recording information. Enclosed an example of a "Notice of Contamination to Property" for your use. If you wish to modify the language, submit a copy to this office for review prior to filing.
- Documentation of the abandonment of monitoring wells MW-1, 2, 3, 5, 6, 7, 15, 17, PZ14, EW1. Please submit abandonment documentation to the Department at the letterhead address.

Thank you for your efforts in the protection of the environment. If you have any questions, please call me at (920) 424-0046.

Sincerely,



Dee Zoellner  
Hydrogeologist  
PECFA Site Review Section

enclosure

cc: Martin Johnson, Environmental Assessments (with enclosure)  
electronic case file



environment and human health. If subsurface work is done in the contaminated areas, the contamination shall be properly treated or disposed of in accordance with applicable laws.

Any person who is or becomes owner of the property described above may request that the Wisconsin Department of Commerce, or its successor, issue a determination that the restrictions set forth in this covenant are no longer required. That property owner shall provide any and all necessary information to the Department in order for the Department to be able to make a determination. Upon receipt of such a request, the Department shall determine whether or not the restrictions contained herein can be extinguished. Conditions under which a restriction may be extinguished will be determined in accordance with the site specific standards, rules and laws for this property. If the Department determines that the restrictions can be extinguished, an affidavit, with a copy of the Department's written determination, may be recorded to give notice that this restriction, or portions of this restriction are no longer binding. Any restriction placed upon this property shall not be extinguished without the Department's written determination.

IN WITNESS WHEREOF, the owner of the property has executed this document, this 5<sup>th</sup> day of March, 2000.

[When appropriate use the following clause]:

By signing this document, [he/she] acknowledges that [he/she] is duly authorized to sign this document on behalf of

Signature: *James Draeger*

Printed Name: JAMES DRAEGER

Title: PRESIDENT

Subscribed and sworn to before me this 9<sup>th</sup> day of March, 2000

Connie L. Kapes  
Notary Public, State of Wisconsin  
My commission April 21, 2002

This document was drafted by the Wisconsin Department of Commerce.

# Legal Description

OWNERS TRACT OF N 1/2 SEC. 20  
T31N R11E BEING 77 LOTS 5 & 6  
COM @ A PT ON CTR LN HWY

45 415.14' S of OLD SEC.

CON TH W 50' TO W LN SD HWY  
E POB TH CONT @ 181' TO A PT

ON E LN of PCH CONV V302 P394

WHICH <sup>PT</sup> IS 439.56' S of OLD SEC  
LN TH S ON E LN of PCH

CONV 196.1' TH E TO A PT 120'  
E of CTR LN of HWY 45 TH SE 47'

TO A POINT 95' W of SD CTR LN  
TH E 45' TO W LN SD HWY TH @ N LN  
R16 W LN SD HWY .. SPECIAL DISTRICTS

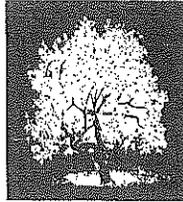
2 TIF DIST #2 - CITY

240' to POB ALSO LOT 3 CSM

V4 P135 EXC PCH CONV.

DOC # 293282

2120 ALUG ROAD



ENVIRONMENTAL  
ASSESSMENTS, INC.

RECEIVED  
JAN 13 2000  
ERS DIVISION

January 5, 2000

Mr. Norm Dunbar  
Wisconsin Department of Natural Resources  
P.O. Box 818  
Rhineland, WI 54501

RE: Request for Transfer of Closure Request/Case File to Department of Commerce  
Draeger Oil-Antigo North, 2120 Neva Road, Antigo, Wisconsin  
WDNR LUST#-1065  
PECFA Claim ID# 54409-2460-20

03-34-001065

Dear Mr. Dunbar,

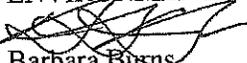
Enclosed please find a Case Summary and Close Out Form for the Draeger Oil-Antigo North site located at 2120 Neva Road in Antigo, Wisconsin. Environmental Assessments, Inc. (EA) has designated this site a low priority site and requests that you forward the closure request and case file to the appropriate Department of Commerce project manager for review.

In addition to the required form the following attachments are included:

- Attachment A Case Summary and Justification for Closure
- Attachment B Site Layout Map  
North-South Cross-Section
- Attachment C Soil Analytical Results Table
- Attachment D Groundwater Analytical Results Table
- Attachment E Groundwater Analytical Results Map with Sample Locations
- Attachment F Maximum Groundwater Contamination Plume and Area of Contamination Map  
Contaminant Mass Calculations  
Evaluation of Contaminant Reduction Using Conservative Tracer Method  
Summary of Field Inorganic Parameters  
Calculations for Determining the Assimilative Capacity of the Groundwater Environment
- Attachment G Groundwater Elevation Table and Groundwater Contour Maps
- Attachment H List of Previous Reports
- Attachment I Tank Information

If there are any questions regarding this closure request or if additional information is required, please contact me at (920) 749-9746.

Sincerely,  
ENVIRONMENTAL ASSESSMENTS, INC.

  
Barbara Busus  
Hydrogeologist

## Case Summary

The Draeger Oil- Antigo North site is located at 2120 Neva Road, Antigo, Wisconsin and is zoned commercial. It is bordered to the north by the Gold Coast Inn Motel, to the east by Neva Road (State HWY 45), to the south by a Pizza Hut restaurant and by Wolf River Realty real estate, and to the west by residential/commercial properties. The area is provided with public water supply from the City of Antigo, however, the property owners were allowed to retain previously installed potable wells. The potable well located on the Draeger site has been abandoned. Due to the timing of the Pizza Hut property, no potable well is associated with the property. The Wolf River Realty property does utilize a potable well for non-drinking facility purposes. This well has been sampled and contamination was not detected at levels in excess of current Wisconsin Department of Natural Resources (WDNR) standards.

Contamination above the WDNR NR 720 guidelines was discovered during a preliminary site investigation conducted by NRP Environmental on December 29, 1993. Following the discovery of contamination, the WDNR was notified. EA conducted a Phase II Remedial Site Investigation. The investigation revealed that groundwater contamination was present at levels in excess of current WDNR standards.

EA prepared and submitted a remedial action plan to the WDNR and Department of Commerce (DCOMM) for review on February 19, 1998. The lowest cost remedial alternative included the installation of a groundwater extraction well. Initially, a feasibility study using temporary groundwater extraction and treatment events was to be conducted in order to determine if groundwater extraction was an effective remedial option. If it was an effective method, a pump and treat system utilizing air stripping was to be installed. Due to changes in WDNR regulations, DCOMM requested that the RAP be revised. On March 25, 1998, EA submitted a response to DCOMM. The remedial alternative was approved by DCOMM on April 22, 1998. A groundwater extraction well was installed in December of 1998. However, the recovery rate on the well was very slow, indicating that groundwater extraction via EW1 was not a viable remedial alternative.

Due to the site conditions and WDNR changes regarding site closure, EA personnel performed natural attenuation monitoring rather than proceed with the feasibility study. The site monitoring wells have been monitored eight times since the submittal of the site investigation report. The monitoring data documents changes in contaminant concentrations and natural attenuation conditions. The results of the monitoring were presented to the WDNR in updates and are included in this request for closure.

## Justification for Closure

It is evident that remediation by natural attenuation (RNA) is occurring and effective at stabilizing contaminant levels. Data collected to support this conclusion includes biological, dissolved oxygen, temperature, pH, nitrate, sulfate and ferrous iron measurements. This data indicates that biodegradation should be effective at reducing 30% of the groundwater BTEX contamination. The most likely pathway for degradation appears to be anaerobic biodegradation via sulfate reduction followed by aerobic respiration. Due to the stability of the plume, it is evident that other attenuation factors such as dilution and dispersion are effective at reducing the remaining contamination.

An evaluation of contaminant reduction using a conservative tracer element (TMB) was performed using data collected in June, 1999. The first evaluation (Zone I to Zone II) indicated that bioattenuation should actively remediate 69% of the remaining BTEX groundwater contamination between these zones. The second evaluation (Zone II to Zone III) indicated that bioattenuation should actively remediate 43% of the remaining BTEX groundwater contamination between these zones. These bioattenuation rates have been and should continue to be sufficient to maintain plume stability.

Groundwater contaminant mass calculations were performed for the three zones within the plume. The scenario presented is intended to be a worst case scenario. In addition, calculations for determining the assimilative capacity of the groundwater environment indicated that the assimilative capacity appears to be sufficient for the bioremediation of 30% of the remaining BTEX contamination. The most likely pathway for degradation appears to be anaerobic biodegradation via sulfate reduction. Contaminant mass and assimilative capacity calculations are presented in Attachment F.

Distance versus contaminant concentration levels were calculated. From Zone I to Zone II, a reduction of 41.67 ppb/ft TMB occurs through dilution, dispersion, advection and adsorption. From Zone II to Zone III, a reduction of 19.62 ppb/ft TMB occurs.

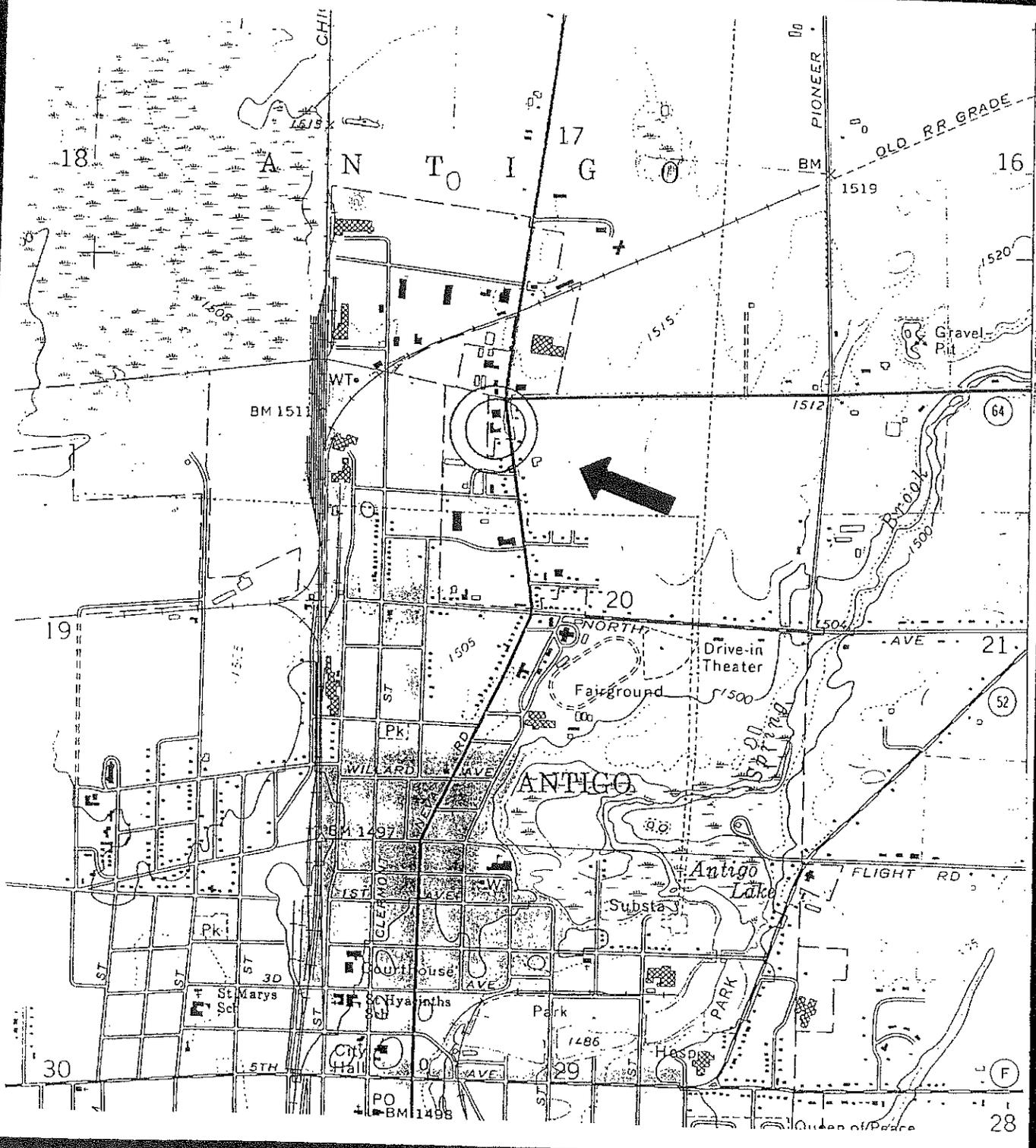
No environmental factors and no sensitive receptors exist at this time that may be adversely affected by the remaining contamination. The utilities on site and on properties contained within the plume boundaries include natural gas, electrical and telephone. These utility lines are present at depths ranging from two to four feet below grade. Seasonal groundwater readings indicate that these utility trenches do not intersect the groundwater table. In addition, the sanitary sewer and water supply laterals are present at depths above the groundwater table.

Since the start of the investigation, the contaminant levels in the most contaminated well (MW7) have been reduced from 2360 ppb benzene to 1900 ppb, 18500 ppb toluene to 16000 ppb, 3960 ppb ethylbenzene to 3300 ppb and 20190 ppb total xylenes to 16000 ppb in the most recent round of sampling. This constitutes a

17% reduction for these four compounds in the source area.

From the information collected during the site investigation and subsequent groundwater monitoring for natural attenuation using the values from September 30, 1999, it is calculated that a maximum of 2.694 pounds of benzene, 41.091 pounds of combined benzene, toluene, ethylbenzene and total xylene (BTEX), 0.005 pounds of MTBE, and 4.309 pounds of trimethylbenzene (TMB) remain in the groundwater.

In summary, the groundwater contamination at this site has been reduced by natural attenuation and the contaminant plume is stable. Although a large quantity of dissolved phase contamination remains in the groundwater at this site and on neighboring properties, data indicates that natural attenuation processes are effective at reducing the remaining contamination. There are no environmental factors, sensitive receptors, water supply or impacted private wells near this site. The native soil has a hydraulic conductivity indicative of high permeability soils and developable groundwater. However, all properties are supplied with an alternative water supply by the City of Antigo. Natural attenuation data indicates that neither MTBE nor TMB have been detected at a level in excess of the current enforcement standard in an off site well. All of this evidence leads to the conclusion that this site does not pose a threat to humans or the environment and, therefore, should be closed. EA respectfully requests that this site be granted closure.



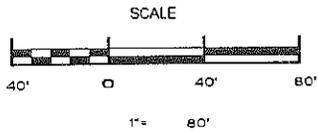
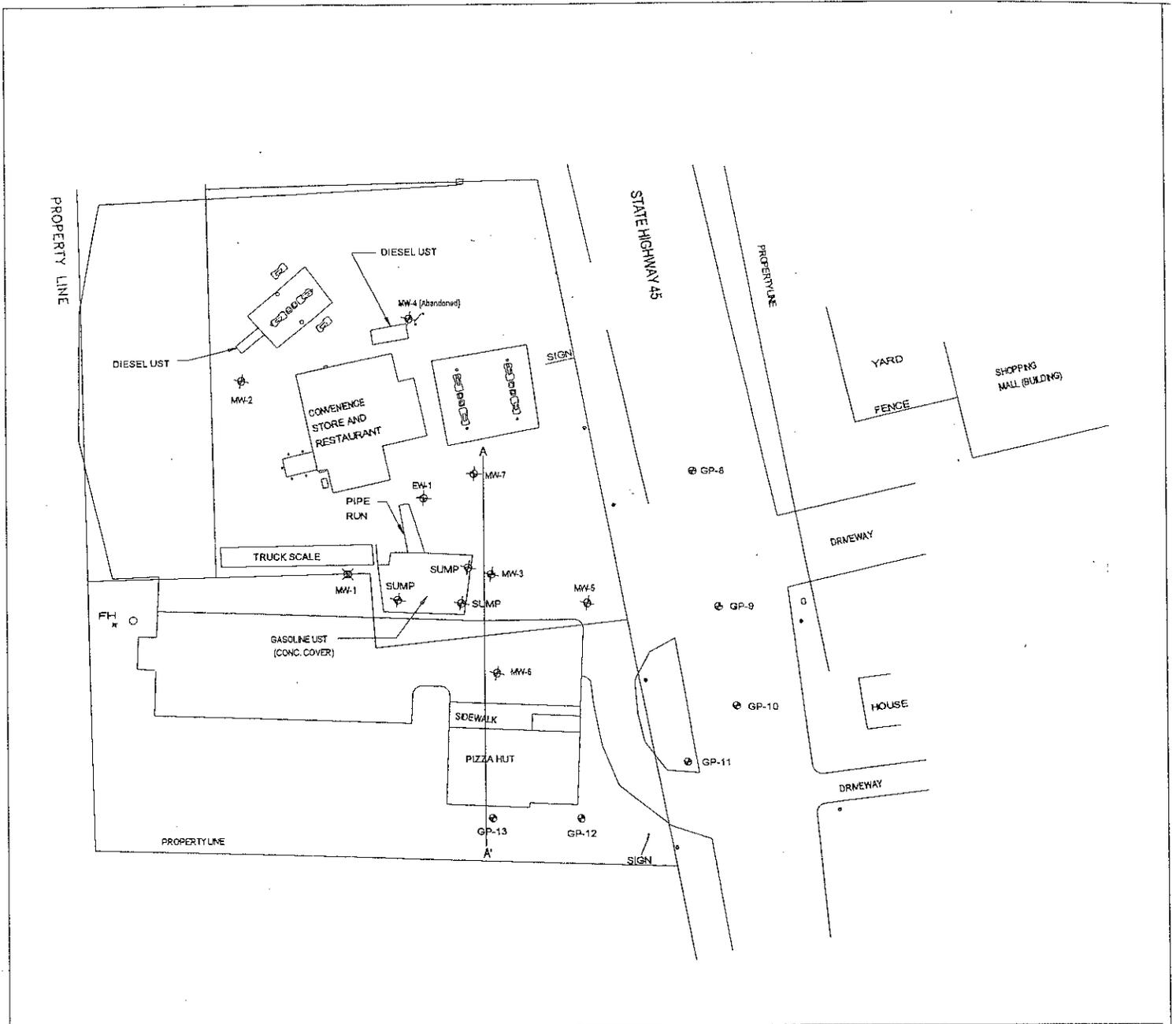
**ENVIRONMENTAL  
ASSESSMENTS,  
INC.**

**Project/Client**

**SITE LOCATION MAP  
DRAEGER OIL-ANTIGO NORTH STATION  
ANTIGO, WISCONSIN**

(Map Source: USGS 7.5' Series Topographic Quad of Antigo)

Figure No.	1
Drawn By	DAB
Scale	1" = 1,500'
Project No.	20097010994

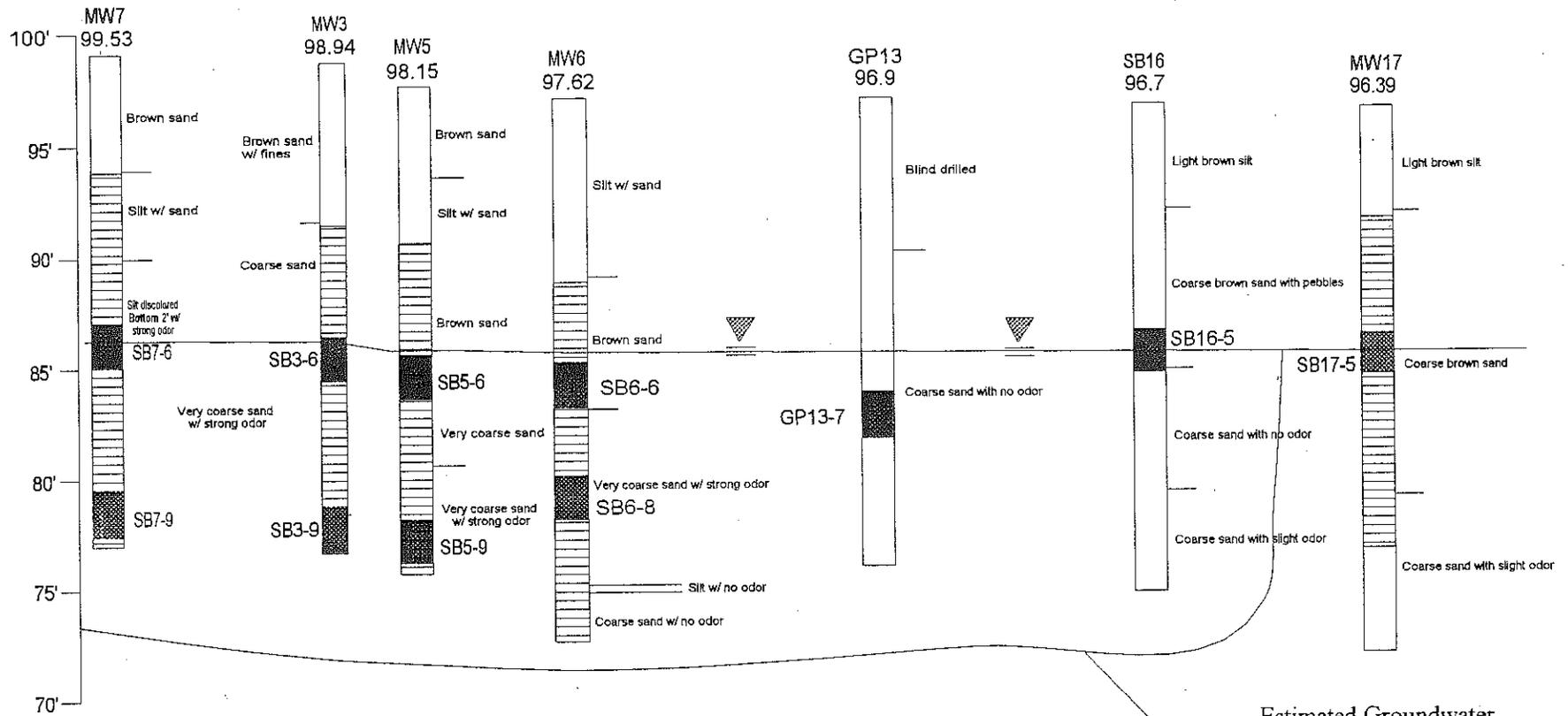


- \* FH FIRE HYDRANT
  - GP-10 GEO-PROBE
  - ★ MW-5 MONITORING WELL
- All soil boring numbers correspond to monitoring well numbers (i.e. SB1 = MW1)

	<p>SITE LOCATION MAP DRAEGER OIL-ANTIGO MAP ANTIGO, WI</p>	<p>ENVIRONMENTAL ASSESSMENTS, INC.  P. O. Box 9217 Appleton, WI 54911  414-749-9746      Fax: 414-749-9748</p>	<p>Figure #: 2</p>
--	--	--	--------------------

A

A'

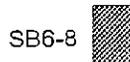


Elevation based on benchmark of 100'

Strong petroleum odor associated with the highly conductive, very coarse sand layer.



Groundwater Table



Sample Location

Estimated Groundwater Contamination Plume

ENVIRONMENTAL ASSESSMENTS, INC.

P. O. Box 9217  
Appleton, WI 54911

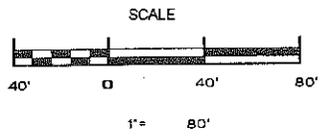
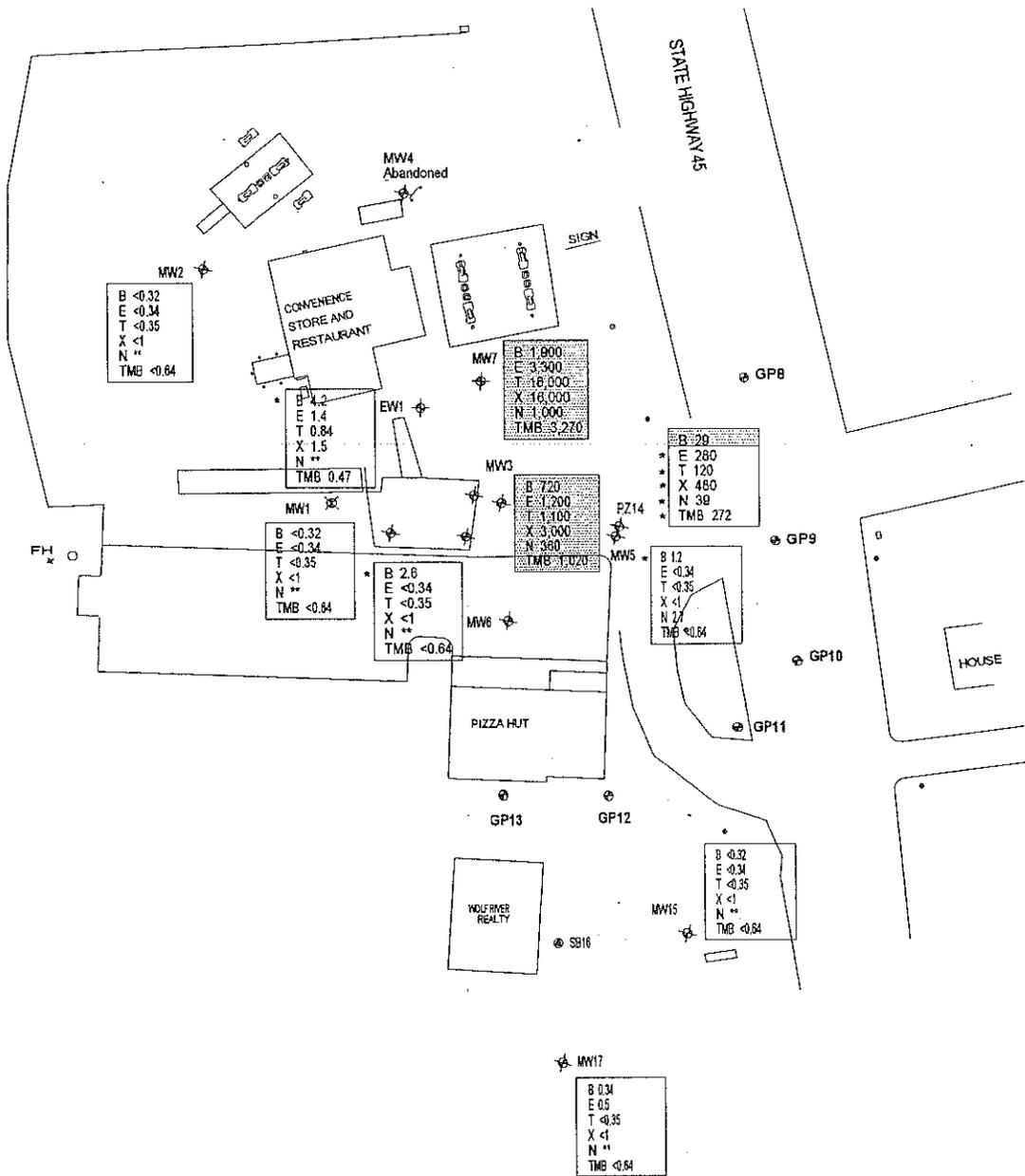
920-749-9746

Fax: 920-749-9748

NORTH-SOUTH CROSS-SECTION

DRAEGER OIL-ANTIGO MAP  
ANTIGO, WI

Figure #: 4



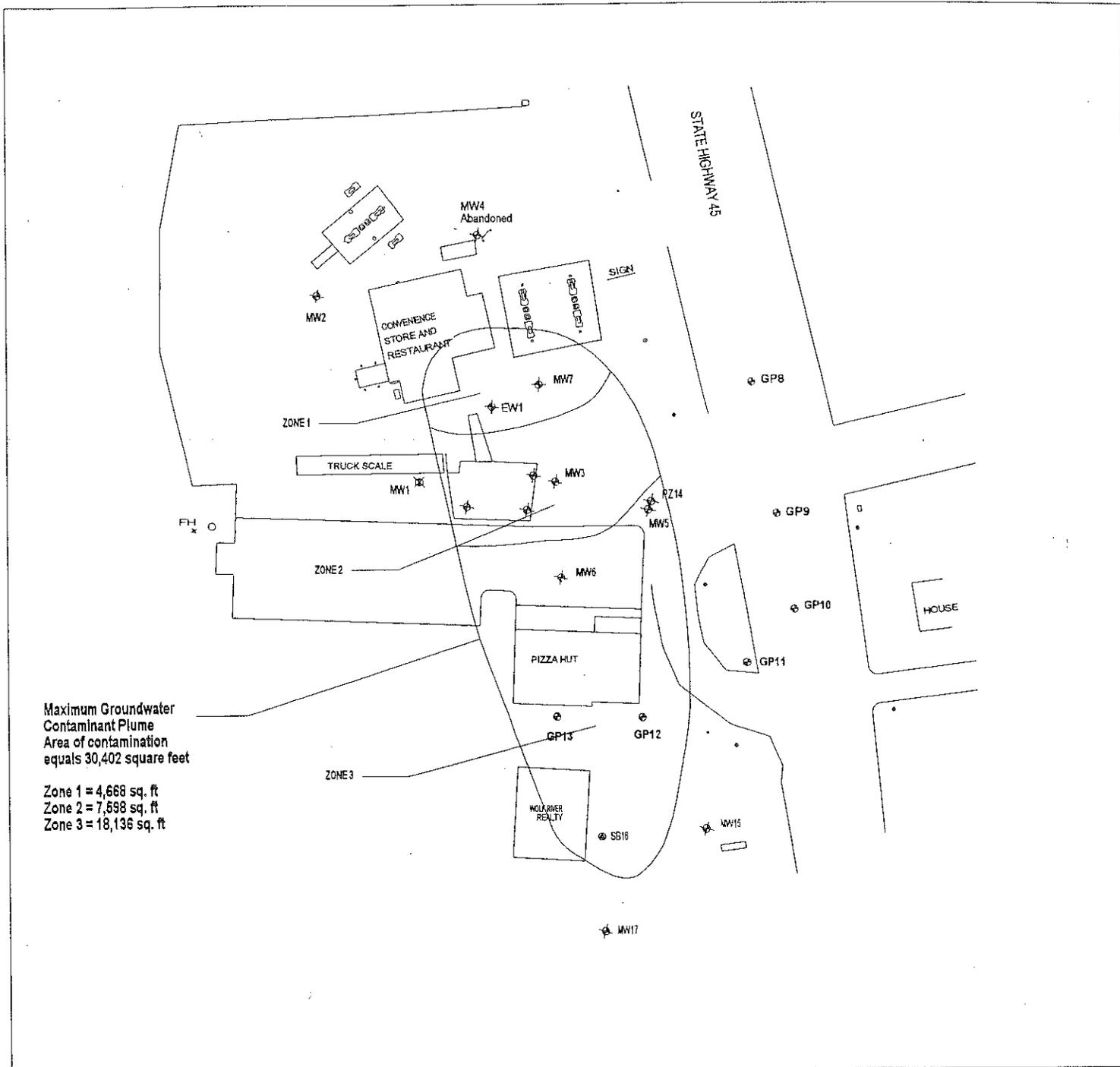
- ⊕ GP-10 GEOPROBE BORING ID
  - ⊙ SB-16 SOIL BORING ID
  - ⊕ MW5 MONITORING WELL ID
- |         |                   |
|---------|-------------------|
| B 280   | Benzene           |
| E 120   | Ethylbenzene      |
| T 480   | Toluene           |
| X 39    | Xylenes           |
| N 272   | Naphthalene       |
| TMB 272 | Trimethylbenzenes |

Shading indicates an ES exceedance  
 Asterisk to left indicates a PAL exceedance  
 Double asterisk means not analyzed for parameter

GROUNDWATER ANALYTICAL RESULTS MAP  
 9/30/99  
 DRAEGER OIL-ANTIGO MAP  
 ANTIGO, WI

ENVIRONMENTAL ASSESSMENTS, INC.  
 P. O. Box 9217  
 Appleton, WI 54911  
 920-749-9746 Fax: 920-749-9748

Figure #:  
 Drawn By: Barbara Burns



- ⊕ GP-10 GEOPROBE BORING ID
- ⊙ SB-18 SOIL BORING ID
- ⊕ MW5 MONITORING WELL ID

**MAXIMUM GROUNDWATER  
CONTAMINATION PLUME MAP**

DRAEGER OIL-ANTIGO MAP

ANTIGO, WI

ENVIRONMENTAL ASSESSMENTS, INC.

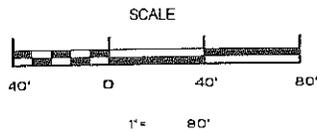
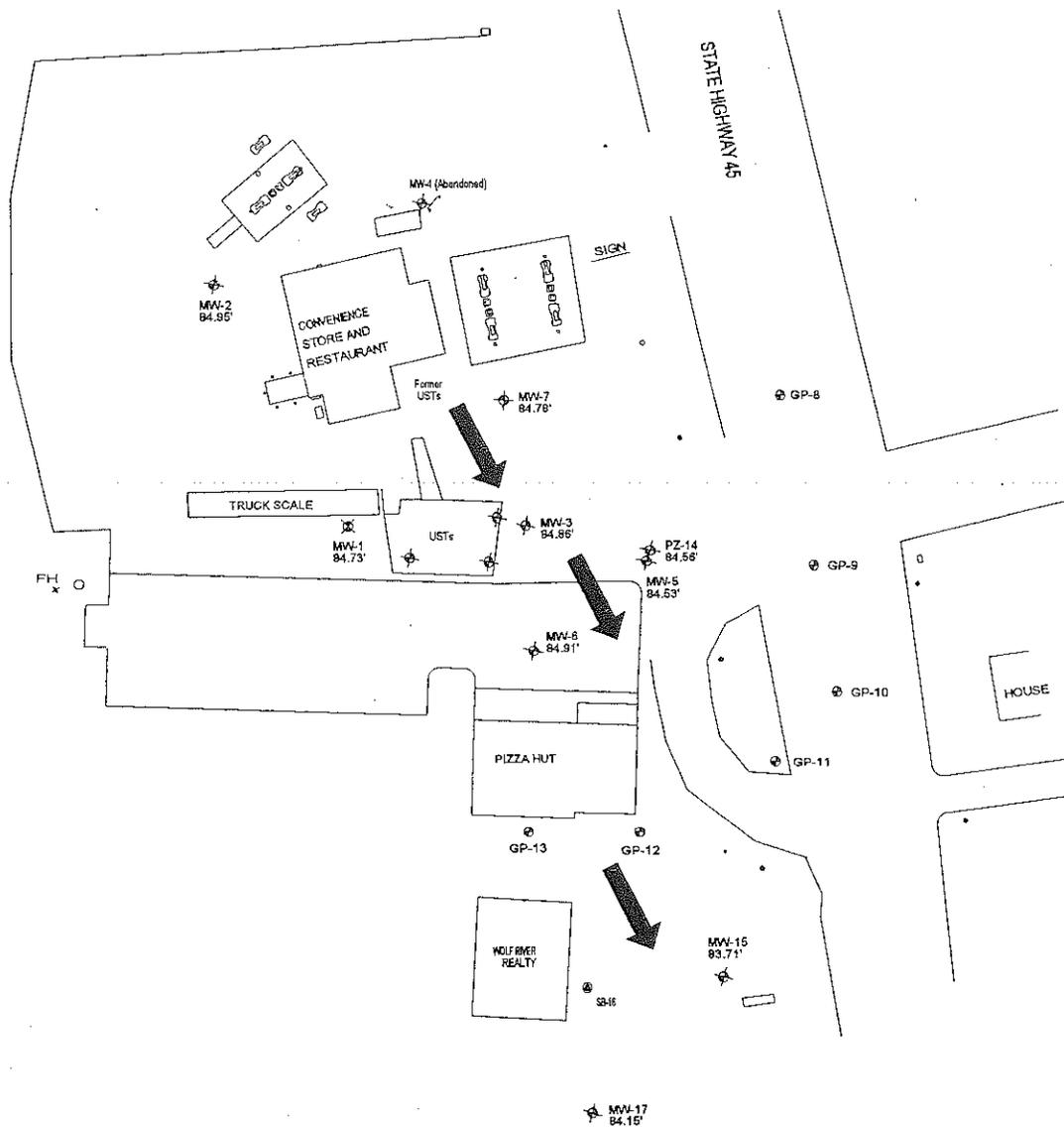
P. O. Box 9217  
Appleton, WI 54911

920-749-9746

Fax: 920-749-9748

Figure #:

Drawn By: Barbara Burns



- x FH FIRE HYDRANT (BENCHMARK=100 FEET)
  - ⊙ GP-10 GEOPROBE
  - ⊙ SB-16 SOL. BORING
  - ⊙ MW-5 MONITORING WELL/PNEUMETER WITH GROUNDWATER ELEVATION IN FEET
- NOTE: PNEUMETER DATA NOT INCORPORATED INTO CONTOUR MAP

GROUNDWATER ELEVATION DATA  
(3/22/99)  
DRAEGER OIL-ANTIGO MAP  
ANTIGO, WI

ENVIRONMENTAL ASSESSMENTS, INC.

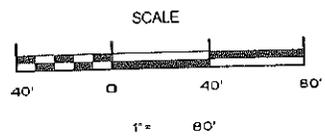
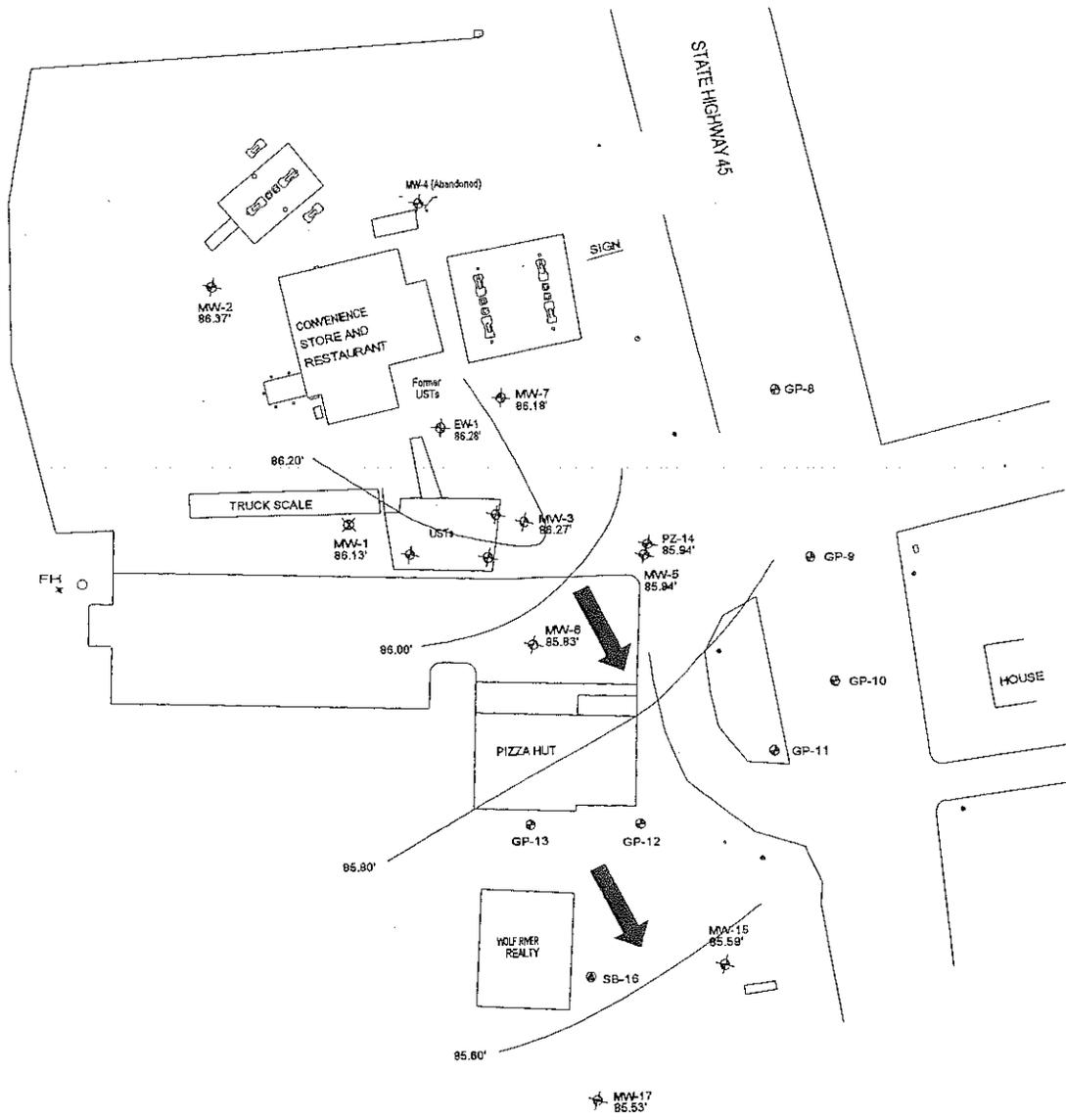
P. O. Box 9127  
Appleton, WI 54911

920-749-9746

Fax: 920-749-9748

Figure #: 3

Drawn By: Barbara Burns



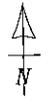
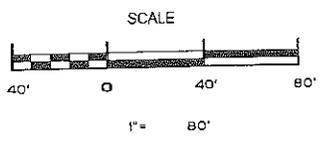
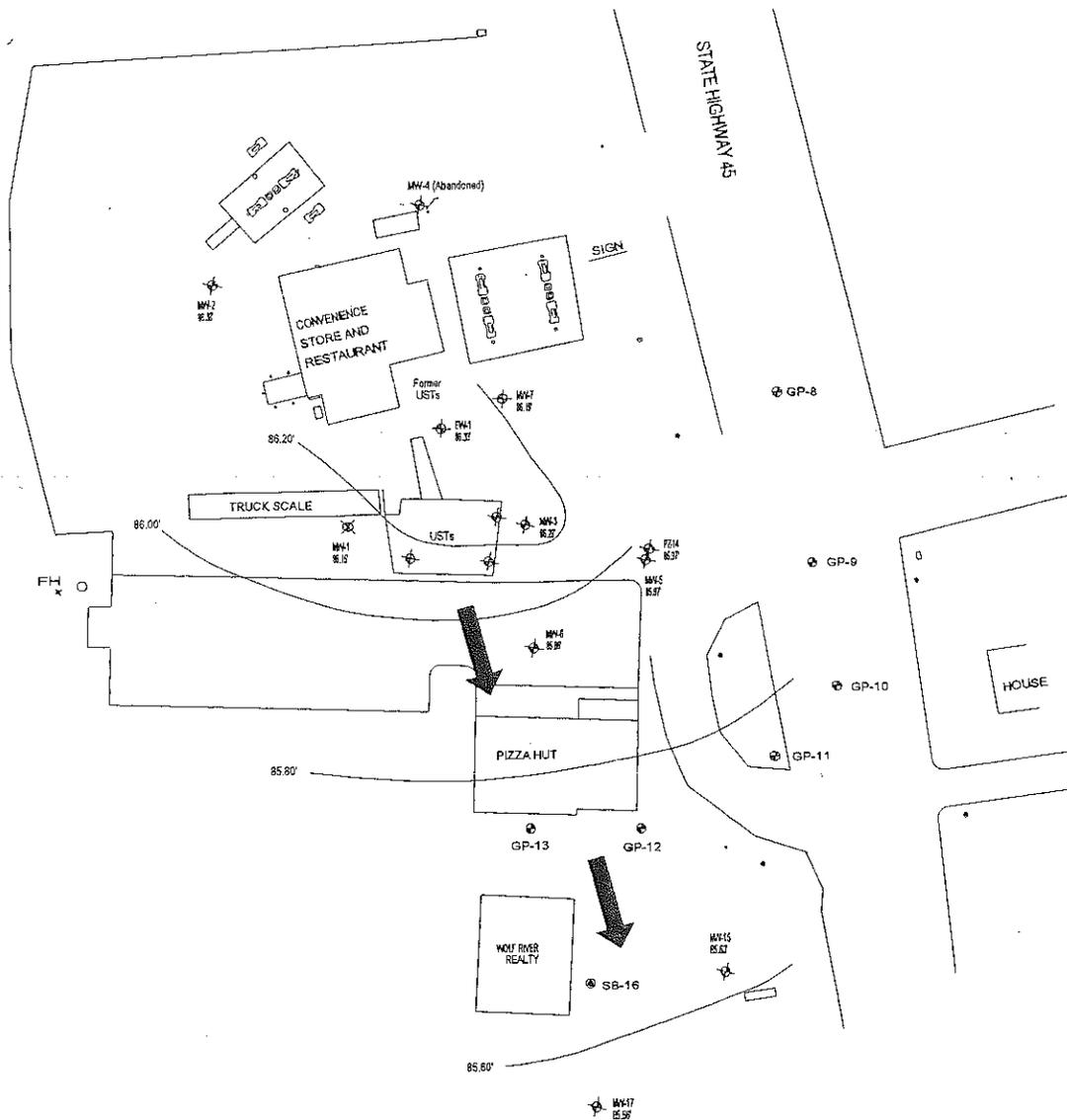
- x FH FIRE HYDRANT (BENCHMARK-100 FEET)
  - ⊙ GP-10 GEOPROBE
  - ⊙ SB-16 SOIL BORING
  - ⊙ MW-5 MONITORING WELL/PIEZOMETER WITH GROUNDWATER ELEVATION IN FEET
- NOTE: PIEZOMETER DATA NOT INCORPORATED INTO CONTOUR MAP

GROUNDWATER ELEVATION DATA  
(6/29/99)  
DRAEGER OIL-ANTIGO MAP  
ANTIGO, WI

ENVIRONMENTAL ASSESSMENTS, INC.  
P. O. Box 9127  
Appleton, WI 54911

920-749-9746 Fax: 920-749-9748

Figure #: 3  
Drawn By: Barbara Burns



- x FH FIRE HYDRANT (BENCHMARK=100 FEET)
  - ⊕ GP-10 GEOPROBE
  - ⊙ SB-16 SOIL BORING
  - ⊗ MW-5 MONITORING WELL/PIEZOMETER WITH GROUNDWATER ELEVATION IN FEET
- NOTE: PIEZOMETER DATA NOT INCORPORATED INTO CONTOUR MAP

GROUNDWATER ELEVATION DATA  
(9/30/99)  
DRAEGER OIL-ANTIGO MAP  
ANTIGO, WI

ENVIRONMENTAL ASSESSMENTS, INC.  
P. O. Box 9127  
Appleton, WI 54911

920-749-9746

Fax: 920-749-9748

Figure #: 3

Drawn By: Barbara Burns

### SOIL BORING SAMPLING SUMMARY

Boring ID	Sample ID	Sample Depth Below Surface (ft)	PID Reading ppm	Petroleum Odor	DRO ppm	GRO ppm	Total Lead ppm
January 24-5, 1995							
SB-1	SB1-5	10.0 - 12.0	0	None	**	<2.5	**
SB-1	SB1-8	17.5 - 19.5	0	None	**	<2.5	**
SB-2	SB2-6	12.5 - 14.5	0	None	3.4	**	**
SB-2	SB2-8	17.5 - 19.5	0	None	<3.2	**	**
SB-3	SB3-6	12.5 - 14.5	614	Strong	**	132	3.36
SB-3	SB3-9	20.0 - 22.0	125	Strong	**	<2.5	**
SB-4	SB4-4	10.0 - 12.0	3.5	None	<2.9	**	**
January 19, 1996							
SB5	SB5-6	12.5 - 14.5	4.6	None	**	<2.9	**
SB5	SB5-9	20.0 - 22.0	60	Strong	**	<3.1	**
SB6	SB6-6	12.5 - 14.5	9.5	None	**	<3.0	**
SB6	SB6-8	17.5 - 19.5	28	Strong	**	<3.1	**
SB7	SB7-6	12.5 - 14.5	>1000	Strong	**	1,400	**
SB7	SB7-9	20.0 - 22.0	>1000	Strong	**	270	**
June 19, 1996							
GP8	GP8-7	13.0 - 15.0	5	Strong	**	<0.9	
GP9	GP9-5	9.0 - 11.0	1.6	None	**	<0.9	
GP10	GP10-5	9.0 - 11.0	1.6	None	**	<0.9	
GP11	GP11-5	9.0 - 11.0	1.6	None	**	<0.9	
GP12	GP12-8	15.0 - 17.0	5	Strong	**	<0.9	
GP13	GP13-7	13.0 - 15.0	1.6	None	**	<0.9	
June 23, 1997							
SB14	**	Within 5' of SB5	Highest Reading = 48	Slight 15-22'	**	**	
SB15	SB15-5	10.0 - 12.0	3	None	**	<0.65	
SB16	SB16-5	10.0 - 12.0	3	None	**	<0.65	
SB17	SB17-5	10.0 - 12.0	3	None	**	<0.65	
December 10, 1998							
SB18	SB18-6	12.5 - 14.5	5	None	4.7	<0.65	2.5

**Notes:**

PID readings are in isobutylene equivalents

< value = parameter detected below the laboratory method detection limit

ppm = parts per million

GRO = WDNR modified gasoline range organics

DRO = WDNR modified diesel range organics

Shaded areas indicate NR 720 RCL exceedance

**SUMMARY OF DETECTED SOIL VOC PARAMETERS**

Analytical Parameter ppb	SB1-5	SB1-8	SB2-6	SB2-8	SB3-6	SB3-9	SB4-4	SB5-6	SB5-9	SB6-6	SB6-8	SB7-6	WDNR RCL
Benzene	<0.9	<0.9	<1	<0.9	3.9	1.7	<0.8	<25	<25	<25	<25	1,400	5.5
Ethylbenzene	<1.1	<1.1	<1.2	<1.1	7.4	4.2	<1	<25	<25	<25	<25	69,000	2,900
Toluene	<1.1	<1.1	<1.2	<1.1	9.3	1.8	<1	<25	<25	<25	<25	74,000	1,500
Total Xylenes	<3.2	<3	<3.3	<3	38	10.3	<2.9	<25	<25	<25	<25	347,000	4,100
1,2-Dichloroethane	<2.1	<2	<2.1	<1.9	<4.9	<2.2	<1.9	<25	<25	<25	<25	<500	4.9
Naphthalene	<1.9	<1.8	<2	<1.8	10	5	<1.7	<25	<25	<25	<25	47,000	NA
1,2,4-Trimethylbenzene	<3.2	<3	<3.3	<3	14	8.8	<2.9	<25	31	<25	<25	220,000	NA
1,3,5-Trimethylbenzene	<1.7	<1.6	<1.8	<1.6	4.7	<1.8	<1.5	<25	<25	<25	<25	71,000	NA
n-Butylbenzene	<3.6	<3.4	<3.7	<3.4	<8.4	<3.9	<3.2	<25	<25	<25	<25	22,000	NA
sec-Butylbenzene	<2.8	<2.7	<2.9	<2.7	<6.7	<3.1	<2.5	<25	<25	<25	<25	5,100	NA
4-Chlorotoluene	<1.3	<1.3	<1.4	<1.2	<3.1	<1.4	<1.2	<25	<25	<25	<25	<500	NA
Isopropylbenzene	<1.1	<1.1	<1.2	<1.1	<2.7	<1.2	<1	<25	<25	<25	<25	8,800	NA
p-Isopropyltoluene	<2.4	<2.3	<2.5	<2.3	<5.8	<2.7	<2.2	<25	<25	<25	<25	2,800	NA
n-Propylbenzene	<1.5	<1.4	<1.6	<1.4	<3.6	<1.6	<1.4	<25	<25	<25	<25	38,000	NA

Analytical Parameter ppb	SB7-9	GP8-7	GP9-5	GP10-5	GP11-5	GP12-8	GP13-7	SB15-5	SB16-5	SB17-5	SB18-6	WDNR RCL
Benzene	91	<25	<25	<25	<25	<25	<25	<9	<9	<9	<10.7	5.5
Ethylbenzene	1,800	<25	<25	<25	<25	<25	<25	<4.5	<4.5	<4.5	<11.1	2,900
Toluene	2,700	<25	<25	<25	<25	<25	<25	<4.2	<4.2	<4.2	<6.27	1,500
Total Xylenes	9,000	<215	<25	<25	<25	<25	<25	<19	<19	<19	<22.3	4,100
1,2-Dichloroethane	<25	<25	<25	<25	<25	<25	<25	<13	<13	<13	<20	4.9
Naphthalene	940	<25	<25	<25	<25	<25	<25	<7.1	<7.1	<7.1	<30.7	NA
1,2,4-Trimethylbenzene	5,700	<25	<25	<25	<25	<25	<25	<9.9	<9.9	<9.9	<26.5	NA
1,3,5-Trimethylbenzene	<25	<25	<25	<25	<25	<25	<25	<10	<10	<10	<19.7	NA
n-Butylbenzene	570	<25	<25	<25	<25	<25	<25	<10	<10	<10	<43.2	NA
sec-Butylbenzene	130	<25	<25	<25	<25	<25	<25	<6.2	<6.2	<6.2	<19.8	NA
4-Chlorotoluene	160	<25	<25	<25	<25	<25	<25	<12	<12	<12	<37.3	NA
Isopropylbenzene	230	<25	<25	<25	<25	<25	<25	<4.5	<4.5	<4.5	<13.2	NA
p-Isopropylbenzene	**	**	**	**	**	**	**	**	**	**	**	NA
p-Isopropyltoluene	93	<25	<25	<25	<25	<25	<25	<18	<18	<18	<29.5	NA
n-Propylbenzene	940	<25	<25	<25	<25	<25	<25	<9.9	<9.9	<9.9	<20.4	NA

Notes:

< value = parameter detected below the laboratory method detection limit

ppb = parts per billion

WDNR RCL = WDNR NR 720 residual contaminant level

Shaded areas indicate RCL exceedance

**SUMMARY OF DETECTED GROUNDWATER PARAMETERS**

Well ID	Date	Benzene	1,2-DCE	Ethylbenzene	Naphthalene	Toluene	Tot. Xylenes	MTBE	TMB	Carbon Tetra	Chloroform	Lead
MW1	02/09/95	ND	ND	ND	ND	ND	ND	ND		ND	ND	**
	06/30/95	ND	**	ND	**	ND	ND	ND		**	**	**
	12/04/96	ND	**	ND	**	ND	ND	ND		**	**	**
	07/17/97	ND	**	ND	**	ND	ND	ND		**	**	**
	10/16/97	ND	**	ND	**	ND	ND	ND		**	**	**
	02/05/98	ND	**	ND	**	ND	ND	ND		**	**	**
	06/12/98	<0.5	**	<0.6	**	<0.6	<1.7	<0.92	<1.7	**	**	**
	09/24/98	<0.5	**	<0.6	**	<0.6	<1.7	<0.92	<1.7	**	**	**
	12/22/98	<0.5	**	<0.6	**	<0.6	<1.7	<0.92	<1.7	**	**	**
	03/22/99	<0.32	**	<0.34	**	<0.35	<1	<0.31	<0.64	**	**	**
	06/29/99	<0.32	**	<0.34	**	<0.35	<1	0.67	<0.64	**	**	**
	09/30/99	<0.32	**	<0.34	**	<0.35	<1	<0.31	<0.64	**	**	**
MW2	02/09/95	ND	ND	ND	ND	ND	ND	ND		ND	ND	**
	06/30/95	ND	**	ND	**	ND	ND	ND		**	**	**
	02/26/96	ND	**	ND	**	ND	ND	ND		**	**	**
	12/04/96	ND	**	ND	**	ND	ND	ND		**	**	**
	07/17/97	ND	**	ND	**	ND	ND	ND		**	**	**
	10/16/97	ND	**	ND	**	ND	ND	ND		**	**	**
	02/05/98	ND	**	ND	**	ND	ND	ND		**	**	**
	06/12/98	<0.5	**	<0.6	**	<0.6	<1.7	<0.92	<1.7	**	**	**
	09/24/98	<0.5	**	<0.6	**	<0.6	<1.7	<0.92	<1.7	**	**	**
	12/22/98	<0.5	**	<0.6	**	<0.6	<1.7	<0.92	<1.7	**	**	**
	03/22/99	<0.32	**	<0.34	**	<0.35	<1	<0.31	<0.64	**	**	**
	06/29/99	<0.32	**	<0.34	**	<0.35	<1	<0.31	<0.64	**	**	**
09/30/99	<0.32	**	<0.34	**	<0.35	<1	<0.31	<0.64	**	**	**	
MW3	02/09/95	1,000	8.9	1,400	300	2,800	5,200	ND		ND	ND	**
	06/30/95	790	ND	1,200	240	1,900	4,400	ND		ND	ND	20
	02/26/96	1,160	**	1,720	**	3,790	6,480	ND		**	**	**
	06/20/96	481	ND	1,190	ND	2,250	4,620	ND		**	**	**
	12/04/96	967	**	1,520	**	2,600	5,880	ND		**	**	**
	07/17/97	1,400	**	1,830	**	1,120	3,659	ND		**	**	**
	10/16/97	831	**	1,600	**	2,480	5,080	ND		**	**	**
	02/05/98	465	**	803	**	666	2,764	ND		**	**	**
	06/12/98	529	**	977	**	1,540	2,854	<9.2	1,068	**	**	**
	09/24/98	533	**	1,100	**	771	2,822	<9.2	1,144	**	**	**
	12/22/98	52.9	<3.5	162	53.6	53.2	356	<7.32	172	**	**	**
	03/22/99	470	**	1,000	270	1,400	3,200	<3.1	1,180	**	**	**
06/29/99	500	**	1,200	210	1,700	4,300	<3.1	1,390	**	**	**	
09/30/99	720	**	1,200	360	1,100	3,000	<3.1	1,020	**	**	**	
MW4	02/09/95	ND	ND	ND	ND	ND	ND	ND		ND	ND	**
	06/30/95	ND	**	ND	**	ND	ND	ND		**	**	**
MW5	02/26/96	1.6	ND	ND	1.4	ND	ND	ND		ND	ND	**
	06/20/96	49	**	116	118	28	550	ND		**	**	**
	12/04/96	108	**	336	**	88	433	ND		**	**	**
	07/17/97	31	**	3.5	**	ND	172.1	ND		**	**	**
	10/16/97	4.9	**	38	**	2.9	22.5	ND		**	**	**
	02/05/98	15	**	229	**	74	210	ND		**	**	**
	06/12/98	1	**	<0.6	**	<0.6	0.56	<0.92	5.8	**	**	**
	09/24/98	2.7	**	<0.6	**	<0.6	34.6	<0.92	44	**	**	**
	12/22/98	6.2	**	45	23	3.9	7.3	<0.92	11	**	**	**
	03/22/99	27	**	320	86	67	210	<0.31	158	**	**	**
	06/29/99	<0.32	**	<0.34	<0.88	<0.35	<1	<0.31	<0.64	**	**	**
	09/30/99	1.2	**	<0.34	2.7	<0.35	<1	<0.31	<0.64	**	**	**
MW6	02/26/96	234	ND	11	107	10	107.2	70		ND	ND	**
	06/20/96	45	**	68	25	73	380	8		**	**	**
	12/04/96	500	**	630	**	817	1,370	ND		**	**	**
	07/17/97	50	**	ND	**	ND	6.1	ND		**	**	**
	10/16/97	136	**	22	**	4.2	0.8	15		**	**	**
	02/05/98	52	**	5.6	**	1.3	1.9	8.4		**	**	**
	06/12/98	28	**	<0.6	**	<0.6	11	3.6	11	**	**	**
	09/24/98	1.2	**	<0.6	**	<0.6	<1.7	<0.92	<1.7	**	**	**
	12/22/98	<0.5	**	<0.6	<2.8	<0.6	<1.7	<0.92	<1.7	**	**	**
	03/22/99	170	**	240	**	61	260	<0.31	166	**	**	**
	06/29/99	<0.32	**	<0.34	**	<0.35	<1	<0.31	<0.64	**	**	**
	09/30/99	2.6	**	<0.34	**	<0.35	<1	1.6	<0.64	**	**	**
WDNR PAL		0.5	0.5	140	8	68.6	124	12	96	0.5	0.6	1.5
WDNR ES		5	5	700	40	343	620	60	480	5	6	15

**SUMMARY OF DETECTED GROUNDWATER PARAMETERS**

Well ID	Date	Benzene	1,2-DCE	Ethylbenzene	Naphthalene	Toluene	Tot. Xylenes	MTBE	TMB	Carbon Tetra	Chloroform	Lead
MW7	02/26/96	2,360	ND	3,960	1,640	18,500	20,190	ND		ND	ND	**
	06/20/96	371	**	1,180	281	3,570	5,670	ND		**	**	**
	12/04/96	1,070	**	2,820	**	10,500	13,500	ND		**	**	**
	07/17/97	2,630	**	2,260	**	12,600	11,320	ND		**	**	**
	10/16/97	947	**	2,600	**	11,200	12,350	ND		**	**	**
	02/05/98	1,370	**	2,410	**	10,900	11,350	ND		**	**	**
	06/12/98	1,690	**	2,020	**	10,300	10,270	<153	2,535	**	**	**
	09/24/98	1,610	**	2,800	**	15,000	13,170	<46	2,774	**	**	**
	12/22/98	1,070	**	2,300	886	<30	10,940	<46	2,668	**	**	**
	03/22/99	74	**	360	170	770	1,800	<6.2	920	**	**	**
	06/29/99	1,200	**	2,100	560	8,300	12,000	<16	2,270	**	**	**
	09/30/99	1,900	**	3,300	1,000	15,000	16,000	<6.2	3,270	**	**	**
GP8	06/19/96	ND	ND	13	ND	1.4	ND	ND		ND	ND	**
GP9	06/19/96	ND	ND	ND	ND	1	ND	ND		ND	ND	**
GP10	06/19/96	ND	ND	ND	ND	1	ND	ND		ND	ND	**
GP11	06/19/96	ND	ND	ND	ND	1.4	ND	ND		ND	ND	**
GP12	06/19/96	20	ND	207	12	86	227	ND		ND	ND	**
GP13	06/19/96	5.8	ND	1.8	ND	ND	ND	33		2.9	2.1	**
PZ14	07/17/97	ND	ND	344	49	147	529	ND		ND	ND	**
	10/16/97	22	**	291	**	47	289	ND		**	**	**
	02/05/98	28	**	527	**	209	584	ND		**	**	**
	06/12/98	28	**	365	**	82	466	<0.92	375	**	**	**
	09/24/98	23	**	297	**	70	397	<0.92	350	**	**	**
	12/22/98	26	**	318	93	82	282	<0.92	343	**	**	**
	03/22/99	44	**	510	100	190	640	<3.1	540	**	**	**
	06/29/99	11	**	230	34	52	320	<3.1	239	**	**	**
	09/30/99	29	**	280	39	120	480	<3.1	272	**	**	**
MW15	07/17/97	3.2	ND	ND	ND	ND	2	ND		ND	ND	**
	10/16/97	ND	**	ND	**	ND	ND	ND		**	**	**
	02/05/98	ND	**	ND	**	ND	ND	ND		**	**	**
	06/12/98	<0.5	**	<0.6	**	<0.6	<1.7	<0.92	<1.7	**	**	**
	09/24/98	<0.5	**	<0.6	**	<0.6	<1.7	<0.92	<1.7	**	**	**
	12/22/98	<0.5	**	<0.6	**	<0.6	<1.7	<0.92	<1.7	**	**	**
	03/22/99	0.61	**	<0.34	**	<0.35	<1	<0.31	<0.64	**	**	**
	06/29/99	<0.32	**	<0.34	**	<0.35	<1	<0.31	<0.64	**	**	**
	09/30/99	<0.32	**	<0.34	**	<0.35	<1	<0.31	<0.64	**	**	**
MW17	07/17/97	ND	ND	ND	ND	ND	0.9	ND		ND	ND	**
	10/16/97	6	**	ND	**	ND	ND	2.3		**	**	**
	02/05/98	2.7	**	ND	**	ND	ND	1.6		**	**	**
	06/12/98	18	**	10	**	0.82	4.7	2.3	2.5	**	**	**
	09/24/98	3.7	**	1.9	**	<0.6	<1.7	<0.92	<1.7	**	**	**
	12/22/98	12	**	4.8	**	1.3	1.3	3.5	<1.7	**	**	**
	03/22/99	8.3	**	1.8	**	1.2	1	<0.31	<0.64	**	**	**
	06/29/99	32	**	38	**	2	28	<0.31	22	**	**	**
	09/30/99	0.34	**	0.5	**	<0.35	<1	<0.31	<0.64	**	**	**
EW1	12/22/98	0.47	<0.35	1.06	0.55	<0.11	1.92	0.91	4.65	<0.23	<0.20	**
	03/22/99	2.7	**	<0.34	**	<0.35	<1	1.6	<0.64	**	**	**
	06/29/99	2	**	0.42	**	<0.35	1.6	1.7	<0.64	**	**	**
	09/30/99	4.2	**	1.4	**	0.84	1.5	2	0.47	**	**	**
2032 Neva	12/17/99	<0.32	<0.36	<0.34	<0.88	<0.35	<0.66	<0.31	<0.64	<0.47	<0.4	**
WDNR PAL		0.5	0.5	140	8	68.6	124	12	96	0.5	0.6	1.5
WDNR ES		5	5	700	40	343	620	60	480	5	6	15

**Notes:**

ND = Not detected above laboratory method detection limit

\*\* = Not sampled for this parameter

1,2-DCE = 1,2-dichloroethane

TMB = 1,2,4-trimethylbenzene plus 1,3,5-trimethylbenzene

Carbon Tetra = Carbon Tetrachloride

WDNR PAL = WDNR NR 140 preventive action limit

WDNR ES = WDNR NR 140 enforcement standard

Numbers in bold indicate a PAL exceedance

Shading indicates an ES exceedance

## Contaminant Mass Calculations

With the data collected and by calculating the amount of contaminated groundwater, it is possible to determine the pounds of dissolved phase contaminant within the groundwater using the following equation<sup>1</sup>:

Water depth on site is approximately 10.5 to 14.0 fbg (allows for seasonal changes) and assuming a 10 ft water column.

An example calculation is provided:

The soils in Zone I from surface to 22 fbg consist of brown sand with gravel with an estimated effective porosity of 0.3

### Zone I

Area of contamination 4,668 ft<sup>2</sup>

Depth of sand with gravel layer 10 ft

Volume of contaminated area 4,668 ft<sup>2</sup> \* 10 ft = 46,680 ft<sup>3</sup>

Cubic feet of groundwater 46,680 ft<sup>3</sup> \* 0.3 = 14,004 ft<sup>3</sup>

Gallons of contaminated groundwater 14,004 ft<sup>3</sup> \* 7.48 gal/ft<sup>3</sup> = 104,750 gallons

Pounds of contaminated groundwater 104,750 gallons \* 8.345 lbs/gal = 874,139 pounds

EX. Solving for pounds of benzene:

Contaminant Level(ppb)/1x10<sup>9</sup> \* pounds of groundwater = lbs of contaminant

1,900ppb / 1,000,000,000 \* 874,139 = 1.661 lbs benzene

Solving for biodegradable compounds yields the following estimated mass of dissolved phase contaminants:

Total pounds of dissolved phase contaminant (09/30/99) in MW7	Benzene	1.661
	Toluene	13.986
	Ethylbenzene	2.885
	Xylene	13.986
	BTEX	32.518
	MTBE	0
	TMB	2.858

The volume of dissolved phase contamination was determined by taking the maximum groundwater contamination plume area and a contaminated water column depth of 10 feet. An effective porosity of 0.3 was used for sand with gravel. The recorded contaminant values from MW7 on 09/30/99 were used for the entire volume of contaminated water to ensure that the worst case scenario would be applied. EA wanted to present the worst case scenario in order to be sure that the amount of remaining groundwater contamination would not be underestimated.

Total pounds of PVOC contamination remaining for Zone I equals 35.376 pounds.

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<sup>1</sup> Values and equations obtained from "Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater". Wiedemeier, Todd, Parsons Engineering Science

With the data collected and by calculating the amount of contaminated groundwater, it is possible to determine the pounds of dissolved phase contaminant within the groundwater using the following equation<sup>2</sup>:

Water depth on site is approximately 10.5 to 14.0 fbg (allows for seasonal changes) and assuming a 10 ft water column.

An example calculation is provided:

The soils in Zone II from surface to 22 fbg consist of brown sand with gravel with an estimated effective porosity of 0.3

### Zone II

Area of contamination 7,598 ft<sup>2</sup>

Depth of sand with gravel layer 10 ft

Volume of contaminated area 7,598 ft<sup>2</sup> \* 10 ft = 75,980 ft<sup>3</sup>

Cubic feet of groundwater 75,980 ft<sup>3</sup> \* 0.3 = 22,794 ft<sup>3</sup>

Gallons of contaminated groundwater 22,794 ft<sup>3</sup> \* 7.48 gal/ft<sup>3</sup> = 170,499 gallons

Pounds of contaminated groundwater 170,499 gallons \* 8.345 lbs/gal = 1,422,814 pounds

EX. Solving for pounds of benzene:

Contaminant Level(ppb)/1x10<sup>9</sup> \* pounds of groundwater = lbs of contaminant

720 ppb / 1,000,000,000 \* 1,422,814 = 1.024 lbs benzene

Solving for biodegradable compounds yields the following estimated mass of dissolved phase contaminants:

Total pounds of dissolved phase contaminant (09/30/99) in MW3	Benzene	1.024
	Toluene	1.565
	Ethylbenzene	1.707
	Xylene	4.268
	BTEX	8.564
	MTBE	0
	TMB	1.451

The volume of dissolved phase contamination was determined by taking the maximum groundwater contamination plume area and a contaminated water column depth of 10 feet. An effective porosity of 0.3 was used for sand with gravel. The recorded contaminant values from MW3 on 09/30/99 were used for the entire volume of contaminated water to ensure that the worst case scenario would be applied. EA wanted to present the worst case scenario in order to be sure that the amount of remaining groundwater contamination would not be underestimated.

Total pounds of PVOC contamination remaining for Zone II equals 10.015 pounds.

<sup>2</sup> Values and equations obtained from "Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater". Wiedemeier, Todd, Parsons Engineering Science

With the data collected and by calculating the amount of contaminated groundwater, it is possible to determine the pounds of dissolved phase contaminant within the groundwater using the following equation<sup>3</sup>:

Water depth on site is approximately 10.5 to 14.0 fbg (allows for seasonal changes) and assuming an 10 ft water column.

An example calculation is provided:

The soils in Zone III from surface to 22 fbg consist of brown sand with gravel with an estimated effective porosity of 0.3

### Zone III

Area of contamination 18,136 ft<sup>2</sup>

Depth of sand with gravel layer 10 ft

Volume of contaminated area 18,136 ft<sup>2</sup> \* 10 ft = 181,360 ft<sup>3</sup>

Cubic feet of groundwater 181,360 ft<sup>3</sup> \* 0.3 = 54,408 ft<sup>3</sup>

Gallons of contaminated groundwater 54,408 ft<sup>3</sup> \* 7.48 gal/ft<sup>3</sup> = 406,972 gallons

Pounds of contaminated groundwater 406,972 gallons \* 8.345 lbs/gal = 3,396,181 pounds

EX. Solving for pounds of benzene:

Contaminant Level(ppb)/1x10<sup>9</sup> \* pounds of groundwater = lbs of contaminant  
 2.6 ppb / 1,000,000,000 \* 3,396,181 = 0.009 lbs benzene

Solving for biodegradable compounds yields the following estimated mass of dissolved phase contaminants:

Total pounds of dissolved phase contaminant (09/30/99) in MW6	Benzene	0.009
	Toluene	0
	Ethylbenzene	0
	Xylene	0
	BTEX	0.009
	MTBE	0.005
	TMB	0

The volume of dissolved phase contamination was determined by taking the maximum groundwater contamination plume area and a contaminated water column depth of 10 feet. An effective porosity of 0.3 was used for sand with gravel. The recorded contaminant values from MW6 on 09/30/99 were used for the entire volume of contaminated water to ensure that the worst case scenario would be applied. EA wanted to present the worst case scenario in order to be sure that the amount of remaining groundwater contamination would not be underestimated.

Total pounds of PVOC contamination remaining for Zone I equals 35.376 pounds.

Total pounds of PVOC contamination remaining for Zone II equals 10.015 pounds.

Total pounds of PVOC contamination remaining for Zone III equals 0.014 pounds.

Total pounds of PVOC contamination remaining for the total plume area equals **45.405 pounds.**

<sup>3</sup> Values and equations obtained from "Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater". Wiedemeier, Todd, Parsons Engineering Science

Using a conservative tracer method (TMB), the effect of other attenuation factors can be determined by the change in TMB from three wells that form a line parallel to the groundwater flow direction. The value calculated is referred to as the TMB corrected concentration value, and is the amount of contaminant expected in that monitoring point after the effects of dilution, dispersion and advection.

#### Evaluation of Contaminant Reduction Using Conservative Tracer Method<sup>4</sup>

Compound	Inner Plume Concentration - MW7 (ppb) $C_A$	Down Gradient Concentration - MW3 (ppb) $C_b$	Corrected Concentration $C_{corr}$	Change due to biodegradation $C_{BIO A,B}$	Mass Loss to Biodegradation (lbs)	% Lost to Biodegradation
Benzene	1200	500	816.55	383.45	0.8808	54.78%
Toluene	8300	1700	2776.26	5523.74	12.6878	83.69%
Ethylbenzene	2100	1200	1959.71	140.29	0.3222	15.59%
Xylene	12000	4300	7022.30	4977.70	11.4335	64.65%
Total BTEX	23600	7700	12574.82	11025.18	25.3243	69.34%
TMB	2270	1390	2270	0	0	0

The formula used to perform this analysis is:

**Example:**

$$(M_A/M_b)C_b = C_{corr}$$

$$(M_A/M_b) = 1.633$$

$M_A$  = Concentration of TMB at upgradient, inner plume monitoring point

$M_b$  = Concentration of TMB at downgradient monitoring point

$C_b$  = Concentration of Contaminant of interest at downgradient monitoring point

$C_{corr}$  = TMB corrected concentration value (the amount of contaminant expected at this point less physical attenuation)

$$C_{BIO A,B} = C_A - C_{CORR}$$

The value,  $C_{corr}$ , then is subtracted from the inner plume monitoring point in order to determine what amount of contamination has been bioattenuated obtaining the value  $C_{Bio}$ . In order to then determine what percentage of BTEX loss can be attributed to bioattenuation the following equation is used:

$$C_{Bio} / C_{total} * 100 = \text{Percent change due to bioattenuation}$$

$C_{Bio}$  = Change in concentration due to bioattenuation

$C_{total}$  = Total change in concentration from inner plume point to downgradient point

The calculation performed to calculate the mass of contaminant lost through biodegradation is calculated by:

$$\text{Pounds of contaminated groundwater} * C_{BIO A,B} * .000000001 = \text{mass lost through biodegradation}$$

Example for Benzene: 2,296,953 pounds \* 383.45 \* .000000001 = 0.881 lbs

<sup>4</sup> Values and equations obtained from "Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater". Wiedemeier, Todd, Parsons Engineering Science

Using a conservative tracer method (TMB), the effect of other attenuation factors can be determined by the change in TMB from three wells that form a line parallel to the groundwater flow direction. The value calculated is referred to as the TMB corrected concentration value, and is the amount of contaminant expected in that monitoring point after the effects of dilution, dispersion and advection.

### Evaluation of Contaminant Reduction Using Conservative Tracer Method<sup>5</sup>

Compound	Inner Plume Concentration - MW3 (ppb) $C_A$	Down Gradient Concentration - MW6 (ppb) $C_b$	Corrected Concentration $C_{CORR}$	Change due to biodegradation $C_{BIO A,B}$	Mass Loss to Biodegradation (lbs)	% Lost to Biodegradation
Benzene	500	0.32	695.00	-195.00	-0.9397	-39.03%
Toluene	1700	0.35	760.16	939.84	4.5291	55.30%
Ethylbenzene	1200	0.34	738.44	461.56	2.2243	38.47%
Xylene	4300	1	2171.88	2128.13	10.2554	49.50%
Total BTEX	7700	2.01	4365.47	3334.53	16.0691	43.32%
TMB	1390	0.64	1390	0	0	0

The formula used to perform this analysis is:

**Example:**

$$(M_A/M_b)C_b = C_{corr}$$

$$(M_A/M_b) = 2172$$

$M_A$  = Concentration of TMB at upgradient, inner plume monitoring point

$M_b$  = Concentration of TMB at downgradient monitoring point

$C_b$  = Concentration of Contaminant of interest at downgradient monitoring point

$C_{corr}$  = TMB corrected concentration value (the amount of contaminant expected at this point less physical attenuation)

$$C_{BIO A,B} = C_A - C_{CORR}$$

The value,  $C_{corr}$ , then is subtracted from the inner plume monitoring point in order to determine what amount of contamination has been bioattenuated obtaining the value  $C_{Bio}$ . In order to then determine what percentage of BTEX loss can be attributed to bioattenuation the following equation is used:

$$C_{Bio} / C_{total} * 100 = \text{Percent change due to bioattenuation}$$

$C_{Bio}$  = Change in concentration due to bioattenuation

$C_{total}$  = Total change in concentration from inner plume point to downgradient point

The calculation performed to calculate the mass of contaminant lost through biodegradation is calculated by:

$$\text{Pounds of contaminated groundwater} * C_{BIO A,B} * .000000001 = \text{mass lost through biodegradation}$$

Example for Toluene: 4,818,995 pounds \* 939.84 \* .000000001 = 4.53 lbs

<sup>5</sup> Values and equations obtained from "Technical Protocol for Implementing Intrinsic Remediation with Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater". Wiedemeier, Todd, Parsons Engineering Science

### Summary of Field Inorganic Parameters

Well ID	Date	Temperature Celsius	Dissolved Oxygen (mg/L)	Nitrate mg/L	Ferrous Iron mg/L	Sulfate mg/L	pH
<b>MW1</b>							
	07/17/97	9.9	0.11				
	10/16/97	13.7	0.09				
	02/05/98	9	0.55	25	0.35	41	6.2
	06/12/98	9.9	0.37	5.9	1	42	6
	12/22/98	13.2	0.59	8.9	<0.25	32	6.2
	03/22/99	9.1	0.47	7.2	<0.2	37	6
	06/29/99	11.2	0.45	4.2	6.1	41	6
	09/30/99	16.1	0.59	20.6	1.9	98	6
<b>MW2</b>							
	07/17/97	10.4	5.12				
	10/16/97	13.9	4.26				
	02/05/98	9	5.38	9.3	1.1	29	6.1
	06/12/98	10.7	5.8	7.4	1.3	21	6
	12/22/98	12.3	3.75	6.1	1.2	32	6.1
	03/22/99	8.1	4.51	7.4	0.6	31	6
	06/29/99	11.4	6.31	8.2	3.8	24	6.1
	09/30/99	15.5	4.44	7.3	2	16	6
<b>MW3</b>							
	07/17/97	11.7	0.11				
	10/16/97	14.1	0.12				
	02/05/98	9	0.22	2	>10	<5	6.1
	06/12/98	10.7	0.28	3.5	>10	1	6.1
	12/22/98	13.1	0.59	8.2	4.3	19	6.2
	03/22/99	8.7	0.37	3.3	>10	0	6.4
	06/29/99	11.4	0.36	2.2	>10	0	6.5
	09/30/99	16.2	0.43	3.7	>10	0	6.4
<b>MW5</b>							
	07/17/97	10	0.13				
	10/16/97	14.6	0.13				
	02/05/98	9.1	0.68	3	3.2	28	6.3
	06/12/98	11.1	0.56	8.3	0.6	72	6
	12/22/98	12.6	0.83	4.2	3.7	43	6
	03/22/99	8.2	0.55	3.5	6.6	21	6.4
	06/29/99	12.2	1.93	7.4	2.2	55	6
	09/30/99	16.9	0.79	3.7	0.23	70	6
<b>MW6</b>							
	07/17/97	12.2	0.31				
	10/16/97	14.8	0.22				
	02/05/98	8.2	0.2	<2.5	>10	5	6.3
	06/12/98	11	0.92		8	12.5	6
	12/22/98	11.6	0.51	2.8	2.4	30	6
	03/22/99	8.2	0.46	2.7	>10	0	6.4
	06/29/99	11.9	1.25	3.1	7.2	36	6
	09/30/99	16.6	0.42	2.3	1.2	24	6.2

Summary of Field Inorganic Parameters Cont'd

Well ID	Date	Temperature Celsius	Dissolved Oxygen (mg/L)	Nitrate mg/L	Ferrous Iron mg/L	Sulfate mg/L	pH
<b>MW7</b>							
	07/17/97	11.1	0.15				
	10/16/97	13.9	0.06				
	02/05/98	9.5	0.08	2.3	>10	0	6.5
	06/12/98	10.5	0.23	7.4	>10	0	6.3
	12/22/98	13	0.91		>10	5	6
	03/22/99	9	0.22	2.6	5.5	25	6
	06/29/99	11.4	0.23	5.7	>10	0	6.3
	09/30/99	15.7	0.18	9.2	>10	0	6.5
<b>PZ14</b>							
	07/17/97	9.9	0.11				
	10/16/97	14.7	0.43				
	02/05/98	9.3	0.15	3.2	>10	5	6.5
	06/12/98	10.8	0.44	4	>10	0	6.2
	12/22/98	12.8	0.43	3.5	>10	0	6.5
	03/22/99	8.9	0.48	3.8	>10	5	6.5
	06/29/99	11	0.64	2.3	>10	0	6.5
	09/30/99	15.8	0.75	2.8	>10	0	6.6
<b>MW15</b>							
	07/17/97	8.9	5.11				
	10/16/97	12.8	0.85				
	02/05/98	8.3	1.9		3	30	6.4
	06/12/98	9.7	6.16	4.2	1.9	28	6
	12/22/98	11.3	0.81	4.6	1.8	30	6.2
	03/22/99	8.1	0.45	1.5	2.3	36	6.1
	06/29/99	10.5	5.07	1.3	4.2	36	6.1
	09/30/99	14	4.09	3.5	1.3	32	6.1
<b>MW17</b>							
	07/17/97	11.1	3.89				
	10/16/97	13.7	1.99				
	02/05/98	8.6	0.75	2.8	>10	30	6.2
	06/12/98	10.1	3.43	7.7	>10	29	6
	12/22/98	11.3	0.84	2.2	>10	33	6.5
	03/22/99	8.1	0.31	2.1	>10	38	6.3
	06/29/99	10.5	3.15	5	6.2	32	6.2
	09/30/99	14.3	2.24	3.9	2.7	41	6.3
<b>EW1</b>							
	12/22/98	12.8	0.15	2	3.3	20	6.1
	03/22/99	9.3	0.6	4.6	2.6	23	6.4
	06/29/99	11.3	0.47	2.4	3.1	17	6.5
	09/30/99	14.5	0.28	2.6	3.6	19	6.2

Calculations for determining the assimilative capacity of the groundwater environment are presented below<sup>7</sup>.

Assimilative Capacity of BTEX per unit of electron acceptor utilized/produced (mg/l or ppm)				
	Oxygen	Nitrate	Sulfate	Iron
Average BTEX degraded per mg/L of electron donor/acceptor produced <sup>1</sup> "C"	0.32	0.21	0.21	0.05
Measured Background Concentration (MW17 - 09/30/99)	2.24	3.9	41	2.7
Measured Inner Plume Concentration (MW7 - 09/30/99)	0.18	9.2	0	10
Assimilative Capacity Potential (mg/L)	0.6592	-1.113	8.61	-0.365
Total calculated mg/L of BTEX in the groundwater				37.2

Assimilative Capacity of BTEX per unit of electron acceptor utilized/produced (mg/l or ppm)				
	Oxygen	Nitrate	Sulfate	Iron
Average BTEX degraded per mg/L of electron donor/acceptor produced <sup>1</sup> "C"	0.32	0.21	0.21	0.05
Measured Background Concentration (MW17 - 06/29/99)	3.15	5	32	6.2
Measured Inner Plume Concentration (MW7 - 06/29/99)	0.23	5.7	0	10
Assimilative Capacity Potential (mg/L)	0.9344	-0.147	6.72	-0.19
Total calculated mg/L of BTEX in the groundwater				23.6

Assimilative Capacity of BTEX per unit of electron acceptor utilized/produced (mg/l or ppm)				
	Oxygen	Nitrate	Sulfate	Iron
Average BTEX degraded per mg/L of electron donor/acceptor produced <sup>1</sup> "C"	0.32	0.21	0.21	0.05
Measured Background Concentration (MW17 - 03/22/99)	0.31	2.1	38	10
Measured Inner Plume Concentration (MW7 - 03/22/99)	0.22	2.6	25	5.5
Assimilative Capacity Potential (mg/L)	0.0288	-0.105	2.73	0.225
Total calculated mg/L of BTEX in the groundwater				3.004

Assimilative Capacity of BTEX per unit of electron acceptor utilized/produced (mg/L or ppm)				
	Oxygen	Nitrate	Sulfate	Iron
Average BTEX degraded per mg/L of electron donor/acceptor produced <sup>1</sup> "C"	0.32	0.21	0.21	0.05
Measured Background Concentration (MW17 - 6/12/98)	3.43	7.7	29	10
Measured Inner Plume Concentration (MW7 - 6/12/98)	0.23	7.4	0	10
Assimilative Capacity Potential (mg/L)	1.024	0.063	6.09	0
Total calculated mg/L of BTEX in the groundwater				24.28

Assimilative capacity is determined by using the following equation:

$$BTEX_{bio"x"} = "C"(x_{back} - x_{measure})$$

- $BTEX_{bio"x"}$  = BTEX Assimilative Capacity Potential of measured electron acceptor  
 "C" = mg/L of BTEX degraded per electron acceptor used/produced  
 $x_{back}$  = mg/L of electron acceptor/donor measured background levels  
 $x_{measure}$  = mg/L of electron acceptor/donor in inner plume monitoring point

Based on this information, the assimilative capacity of the groundwater appears to be sufficient for the bioremediation of approximately 30% of the remaining contaminants. The most likely pathway for degradation of the greatest amount of BTEX contamination appears to be anaerobic biodegradation via sulfate reduction followed by aerobic respiration.

**GROUNDWATER ELEVATION DATA**

Well ID	Ground Elev	Pipe Elev	Depth to Groundwater										
			02/09/95	06/30/95	02/26/96	06/20/96	12/04/96	07/17/97	10/16/97	02/05/98	06/12/98	09/24/98	12/22/98
MW1	97.98	97.57	84.42	85.06	NA	NA	85.19	87.17	86.4	85.1	86.55	85.23	84.93
MW2	99.79	99.43	85.38	86.07	86.09	88.91	85.41	87.4	86.63	85.28	86.77	85.4	85.11
MW3	98.94	98.7	85.24	85.93	85.94	88.75	85.2	87.29	86.51	85.22	86.66	85.39	85.08
MW5	98.15	97.54	NA	NA	85.8	88.65	84.95	87.09	86.29	84.91	86.39	85.05	84.73
MW6	97.62	97.1	NA	NA	85.75	88.6	84.93	87.03	86.22	84.84	86.29	84.97	84.67
MW7	99.53	99.05	NA	NA	85.99	88.81	85.23	87.27	86.49	85.14	86.61	85.27	84.97
PZ14	98.14	97.77	NA	NA	NA	NA	NA	87.06	86.29	84.96	86.4	85.09	84.79
MW15	96.69	96.41	NA	NA	NA	NA	NA	86.7	85.96	84.64	86.05	84.76	84.45
MW17	96.39	96.09	NA	NA	NA	NA	NA	86.58	85.85	84.53	85.95	84.66	84.35
EW1	99.5	99.32	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	85

Well ID	Ground Elev	Pipe Elev	Depth to Groundwater										
			03/22/99	06/29/99	09/30/99								
MW1	97.98	97.57	84.73	86.13	86.15								
MW2	99.79	99.43	84.95	86.37	86.38								
MW3	98.94	98.7	84.86	86.27	86.29								
MW5	98.15	97.54	84.53	85.94	85.97								
MW6	97.62	97.1	84.91	85.83	85.86								
MW7	99.53	99.05	84.78	86.18	86.19								
PZ14	98.14	97.77	84.56	85.94	85.97								
MW15	96.69	96.41	83.71	85.59	85.63								
MW17	96.39	96.09	84.15	85.53	85.56								
EW1	99.5	99.32	84.84	86.28	86.3								

Notes:  
NA = Not available

The following reports were prepared for the Draeger Oil-Antigo North site:

12/15/94	Workplan submittal
3/20/95	"Project Update, Draeger Oil-Antigo North Station, 2120 Neva Road, Antigo, WI"
9/11/95	"Groundwater Quarterly Monitoring Update, Draeger Oil-Antigo North Station, 2120 Neva Road, Antigo, WI"
3/20/96	"Project Update, Draeger Oil-Antigo North Station, 2120 Neva Road, Antigo, WI"
3/18/97	"Project Update, Draeger Oil-Antigo North Station, 2120 Neva Road, Antigo, WI"
5/22/97	"Project Update, Draeger Oil-Antigo North Station, 2120 Neva Road, Antigo, WI"
8/28/97	"Underground Storage Tank Site Characterization, Draeger Oil-Antigo North Station, 2120 Neva Road, Antigo, WI, Langlade County"
9/9/97	"Project Update, Draeger Oil-Antigo North Station, 2120 Neva Road, Antigo, WI"
2/19/98	"Remedial Action Plan, Draeger Oil-Antigo North Station, 2120 Neva Road, Antigo, WI, Langlade County"
3/25/98	"Project Update, Draeger Oil-Antigo North Station, 2120 Neva Road, Antigo, WI"
10/22/99	"Project Update, Draeger Oil-Antigo North Station, 2120 Neva Road, Antigo, WI, Langlade County"
1/5/00	"Project Update, Draeger Oil-Antigo North Station, 2120 Neva Road, Antigo, WI"